Inorganic fertilizers efficiency with using the liquid organic fertilizer to increase the cabbage yield (*Brassica oleracea* var. *capitata* L.)

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Abstract. Using organic materials as fertilizer has contributed a lot to protecting the environment and the future of human life through sustainable agriculture. Local resources are used in such a way that synthetic nutrients can be reduced as low as possible. This study aims to determine the effect of liquid organic fertilizer (LOF) on cabbage yield with inorganic fertilizers’ efficiency. The research was conducted in Berastagi experimental farm, Karo regency, with the soil type and altitude of 1,340 m asl, which began from July - September 2018. The design used was a randomized block design consisting of 16 treatments with three replication. The treatments tested were: A. Without inorganic fertilizer + LOF 1, B. 25% inorganic fertilizer + LOF 1, C. 50% inorganic fertilizer + LOF 1, D. 75% inorganic fertilizer + LOF 1, E. 100% inorganic fertilizer + LOF 1, F. Without inorganic fertilizer + LOF 2, G. 25% inorganic fertilizer + LOF 2, H. 50% inorganic fertilizer + LOF 2, I. 75% inorganic fertilizer + LOF 2, J. 100% Inorganic Fertilizer + LOF 2, K. Without inorganic fertilizers + LOF 3, L. 25% inorganic Fertilizer + LOF 3, M. 50% inorganic Fertilizer + LOF 3, N. 75% inorganic Fertilizer + LOF 3, O. 100% Inorganic Fertilizer + LOF 3, P. 100% Inorganic Fertilizer + without LOF (Control). The results showed that, in general, the application of liquid organic fertilizer for rabbit urine, fish fertilizer, and fish teillation could stimulate the growth and yield of cabbage better than inorganic fertilizers. Applicationthe liquid organic fertilizer can increase the height growth of cabbage was 0.67 - 0.88%, plant diameter was 0.33 - 2.56%, crop weight per plant was 5.14 - 5.84%, production per plot was 2.96 – 9.78%, and the crop ratio of 3.36 - 10.84% compared to the use of inorganic fertilizers.

1. Introduction

Generally, farmers in Indonesia cultivate a lot of cabbage in the highlands. Cabbage is a vegetable rich in vitamins such as vitamin A 200 IU, B 20 IU, and C 120 IU, which are very important for health. The need for vegetables is increasing with the increasing population. Therefore, vegetables, especially cabbage, need to be increased to provide these needs [1],[2].

Currently, cabbage vegetable farmers in general still use fertilization with synthetic chemical fertilizers. The continued use of synthetic chemical fertilizers has had a negative impact on the soil and the environment. The negative impact that arises is damaging the soil structure (physical) and the environment. The soil becomes hard in the dry season and sticky in the rainy season with decreased soil porosity. Synthetic chemical fertilizers do not have properties that can directly improve soil's...
physical and biological functions[3],[4]. Based on the previous, it is necessary to have organic fertilizers that can increase cabbage production, such as synthetic chemical fertilizers.

Increasing vegetable productivity can be done by handling proper cultivation, one of which is fertilization. Fertilization can be done using synthetic chemical fertilizers and organic fertilizers [5]. Organic fertilizers have an essential role in improving the soil's physical, chemical, and biological properties. Although the nutrient content in organic fertilizers is relatively low, soil chemical properties far exceed synthetic chemical fertilizers [6].

One of the organic fertilizers is in the form of a liquid, one of the essential components in organic agriculture, which contains many macros, micro, hormone, and amino acids needed by plants. Liquid organic fertilizers have several benefits, including reducing the use of chemical fertilizers [7]. Liquid organic fertilizers can also increase the growth and production of mustard plants [8][9], tomatoes [10][11], soybeans [12], sweet corn [13], scallions [14]. The provision of liquid organic fertilizer from kirinyu and rabbit manure can increase cabbage growth and production[15]. Provision of liquid organic fertilizer from rabbit manure as the raw material can increase tuber weight per plant (49.21%), output per plot (48.35%), and tuber length (12.83%) compared without LOF on carrots [16].

Liquid organic fertilizer, which is used as the primary raw material, uses local natural ingredients around the agricultural location, such as rabbit manure, fish fertilizer, fish teillation, and coconut water. Rabbit urine has higher N and mucosa than other animals, which can bind available nutrients [17]. Fertilizers made from fish raw as a nutrient source can also induce Actinomycetes and Rhizobacteria groups that play a role in producing growth hormones around plant roots [18]. Coconut water can replace synthetic root stimulants as a growth regulator, where the results of [19] research resulted in faster sprouting time, shoot length, number of leaves, length, and high root wet weight in tin seeds.

This research aims to determine the effect of giving liquid organic fertilizer on cabbage yield with inorganic fertilizers' efficiency.

2. Methods
The research was conducted at Berastagi experimental farm, Dolat Rayat District, Karo District, with andisol soil type, the altitude of 1,340 m asl, the temperature of 22-28°C, humidity 80-90%, and rainfall 2,500 mm / year, and starting in July until September 2018.

The research used non-factorial Randomized Block Design (RBD) with three replications. The treatments tested were: A. Without inorganic fertilizer + liquid organic fertilizer (LOF) 1, A. Without inorganic fertilizer + LOF 1, B. 25% inorganic fertilizer + LOF 1, C. 50% inorganic fertilizer + LOF 1, D. 75% inorganic fertilizer + LOF 1, E. 100% inorganic fertilizer + LOF 1, F. Without inorganic fertilizer + LOF 2, G. 25% inorganic fertilizer + LOF 2, H. 50% inorganic fertilizer + LOF 2, I. 75% inorganic fertilizer + LOF 2, J. 100% Inorganic Fertilizer + LOF 2, K. Without inorganic fertilizers + LOF 3, L. 25% inorganic Fertilizer + LOF 3, M. 50% inorganic Fertilizer + LOF 3, N. 75% inorganic Fertilizer + LOF 3, O. 100% Inorganic Fertilizer + LOF 3, P. 100% Inorganic Fertilizer + without LOF (Control)

Making Liquid Organic Fertilizer
- LOF 1 (LOF rabbit urine) = EM0 + Coconut water + Rabbit urine (2.5: 5: 4.5)
- LOF 2 (LOF fish fertilizer) = EM0 + Coconut water + fish fertilizer (2.5: 5: 2)
- LOF 3 (LOF of fish teillation) = EM0 + Coconut water + fish teillation (2.5: 5: 2)

All ingredients are cooked to a boil and then fermented for one month.

Experimental plots were made with a size of 1 m x 5 m; the distance between treatment plots was 0.75 m, and the distance between replicates was 1 m. The total population of cabbage consists of 24 plants. Then given manure according to the tested treatment with a dose of 300 g per plant and given at planting. Watering is done when it does not rain. Weeding depends on the growth of weeds in the field. According to the type tested with a concentration of 20 ml LOF/liter of water, the next fertilization of liquid organic fertilizer is given by spraying 1 x 1 week, starting at the age of 2 weeks after the plant (WAP) until the plant at 10 WAP. Pest and disease control is carried out every 1 x 7 days using insecticides with active ingredients. Sipermetrin 50 g / l, Piridaben 135 g / l, and Spinetoram 120 g / l, with a concentration of 0.5 - 1.0 cc / l water and 2 g chlorothalonil fungicide. / l water and
azoxystrobin 200 g / l + difenoconazole 125 g / l 0.5 - 1 ml / l water. Harvesting is carried out at the age of 3 months after planting. The variables observed were as follows: plant height and diameter at 1 and 2 months after plant, leaf width at two months after plant, crop weight per plant, production per plot, and crop ratio.

The observed data were analyzed with the F test and continued with the HSD average difference test at the 5% level.

3. Results and discussion

3.1. Plant height, plant diameter, and leaf width

Based on the results of the analysis of variance, it showed that the fertilization treatment had no significant effect on the growth of plant height, plant width, and cabbage leaf width at the age of 1 and 2 months after planting (Table 1).

| Varieties                  | Plant Height (cm) | Plant Diameter (cm) | Leaf Width (cm) |
|----------------------------|-------------------|---------------------|-----------------|
|                            | 1 MAP             | 2 MAP               | 1 MAP           | 2 MAP           |
| A. 0% + LOF1               | 31.08 a           | 37.25 a             | 55.38 a         | 65.25 a         | 30.25 a         |
| B. 25% + LOF1              | 30.08 a           | 36.08 a             | 54.50 a         | 65.88 a         | 27.50 a         |
| C. 50% + LOF1              | 31.42 a           | 35.33 a             | 53.00 a         | 66.04 a         | 27.83 a         |
| D. 75% + LOF1              | 30.58 a           | 36.67 a             | 54.88 a         | 64.58 a         | 28.50 a         |
| E. 100% + LOF1             | 28.54 a           | 32.58 a             | 51.46 a         | 61.96 a         | 28.67 a         |
| F. 0% + LOF2               | 28.33 a           | 37.33 a             | 51.42 a         | 63.13 a         | 28.67 a         |
| G. 25% + LOF2              | 31.33 a           | 35.33 a             | 53.25 a         | 66.79 a         | 27.67 a         |
| H. 50% + LOF2              | 31.92 a           | 34.58 a             | 55.54 a         | 64.79 a         | 26.92 a         |
| I. 75% + LOF2              | 31.46 a           | 36.50 a             | 54.13 a         | 67.17 a         | 29.58 a         |
| J. 100% + LOF2             | 31.38 a           | 36.00 a             | 56.83 a         | 64.67 a         | 27.50 a         |
| K. 0% + LOF3               | 29.42 a           | 36.00 a             | 50.88 a         | 63.79 a         | 27.50 a         |
| L. 25% + LOF3              | 29.83 a           | 34.00 a             | 52.79 a         | 62.88 a         | 28.42 a         |
| M. 50% + LOF3              | 30.92 a           | 35.58 a             | 51.71 a         | 64.04 a         | 29.33 a         |
| N. 75% + LOF3              | 31.08 a           | 35.17 a             | 53.46 a         | 65.00 a         | 27.83 a         |
| O. 100% + LOF3             | 31.63 a           | 36.00 a             | 53.33 a         | 65.04 a         | 28.92 a         |
| P. 100% + 0                | 30.46 a           | 37.00 a             | 53.25 a         | 63.58 a         | 30.25 a         |

| CV (%)                     | 5.94              | 5.92                | 6.65            | 4.57            | 7.11            |

Note: Mean followed by the same letters on the same column is not significantly different according to honestly significantly different test at 5% level

MAP = Month after Planted
LOF 1 (LOF rabbit urine), LOF 2 (LOF fish fertilizer), LOF 3 (LOF of teillation)

Cabbage growth showed no significant difference between inorganic fertilization treatment with the reduced inorganic fertilization addition of liquid organic fertilizer and only LOF application. Application of the LOF can increase the height growth of cabbage was 0.67 - 0.88% and plant diameter were 0.33 - 2.56% compared to inorganic fertilizers. The highest gain of cabbage was found in the treatment of liquid organic fertilizer 1 (rabbit urine) and liquid organic fertilizer 2 (fish fertilizer), each 37.25 cm and 37.33 cm. This shows that liquid organic fertilizer can be used by cabbage for growth. This is consistent with the research results of [20] that the rabbit manure liquid organic fertilizer can support cabbage plants’ vegetative growth. Likewise, the application of fish fertilizer can also increase cabbage growth [21].

Plant diameter at the age of 2 months after plant, application of the liquid organic fertilizer rabbit manure and fish teillation without inorganic fertilizers produced a higher plant diameter, each 65.25 63.79 cm. Likewise, with leaf width, the treatment liquid organic fertilizer of rabbit urine without inorganic fertilizers resulted in the most sweeping leaves than other treatments. This is consistent with the research results of [22], that rabbit urine can also support the height growth of shallot plants.
3.2. Crop weight per plant, production, and crop ratio

The application of liquid organic fertilizer resulted in cabbage crop weight per plant, production, and crop ratio, which were not significantly different from the application of 100% chemical fertilizers (Table 2). This shows that using liquid organic fertilizers can increase cabbage production even though chemical fertilizers are reduced and even without being used.

| Treatments | Crop Weight (g) | Production (kg/5 m²) | Crop Ratio (%) |
|------------|-----------------|-----------------------|----------------|
| A. 0% + LOF | 1.36 a          | 32.73 a               | 53.68 a        |
| B. 25% + LOF | 1.47 a         | 31.60 a               | 55.15 a        |
| C. 50% + LOF | 1.38 a         | 32.50 a               | 49.96 a        |
| D. 75% + LOF | 1.52 a         | 36.20 a               | 52.46 a        |
| E. 100% + LOF | 1.28 a        | 29.67 a               | 49.91 a        |
| F. 0% + LOF2 | 1.26 a         | 30.43 a               | 51.23 a        |
| G. 25% + LOF2 | 1.37 a         | 34.57 a               | 50.32 a        |
| H. 50% + LOF2 | 1.42 a         | 34.10 a               | 53.03 a        |
| I. 75% + LOF2 | 1.38 a         | 33.47 a               | 52.25 a        |
| J. 100% + LOF2 | 1.41 a        | 34.67 a               | 52.21 a        |
| K. 0% + LOF3 | 1.37 a         | 31.20 a               | 55.53 a        |
| L. 25% + LOF3 | 1.35 a         | 31.63 a               | 52.38 a        |
| M. 50% + LOF3 | 1.35 a         | 31.47 a               | 54.55 a        |
| N. 75% + LOF3 | 1.31 a         | 29.23 a               | 51.11 a        |
| O. 100% + LOF3 | 1.46 a         | 34.57 a               | 54.84 a        |
| P. 100% + 0 | 1.29 a         | 29.53 a               | 49.51 a        |

CV (%) 13.88 13.15 6.36

Note: Mean followed by the same letters on the same column is not significantly different according to honestly significantly different test at 5% level

LOF = Liquid organic fertilizer
LOF 1 (LOF rabbit urine), LOF 2 (LOF fish fertilizer), LOF 3 (LOF of fish teillation)

In general, the cabbage crop weight per plant, production per plot, and crop ratio in the use of liquid organic fertilizers resulted have higher values than the use of 100% chemical fertilizers, although no significant. The liquid organic fertilizer can increase the crop weight per plant was 5.14 - 5.84%, production per plot was 2.96 – 9.78%, and the crop ratio of 3.36 - 10.84% inorganic fertilizers. The highest weight of cabbage crops per plant and production per plot was found in the treatment of using 75% inorganic fertilizer + LOF 1 (rabbit urine), each 1.52 kg, and 35.20 kg per plot. Meanwhile, the highest yield ratio resulted in using LOF 3 (fish teillation) without inorganic fertilizers, 55.53%. This is following the research results by [7], which shows that using liquid organic fertilizers can reduce the use of chemical fertilizers on chicory and increase growth and production. The obtained efficiency of urea fertilizer was 50% and 75 ml/L of liquid organic fertilizer treatment was able to increase the growth and production of chicory, which was higher than the 100% chemical fertilizer treatment although it was not significantly different.

4. Conclusion

In general, the application of liquid organic fertilizer for rabbit urine, fish fertilizer, and fish teillation could stimulate the growth and yield of cabbage better than inorganic fertilizers. Application the liquid organic fertilizer can increase the height growth of cabbage was 0.67 - 0.88%, plant diameter was 0.33 - 2.56%, crop weight per plant was 5.14 - 5.84%, production per plot was 2.96 – 9.78%, and the crop ratio of 3.36 - 10.84% compared to the use of inorganic fertilizers.
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