Effect of liquid bio-slurry on the growth and production of two varieties of melon (\textit{Cucumis melo} L.)

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Abstract. The purpose of this study was to determine the growth and production of two varieties of melon plants due to the application of liquid bio-slurry. The research was carried out in Kaloling Village, Gantarangkeke District, Bantaeng Regency, South Sulawesi Province from June to August 2017. The research was conducted in the form of an experiment using a Split Plot design. The first factor set as the main plot was the variety consisted of two levels, namely: var. Sonya and var. Action 434. The second factor set as subplot was bio-slurry concentration consisted of four levels, namely: control (0 mL L\textsuperscript{-1}), and bio-slurry concentration of 25, 50, and 75 mL L\textsuperscript{-1}, respectively. The results show that the interaction of var. Action 434 with the application of 75 mL L\textsuperscript{-1} bio-slurry resulted in the largest fruit diameter (14.87 cm). The liquid bio-slurry treatment with a concentration of 25 mL L\textsuperscript{-1} produced the heaviest fruit weight (1.65 kg), while the concentration of 75 mL L\textsuperscript{-1} produced the highest plant (176.72 cm), the highest number of leaves (29.06 leaves). No significant effect of the treatments found on the fruit brix level.

1. Introduction
Melon is a seasonal fruit that is now developing as an agribusiness commodity. Melon has considerable economic value and prospects in its marketing, and requires intensive handling in its cultivation. Although the volume of demand for melons is high, often the Indonesian domestic market demand is not met [1]. The limitation of melon production is caused by the small number of melon cultivation centers in Indonesia. Melon production centers are dominated by East Java areas such as Ngawi, Madiun, Banyuwangi, Nganjuk, Lamongan and Jember. Beyond these regions, melon also planted in Lampung, South Sulawesi, Banten, Cilegon City and Serang as new centers.

Efforts to increase melon production have been carried out by improving cultivation technology. The low melon production in the field is often caused by the use of local cultivars with less optimal crop management [2]. The use of superior cultivars has a very prominent role, both in increasing yields per unit area and as a component of pest and disease control [3]. Although the production of melons continues to increase, good melons must have good quality too. To produce good quality fruit, fertilizing activities are important to do. Efforts to increase crop production are influenced by many factors, one of which is fertilization, both the method, dosage and time of administration [4].

Fertilization can use organic or inorganic fertilizers. One type of organic fertilizers is cow urine or commonly known as liquid bio-slurry. Bio-slurry fertilizer is a waste from biogas so bio-slurry
fertilizer is a high-quality organic fertilizer that is rich in humus [5]. Besides having a good nutritional content, bio-slurry fertilizer contains probiotic microbes that are useful for improving fertility and health of agricultural land, so that it will have an impact on increasing the quality and quantity of the crop. [6] found that the application of liquid bio-slurry to melon plants with a concentration of 50 mL.L\(^{-1}\) per plant gives the best results on plant height, leaf area and gives the highest average fruit diameter. Research on liquid organic fertilizer was also carried out by Mappanganro [7] with the addition of fermented cow urine. Addition of fermented cow urine (50 mL.L\(^{-1}\)) gives the best results on the vegetative growth of strawberry plants namely plant height (7.65 cm) and number of leaves (4.50 leaves).

Cow urine was found to contain IAA producing bacteria, hence can provide plant growth regulators of IAA [8]. The distinctive smell of the urine can prevent the arrival of various plant pests [9]. Therefore, cow urine can also function as pest control. Some farmers have used bio-slurry especially as fertilizer on agricultural land owned by farmers. Based on various experiments in Nepal and Vietnam [10], bio-slurry is an organic fertilizer that has a high enough organic matter content, useful for improving soil structure. Bio-slurry-given soils become more crumb, easily bind nutrients and water. Bio-slurry also increases the population and activity of soil microorganisms. Indicator of bio-slurry as good quality organic fertilizer is shown by the average C-organic content which is higher than the standard of organic fertilizer issued from the Organic Fertilizer Quality Standard, No.28 Permentan OT.140/2/2009 which is greater than 12%.

Based on these considerations, a study was carried out to further examine the use of liquid bio-slurry and to determine the best concentration on the growth and production of several varieties of melon plants.

2. Methodology
This research was carried out in Kaloling Village, Bantaeng Regency, Gantarangkeke District, South Sulawesi Province from June to August 2017. Two types of varieties used were Sonya and Action 434 varieties while liquid bio-slurry fertilizers used was a commercial liquid bio-slurry fertilizer. In addition to bio-slurry, NPK fertilizer (16:16:16) and cow manure also were given to the plants as basic fertilizers.

2.1. Treatments and research design
This research was conducted in the form of an experiment using a split plot design. The first factor as the main plot was variety (V) which consisted of two levels, namely: Sonya variety (v1) and Action 434 variety (v2). The second factor as subplot was the concentration of bio-slurry (P) consisted of four levels, namely without bio-slurry (0 mL.L\(^{-1}\)) (p0), bio-slurry 25 mL.L\(^{-1}\) (p1), bio-slurry 50 mL.L\(^{-1}\) (p2), and 75 mL.L\(^{-1}\) (p3) bio-slurry.

Media for seeding was a mixture of soil and manure with a ratio of 2:1 placed into 8 cm x 10 cm sized polybags, then watered before planting the seeds. Seedlings was transplanted onto the trial plots at nine days after planting (DAP) or when seedlings showed two pairs of true leaves using spacing of 80 cm x 60 cm. Before planting, each of planting hole was installed with a ± 1.5 m stake. Application of basic fertilizer of NPK and cow manure fertilization carried out twice, at 14 and 24 DAP. Whereas the application of the liquid bio-slurry was carried out four times at 14, 24, 40, 60 DAP by pouring 200 mL of the fertilizer per plant into the planting holes according to the treatment.

Pruning was conducted by removing the new shoots and flowers that grow on the armpit of the leaf. Shoots pruned were the shoots that appear in stem segments of 1-8, while shoots that grow in the armpit of leaves in sections 9-12 were maintained to obtain fruits prior to fruit selection. Fruit was selected based on the size of the fruit, leaving one fruit in one plant. The fruit stalks were tied with strings to the stakes to avoid direct contact with the ground. Harvesting was conducted when the fruit is ripe, characterized with a fragrant aroma, cracked fruit stalks, a ring-like crack between the base of the fruit stalk with the fruit, nets on the rind of the rough fruit and filled the entire surface of the melon, and the leaves around the fruit already started to dry.
2.2. Data Analysis and parameters

The data obtained were analysed by analysis of variance (ANOVA). A further significance difference test, using a Least Significance Difference (LSD) with the level of p ≤ 0.05, was carried out when there is significant effect of the treatment. Parameters observed were plant height, number of leaves, fruit weight, fruit diameter, and brix level. Fruit brix level, expressed in units of °Brix, was measured in the inner layer (near the seeds) using a refractometer at harvest.

3. Results and discussion

3.1. Effect of bio-slurry on plant height, leaf numbers, and weight per fruit

Application of bio-slurry significantly affect the vegetative growth and production of melon plants. No significance difference found between varieties. The use of bio-slurry with the concentration of 50 and 75 mL.L⁻¹ water on the plant increased the plant height and leaf numbers of melon compared to control (table 1). The control treatment did not significantly differed to the use of 25 mL.L⁻¹ of bio-slurry. The best result for plant height and leaf numbers parameters were shown by the highest concentration of bio-slurry used (75 mL.L⁻¹) which resulted in a plant height of 185.77 cm and 29.06 leaves.

Similarly, the weight of melon fruit increased with the increase of bio-slurry concentration. The recent study shows that application of bio-slurry on the melon plant can improve the fruit weight parameter up to 40 to 60% compared to control. The highest fruit weight was by resulted from the application of 25 mL.L⁻¹ bio-slurry (1.65 kg/fruit) and did not significantly differed with the application of 50 and 75 mL.L⁻¹ (1.52 and 1.42 kg/fruit, respectively) compared to control which resulted in the average fruits weight of only 1 kg/fruit.

| Liquid bio-slurry concentration (mL.L⁻¹) | Plant Height (cm) | Leaf Number (leaves) | Fruit weight (kg/fruit) |
|----------------------------------------|------------------|----------------------|------------------------|
| 0 (p0)                                 | 166.98 a         | 25.94 a              | 1.00 a                 |
| 25 (p1)                                | 166.18 a         | 26.94 a              | 1.65 b                 |
| 50 (p2)                                | 181.32 b         | 28.44 b              | 1.52 b                 |
| 75 (p3)                                | 185.77 b         | 29.06 b              | 1.42 b                 |
| LSD₀.₀₅                               | 1.73             | 1.51                 | 0.25                   |

Numbers followed by different letters mean significantly different in the LSD test p ≤ 0.05.

Observation on the parameter of plant height and leaf numbers indicated that even though the use of 75 mL.L⁻¹ bio-slurry treatment produced the highest parameter values, it were not significantly different from the concentration of 50 mL.L⁻¹. Bio-slurry is known as an organic fertilizer with high organic matter content that could improve soil fertility [11], enrich soil microorganism [10] and contain plant growth regulator such as IAA [8]. Addition of this substance into the soil would create an optimal growing condition to the plant hence improve the vegetative growth of the plant. Previous studies also obtained similar results [6,7] to the finding in this study indicating that bio-slurry applied to various plant resulted in better plant growth and production. Concentration of 50 mL.L⁻¹ of the bio-slurry tend to be the best concentration for bio-slurry application. During its growth, melon plants require nutrients, especially N, so by providing bio-slurry can increase the availability of the N elements. Lakitan [12] suggested that the most influential nutrient on leaf growth and development was the nitrogen, the high levels of N element would generally produce more and bigger leaves. It is
suspected that the nutrients in liquid bio-slurry are nutrients that contribute to plant growth including leaf growth which is reflected by the number of leaves. The number of leaves produced is closely related to plant height where the higher the number of plants produced, the more leaves.

Similarly to the plant height and leaf number parameters, bio-slurry increase the fruit weight of the melon plant. Increasing the weight of melon plants at a concentration of 25 mL.L\(^{-1}\) indicates that the concentration was an optimal concentration for melon plants, providing both macro nutrients and micro nutrients. These elements could help the process of cell metabolism, enzyme formation and plant physiology processes so that it can support growth and production in plants [12,13] suggested that the availability of sufficient nutrients at the time of growth causes the metabolic activity of plants to be more active so that the process of elongation and enlargement of cells will be better which can ultimately encourage increased fruit weight. A right use of the bio-slurry could improve soil fertility and increase crop production by an average of 10-30% compared to ordinary manure [11]. Besides, bio-organic fertilizer can increase the efficiency of nutrient uptake and increase resistance to pests and diseases [14] hence improve growth and yields such as fruit weight and fruit quantity.

3.2. Effect of bio-slurry on fruit diameter
Responses of two melon varieties on the different concentration of bio-slurry is shown in table 2. Fruit diameter increased with the concentration of bio-slurry applied and the responses were differed between the varieties. Increasing the concentration of bio-slurry did not necessarily improve the fruit diameter in Sonya variety. On the contrary, fruit diameter of melon variety of Action 434 increased with the concentration of the bio-slurry. Highest fruit diameter obtained in the trial was in the application of 25 mL.L\(^{-1}\) of bio-slurry in Sonya variety (14.40 mL.L\(^{-1}\)), while the use of 75 mL.L\(^{-1}\) of the bio-slurry on melon variety of Action 434 resulted in the biggest melon fruit (14.87 cm).

Increment of the fruit diameter as response to the concentration of the bio-slurry followed a polynomial trendline with the equation of 
\[ y = -0.001x^2 + 0.1239x + 10.899 \] 
for Action 434 variety (\( r = 0.99 \)), while for Sonya variety followed the equation of 
\[ y = -0.0011x^2 + 0.0933x + 11.762 \] 
\( r = 0.73 \), respectively. Optimal bio-slurry concentration for the two melon varieties used in the recent study were 25 mL.L\(^{-1}\) and 75 mL.L\(^{-1}\) for Sonya and Action 434 varieties, respectively.

| Liquid bio-slurry concentration (mL.L\(^{-1}\)) | Varieties | LSD \(_{0.05}\) bio-slurry concentration |
|---------------------------------------------|-----------|----------------------------------------|
| 0 (p0)                                       | Sonya (v1) | 10.80 \(_a\) x                        |
| 25 (p1)                                      | Action 434 (v2) | 13.69 \(_a\) x                       |
| 50 (p2)                                      | 12.82 \(_b\) x | 14.39 \(_a\) y                        |
| 75 (p3)                                      | 13.14 \(_b\) x | 14.87 \(_b\) y                        |

\( \text{LSD}_{0.05} \text{ variety} \) 1.59

Numbers followed by different letters in the same columns (a and b) and rows (x and y) mean significantly different in the LSD test \( p \leq 0.05 \).

Observation on fruit diameter parameter shows that the application of 25 mL.L\(^{-1}\) liquid bio-slurry produced the best fruit diameter and was not significantly different from the treatment of 50 and 75 mL.L\(^{-1}\) bio-slurry concentrations (\( p \leq 0.05 \)). While the lowest average fruit diameter was at control treatment without application of bio-slurry. It is suspected that the application of liquid bio-slurry at a concentration of 25 mL.L\(^{-1}\) provided the nutrient requirements in melon plants and could to increase the availability of nutrients in the soil as needed. This is confirmed by the results of the previous study by [15] which found that the application of liquid bio-slurry improved the chemical properties of the soil such as increase N-total and K-available, and increase plant growth and yield.
The use of bio-slurry fertilizer at a concentration of 25 mL.L$^{-1}$ was more optimal to be used in addition to other plant nutrient elements and the costs used were also not expensive as the fertilizer was used in lower concentration. The content of microorganisms contained in liquid bio-slurry could also accelerate the breakdown of organic material in the soil to become more available form to the plants [10]. Different concentrations of liquid bio-slurry applied to the soil means adding different levels of auxin and nutrients that contribute to the growth and development of melons, the number of microorganisms that contribute to the decomposition of organic materials. Hence, the higher concentrations of liquid bio-slurry, the higher increase in melon fruit diameter.

The results of the research of Ignatius et al. [16] showed that the application of cow urine liquid organic fertilizer can increase fruit length, fruit diameter, weight per fruit and weight of fruit per eggplant plant. However, the use of organic fertilizer needs to be balanced with inorganic fertilizer to meet crop nutrient needs such as NPK fertilizer. Response of the varieties used in this study (table 2, figure 1) on the use of bio-slurry could be due to different genetic performance. The diameter of the fruit is not only influenced by a treatment but also influenced by the environment in which it lives. In addition to genetic factors, soil factors, the availability of light, water, and nutrients also play a role in the plant growth and process of fruit formation [17]. The higher the concentration of fertilizer given resulted in the higher amount of nutrients and organic matter that affect the characteristics of the soil so it allowed an increase in soil pH, N, P, and K content in the soil [18,19].

Fermented cow urine liquid organic fertilizer also contains hormones that stimulate plant growth and development [8]. The hormone in the form of IAA (Indol Acetic Acid), known as auxin whose effects on plants will stimulate the growth and development of eggplant plants, so that it can provide a better influence on plant growth. Application of cow urine urine organic fertilizer increased fruit length and fruit diameter could related to the auxin hormone contained in cow urine which plays a role in increasing the length, and diameter of the fruit.

According to Dewi [20] auxin can increase growth, root differentiation and branching, and fruit development. Auxin has a major role in the proton pumping of the plasma membrane. Auxin stimulates pumping of protons in the plasma membrane, thereby increasing membrane potential and decreasing pH in the cell wall. This will increase the absorption of ions into the cell followed by osmotic absorption of water, as well as increase the plasticity of the cell wall so that it allows the cell to grow long or large.

![Figure 1. Average of fruit diameter (cm) of two melon varieties on varieties on different concentration of liquid bio-slurry.](image-url)
3.3. Effect of bio-slurry on fruit brix values of two melon varieties

Figure 2 shows the brix values of two melon varieties on different concentration of bio-slurry. Application of bio-slurry on two varieties of melon did not have significant effect on the fruit brix levels. Nevertheless, plants applied with bio-slurry showed slightly higher brix values compared to the control plants. Sonya variety showed slightly higher average of brix values compared to Action 434 variety.

Increase in the bio-slurry concentration consistently improved fruit brix in Action 434 variety. However, in Sonya variety, the fruit brix increased with the bio-slurry application up to a concentration of 50 mL.L⁻¹ after that a decline in fruit brix was observed in the use of higher concentration. The highest brix value of 11.44 °Brix was obtained with the application of 50 mL.L⁻¹ bio-slurry on Sonya variety. On the other hand, lowest brix value was shown by the use of bio-slurry of 0 mL.L⁻¹ (9.44 °Brix).

![Figure 2. Fruit Brix values of two melon varieties on different concentration of liquid bio-slurry.](image)

Despite the effect of bio-slurry on some of growth and yield parameters in this study, no significant effect of the treatments on the quality of the melon fruit. This finding agree with the study of Silva et al. [21] that found no effect of nitrogen doses (N) on total soluble solids content with the mean value for this parameter was 11.93 °Brix. The soluble solids content in the melon fruit juice obtained in this study by the use of bio-slurry were in the range of the value standard for brix content used in other country (10-11 °Brix) even higher in the Sonya variety applied with 50 mL.L⁻¹ of bio-slurry [22].

4. Conclusion

Based on the research results obtained, it can be concluded that:

- The treatment of liquid bio-slurry with a concentration of 25 mL.L⁻¹ produces the heaviest weight per fruit (1.65 kg), and a concentration of 75 mL.L⁻¹ produces the highest plant height (176.72 cm), the highest number of leaves (29.06 strands) and the largest fruit diameter (14.87 cm).
- Interaction of Action 434 varieties with 75 mL.L⁻¹ bio-slurry concentration showed fruit diameter (14.87cm), but still equal to concentrations of 50 mL.L⁻¹ and 25 mL.L⁻¹.

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