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Utilization of Liquid Organic Fertilizer to Increase Growth and Production of Mustard Plants (*Brassica juncea* L.)

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ABSTRACT

Some of the nutritional content possessed by mustard makes the demand for this plant in Indonesia always increase every year. The selection of a sustainable agricultural system by utilizing liquid organic fertilizer is important to fulfill nutrient needs to increase the productivity of mustard. A number of studies have demonstrated that liquid organic fertilizers are high in nutrients and can improve plant growth and production. The purpose of this study is to assess the effect of liquid organic fertilizer application on the growth and production of mustard (*Brassica juncea* L.) and to determine the most effective concentration of liquid organic fertilizer to increase the growth and production of mustard (*Brassica juncea* L.). This study used a one-factor RBD with four treatments and one control. The treatment used is the concentration of liquid organic fertilizer application as much as 10 mL / 1 L of water, 20 mL / 1 L of water, 30 mL / 1 L of water, and 40 mL / 1 L of water. Each treatment consisted of two plant units and was repeated five times, so there were 50 experimental units. The observational data were analyzed with ANOVA (Analysis of Variance) and continued with Duncan's test at a level of 5%. The results showed that the application of liquid organic fertilizer with a concentration range of 10-30 mL / 1 L of water can increase all growth and production parameters and had a significant effect in increasing the length, width, number, and area of leafs. The most effective concentration of liquid organic fertilizer was 30 mL/ 1 L of water (treatment D) which showed the best results on all observation parameters and was significantly different from treatment A (control) on the parameters of length and number of leafs at 14-28 DAP.

1. Introduction

The existence of mustard plants as one of the horticultural commodities from vegetable types is very necessary for improving community nutrition (Triadiawarman and Rudi, 2019; Saban et al., 2018). Every 100 g of mustard greens is known to contain various nutrients, such as 92.2 g of water, 2.3 g of protein, 2.5 g of fiber, 0.3 g of fat, 436.5 mg of potassium, 220 mg of calcium, 38 mg of phosphorus, 22 mg of sodium, and 2.9 mg of iron (Kementerian Kesehatan Republik Indonesia, 2018). Some of the nutritional content possessed by mustard greens makes the demand for this plant in Indonesia always increase along with the increasing population and public awareness of nutritional needs (Kasmawati et al., 2019; Kurniawan et al., 2022). Although mustard production tends to increase every year, mustard productivity in Indonesia is still relatively low. Given the above, efforts to develop mustard cultivation so that it grows optimally need to be carried out (Febrianna et al., 2018).

Efforts to develop cultivation to continue to increase production and improve the quality of mustard plants can be done by using the right fertilizer (Delfiya and Ariska, 2022). This is related to several factors that can affect mustard production and growth, such as soil fertility levels and the application of fertilizers used (Cholisoh et al., 2018). According to Fauziah et al. (2022), the growth and development of mustard plants are directly proportional to the fulfillment of essential nutrients in these plants, so the selection of a sustainable agricultural system is important to do about increasing production and improving the quality of mustard

plants (Munthe et al., 2018).

Products in the form of synthetic chemicals cannot be used in this agricultural system because it can damage natural ecosystems and cause other problems so that this agricultural system is often associated with the use of organic fertilizers, which are expected to maintain a balance between organisms and the environment (Munthe et al., 2018). Fertilization with organic raw materials is known to improve soil conditions and at the same time can play a role in soil conservation (Kasmawati et al., 2019). Organic fertilizers according to their physical condition are divided into two categories, namely solid and liquid organic fertilizers (Purnomo et al., 2020). According to Sholikhah and Winarsih (2019), the nutrient availability and absorption by plant roots of liquid organic fertilizer is more easily available than in the case of solid organic fertilizer.

Several studies show that liquid organic fertilizer affects plant production and growth. Research by Marpaung (2017) shows that applying liquid organic fertilizer to rabbit manure with 10 mL/L of water can increase the crop diameter of cabbage plants. Based on research by Rambe et al. (2019), the application of GDM liquid organic fertilizer of 4 mL/L of water affects the growth and production of onion plants. Based on this background, researchers are interested in researching the use of liquid organic fertilizer for higher growth and production of mustard plants (*Brassica juncea* L.), when considering the potential of liquid organic fertilizer to grow and produce mustard plants.

2. Methodology

2.1 Time and place of study

This research was conducted from December 2022 to March 2023. Observation of growth parameters and seed preparation to harvesting were carried out at Subak Dalem Street, Taman Indah Alley No. 3, Peguyangan Kangin, North Denpasar, Denpasar, Bali. Observation of production parameters was carried out at the Genetics Laboratory, Biology Study Program, Faculty of Mathematics and Natural Sciences, Udayana University. The chlorophyll content testing was carried out at the Integrated Research Laboratory of the Faculty of Mathematics and Natural Sciences, Udayana University.

2.2 Tools and materials

The materials that have been applied to this research were mustard seeds of the Tosakan variety produced by *PT. East West Indonesia Cap Panah Merah*, water, liquid organic fertilizer, soil, organic compost, coco peat, and acetone 80%. The tools used were seedling tray, plastic container, spoon, shovel, scissors, sprayer, polybag (with a size of 20x20 cm), label, thread, ruler, *Image J* application, digital scale "Sonic High Precision Balance" with 0.01 gr precision, oven, plastic bag, UV Spectrophotometer, calculator, stationery, and documentation tools.

2.3 Methods

Research design
A one-factor Randomized Block Design (RBD) was used in this study, which consisted of 5 treatments with 5 replications. Each treatment consisted of 2 plant units, so there were 50 experimental units. The treatment of the liquid organic fertilizer application, namely A (control (without application of liquid organic fertilizer)), B (10 mL / 1 L of water), C (20 mL / 1 L of water), D (30 mL / 1 L of water), and E (40 mL / 1 L of water).

Seed Seedling
Seeds were first soaked in warm water for three hours. Viable mustard seeds were soaked with a solution of liquid organic fertilizer for 30 minutes. Liquid organic fertilizer solution is made by adding as much as 1 liter of water with liquid organic fertilizer according to treatment, stirring, then taken as much as 200 mL for each treatment. Mustard seeds are then sown in a seedling tray that contains soil media mixed with organic compost and coco peat in a ratio of 1: 1: 1 (Missdiani et al., 2020). The seedling was carried out for approximately 14 days, then the seedlings are transplanted in the morning (Dahlianah, 2019).

Preparation of Planting Media
The planting media used are soil and compost organic mixed evenly in a ratio of 4: 1. The planting media is utilizing of 44 kg of soil and 11 kg of compost mixed evenly according to the ratio until it reaches the total weight needed for all unit plants. The planting media is then inserted into polybags measuring 20 x 20 cm with a weight of 875 g for each polybag.

Planting
Mustard seeds planted are seedlings that have aged 14 Days After Seedling (DAS) and have had three to four leafs. The transplanted mustard seedlings are mustard seedlings with the best conditions and have the same height (Murtafaqoh and Winarsih, 2022). Before planting, seedlings are soaked with as much as 1 Liter of liquid organic fertilizer solution according to the treatment for 30 minutes. Planting seedlings carried out is as much as one mustard seedling in each polybag and placed in the middle of the

planting media.

Application of Liquid Organic Fertilizer
The liquid organic fertilizer used is brand x commercial fertilizer which consists of several kinds of content, such as fish waste, potatoes, *Piper caninum* leaf extract, Rhizobacteria, and water. The application of liquid organic fertilizer is carried out by watering directly to the soil surface in polybags evenly (Missdiani et al., 2020). The intensity of applying liquid organic fertilizer to mustard plants is twice a week. The application of liquid organic fertilizer is carried out in the evening (Andriani, 2020) according to the treatment concentration with a volume of 100 mL. A solution of liquid organic fertilizer is made at the time when the treatment is carried out.

Plant Care
The intensity of watering water in the growth phase is carried out twice a day, namely in the morning and evening with the same volume of water in each plant, which is as much as 100 mL (Marasabessy and Tanasale, 2020), but when the condition of the growing media still looks moist, watering is not done. Pest control is carried out when there are signs of pest attacks on mustard plants (Jarangga et al., 2018).

Parameter Observation
The observation process is carried out on several parameters including growth parameters, chlorophyll content, and production. The mustard plant growth parameters observed include plant height (cm), leaf length (cm), leaf width (cm), number of leafs (strands), leaf area (cm^2), and root length (cm). The chlorophyll content parameter consists of chlorophyll a (ppm), chlorophyll b (ppm), and total chlorophyll (ppm). The observed mustard crop production parameters consisted of plant wet weight (g), harvest wet weight productivity (tons/ha), and plant dry weight (g)

Harvest
Harvesting is carried out 30 days after planting (30 DAP) which is done by removing all parts of the plant and its roots. The criteria for mustard plants that are ready to harvest include wavy leafs, yellowed bottom leafs, and no flowering has occurred (Jarangga et al., 2018).

2.4 Data analysis
The analysis of the data was conducted using one-way ANOVA. If there is a significant effect ($p \leq 0.05$) between treatments, a follow-up test was carried out with the Duncan test (Duncan Multiple Range Test) at the level of 5% using the IBM SPSS Statistics 20 program to determine the difference between treatments.

3. Results and Discussion

3.1 Result

Growth Parameters
Plant Height
The results of the statistical test showed that the application of various concentrations of liquid organic fertilizer to mustard (*Brassica juncea* L.) had an insignificant effect on the average plant height at 7, 14, and 28 DAP observations, but a significant effect on 21 DAP observations. The lowest mustard plant growth at four observation ages was found in mustard plants applied with E treatment (liquid organic fertilizer 40 mL / 1 L of water), which was 9,43 cm, 11,92 cm, 15,10 cm, and 17,17 cm, while the highest growth was produced by mustard plants treated with D (liquid organic fertilizer 30 mL / 1 L of water), which was 12,43 cm, 16,76 cm, 20,59 cm, and 22,06 cm. Duncan's test showed that at 21 DAP, treatment A has been significantly different compared to treatment D but insignificantly different compared to treatments B, C, and E. Data related to the effect of applying different concentrations of liquid organic fertilizer on the height parameters of mustard plants are presented in Table 1.

Table 1. The effect of liquid organic fertilizer treatment on the average height of mustard plants (*Brassica juncea* L.) (cm)

Treatment	Plant Height (cm)			
	7 DAP	14 DAP	21 DAP	28 DAP
A	10,36 ± 2,41 ab	13,26 ± 3,63 ab	17,13 ± 3,00 a	18,89 ± 2,53 ab
B	9,68 ± 2,51 a	13,23 ± 3,56 ab	17,66 ± 2,67 ab	19,88 ± 2,74 ab
C	10,97 ± 1,65 ab	14,46 ± 2,32 ab	18,17 ± 2,03 ab	19,97 ± 1,30 ab
D	12,43 ± 3,31 b	16,76 ± 4,58 b	20,59 ± 3,91 b	22,06 ± 3,04 b
E	9,43 ± 1,54 a	11,92 ± 2,34 a	15,10 ± 3,86 a	17,17 ± 3,88 a

Note: The values in the table above show the average of 2 plant units and 5 groups, the numbers accompanied by different letter notations in the same column show significantly different average values based on the DMRT (Duncan Multiple Range Test) at the level of 5% after statistical test using ANOVA; DAP = day after planting; A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water;

D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

Leaf Length

The results of the statistical test showed that the application of various concentrations of liquid organic fertilizer had an insignificant effect on the average leaf length at 7 DAP observations, but had a significant effect on 14, 21, and 28 DAP. Mustard plants with the lowest leaf length at four observation ages were found in mustard plants applied with treatment E (liquid organic fertilizer 40 mL / 1 L of water), which is 4,78 cm, 6,96 cm, 7,44 cm, and 7,66 cm, while the longest leafs were produced by mustard plants treated with D (liquid organic fertilizer 30 mL / 1 L of water), which is 6,48 cm, 9,80 cm, 10,46 cm, and 10,74 cm. Duncan's tests showed that at 14-28 DAP, treatment A produced leaf lengths of mustard plants that were significantly different compared to treatment D, but insignificantly different from treatments B, C, and E. Data related to the effect of applying different concentrations of liquid organic fertilizer on the parameters of mustard plant leaf length are presented in Table 2.

Table 2. The effect of liquid organic fertilizer treatment on the average leaf length of mustard plants (*Brassica juncea* L.) (cm)

Treatment	Leaf Length (cm)			
	7 DAP	14 DAP	21 DAP	28 DAP
A	5,65 ± 1,32 ab	7,52 ± 1,66 a	8,54 ± 1,08 ab	8,70 ± 0,99 ab
B	5,12 ± 1,68 ab	7,40 ± 1,82 a	8,66 ± 1,63 ab	9,05 ± 1,47 abc
C	6,31 ± 1,04 b	8,62 ± 1,52 ab	9,91 ± 1,63 bc	10,37 ± 2,04 bc
D	6,48 ± 1,99 b	9,80 ± 3,04 b	10,46 ± 3,01 c	10,74 ± 3,21 c
E	4,78 ± 0,84 a	6,96 ± 1,14 a	7,44 ± 1,34 a	7,66 ± 1,37 a

Note: The values in the table above show the average of 2 plant units and 5 groups, the numbers accompanied by different letter notations in the same column show significantly different average values based on the DMRT (Duncan Multiple Range Test) at the level of 5% after statistical test using ANOVA; DAP = day after planting; A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water; D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

Leaf Width

The results of the statistical test showed that the application of various concentrations of liquid organic fertilizer had an insignificant effect on the average leaf width at 7 DAP observations, but had a significant effect on 14, 21, and 28 DAP. Mustard plants with the lowest leaf width at four observation ages were found in mustard plants applied with E treatment (liquid organic fertilizer 40 mL / 1 L of water), which is 2,88 cm, 3,67 cm, 4,29 cm, and 4.61 cm, while the widest leafs at 14, 21, and 28 DAP were produced by mustard plants treated with D (liquid organic fertilizer 30 mL / 1 L of water), which is 5.22 cm, 5.94 cm, and 6.76 cm. Duncan's tests showed that at 14-28 DAP treatment A produced leaf widths of mustard plants that differed insignificantly with all treatments, including treatments B, C, D, and E. Data related to the effect of applying different concentrations of liquid organic fertilizer on the parameters of mustard plant leaf width are presented in Table 3.

Table 3. The effect of liquid organic fertilizer treatment on the average leaf width of mustard plants (*Brassica juncea* L.) (cm)

Treatment	Leaf Width (cm)			
	7 DAP	14 DAP	21 DAP	28 DAP
A	3,10 ± 0,77 ab	4,19 ± 1,10 abc	5,01 ± 0,79 ab	5,69 ± 0,72 b
B	2,95 ± 0,54 a	3,86 ± 0,76 ab	4,94 ± 0,55 ab	5,80 ± 0,52 b
C	3,79 ± 0,48 b	4,96 ± 0,85 bc	5,81 ± 1,05 b	6,19 ± 0,67 b
D	3,65 ± 0,95 ab	5,22 ± 1,43 c	5,94 ± 1,49 b	6,76 ± 1,08 b
E	2,88 ± 0,71 a	3,67 ± 0,76 a	4,29 ± 0,93 a	4,61 ± 0,85 a

Note: The values in the table above show the average of 2 plant units and 5 groups, the numbers accompanied by different letter notations in the same column show significantly different average values based on the DMRT (Duncan Multiple Range Test) at the level of 5% after statistical test using ANOVA; DAP = day after planting; A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water; D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

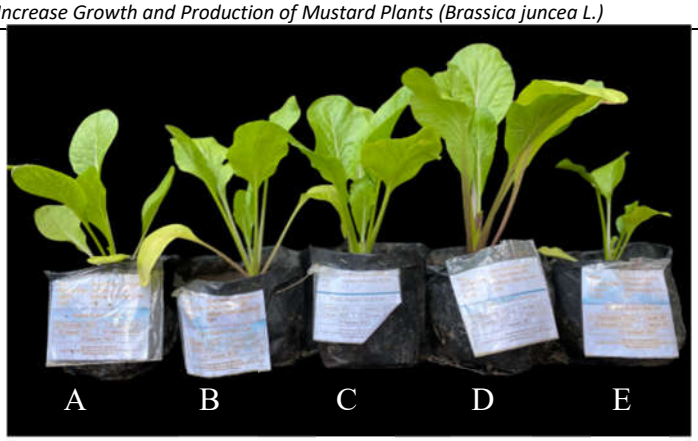

Figure 1. Growth of mustard at 30 DAP (Days After Planting), A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water; D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

Number of Leafs

The use of different concentrations of liquid organic fertilizer had an insignificant effect on the average number of leafs at 7 DAP observations, but had a significant effect on 14, 21, and 28 DAP. Mustard plants with the least number of leafs at 28 DAP are found in mustard plants without the use of liquid organic fertilizer or treatment A (control) and treatment E (liquid organic fertilizer 40 mL / 1 L of water), which is as much as 5.00 strands. The highest number of leafs at four observation ages was produced by mustard plants treated with D (liquid organic fertilizer 30 mL / 1 L of water), which was 2.80 strands; 5.00 strands; 5.70 strands; and 5.80 strands. Duncan's tests showed that at 14 and 21 DAP treatment A produced a significantly different number of mustard leafs with treatment C and D, but insignificantly different from treatment B and E, whereas at 28 DAP, treatment A produced a significantly different number of leafs with treatment D only. Data related to the effect of applying different concentrations of liquid organic fertilizer on the number of leafs parameters of mustard plants are presented in Table 4.

Table 4. The effect of liquid organic fertilizer treatment on the average number of leaf of mustard plants (*Brassica juncea* L.) (strands)

Treatment	Number of Leaf (Strands)			
	7 DAP	14 DAP	21 DAP	28 DAP
A	2,40 ± 0,65 a	4,30 ± 0,84 a	4,50 ± 0,61 a	5,00 ± 0,35 a
B	2,30 ± 0,45 a	4,30 ± 0,45 a	4,80 ± 0,76 ab	5,40 ± 0,65 ab
C	2,80 ± 0,67 a	5,00 ± 0,50 b	5,30 ± 0,27 bc	5,60 ± 0,42 ab
D	2,80 ± 0,76 a	5,00 ± 0,61 b	5,70 ± 0,76 c	5,80 ± 0,67 b
E	2,20 ± 0,45 a	4,00 ± 0,50 a	4,60 ± 0,42 a	5,00 ± 0,35 a

Note: The values in the table above show the average of 2 plant units and 5 groups, the numbers accompanied by different letter notations in the same column show significantly different average values based on the DMRT (Duncan Multiple Range Test) at the level of 5% after statistical test using ANOVA; DAP = day after planting; A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water; D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

Leaf Area

The use of different concentrations of liquid organic fertilizer on mustard plants had a significant effect on the average leaf area at the time of harvest. Mustard plants with the lowest leaf area were found in mustard plants applied with treatment E (liquid organic fertilizer 40 mL / 1 L of water), which was 23.6154 cm2, mustard plants that were not given liquid organic fertilizer or treatment A (control) produced the second lowest leaf area, which was 34.0875 cm2, while the highest leaf area was produced by mustard plants treated D (liquid organic fertilizer 30 mL / 1 L water), which is 47.3915 cm2. Duncan's test showed that treatment A produced leaf area of mustard plants that differed insignificantly from all treatments, including treatments B, C, D, and E. Data related to the effect of applying different concentrations of liquid organic fertilizer on the parameters of mustard plants leaf area are presented in Table 5.

Table 5. The effect of liquid organic fertilizer treatment on the average leaf area of mustard plants (*Brassica juncea* L.) (cm)

Treatment	Leaf Area (cm^2)
A	34,0875 ± 8,27 ab
B	34,1820 ± 4,01 ab
C	43,4085 ± 13,45 b
D	47,3915 ± 17,35 b

E	23,6154 ± 7,33 a

Note: The values in the table above show the average of 2 plant units and 5 groups, the numbers accompanied by different letter notations in the same column show significantly different average values based on the DMRT (Duncan Multiple Range Test) at the level of 5% after statistical test using ANOVA; DAP = day after planting; A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water; D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

Root Length

The use of various concentrations of liquid organic fertilizer to mustard plants had an insignificant effect on the average root length at the time of harvest. Mustard plants with the shortest roots are found in mustard plants applied with treatment E (liquid organic fertilizer 40 mL / 1 L of water), which is 13.24 cm, mustard plants that are not given liquid organic fertilizer or treatment A (control) produce the second shortest plant roots, which is 13.79 cm, while the longest roots are produced by mustard plants that are given treatment D (liquid organic fertilizer 30 mL / 1 L water), which is 17.79 cm. Data related to the effect of applying different concentrations of liquid organic fertilizer on the root length parameters of mustard plants can be seen in Table 6, while the length of roots produced by mustard plants can be seen in Figure 2.

Table 6. The effect of liquid organic fertilizer treatment on the average root length of mustard plants (*Brassica juncea* L.) (cm)

Treatment	Root Length (cm)
A	13,79 ± 3,46 a
B	15,46 ± 4,99 a
C	17,24 ± 3,31 a
D	17,79 ± 9,61 a
E	13,24 ± 2,78 a

Note: The values in the table above show the average of 2 plant units and 5 groups, the numbers accompanied by different letter notations in the same column show significantly different average values based on the DMRT (Duncan Multiple Range Test) at the level of 5% after statistical test using ANOVA; DAP = day after planting; A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water; D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

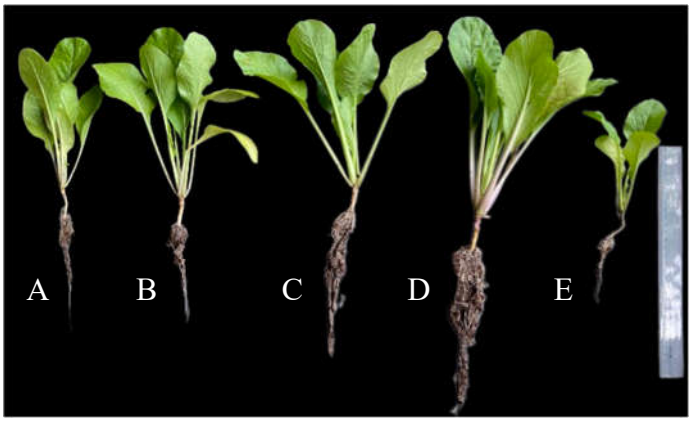

Figure 2. The length of the roots produced by each treatment at 30 DAP (Days After Planting), A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water; D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

Chlorophyll Content

The laboratory tests showed that mustard plants with the lowest chlorophyll a content were found in mustard plants without liquid organic fertilizer or treatment A (control), which was 51.889 ppm, while the highest chlorophyll a content was produced by mustard plants given treatment D (liquid organic fertilizer 30 mL / 1 L water), which was 69.105 ppm. Mustard plants with the lowest chlorophyll b content were found in mustard plants applied with treatment B (liquid organic fertilizer 10 mL / 1 L of water), which was 296.977 ppm, while the highest chlorophyll b content was produced by mustard plants given treatment D (liquid organic fertilizer 30 mL / 1 L of water), which was 358.542 ppm. Mustard plants with the lowest total chlorophyll content were found in mustard plants applied with treatment B (liquid organic fertilizer 10 mL / 1 L water), which was 352.938 ppm, while the highest total chlorophyll content was produced by mustard plants given treatment D (liquid organic fertilizer 30 mL / 1 L water), which was 427.472 ppm. The effect of applying different concentrations of liquid organic fertilizers on the parameters of chlorophyll content a, chlorophyll b, and total chlorophyll of mustard plants is presented in Table 7.

Table 7. The effect of liquid organic fertilizer treatment on the content of chlorophyll a, chlorophyll b, and total chlorophyll of mustard plants (*Brassica juncea* L.) (ppm)

Treatment	Chlorophyll a (ppm)	Chlorophyll b (ppm)	Total Chlorophyll (ppm)
A	51,889	302,211	353,953
B	56,106	296,977	352,938
C	57,688	298,759	356,301
D	69,105	358,542	427,472
E	56,819	312,966	369,633

Note: A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water; D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

Production Parameters

The use of various concentrations of liquid organic fertilizer to mustard plants had an insignificant effect on the average wet weight, the productivity of the wet weight of harvest, and dry weight of plants. Mustard plants with the lowest wet weight, harvest wet weight productivity, and dry weight were found in mustard plants applied with E treatment (liquid organic fertilizer 40 mL / 1 L of water), which amounted to 4.075 g, 0.501 tons/ha, and 0.386 g. Mustard plants that were not given liquid organic fertilizer or treatment A (control) produced the second lowest wet weight, the productivity of the wet weight of harvest, and dry weight, while the highest wet weight, the productivity of the wet weight of harvest, and dry weight were produced by mustard plants treated D (liquid organic fertilizer 30 mL / 1 L of water), which was 11.818 g, 1.452 tons/ha, and 1.328 g. Data related to the effect of applying different concentrations of liquid organic fertilizer on mustard plants production parameters can be seen in Table 8.

Table 8. The effect of liquid organic fertilizer treatment on the average wet weight (g), harvest wet weight productivity (tons/ha), and dry weight (g) of mustard plants (*Brassica juncea* L.)

Treatment	Wet Weight (g)	Harvest Wet Weight Productivity (tons/ha)	Dry Weight (g)
A	5,83 ± 2,93 ab	0,716 ± 0,36 ab	0,697 ± 0,31 ab
B	6,308 ± 3,36 ab	0,775 ± 0,41 ab	0,710 ± 0,29 ab
C	10,211 ± 4,69 ab	1,254 ± 0,58 ab	1,158 ± 0,55 ab
D	11,818 ± 8,47 b	1,452 ± 1,04 b	1,328 ± 0,91 b
E	4,075 ± 1,54 a	0,501 ± 1,89 a	0,386 ± 0,14 a

Note: The values in the table above show the average of 2 plant units and 5 groups, the numbers accompanied by different letter notations in the same column show significantly different average values based on the DMRT (Duncan Multiple Range Test) at the level of 5% after statistical test using ANOVA; A = control treatment (without application of liquid organic fertilizer); B = treatment of organic fertilizer 10 mL/1 L of water; C = treatment of organic fertilizer 20 mL/1 L of water; D = treatment of organic fertilizer 30 mL/1 L of water; E = treatment of organic fertilizer 40 mL/1 L of water

Liquid Organic Fertilizer Content

Based on secondary data, the liquid organic fertilizer used in this research contains N elements of 1.1%; P of 221.12 mg/L; organic C by 0.95%; and K at 39.21 mg/L; several other chemical compounds including alkaloids, phenols, flavonoids, and growth hormones, and have a pH of 5.8. The results of the analysis of nutrient content and chemical properties of liquid organic fertilizers are presented in Table 9.

Table 9. Secondary data from the analysis of nutrient content and chemical properties of liquid organic fertilizer

Types of Analysis	Result
N (Nitrogen)	1,1%
P (Phosphorus)	221,12 mg/L
K (Potassium)	39,21 mg/L
Organic-C	0,95%
pH	5,8
Other Chemical Compounds	alkaloids, phenols, flavonoids, and growth hormones

3.2 Discussion

Growth Parameters

Treatment of liquid organic fertilizer at 7 DAP (Days After Planting) had an insignificant effect on the growth parameters of mustard plants (Table 1-4). This happens because in the first-week mustard plants are still in the recovery stage due to transplanting (Matulessy et al, 2020). Sarido and Junia (2017) added that mustard plants up to the age of 10 DAP are still relatively young and included in the early growth stages so accumulation of photosynthesis results is still more widely used to make adjustments to the environment. Treatment of liquid organic fertilizers at 14 and 28 DAP also had an insignificant effect on the height growth parameters of mustard plants (Table 1). These results are in accordance with research conducted by Choliosoh et al. (2018) that the type and dose of rabbit urine fertilizer have an insignificant effect on the height parameters of mustard plants. This is related to the ability of plants to absorb nitrogen (N). If the amount of nitrogen absorbed is low, the plant growth rate will be low as well. The absorption of nitrogen can affect the growth rate of plants because this element plays an important role in plants (Choliosoh et al., 2018).

Observations 7 and 14 DAP (Table 1-4) show that treatment B growth is lower in all growth parameters compared to treatment A. This situation can occur because the provision of treatment B to mustard plants is still relatively unbalanced in that time frame (7 and 14 DAP). This is in line with the opinion of Sarida et al. (2021) that unbalanced fertilizer application will cause plants to lack nutrients to support their growth. Dahlianah et al. (2020) added that plants have a minimum tolerance limit for the nutrients provided so nutrients must be in the range that suits the needs of plants to produce optimal growth. After passing the recovery stage, the plant will adapt well and the roots will perform their function to absorb water and nutrients well (Matulessy et al, 2020). This can be seen in the observation data which shows that the application of liquid organic fertilizer treatment has begun to show a significant effect on the observation results of 14 DAP to 28 DAP on all mustard plant growth parameters, except plant height (Table 1-5). The results showed that treatment B and treatment C had begun to show good growth with the third and second highest results at the end of the observation on all growth parameters when compared to other treatments (Table 1-5).

These results have shown that a growing mustard plants can be stimulated through the use of liquid organic fertilizer. In accordance with Hadiyal et al. (2017), liquid organic fertilizer can provide nutrients and improve soil physical, chemical, and biological characteristics to increase plant growth, so it is able to produce higher plant growth compared with control (without the application of liquid organic fertilizer). These results are also inseparable from the opinion of Upe et al. (2020) that the availability of nutrients both macro and micro under certain circumstances can support the process of plant tissue formation. According to Suhastyo and Raditya (2021), plants will achieve good growth if the nutrients needed are available, balanced, and in optimal quantities.

The results showed that treatment D gave the best results on all growth parameters compared to other treatments (Table 1-5). The results also showed that treatment D was significantly different compared with treatment A (control) on plant height growth parameters at 21 DAP, leaf length at 14-28 DAP, and the number of leafs at 14-28 DAP. This situation can occur because the treatment of liquid organic fertilizer 30 mL / 1 L of water (treatment D) is able to provide nutrients suitable for the growth of mustard plants. According to Siregar (2017), the fulfillment of nutrients properly will result in maximum plant growth so that the photosynthesis process will take place properly and the formation of chlorophyll will be optimal.

Good and optimal growth produced by mustard plants can be influenced by the materials contained in the liquid organic fertilizer. The liquid organic fertilizer used in this study has a variety of ingredients, two of which are *Piper caninum* and Rhizobacteria. Suriani et al. (2022) said that one species of Rhizobacteria, namely *Brevibacillus agri* can be combined with Piper caninum to be applied to plants. The study showed that *Piper caninum* fermented with *Brevibacillus agri* showed the highest yield compared to other controls and single treatments on the growth parameters of red rice plants (*Oryza sativa* L.). This can occur due to the synergy between the growth hormone produced by *Piper caninum* and secondary metabolites produced by *Brevibacillus agri* (Suriani et al., 2022).

The liquid organic fertilizer used in this study is known to contain several nutrients and chemical compounds (Table 12). The content of nutrients and chemical compounds has an impact on increasing growth at each age of observation on all growth parameters of mustard plants. This is related to the opinion of Murtafaqoh and Winarsih (2022) that phosphate elements are known to play a role in forming nucleoproteins, moving and storing energy, cell division, root development, and strengthen stems. According to Rani et al. (2021), potassium and nitrogen nutrients can affect the quality of Brassica juncea, either separately or together. This is inseparable because potassium plays a role in various enzymatic reactions, such as carbohydrate biosynthesis, photosynthesis, and stress regulation. The role of nitrogen is seen in the formation of amino acids and proteins, as well as the improvement of vegetative growth. (Ibrahim and Tanaiyo, 2018).

The application of liquid organic fertilizers of various concentrations produces an insignificant influence on root length parameters (Table 7). The presence of an insignificant influence on the length of the roots can be caused by external factors. This study was conducted from December to January which is still entering the transition season so the intensity of sunlight at that time is relatively

low. This is in line with the opinion of Novianti et al. (2018), that root lengths that are not significantly different can be caused by the influence of external factors, such as lack of light intensity which has an impact on the underdevelopment of mustard plant root growth. During the observation time, it was known that the E treatment showed the lowest yield on all growth parameters. These results are in accordance with Efendi's opinion (2022) that the greater concentration of liquid organic fertilizer provided does not guarantee that plant growth will increase. Dahlianah et al. (2020) also added that plants have a maximum tolerance limit to the nutrients given. If the nutrients provided have exceeded the maximum tolerance limit, toxicity symptoms will be shown by the plant. Suriani et al. (2020) added that the use of *Piper caninum* leaf extract above the optimal concentration will show symptoms of toxicity to plant growth and yield due to the toxic properties of several active compounds present in the extract. Correspondingly, the content of chemical compounds contained in liquid organic fertilizers such as phenols and flavonoids (Table 9). According to Amani et al. 2021, in excess amounts, these two types of compounds can suppress the process of cell mitosis so that cell division and development will be disrupted and have an impact on inhibiting plant development and growth.

The test results of chlorophyll content, be it chlorophyll a, chlorophyll b, or total chlorophyll showed that treatment D showed the highest results (Table 7). This situation can occur because in treatment D the nutrient needs of mustard plants have been met more optimally compared to other treatments. The fulfillment of nutrients will maximize plant growth, this will have an impact on photosynthesis properly so that the formation of chlorophyll will be optimal (Siregar, 2017). One of the nutrients that play a role in increasing chlorophyll efficiency is potassium (Rani et al., 2021). Not only potassium, Geremew et al. (2021) stated that the formation of chlorophyll depends on the nitrogen content available in plants.

Application of liquid organic fertilizers with various concentrations resulted in insignificant influences on the parameters of wet weight, production wet weight of harvest, and dry weight of plants (Table 9). The same result is found in Prasetyio's (2022) research that there is no significant effect on the application of durian peel compost and phosphorus fertilizer on the fresh weight parameters of mustard plants. The application of liquid organic fertilizer that does not have a significant effect on the wet weight of plants is inseparable from the insignificance of the use of liquid organic fertilizer to the height of plants produced by mustard plants at the end of observation (28 DAP) in this study. This is supported by Suradi et al. (2022) who argue that significantly different plant heights will also affect the weight of the stash so that the weight of the stash produced differs significantly, and vice versa.

Insignificant influences can be caused by unstable weather at the time the study was conducted, be it sunlight that is sometimes hot or cloudy. This situation will cause the process of photosynthesis and plant growth to be disrupted (Agustin et al., 2019). Although not significant, treatment D still showed the best results compared to other treatments, besides that the application of liquid organic fertilizer at other concentrations also still showed higher results when compared to controls, except for treatment E. The highest harvest wet weight productivity is known to be found in mustard plants given D treatment, with an increase of 102.793% when compared to controls. During the harvest observation, it was found that treatment E showed the lowest yield on all production parameters which included wet weight of plants, the productivity of wet weight of harvest, and dry weight of plants. This situation can occur due to the high concentration of IAA produced in the treatment. Excessively high concentrations of IAA (auxin) will inhibit cell division due to the induction of biosynthesis of other PGR such as ethylene (Dermawan et al., 2020; Yulia et al., 2020). Ethylene will act as a 'secondary messenger' hormone in auxin signaling which leads to inhibition of leaf and stem growth so that the production produced decreases.

Less than optimal results and the absence of significant influence on some growth and production parameters cannot be separated from the influence of the growing media used at the time of seeding. The high ratio of cocopeat composition as seedling media used in this study is one of the factors lacking optimal growth and production of mustard plants. This is in line with research conducted by Ramadhan et al. (2018) that media composed with cocopeat levels of more than 25% show less than optimal growth. This is because cocopeat contains tannins that can slow growth (Murniati et al., 2021).

4. Conclusion

The growth and production of mustard plants (*Brassica juncea* L.) can be increased by the use of liquid organic fertilizers in the concentration range of 10-30 mL/1 L of water on all observation parameters and had a significant effect on the parameters of leaf length, leaf width, number of leafs, and leaf area. The most effective concentration in increasing the growth and production of mustard plants (*Brassica juncea* L.) is Treatment D (application of liquid organic fertilizer 30 mL/1 L water), with results that differ significantly from treatment A (control) of plant height parameters at 21 DAP, leaf length at 14-28 DAP, and number of leafs at 14-28 DAP.

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