Growth of passion fruit plants on various origins of cuttings and concentration of Liquid Organic Fertilizer

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Abstract. It is a report of an experiment aimed to determine part of branch cutting along with the concentration of liquid organic fertilizer which is best for the growth of passion fruit seedling. The experiment took place in Lemo-Lemo Village, Sub-district of Pattapang-Tinggi Moncong, Regency of Gowa Regency, South Sulawesi. The experiment was designed in the form of a 2-factor factorial experiment in a Randomized Block Design. The first factor consisted of four levels of concentration of liquid organic fertilizer, namely: (1) without application of liquid fertilizer, (2) concentration of 5 mL L\textsuperscript{-1}, (3) concentration of 10 mL L\textsuperscript{-1}, and (4) concentration of 15 mL L\textsuperscript{-1}. The second factor was the source of cuttings with three levels: (1) base cutting, (2) middle cutting, and (3) tip cutting. The results showed that application of liquid organic fertilizer of 10 mL of L\textsuperscript{-1} gave the best influence on several variables. They were shoot length (38.33 cm), number of leaves (9.17 leaf unit), number of branches (7.33 branch), length root (22.27 cm), and leaf area (13.81 cm\textsuperscript{2}). Compared to base and tip cuttings, the middle cuttings gave the best influence on several variables. These variables were: shoot length (38.33 cm), number of leaves (9.17 leaf unit), number of branches (7.33 branches), root length (22.27 cm), and leaf area (15.67 cm\textsuperscript{2}). The interaction between the concentration of 10 mL L\textsuperscript{-1} and the middle cutting gave the best effect on shoot length (38.33 cm) and root length (22.27 cm).

1. Introduction
Indonesia is a tropical country which can produce almost all types of fruits in its high and low lands. One type of fruit that has potential as a leading agribusiness commodity is passion fruit [1]. Passion fruit is the raw material for the beverage industry (syrup and juice), which has bright market prospects, both for domestic overseas markets [2].

Passion fruit development in Indonesia started back in the 19th century. It initially developed in the provinces of West Java and West Sumatra. Nowadays, the fruit is expanding to other provinces in Indonesia, such as North Sumatra (Karo), South Sulawesi (Gowa and Sinjai), West Sulawesi (Mamasa and Polewali) [3].

Based on statistical data of Gowa Regency [4], passion fruit's production experience decrease which due to the reduced number of passion fruit plants. It happened because farmers tend to replace their passion fruit plants with other horticulture plants. Another cause of production decline due to aging plants which require rejuvenation by new plants propagated through cuttings. Passion fruit propagation by the use of cuttings produces large quantities of seedlings and shorter producing age.
when compared to propagation by seeds [5]. Moreover, cutting propagation produces plants with the same properties and qualities as the parent plant. In general, this cutting method is simple, fast, and does not require special techniques [6].

Passion fruit twigs are the most valuable part to be cut in large quantities since it is a vine and the twigs have adequate food reserves. Cutting for new plants could be taken from the base, middle, and tip because these three parts have enough carbohydrates to grow and develop into passion fruit seedlings. One important thing in cutting multiplication is the availability of nutrients in the growing media. Provision of fertilizers is a solution for improving soil biology and chemical conditions.

During the vegetative period, plants desperately need nutrients available in the soil for the formation of roots, leaves, and stems. Liquid organic fertilizer can provide essential nutrients for plants as it is soluble in the soil for quicker absorption.

An experiment was conducted in order to determine the concentration of liquid organic fertilizer and the origin of cuttings that most suitable for the growth of passion fruit seedlings.

2. Methodology

A research in the form of an experiment, was conducted in Lemo-Lemo Village, Pattapang, Tinggi Moncong Subdistrict of Gowa Regency, South Sulawesi province.

The research was in the form of a factorial experiment using a randomized block design. The first factor was the concentration of liquid organic fertilizer (P) which consists of four levels, namely: $p_0$= no application; $p_1$= 5 ml L$^{-1}$; $p_2$= 10 ml L$^{-1}$; $p_3$= 15 ml L$^{-1}$. The second factor was the origin of the passion fruit twigs (S), which consists of 3 levels, namely: $s_1$= base part $s_2$= middle part; $s_3$= tip part. Each combination of treatments was repeated three times, with three units each, making a total of 108 experimental units.

3. Results and discussion

3.1. Results of various variables

Variance analysis showed that various concentrations of fertilizers, the various origin of cuttings, and interactions of both have a very significant effect on shoot length.

| Concentration of organic fertilizer | Cutting origin |
|------------------------------------|----------------|
|                                    | Base ($s_1$)  | Middle ($s_2$) | Tip ($s_3$) |
| 0 mL L$^{-1}$ ($p_0$)              | 17.90$^{cd}$  | 14.42$^{de}$  | 9.00$^e$    |
| 5 mL L$^{-1}$ ($p_1$)              | 26.60$^b$     | 33.00$^a$     | 11.67$^{de}$|
| 10 mL L$^{-1}$ ($p_2$)             | 22.67$^{bc}$  | 38.33$^a$     | 18.00$^{ad}$|
| 15 mL L$^{-1}$ ($p_3$)             | 8.64$^e$      | 21.33$^{bc}$  | 12.92$^{de}$|

Notes: The numbers followed by the same letters were not significantly different from the Duncan Multiple Range Test (DMRT) at 0.01. with contrasting values respectively are: 5.89258, 6.15841, 6.32086, 6.43901, 6.52762, 6.61623, 6.69007, 6.74915, 6.79345, 6.83037, 6.86729.

The correlation between fertilizer concentration and the average shoot length at 14 weeks after planting is shown in figure 1. It depicts the relationship between fertilizer concentration and average shoot length is quadratic. The maximum fertilizer concentration was 7.69 mL L$^{-1}$ of water which results in a shoot length of 26.42 cm ($r$-value = 0.9895). At this concentration, the length of the shoots of passion fruit seedling was the longest.
Figure 1. The correlation between fertilizer concentration and the average length of passion fruit shoots at 14 weeks after planting.

Table 2 shows that the fertilizer concentration of 10 mL L$^{-1}$ of water produced the highest number of leaves at 14 weeks after planting and significantly different from other concentrations. The variance showed various fertilizer concentrations have a significant effect. Various origins of the cuttings have a very significant effect. Whereas, the interactions of both have no significant effect on the number of leaves.

| Concentration of organic fertilizer | Cutting origin | Average | LSD$_{0.05}$ |
|------------------------------------|----------------|---------|--------------|
| 0 mL L$^{-1}$ (p$_0$)              | Base (s$_1$)   | 7.33    | 7.06$^c$     |
|                                   | Middle (s$_2$)| 7.50    | 8.37$^{bc}$  |
|                                   | Tip (s$_3$)   | 6.33    | 9.17$^a$     |
| 5 mL L$^{-1}$ (p$_1$)              | Base (s$_1$)   | 6.11    | 1.4278       |
|                                   | Middle (s$_2$)| 9.33    | 6.67$^b$     |
|                                   | Tip (s$_3$)   | 9.67    | 8.00$^a$     |
| 10 mL L$^{-1}$ (p$_2$)             |                | 6.67    | 7.59$^b$     |
| 15 mL L$^{-1}$ (p$_3$)             |                | 6.11    |              |
| Average                            |                | 6.56$^b$|              |
|                                   | Base (s$_1$)   | 9.21$^a$|              |
|                                   | Middle (s$_2$)| 8.38$^a$|              |
|                                   | Tip (s$_3$)   |         |              |
| Average                            |                | 8.59$^b$|              |
| LSD$_{0.01}$                       |                | 1.6806  |              |

Notes: The numbers followed by the same letters were not significantly different from the LSD Test $\alpha = 0.05$ and LSD $\alpha = 0.01$

The correlation between fertilizer concentration and the average number of leaves 14 weeks after planting as seen in figure 2 revealed the correlation was quadratic.

Figure 2. The correlation between fertilizer concentration and the average number of leaves of passion fruit at 14 weeks after planting.
The maximum fertilizer concentration was 8.33 mL L\(^{-1}\) of water which produced 8.97 leaves (r = 0.9658). At this concentration, the highest number of leaves was achieved. Applying higher concentrations will reduce the number of leaves.

Table 3 shows that the concentration of fertilizer 10 mL L\(^{-1}\) of water produced the highest number of branches at 14 weeks after planting and significantly different from other concentrations. The cuttings of the middle branch produce the best average number of branches at 14 weeks after planting and differs very significantly compared to base and tip cuttings. Variance analysis shows that various fertilizer concentrations have a significant effect. The various origin of cuttings has a very significant effect, while the interactions of both have no significant effect on the number of branches.

**Table 3.** The average number of branches of passion fruit at 14 weeks after planting

| Concentration of organic fertilizer | Cutting origin | Average | LSD\(\alpha=0.05\) |
|-------------------------------------|----------------|---------|---------------------|
| 0 mL L\(^{-1}\) (p\(_0\))          | Base (s\(_1\)) | 5.00    | 5.33                |
| 5 mL L\(^{-1}\) (p\(_1\))          | Middle (s\(_2\)) | 6.50    | 7.00                |
| 10 mL L\(^{-1}\) (p\(_2\))         | Tip (s\(_3\)) | 5.33    | 5.33                |
| 15 mL L\(^{-1}\) (p\(_3\))         | Average       | 5.67\(^b\) | 5.75\(^b\)         |
| LSD\(\alpha=0.01\)                 |                | 1.2944  |                     |

Notes: The numbers followed by the same letters were not significantly different from the LSD Test \(\alpha=0.05\) and LSD \(\alpha=0.01\)

The correlation between fertilizer concentration and the average number of branches at 14 weeks after planting can be seen in figure 3. It shows a quadratic correlation. The maximum fertilizer concentration is 8.133 mL L\(^{-1}\) of water which produces number of branches of 6.99 stalks (r value = 0.8593). Application of higher concentrations will reduce the number of branches.

![Figure 3](image_url)

**Figure 3.** The correlation between fertilizer concentration and the average number of branches of passion fruit at 14 weeks after planting

Table 4 shows the fertilizer concentration of 10 mL L\(^{-1}\) produced the widest average leaf area (13.81 cm\(^2\)) and was significantly different from the control (0 mL L\(^{-1}\)) but not significantly different from other concentration. The cuttings of the middle branch produced the widest average leaf area (15.67 cm\(^2\)) and was significantly different from the base and tip cuttings.
Table 4. The average leaf area of passion fruit at 14 weeks after planting

| Concentration of organic fertilizer | Cutting origin | Average | LSD<sub>α=0.05</sub> |
|-------------------------------------|----------------|---------|-----------------------|
|                                    | Base (s₁)      | Middle (s₂) | Tip (s₃) | |
| 0 mL L⁻¹ (p₀)                      | 12.33          | 14.89   | 8.22      | 11.81<sup>b</sup> |
| 5 mL L⁻¹ (p₁)                      | 13.44          | 16.11   | 10.78     | 13.44<sup>a</sup> |
| 10 mL L⁻¹ (p₂)                     | 13.89          | 16.22   | 11.33     | 13.81<sup>a</sup> |
| 15 mL L⁻¹ (p₃)                     | 13.33          | 15.44   | 10.67     | 13.15<sup>ab</sup> |
| Average                            | 13.25<sup>b</sup> | 15.67<sup>a</sup> | 10.25<sup>c</sup> | |
| LSD<sub>α=0.01</sub>              | 1.6836         |          |           | |

Notes: The numbers followed by the same letters were not significantly different from the LSD Test α = 0.05 and LSD α = 0.01

The correlation between fertilizer concentration and average leaf area as seen in figure 4 was quadratic. The maximum fertilizer concentration is 9.36 mL L⁻¹ of water, which resulted in a leaf area of 13.85 cm² (r-value = 0.9994). Application of higher concentrations will reduce leaf area.

![Figure 4](image)

Figure 4. The correlation between fertilizer concentration and the average leaf area of passion fruit at 14 weeks after planting

3.2. Effects of organic fertilizers

The results of the statistical analysis showed that application of organic fertilizer at a concentration of 10 mL L⁻¹ water, gave the best results on the parameters of shoot length, number of leaves, number of branches, root length, and leaf area compared to other liquid organic fertilizer concentrations.

Presumably, the presence of fertilizer treatment was at the right concentration. The concentration of 10 mL L⁻¹ could increase the nutrient content in the media, which stimulated vegetative growth. Hardjowigeno [7] stated that the amount of fertilizer given is related to the plant's need for nutrients, which in turn affects nutrient content in the soil. Plants will respond to certain concentration limits according to the needs for plant growth and development. Harjadi [8] added that plants need nutrients in plant growth and development which can be a limiting factor for plant growth and development.

The results of statistical analysis of orthogonal polynomial tests indicated that application of liquid fertilizer at a concentration of 10 mL L⁻¹ water showed a quadratic curve. It indicated that organic fertilizers at a concentration below 10 mL L⁻¹ i.e. 9 mL L⁻¹ water, nutrients were absorbed in maximum conditions to meet the needs of plants. Marsono and Sigit [9] reminded that the use of
excessive fertilizer concentrations could be detrimental, while too low concentrations will not have the
effect of plant growth as expected. Gardner, Pearce, and Mitchell [10] strengthened when plants get all
the nutrients needed in sufficient quantities, they will give a good growth response.

3.3. Effects of cutting origins

Statistical analysis showed that the origin of the branch has a very significant effect on the
parameters of shoot length, number of leaves, number of branches, and leaf area. There are differences
in growth between the three origins of the cuttings used. Cuttings as the propagative unit are
successful if they can form perfect plant organs such as roots, leaves, and branches. Growth of cuttings
begins with the formation of roots because if the roots fail to form, then the cuttings will dry out and
die.

Cuttings derived from the middle part of the branch had better results than other origins of
cuttings. It could be assumed that the middle cuttings have better roots and shoot growth. Caldwell et.
al. [11] confirmed that the age of shoots in branches is related to the accumulation of carbohydrates as
food reserves and growth hormones. The top part with younger tissue has a higher hormone content,
but the carbohydrate content is less than the base portion.

An explanation by Qodriyah and Sutisna [12]: the base section has a high carbohydrate content,
and the meristematic tissue activity starts slowly, the middle cuttings have sufficient carbohydrate
content and quite active meristematic tissue activity, and the tip cuttings have less carbohydrate
content but high meristematic activity

4. Conclusion

- The concentration of organic fertilizer of 10 mL of L⁻¹ water gave the best effect on shoot
  length, number of leaves, number of branches, root length, and leaf area. The concentration of
  9.36 mL of L⁻¹ water is the maximum fertilizer concentration in passion fruit cuttings growth.
- The propagative cutting derived from the middle part of twigs gave the best influence on the
  length of shoots, number of leaves, number of branches, length of root, and leaf area.

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