The effectiveness of the application method of liquid organic fertilizer in different concentration on lettuce

B Frasetya*, A Taofik1 and L Nasrulloh1
1 UIN Sunan Gunung Djati, Bandung, West Java, Indonesia

*Email: budyfrasetya@uinsgd.ac.id

Abstract. Fertilization using organic materials has a double benefit in preserving the environment and plant growth. This study aims to determine the effectiveness of the application method of liquid organic fertilizer (LOF) with various concentrations on lettuce plants' growth. The research method used was experimental research using a factorial complete randomized design. Factor 1 is the concentration of liquid organic fertilizer (LOF) (10, 15, 20, 25, 30 ml l⁻¹), and Factor 2 is the method of applying LOF (spray, watering, and combination spray and watering). Each unit of the experiment was repeated three times. Growth and yield parameters observed in this study: plant height, leaf area, dry weight, and fresh plant weight. The data of growth parameters and lettuce yields were then analyzed using variance analysis at 5% level and Duncan’s test at 5% level. The results showed an interaction between the application method and LOF concentration on leaf area, dry weight, and fresh weight. The independent effect occurs on plant height parameters. The application of LOF concentrations of 15 ml l⁻¹ in lettuce plants using watering and spraying is more effective than the other treatment.

1. Introduction
Nutrient management in conventional cultivation systems using soil media is different from nutrient management in hydroponic cultivation systems, although, in principle, plants require the same macro and micronutrients. The availability of sufficient organic matter in the soil is essential for plant survival. The organic matter applied to the soil can be given in solid or liquid form [1]. There are various types of organic material sources, one of which is utilizing organic waste from traditional markets. Organic waste in traditional markets that is not managed properly can harm health. The utilization of leaf vegetable waste from traditional markets has multiple benefits to reduce the volume of organic waste and a source of organic fertilizer. If composted in solid form, leaf vegetable waste will require a large volume to meet the need for organic fertilizer per unit area.

The alternative is to process leaf vegetable waste into liquid organic fertilizer. Liquid organic fertilizer (LOF) has the advantage of being easy to apply by spraying or by sprinkling it. The research on the LOF application method by watering and spraying has been investigated, but the LOF application method by combining watering and spraying is still limited in information [1][2]. The LOF application method will be effective if the given LOF concentration is adjusted according to lettuce's nutrient needs [3].
2. Methods

This research was conducted from May 2018 to July 2018 at the greenhouse of Padjadjaran University, Jatinagor-Sumedang, West Java (753 m above sea level). The tools and materials used in this research include measurement tape, thermo-hygrometer, hand sprayer, volume glass, rapid red variety of lettuce seeds, EM bio activator, polybag (40 cm x 40 cm). The research method used was experimental research using a two-factor factorial, completely randomized design. The first factor is the concentration of LOF (P) consisting of five levels, namely: \( P_1 = 10 \text{ ml l}^{-1} \), \( P_2 = 15 \text{ ml l}^{-1} \), \( P_3 = 20 \text{ ml l}^{-1} \), \( P_4 = 25 \text{ ml l}^{-1} \), and \( P_5 = 30 \text{ ml l}^{-1} \). The second factor is the LOF (M) application method consisting of five levels: \( M_1 = \text{spray} \), \( M_2 = \text{watered} \), and \( M_3 = \text{spraying & watering} \). The combination of treatment levels was repeated three times each. Growth parameters observed to measure plant response were plant height, leaf area, dry weight, and fresh plant weight. All observations were made at the age of 35 days after transplanting (DAT).

The research procedure was divided into two stages: liquid organic fertilizer production (Figure 1) and the lettuce stage cultivation. The first procedure to produce LOF is to chop 25 kg vegetable waste from the traditional market, activate 250 ml of bio activator (effective microorganism) with 250 ml water, containing bio activator solution, and place at room temperature for 24 hours. After 24 hours, the bio activator and the vegetable waste pour into a plastic bucket, adding 19-liter tap water. Next step, place the bucket at room temperature (25-30°C); every day for 15 minutes, open the bucket lid to release the gas. The fermentation process will take time for three weeks. After three weeks, the LOF then filter to separate the solid materials. After the filter, the LOF was ready to use (Figure 2 (a) [4].

![Figure 1. The research preparation stage. (a) Chopping vegetable waste, (b) Mixing vegetable waste with bio activator and tap water, and (c) Fermenting the liquid organic fertilizer.](image)

The lettuce cultivation stage was started with preparation soil as growing media and accompany with seedling lettuce plant. The soil used in this research based on laboratory analysis has chemistry properties, i.e., pH (H2O) 5.22, Carbon organic 1.79%, Total Nitrogen 0.15%, \( P_2O_5 \) Bray 2.85 ppm, \( K_2O \) (HCl 25%) 19.73 mg per 100 g, CEC 13.54 cmol kg⁻¹, Base saturation 62.99 %, Al exchangeable 0 cmol kg⁻¹ and Hydrogen exchangeable 0.84 cmol kg⁻¹. Before the soil fills into the polybag, the dolomite was added to the soil 10 g per polybag. The polybag size 40 cm x 40 cm, filled with soil until it reaches 5 kg. One week before transplanting the lettuce plant into the polybag, compound fertilizer NPK (16:16:16) was added into the soil 3.5 g each polybag. The lettuce plant transplanting after two weeks in the nursery room, and this process was doing in the morning (7:00 AM GMT+7:00). The treatment was applied for five times when the plant age from the first day until the fifth day after transplanting. The lettuce plant is nurture carefully with irrigation, weeds control, pest, and plant disease control. The lettuce plant was harvested when the plant age 40 days after transplanting.
Analysis of variance at the 5% level was used to test whether the treatment factor affected the observed growth parameters. Duncan's multiple range test at 5% was used to analyze the difference of each factor level.

3. Results and discussion

The results of the analysis of variance (Table 1) show that the application method and the various concentrations of LOF interact with the leaf area, dry weight, and fresh weight parameters. Plant height parameters are independently influenced by the LOF application method. This study's results provide different information from the results of research [1], which explained that the application of LOF Tithonia in different applications and concentrations did not affect maize plants' growth. The success of the LOF application is influenced by the type of plant and the expected yield. In vegetable plants, the harvested leaves are the leaves so that the plant growth is sufficient until the vegetative phase. The plants harvested in the form of fruit in the growth phase entered the vegetative phase and the generative phase to need more nutrients. Making LOF by the anaerobic method has the advantage of minimizing the loss of N elements compared to aerobic composting [5].

Table 1. Results of variance analyses

| Parameters       | CV (%) | P   | M   | PxM |
|------------------|--------|-----|-----|-----|
| Plant height     | 12.34  | ns  | *   | ns  |
| Leaf area        | 24.83  | ns  | ns  | *   |
| Dry weight       | 23.53  | *   | ns  | *   |
| Fresh weight     | 23.98  | *   | ns  | *   |

Remarks: *= significant at 5% significant level; ns= not significant. CV= coefficient of variation; P= LOF concentration; M= method of LOF application; PxM= interaction between LOF concentration with method of LOF application

The results of LOF analysis in the soil chemistry and plant nutrition laboratory of the Faculty of Agriculture, Padjadjaran University in 2018 contained N = 0.07%, P$_2$O$_5$ = 0.41%, and K$_2$O = 0.44%. Based on the Indonesian Standardization Board (SNI 19-7030-2004) for organic fertilizer, the N LOF content used is still below 0.4%. Element P (P$_2$O$_5$) has met the criteria, namely $>$ 0.1%, and element K (K$_2$O) also fulfills the minimum criteria, namely $>$ 0.2%.

3.1. Plant height (cm)

The results of the analysis of variance (Table 1) showed that there was no interaction between the LOF concentration treatment and the LOF application method. The LOF concentration independently did not affect plant height, but the application method independently affected plant height (Figure 3). The LOF application method by watering produced higher lettuce than the application method of watering.
and spraying. The low N content in the LOF used is thought to be insufficient for nutrient needs so that a concentration of 10-30 ml l\(^{-1}\) produces the same growth response.

The results of this study also confirmed previous studies that stated that the LOF application did not affect cabbage plant height [6]. The LOF application method by spraying gives better plant height at various LOF concentrations of 10-30 ml l\(^{-1}\). Fertilization through leaves has the advantage of being able to supply nutrient deficiencies in plants [7].

![Graph of lettuce plant height](image)

**Figure 3.** Graph of lettuce plant height

### 3.2. Leaf area (cm\(^2\))

The results of the analysis of variance (Table 1) show that the LOF concentration and its application method mutually support the growth of the lettuce leaf area. The LOF application method treatment was sprayed, and the LOF concentration of 30 ml l\(^{-1}\) produced the highest leaf area. Based on the results of the Duncan test (Table 2), the effectiveness of the LOF concentration using the spray-flush application method is the LOF concentration of 15 ml l\(^{-1}\). The combination of a spray application method is effective in supporting the growth of lettuce [8].

**Table 2.** Average of leaf area

| LOF concentration | Method of application | m1       | m2       | m3       |
|-------------------|-----------------------|----------|----------|----------|
| P1                | 1489.33 a             | 1658.27 a| 1542.30 a|          |
|                   | AB                    | A        | AB       |
| P2                | 2064.67 a             | 1461.83 a| 2089.80 a|          |
|                   | B                     | A        | B        |
| P3                | 1420.60 a             | 1507.60 a| 1017.37 a|          |
|                   | AB                    | A        | A        |
| P4                | 1969.10 b             | 1136.63 a| 1418.20 ab|        |
|                   | AB                    | A        | AB       |
| P5                | 1328.40 a             | 1418.70 a| 2107.10 b|          |
|                   | A                     | A        | B        |

Remarks: The numbers followed by the same letters (lowercase letters horizontally and uppercase letters vertically) indicate no significant difference according to Duncan Multiple Range Test at 5% level.

Plants get nutrients from the soil through the roots as well as get nutrients from the leaves. Fertilization with organic matter can increase plant growth. The slow-release nature of organic matter and its low nutrient content can affect plant growth if applied with the right method [3].
3.3. Dry weight (g)
The results of the analysis of variance (Table 1) show that the interaction of the LOF concentration and its application method can increase plant biomass formation. The best plant biomass was obtained in 15 ml l\(^{-1}\) LOF concentration treatment and spray-flush application (Table 3). Photosynthate formation will be significant if the plant needs fulfilling, namely water, sunlight, and nutrients. The results of this study indicate that a sufficient LOF concentration may not necessarily support growth if the application method is not correct (4).

Table 3. Average of plant dry weight

| LOF concentration | Method of application | M1 | M2 | M3 |
|-------------------|-----------------------|----|----|----|
| P1                | 7.07 a                | 5.83 a | 5.87 a |
|                   | AB                    | AB  | AB |
| P2                | 7.97 b                | 5.43 a | 9.33 b |
|                   | B                     | AB  | C  |
| P3                | 4.67 a                | 6.40 a | 4.20 a |
|                   | A                     | AB  | A  |
| P4                | 8.13 b                | 4.47 a | 4.77 a |
|                   | B                     | A   | A  |
| P5                | 4.67 a                | 7.90 b | 8.10 b |
|                   | A                     | B   | BC |

Remarks: The numbers followed by the same letters (lowercase letters horizontally and uppercase letters vertically) indicate no significant difference according to Duncan Multiple Range Test at 5% level.

3.4. Fresh weight (g)
The results of the analysis of variance (Table 1) show that the LOF concentration and its application method mutually support the increase in plant fresh weight. Plant fresh weight as a component of yield in lettuce plants. The highest plant fresh weight was obtained at a concentration of 15 ml l\(^{-1}\), and the LOF application method was by spray-flush. The spray-flush method complements the plant's nutrient needs. Plants whose nutrient needs are met during the growing period will produce high yields [6][7].

Figure 4. Visual appearance of lettuce plant with higher yield (35 DAT) (a) P1M1, (b) P1M2, (c) P1M3, (d) P2M1, (e) P2M2, and (f) P2M3
Figure 4 show that the visual appearance of some lettuce plant has an attractive performance. The lettuce plant's excellent looking is an added value to increase profit, especially if the lettuce product is displayed at a modern retailer. The harvest yield in this research (Table 4) shows that the treatment combination has a harvest yield of over 200 g per plant, i.e., p1m1, p2m3, p4m1, and p5m3. The present research harvest yield shows that each LOF dosage has its method application to reach a high yield.

Table 4. Average of plant fresh weight

| LOF concentration | Method of application | M1   | M2   | M3   |
|-------------------|-----------------------|------|------|------|
| P1                |                       | 209.50 a | 147.77 a | 189.10 a |
|                   | BC                    |      | AB   | B    |
| P2                |                       | 185.57 a | 197.50 a | 274.73 b |
|                   | ABC                   |      | B    | C    |
| P3                |                       | 122.63 a | 164.77 a | 111.37 a |
|                   | A                     |      | AB   | A    |
| P4                |                       | 247.00 b | 101.10 a | 110.73 a |
|                   | C                     |      | A    | A    |
| P5                |                       | 156.60 a | 191.03 a | 219.03 a |
|                   | AB                    |      | B    | BC   |

Remarks: The numbers followed by the same letters (lowercase letters horizontally and uppercase letters vertically) indicate no significant difference according to Duncan Multiple Range Test at 5% level.

4. Conclusion
The results showed an interaction between the application method and LOF concentration on leaf area, dry weight, and fresh weight. The independent effect occurs on plant height parameters. The application of LOF concentrations of 15 ml l⁻¹ in lettuce plants by the application method of watering and spraying is more effective than using only the spraying or watering method at a concentration of LOF 10 ml l⁻¹ - 30 ml l⁻¹.

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