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Pakcoy's (*Brassica rapa* L.) Response to the Provision of Liquid Organic Fertilizer in Polybags

Respon Pakcoy (*Barassica rapa L.*) *terhadap Pemberian Pupuk Organik Cair di Polybag*

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ABSTRAK

Penelitian ini bertujuan untuk mengkaji pengaruh Pupuk Cair Organik (POC) dalam meningkatkan pertumbuhan dan hasil pakcoy, serta mendapatkan konsentrasi POC yang memberikan pertumbuhan dan hasil terbaik pada tanaman pakcoy. Penelitian dilakukan di *Teaching and Research Farm*, Fakultas Pertanian Universitas Jambi, 35 dpl. Penelitian menggunakan Rancangan Acak Kelompok dengan satu faktor yaitu berbagai konsentrasi POC: 0 ml/l; 5 ml/l; 10 ml/l, 15 ml/l. Setiap perlakuan diulang sebanyak lima kali. Hasil penelitian menunjukkan bahwa aplikasi POC mampu meningkatkan pertumbuhan dan hasil tanaman pakcoy berupa tinggi tanaman (4,94%–24,49%), jumlah daun (4,63%–9,26%), luas daun (18,17%–46,12%), bobot kering (50,98%–94,90%), dan bobot segar tanaman (50,46%–102,60%). Konsentrasi POC 10ml/l memberikan pertumbuhan dan hasil pakcoy terbaik. Hasil penelitian ini baru mampu menghasilkan bobot segar pakcoy 26%–33% dari potensi hasil pakcoy.

Kata kunci: aplikasi, pertumbuhan, pupuk organik cair, hasil

ABSTRACT

This study aimed to examine the effect of Liquid Organic Fertilizer (LOF) in increasing the growth and yield of pakcoy, as well as obtaining LOF concentrations that provided the best growth and yields of pakcoy plants. It was conducted at the Teaching and Research Farm, Faculty of Agriculture, University of Jambi, 35 asl. The study used a Randomized Block Design with one factor, namely various LOF concentrations: 0ml/l; 5ml/l; 10ml/l, 15ml/l. Each treatment was repeated five times. The results showed that LOF application was able to increase the growth and yield of pakcoy plants in the form of plant height (4.94%–24.49%), number of leaves (4.63%–9.26%), leaf area (18.17%–46.12%), dry weight (50.98%–94.90%), and plant fresh weight (50.46%–102.60%). The LOF concentration of 10ml/l provided the best pakcoy growth and yield. The results of this study have just been able to produce a fresh weight of pakcoy 26%–33% of the potential pakcoy yield.

Keywords: application, growth, liquid organic fertilizers, yield

INTRODUCTION

Urban farming is a new trend and activity that is fond of by many people, especially in urban areas. It provides a solution by creating a green open land in the midst of dense urban buildings, providing sufficient availability of foodstuffs, strengthening urban food security, and providing healthy and quality food through planting systems such as *verticulture* (vertical and culture), hydroponics and aquaponics, or by using pots or polybags.

A plant that is widely cultivated in urban farming is a green-leaf vegetable plant. This is because green vegetables contain high nutrients with a short lifespan. One of the cultivable green vegetables is pakcoy (*Brassica rapa* L.). The pakcoy in urban farming needs to be considered in relation to the availability of nutrients to support the plant growth. In urban farming system with limited growing media (pot or polybag), the provision of nutrients outside the planting medium is very much needed for the optimal plant growth to produce, especially if the media used comes from suboptimal soils such as Ultisols.

One of the things that can be done is to apply liquid organic fertilizer that contains mineral nutrients needed by the plants. The liquid organic fertilizer (LOF) is a solution derived from fermented organic matter of plant remains or animal waste. It is easy to apply evenly, can quickly overcome nutrient deficiencies, and does not damage the soil and plants (Prizal & Nurbaiti, 2017). One of the liquid organic fertilizers is NASA LOF. It is a commercial LOF containing macro, micronutrients, growth regulators, humic acids and fulvic acid, with C/N 0.86 (PT Natural Nusantara, 2021).

Various research results show that the use of LOF in increasing the growth and yield of vegetables provides positive results. The liquid organic fertilizer derived from fruit peel waste with a concentration of 20% can increase the number of leaves, the total dry weight of the plant, the dry weight of the roots, and the dry weight of the pakcoy plant canopy (Ghasiani et al., 2021). Furthermore, the results of the research of Ginanjar et al. (2019) in strawberry plants given the liquid organic fertilizer derived from the vegetable waste at the age of 7 and 21 DAP at a dose of 750 ml per plant show better growth and yield compared to those of 250, and 500 ml.

The study conducted by Hidayat et al. (2015) using various types of commercial LOF with recommended doses on corn plants provides the same growth and results. The application of LOF can reduce the use of inorganic fertilizers by 25%. Moreover, the study conducted by Harahap et al. (2020) using NASA LOF on tomato plants with concentrations of up to 3 cc/l cannot increase the tomato yield, but increase the soil pH and C-organics. The NASA LOF provision improves the eggplant growth and yield, and the NASA's 6 ml/l concentration provides the best growth and results compared to those of 0; 2; and 4 ml/l (Neli et al., 2016).

The various descriptions above indicate that the LOF is able to increase the growth and yield of plants. Information about the use of NASA LOF in pakcoy cultivation in pots or polybags is still limited. As a result, a study is required to assess the effect of NASA LOF on the growth of pakcoy planted in polybags, as well as to determine the optimal concentration of NASA LOF to provide the best pakcoy results. This study aimed to examine the effect of Liquid Organic Fertilizer (LOF) in increasing the growth and yield of pakcoy, as well as obtaining LOF concentrations that provided the best growth and yields of pakcoy plants.

MATERIALS AND METHODS

Research Place

This study was carried out at the Teaching and Research Farm of the Faculty of Agriculture, University of Jambi, located 35 m above sea level.

Experimental Design

The study used a Randomized Group Design with 5 repetitions. The tried treatment was a variety of NASA LOF concentrations consisting of: 0 ml/l; 5 ml/l; 10 ml/l; and 15 ml/l.

Implementation of Research

The seeds of the Nauli variety pakcoy were sown on a seedling medium consisting of a mixture of soil and sand (1:1), and after 2 weeks of age the seedlings were transferred to the small polybags (nurseries) with a mixture of soil planting medium, manure and sand (2:1:1). One week later the seedlings were ready to be planted in large polybags measuring 5 kg with the same media mixture at the time of nursery.

The seedlings ready for transplanting were those that meet the following criteria: six-leafed, healthy and uniform. After being transferred and aged 3 days old, the plants were given the NPK fertilizer as much as 2 g per plant or polybag. The LOF used was the NASA's commercial LOF.

The LOF administration was carried out by spraying on the plant, and stopped when the whole leaf was evenly wet. The LOF was given 5 times during the plant growth, starting at 7 days after planting (DAP) at intervals of 3 days.

The harvesting was conducted at the age of 25 DAP, by disassembling the plant and its roots from the planting medium, then washing it with water until it got clean.

Observed variables and Data Analysis

The plant observation was carried out at the time of the harvest by observing the plant growth including: the plant height; the number of leaves; the longest leaf length.

The widest leaf width; the leaf area of the total plant; the total dry weight of the plant; and the yield of the crop was in the form of the plant fresh weight. The data analysis used ANOVA and it continued with the DMRT.

RESULTS AND DISCUSSION

Results

The results of the study showed that giving various concentrations of LOF had a significant effect on the plant height and the number of pakcoy leaves aged 25 DAP. The LOF concentration of 10 ml/l gave the highest plant height and the highest number of leaves in pakcoy (Table 1).

Table 1 showed that an increase in the given concentration of LOF raised the height of the plant and the number of pakcoy leaves; however, the concentration of 5 ml/l provided the same height and number of pakcoy leaves as if it were not given the LOF. An increase in the LOF concentration of more than 10 ml/l actually provided a higher and lower number of pakcoy leaves, even equal to the concentration of 0 ml/l

The provision of LOF also had a significant effect on the longest leaf length, the widest leaf width and total leaf area of pakcoy. The highest leaf length, widest leaf width and leaf area were obtained at the LOF concentration of 10 ml/l (Table 2). Various LOF concentrations produced the same length of pakcoy leaves, and it was different when it was not given the LOF. Meanwhile, the widest leaf width and the total leaf area of pakcoy were obtained at the concentration of 10 ml/l and were different from the other LOF concentrations. The lowest leaf length, leaf width and total leaf area were obtained when it was not given the LOF. The dry weight of pakcoy was also significantly affected by the provision of various LOF concentrations.

The increased LOF concentrations raised the dry weight of pakcoy; however, the concentrations of 10 ml/l and 15 ml/l gave the same dry weight (Table 3). Meanwhile, the pakcoy yields in the form of fresh weights also increased as the increasing concentrations of LOF given (Table 3). The increase in dry weight and fresh weight of pakcoy due to the LOF administration showed the same pattern. The study results

showed that an increase in the LOF concentration up to 10 ml/l increased plant growth and yield. The increased concentrations of more than 10 ml/l decreased plant growth and yield. Based on these results, it could be concluded that a concentration of 10 ml/l was the maximum concentrationthat provides the best pakcoy growth and results.

The administration of LOF with various concentrations was able to augment the growth and yield of pakcoy when compared to the ones without LOF administration by increasing the plant height (4.94%–24.49%), number of leaves (4.63%–9.26%), leaf area (18.17%–46.12%), dry weight (50.98%–94.90%), and fresh weight (50.46%–102.60%). The largest increase in growth and yield of pakcoy was obtained at the LOF concentration of 10 ml/l (Table 4).

Discussion

The results of this study were in line with those conducted by Mebang et al. (2016) in lettuce plants, in which the NASA LOF administration increases plant height, leaf count, fresh weight, and harvest weight, and the concentration of 3 ml/l was the concentration that gives the best results. Likewise, the results of the study of Handayani et al. (2019) on mung bean crops, the NASA's LOF significantly affects the crop yields such as the number of pods per plant, the number of pods contained per plant, production per plant and weight of 100 seeds per plot.

This shows that the complete nutrient content in NASA's LOF coupled with the presence of plant growth regulators, was able to meet the needs of pakcoy plants growth and development. The results of the study conducted by Prizal and Nurbaiti (2017) show that using the NASA LOF on pakcoy plants were also able to increase plant height, number of leaves, leaf area and fresh weight of plants, and the concentration of 8 ml/l provides the highest growth and yield.

Table 1. Plant height and the number of pakcoy leaves on various concentrations of liquid organic fertilizer aged 25 DAP

LOF Concentration (ml/l)	Plant Height (cm)	Number of Leaves (strands)
0	13.15 $_{b}$	13.17 $_{b}$
5	13.80 $_{b}$	13.78 $_{ab}$
10	16.37 $_{a}$	14.39 $_{a}$
15	14.22 $_{b}$	13.33 $_{b}$

Note: The numbers followed by the same letter were not significantly different according to the DMRT test α = 5%

Table 2. Longest leaf length, the widest leaf width, and the total leaf area at various concentrations of liquid organic fertilizer aged 25 DAP

LOF Concentration (ml/l)	Longest Leaf Length (cm)	Widest Leaf Width (cm)	Total Leaf Area (cm^2)
0	15.15 $_{b}$	7.27 $_{c}$	115.37 $_{s}$
5	17.03 $_{a}$	8.10 $_{b}$	136.33 $_{c}$
10	18.07 $_{a}$	9.48 $_{a}$	168.57 $_{a}$
15	17.75 $_{a}$	8.49 $_{b}$	142.18 $_{b}$

Note: The numbers followed by the same letter were not significantly different according to the DMRT test α = 5%

Table 3. Dry and fresh weight of pakcoy on various concentrations of liquid organic fertilizer aged 25 DAP

LOF Concentration (ml/l)	Dry Weight (g)	Fresh Weight (g)
0	2.55 $_{c}$	69.89 $_{c}$
5	3.85 $_{b}$	105.49 $_{b}$
10	4.97 $_{a}$	141.60 $_{a}$
15	4.45 $_{ab}$	128.92 $_{a}$

Note: The numbers followed by the same letter were not significantly different according to the DMRT test α = 5%

Table 4. Increased growth and yield of pakcoy on various concentrations of liquid organic fertilizer compared to the ones without liquid organic fertilizer

LOF Concentration (ml/l)	Increase (%)				
	Plant Height	Number of Leaves	Leaf Area	Dry Weight	Fresh Weight
5	4.94	4.63	18.17	50.98	50.94
10	24.49	9.26	46.12	94.90	102.60
15	8.14	1.21	23.24	74.51	84.46

The nitrogen (N), phosphor (P), potassium (K), calcium (Ca), sulfur (S), and magnesium (Mg) were macro essential nutrients contained in the NASA LOF. The content of macronutrients and equipped with micronutrients such as Fe, Cu, Zn B, Mn, Mo and Cl were able to augment the plant height, number of leaves, leaf length, leaf width and total leaf area of pakcoy. Compared to the pakcoy plants that were not given the NASA LOF, there was an increase in growth in the form of dry weight of plants by 50.98–94.80% and an increase in yield in the form of fresh weight by 50.94–102.60%. The results of the correlation analysis among the various observed variables showed that the dry weight of the plant was more influenced by leaf area and plant height compared to the number of leaves ($r = 0.68^{**}$ and 0.65^{**} and 0.49^{*}). Likewise, the fresh weight of the plant, closely correlated with the leaf area of the plant with $r = 0.68^{**}$, compared to the height of the plant with $r = 0.44^{*}$, while with the number of leaves there was no correlation ($r=0.21$). This showed that the area of the leaves greatly affects the growth and yield of pakcoy plants.

Leaves were important organs for photosynthesis, so the functional properties of leaves such as weight and leaf area were an important index to describe the photosynthetic capacity of plants (Jiao et al., 2022). The plant height, number of leaves and dry weight as well as the fresh weight of pakcoy given the LOF were caused by the increase in the plant leaf area. The growth and development of these leaves requires various nutrients such as Nitrogen, Phosphor, and Potassium which play a role in the process of photosynthesis and translocation of photosynthates.

N was one of the nutrients which was the most abundant on earth and plays an important role in modern agriculture. The sufficient application of N could improve the photosynthesis efficiency of the leaves (Liu et al., 2018). While K was an activator of various important enzymes such as protein synthesis, sugar transport, N and C metabolism, and photosynthesis (Marschner, 2012).

The administration of nano NPK sprayed onto the leaves on *Vicia faba* (baby beans) increases growth and yield and differs markedly from those not given (Aziz & Zrar, 2021). The NPK used at optimal doses could complement the adequate absorption of nutrients, which promotes conditions for better plant growth and development (Gaber et al., 2019).

Other nutrients that also play an important role in the growth and development of pakcoy plants were Ca, Mg and Mn. Calcium (Ca) plays a role in the integrity of cell membranes and synergizes with boron (B) in building plant cell walls (Galeriani et al., 2022). The Mg deficiency affects photosynthesis and sugar transport from the source-to-sink organ (Ye et al., 2019).

Magnesium and mangan (Mn) were nutrients that make up plant chlorophyll, the drivers of various plant enzymes needed in the growth process, and to balance the use of N, P and K which were generally high from fertilizers. The study results of Shaheen et al. (2013) show that the administration of Ca, Mg and Mn in onion plants increases plant vigor and bulb yield. The combination of Mg and Zn administered through leaves increases chlorophyll content and stomata resistance in chickpeas (Yeboah et al., 2021).

The micronutrients were nutrients needed by the plants in small quantities, and their lack causes a decrease in plant productivity (Sherefu & Zewedi, 2021). The presence of micronutrients in NASA LOF encourages better pakcoy growth. The study results of Singh et al. (2017) in broccoli show that given B, Mn and Zn simultaneously increase the growth and yield; likewise, the shallots (Rashid & Islam, 2019), and tomatoes (Kumari & Sarika, 2021). The content of hormones such as auxin, gibberellin, and cytokinins makes NASA LOF a very complete liquid fertilizer. The results of this study were in line with the results of the research conducted by Khadr et al. (2020) where the provision of IBA (Indole 3-butyric acid) improves the morphological character of carrot plants, while cytokinin and gibberellin given to corn were able to increase the leaf length and the panicle length (Nasution & Friska, 2020).

The study results showed that an increase in LOF concentrations above 10 ml/l decreased the plant growth and yield. The application of NASA liquid organic fertilizer with a concentration of 10 ml/l was able to provide nutrients that were in accordance with the needs of pakcoy plants for their growth and development, especially when grown in limited and suboptimal growing media. The provision of LOF with excessive concentration could cause antagonistic effects between nutrients, thereby affecting their effectiveness and could reduce the plant growth and yield. The results of this study were in line with those conducted by Ichwan et al. (2021) in red chili peppers where the application of foliar fertilizers containing various macro and micro nutrients decreases the Ca and Mg levels of the leaves by increasing the K levels of the leaves.

There was an increase in pakcoy yields with the administration of NASA LOF; however, compared to the potential yield of pakcoy variety of Nauli in the form of fresh weights per plant of 400–500 g or around 37–39 tons per hectare with a population of 93.000 plants, the results obtained from this study were still low (70–130 g per plant). This was presumably because the growing environment was less supportive of the plant growth and development such as excessive sunlight and the mixture of growing media used. The use of paranet and biological fertilizers such as trichoderma or tricho-compost were expected to increase the growth and yield of pakcoy better to achieve the potential results.

CONCLUSION

The application of liquid organic fertilizer can increase the growth and yield of pakcoy grown in pots or polybags. The pakcoy yield in the form of the highest fresh weight of 130 g per plant is obtained on the liquid organic fertilizer with a concentration of 10ml/l. The results of this study have just been able to meet 26%–33% of the potential pakcoy yields.

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