

Analysis Of The Use Of Moringa Leaf (*Moringa oleifera*) Liquid Organic Fertilizer (LOF) On The Growth And Yield Of Pak Choi (*Brassica rapa* l.)

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ABSTRACT

The purpose of the research to determine the effect of providing liquid organic fertilizer (POC) from moringa leaves on several parameters of pak choi plants, namely plant height, number of leaves, root volume, wet weight of plants, and growth rate. The study was conducted in April - June 2025 in a yard located in Sentulan Hamlet, Bongkot Village, Peterongan, Jombang. The method used in this study is a quantitative method with a Completely Randomized Design (CRD). This method applies 5 treatments, namely P0 (Control Land), P1 (Provision of 30 ml/L moringa leaf POC), P2 (Provision of 40 ml/L moringa leaf POC), P3 (Provision of 50 ml/L moringa leaf POC), and P4 (Provision of 60 ml/L moringa leaf POC). The results of the study showed that from the results of the ANOVA, plant height was known to be $F_{hit} (0.64) < F_{5\%} (2.57)$, the number of leaves was known to be $F_{hit} (0.93) < F_{5\%} (2.57)$, wet weight was known to be $F_{hit} (0.55) < F_{5\%} (2.57)$, and growth rate is known $F_{hit} (0.69) < F_{5\%} (2.57)$ meaning that liquid organic fertilizer of Moringa leaves had no effect on the four growths, but on root volume it was known that $F_{hit} (2.94) > F_{5\%} (2.57)$, meaning that liquid organic fertilizer of Moringa leaves only had an effect on the growth of the root part. So that the liquid organic fertilizer (POC) treatment of moringa leaves only affects the root volume of the pak choi plant.

Keywords: Liquid organic fertilizer; Moringa leaves; Pak choi.

INTRODUCTION

Indonesia is an archipelago situated in the tropics, blessed with abundant natural resources. One manifestation of this abundance is the wide variety of vegetables grown. The vegetables consumed by the population are rich in nutrients essential for human health, such as fibre, minerals and vitamins. In this cultivation, to maintain and produce high-quality vegetables, the most popular or favoured vegetable is pak choi (*Brassica rapa* L.). According to data from the Indonesian Central Statistics Agency (2019), the production of pak choi in West Java from 2017 to 2019 has been declining year on year. There has been a decline in the production of pak choi in West Java. Between 2017 and 2018, production fell by 7% from 216,174 tonnes to 201,004 tonnes, then in 2018–2019, Chinese cabbage production in West Java fell again by 11%, from 201,004 tonnes to 179,925 tonnes in 2019, particularly as the Indonesian public desires an abundance of horticultural produce.

Pak choi is a leafy vegetable belonging to the Brassicaceae family; it is a vegetable introduced from China that is now widely cultivated in Indonesia. Pak choi, commonly known as 'spoon cabbage', is a heat-tolerant vegetable, meaning it can be grown in lowland to highland areas (100 to 1,000 metres above sea level). Pak choi has a relatively short growing cycle, maturing 30 to 45 days after planting, with a potential yield of 20 to 25 tonnes per hectare (Wahyudi, 2010). There are four identifiable types of Chinese cabbage: pak choi, green Chinese cabbage, white Chinese cabbage and kailan (Safitri, 2019).

Fertilisation is intended as a means of improving soil fertility, which can boost the yield of Chinese cabbage. Another objective of fertilisation is to provide sufficient nutrients for healthy growth; fertilisers are categorised into two types: organic and inorganic. Inorganic fertilisers, however, tend to pose risks to the environment, which can adversely affect the soil and hinder plant growth and development (Haryadi et al., 2007). One way to increase crop yields is by improving soil fertility through the application of organic fertilisers (Effendy et al., 2019).

Liquid organic fertiliser (LOF) is a type of fertiliser that can help restore soil fertility and promote

optimal growth in Chinese cabbage plants. Generally, liquid fertiliser is made from a mixture of materials, including plant waste and other organic matter that can provide nutrients essential for plant growth, such as moringa leaves, which are used as an ingredient in the production of liquid fertiliser. According to Fuglie (2020), the application of moringa extract to onions, peppers, beans, soya, sorghum, coffee, tea, chillies, melons and maize will result in optimal growth and development. Moringa leaf extract can be sprayed onto the leaves to accelerate plant growth (Krisnadi, 2012).

When applying foliar fertiliser, the timing of application must be carefully considered. According to Pertiwi (2011), plants can only absorb a limited amount of nutrients, so foliar fertiliser must be applied regularly. Therefore, to make it more efficient, due attention must be paid to the concentration and the interval between doses when applying it. The timing of fertiliser application influences plant growth in various ways, as stated by Soetejo and Kartasapoetra (1988) in the study by Jumini et al. (2012).

This study aims to investigate the effect of liquid organic fertiliser made from moringa leaves on plant height, growth rate, number of leaves, root volume and fresh weight in pak choi plants.. Although several studies have reported the beneficial effects of Moringa leaf extract on vegetable crops, information regarding the optimum concentration of Moringa leaf liquid organic fertilizer for pak choi under local cultivation conditions remains limited. Therefore, this study evaluated several concentrations of Moringa leaf liquid organic fertilizer to identify the most effective concentration for improving pak choi growth

METHOD

The study was conducted on backyard plots in Sentulan Hamlet, Bongkot Village, Peterongan Sub-district, Jombang Regency, East Java, from April 2025 to June 2025. This study employed a Completely Randomised Design (CRD) with five treatments and ten replicates, arranged in several polybags. The method used are bok choy seeds, moringa leaves, EM4, compost soil, brown sugar, distilled water or plain water, and liquid organic fertilizer. The tools used in the research include small polybags, label paper, a hoe, a knife, a ruler, a digital scale, writing instruments, a camera, a TDS meter, a container (bucket or gallon), and the tools needed for the writing. Each polybag was treated with one plant, resulting in a total of 50 pak choi plants. The treatments comprised five levels: K0 = Control; K1 = Soil and 30 ml/L liquid organic fertiliser; K2 = Soil and 40 ml/L liquid organic fertiliser; K3 = Soil and 50 ml/L liquid organic fertiliser; K4 = Soil and 60 ml/L liquid organic fertiliser (POC is applied by watered).

Observations were made when the plants were 7, 14, 21, 28, 35 and 42 days old. The observations included plant height, number of leaves and growth rate. Observations of root volume and fresh plant weight were carried out at harvest, i.e. 42 days after sowing. Data analysis was performed using analysis of variance at the 5% significance level. Significant results from the analysis of variance were followed by a Least Significant Difference test at the 5% level (Data analysis using Excel software).

RESULT AND DISCUSSION

The growth of pak choi plants treated with liquid organic fertiliser (POC) made from moringa leaves was monitored by measuring plant height, number of leaves, root volume, fresh weight, and growth rate, with measurements taken from 7 days after sowing (DAS) until the final observation at 42 DAS.

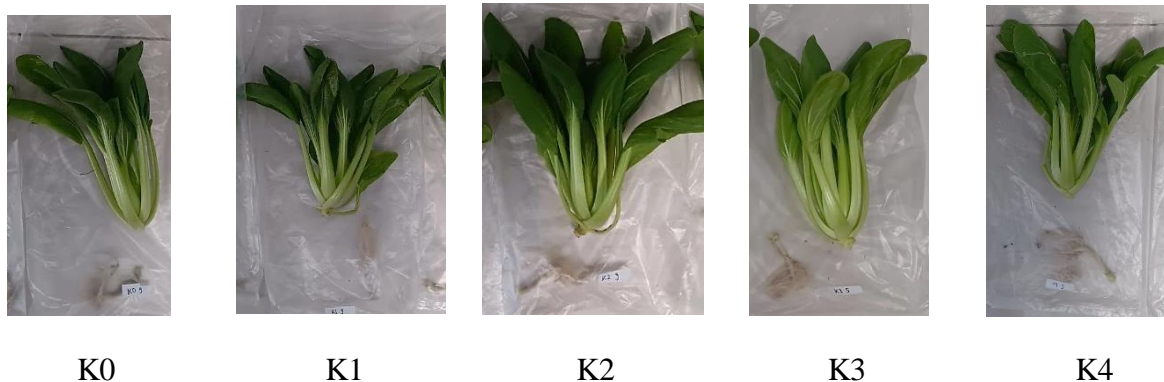


Figure 1 Photographs of plants per treatment

Notes: K0; Control, K1; 30 ml/L moringa leaf POC, K2; 40 ml/L moringa leaf POC, K3; 50 ml/L moringa leaf POC, K4; 60 ml/L moringa leaf POC

Result

Plant Height

The results of the study on plant height, following the application of liquid organic fertiliser made from moringa leaves, showed no significant effect or difference on the height of pak choi plants. Although not significant at 42 days after sowing, treatment K2 (40 ml/L) showed the highest average result of all treatments, not differing significantly from treatment K0 (Control). Thus, treatment K2 contributed to the application of liquid organic fertiliser made from moringa leaves to the pak choi plants. Table 1 below shows the results of further tests on the plant height parameter;

Table 1 Results of Further Tests on Plant Height in Pak Choi Plants Treated with Moringa Leaf POC at 42

Treatment	Average Plant Height (cm)		
	14	28	42
K0: Control	4,75	16,65	20,59
K1: POC 30 ml/L	5,12	15,21	19,81
K2: POC 40 ml/L	4,77	15,22	20,83
K3: POC 50 ml/L	4,81	15,11	20,39
K4: POC 60 ml/L	4,78	15,76	19,47
F count	0,556598	1,061695	0,649041
F table 5%		2,578739	
BNT	tn	tn	tn

Note: tn = Not significantly different at the 95% confidence level ($\alpha = 0.05$).

Number of Leaves

The results of the study on leaf number showed that the application of liquid moringa leaf organic fertiliser had no effect on the number of leaves on pak choi plants. Although not statistically significant at 42 days after sowing, treatment K1 (30 ml/L) showed the highest average number of leaves, which was not significantly different from treatment K0 (Control), which had the highest number of leaves on the pak choi plants. Table 2 below shows the results of the post-hoc test for the leaf number parameter;

Table 2 Results of Further Tests on Leaf Count in Pak Choi Plants Treated with Moringa Leaf POC at 42

Treatment	Average Number of Leaves		
	14	28	42
K0: Control	4,9	7,6	13,4
K1: POC 30 ml/L	4,6	7,4	13,4
K2: POC 40 ml/L	4,6	7,4	13,1
K3: POC 50 ml/L	4,6	7,1	12,4
K4: POC 60 ml/L	4,7	7,1	12,4
F count	0,75	0,72931	0,93253
F table 5%		2,578739	
BNT	tn	tn	tn

Note: tn = Not significantly different at the 95% confidence level ($\alpha = 0.05$).

Root Volume

The results of the study on root volume parameters indicate that the application of liquid organic fertiliser made from moringa leaves affects the root volume of pak choi plants. The table above shows that the smallest root volume was observed in the treatment using 50 ml/L of liquid organic fertiliser made from moringa leaves, suggesting that the uptake of this liquid organic fertiliser was insufficient. Table 3 below shows the results of further tests on root volume parameters;

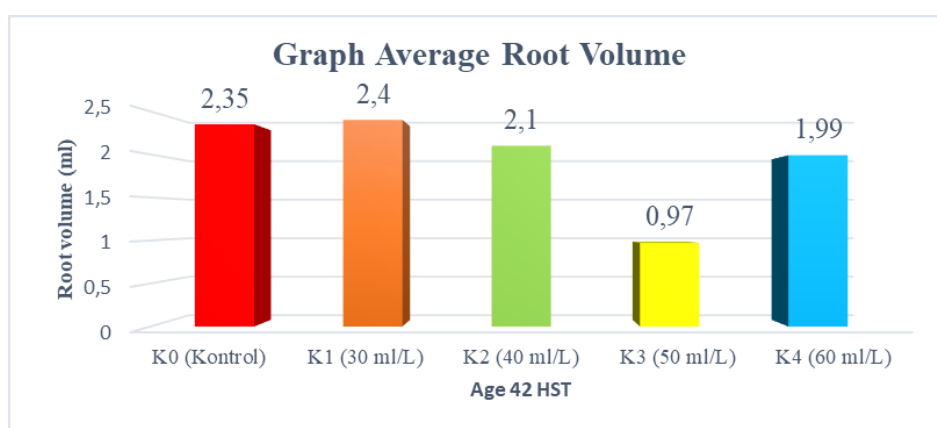
Table 3 Results of Further Tests on Average Root Volume in Pak Choi Plants Treated with Moringa Leaf POC

Treatment	Average Root Volume (ml)
K0: Control	2,35 cd
K1: POC 30 ml/L	2,4 cde
K2: POC 40 ml/L	2,1 c
K3: POC 50 ml/L	0,97 a
K4: POC 60 ml/L	1,99 b
F count	2,946911
F table 5%	2,578739
BNT	*

Note: * = statistically significant at the 95% confidence level ($\alpha = 0.05$).

The highest average root volume was observed in treatment K1 (30 ml/L), followed by treatment K0 (Control) and K2 (40 ml/L). Treatments K4 (60 ml/L) and K3 (50 ml/L) had the lowest average root volumes when moringa leaf POC was applied to pak choi plants. Below is a graph showing the average root volume following the application of moringa leaf POC to pak choi plants;

Figure 2 Graph of the average volume of the root



Wet Weight of Crops

The results of the study on plant fresh weight showed that the application of liquid organic fertiliser made from moringa leaves had no effect on the fresh weight of pak choi plants. Although not statistically significant, treatment K2 (40 ml/L) involving the application of liquid organic fertiliser did not differ significantly from the treatment without liquid organic fertiliser, namely treatment K0 (Control). It can be observed that the average fresh weight was almost the same with and without organic fertiliser; however, the insufficient application rate may have resulted in stunted growth and development of the pak choi plants. Table 4 below shows the results of further tests on the fresh weight parameters of the plants;

Table 4 Results of Further Tests on the Average Wet Weight of Pak Choi Plants Treated with Moringa Leaf POC

Treatment	Average Wet Weight (gr)
K0: Control	35,6
K1: POC 30 ml/L	33,9
K2: POC 40 ml/L	35,3
K3: POC 50 ml/L	30,2
K4: POC 60 ml/L	29,6
F count	0,555962
F table 5%	2,578739
BNT	tn

Note: tn = Not significantly different at the 95% confidence level ($\alpha = 0.05$).

Plant Growth Rate

The results of the study on growth rate parameters showed that the application of liquid organic

fertiliser made from moringa leaves had no effect on the growth rate of pak choi plants. Although not statistically significant, treatment K3 (50 ml/L), which involved the application of liquid organic fertiliser, did not differ significantly from treatment K0 (Control), which did not involve any fertiliser. It can be seen that the control group (without fertiliser) exhibited the highest growth rate, but this was not significantly different from the group with fertiliser, due to the application of a low concentration dose, which resulted in insufficient nutrient uptake by the pak choi plants. Table 5 below shows the results of further tests on the growth rate parameters of the plants;

Table 5 Results of Further Tests on the Average Growth Rate of Pak Choi Plants Treated with Moringa Leaf POC

Treatment	Average Growth Rate
	(cm/week)
	42
K0: Control	17,72
K1: POC 30 ml/L	17
K2: POC 40 ml/L	18,03
K3: POC 50 ml/L	17,58
K4: POC 60 ml/L	16,71
F count	0,6948341
F table 5%	2,578739
BNT	tn

Note: tn = Not significantly different at the 95% confidence level ($\alpha = 0.05$).

Discussion

Plant Height

Plant height is measured from the base of the stem at ground level to the tip of the leaf pointing straight upwards in line with the stem (Sulaiman et al., 2018). The application of moringa leaf POC had virtually no effect, as doses of just 30 ml/L to 60 ml/L do not affect plant height; a higher concentration, such as above 70 ml/L, must be applied, and this should be done once a week. The higher the concentration applied, the more the moringa leaf POC promotes optimal growth in the height of the pak choi plants. This is consistent with Suhastyo (2019), who found that applying moringa leaf extract at a concentration of 70 mL/L MOL every 6 days was able to increase plant height. As for hormones useful for plant height, gibberellins are beneficial for the height of pak choi plants. This is in line with Rady et al. (2021), who explain that the presence of gibberellins also contributes to stem elongation and flower formation, which ultimately impacts increased plant productivity. According to Junaidi (2021), moringa leaves are rich in macronutrients such as N, P, K, and Ca, indicating their potential as a liquid organic fertiliser. Plant height requires nitrogen (N) content, which influences cell division, particularly in the shoot tips, and plays a role in vegetative growth, whilst potassium plays a role in photosynthesis.

Number Of Leaves

Leaf number is one of the parameters influenced by the nitrogen content absorbed by plants for photosynthesis, and it also reflects the vegetative growth of plants (Wasilah et al., 2019). Pak choi plants require a significant amount of nitrogen due to their vegetative growth in stems and leaves. Leaf number will increase as the nitrogen content absorbed by the pak choi plants increases. According to Rajak (2016), nitrogen serves to stimulate overall growth, particularly of the stem, branches and leaves, and plays a vital role in the formation of chlorophyll, which is essential for the process of photosynthesis. According to Cahyono (2016), the nutrients most influential in increasing leaf number are N, Fe, and Mg. Each week, the number of leaves per plant increases, although some plants exhibit a lower leaf count. This relates to the role of leaves in photosynthesis; if the number of leaves is insufficient, photosynthetic capacity decreases due to reduced chlorophyll content and a lower photosynthetic rate per unit leaf area. This is consistent with Suhastyo et al. (2019), who state that leaves are the site of photosynthesis because they contain chlorophyll; thus, the greater the number of leaves, the more sites there are for photosynthesis to support the plant's needs. Consequently, a deficiency in nitrogen (N) can inhibit the ability to stimulate the growth of new leaves. The reduced number of leaves is due to the very limited amount of nutrients absorbed.

The number of leaves in the moringa leaf POC treatments K1 at a concentration of 30 ml/L, K2 at 40 ml/L, K3 at 50 ml/L, and K4 at 60 ml/L was sufficiently high, indicating that pak choi received adequate nutrition. According to research conducted by Kurniawan (2024), it was shown that the application of moringa leaf POC at concentrations of 25 ml/L, 50 ml/L, and 75 ml/L resulted in a greater number of leaves and provided sufficient nutrients, leading to improved metabolism and a positive impact on the growth of the pak choi plants.

Root Volume

Roots are plant organs that function to absorb nutrients and water (which plants require for their growth and development) from the soil. Moringa leaf liquid organic fertiliser has a significant effect on the root volume of pak choi plants. According to Noer et al., (2023), the nutrients contained in liquid organic moringa leaf fertiliser include nitrogen (N), phosphorus (P), potassium (K), iron (Fe), magnesium (Mg), calcium (Ca), and sulphur (S). Phosphorus is required in greater quantities in plant parts with high metabolic activity and rapid cell division, such as plant shoots and root tips, during flower initiation, and the formation, development, and ripening of seeds and fruits (Purba et al., 2021). Another factor influencing root volume is the iron (Fe) content found in liquid organic fertiliser made from moringa leaves, which aids root development. This aligns with Purba et al. (2021), who explain that one of the key functions of iron is to support the development of root tip meristems. The highest root volume was observed with the liquid organic fertiliser treatment compared to the control without liquid organic fertiliser, indicating a significant effect and maximised nutrient uptake.

Liquid organic fertiliser plays a vital role in soil by loosening the topsoil, improving water absorption and retention capacity, and enhancing soil fertility, thereby facilitating root growth for nutrient uptake. This is consistent with Laviendi et al., (2015), who explain that the use of organic fertilisers can provide several benefits, namely supplying macro- and micro-nutrients to plants, loosening the soil, improving soil structure, facilitating plant root growth, and prolonging water absorption in the soil. According to Jayantie et al. (2017), liquid organic fertiliser influences root volume; the larger the root volume, the wider the root spread, thereby maximising the uptake of water and nutrients from the soil.

Wet Weight Of Crops

The fresh weight of a plant is the result of the accumulation of various food reserves, such as proteins, carbohydrates and fats (Wasilah et al., 2019). The higher the fresh weight, the more optimal the metabolic processes taking place. Conversely, a low fresh weight indicates an impediment to the plant's metabolism. Liquid organic fertiliser made from moringa leaves had no significant effect on the fresh weight of pak choi plants. The fresh weight of pak choi plants treated with liquid organic moringa leaf fertiliser was not significantly different from that of untreated plants, but the results suggest that the higher the dose of fertiliser, the greater the amount of nutrients absorbed by the plants. Sufficient and balanced nutrient availability ensures that the plant's metabolic processes run optimally. This is consistent with the theory of Machfudz et al. (2019), that fresh weight is influenced by the carbohydrate and water content formed during photosynthesis; photosynthetic activity is greatly influenced by the number of leaves and the intensity of sunlight received by the leaves.

According to Munthe et al. (2018), photosynthesis undergoes changes through the process of respiration, which produces the energy required by plant cells so that leaves can grow in width and length. Liquid organic fertiliser made from moringa leaves contains macro- and micro-nutrients that enhance photosynthetic activity in pak choi plants and the production of carbohydrates as food reserves. The presence of nutrients in pak choi plants aids plant growth and development; for instance, nitrogen (N) functions as a protein component, phosphorus (P) facilitates cell division, and potassium (K) regulates stomatal activity to optimise transpiration control and enhance the conversion of carbon dioxide into carbohydrates. The fresh weight of pak choi plants is significantly influenced by the number of leaves. This is consistent with the theory of Veranica et al. (2015), which states that photosynthesis occurs in the leaves. As pak choi plants produce a large number of leaves, this results in a higher fresh weight of the plant. The fresh weight of the plant is also influenced by the water content absorbed; the more water absorbed, the higher the fresh weight of the plant.

Plant Growth Rate

Growth rate indicates the early stage at which a plant begins to develop. If the plant fails to grow optimally at this stage, its growth process will be disrupted overall. A lack of visible response suggests that the availability of nutrients in the soil is sufficient to meet the plant's requirements. When soil conditions are favourable, plants can carry out photosynthesis to the full, resulting in an increase in both size and height (Winata et al., 2012). Moringa leaf liquid organic fertiliser had no significant effect on growth rate due to the lack of an appropriate concentration dose being applied to the pak choi plants. However, the highest growth rate was observed in the moringa leaf liquid organic fertiliser treatment compared to the control.

Moringa leaf liquid organic fertiliser contains macro- and micro-nutrients that aid plant growth, such as nitrogen (N) and phosphorus (P). According to Omariah et al. (2019), nitrogen is a macronutrient that plays a role in cellular metabolism; in addition to nitrogen, phosphorus also has a significant impact on growth. This is also consistent with Hawkesford et al. (2023), who explain that the primary increase is due to the role of nitrogen in accelerating cell division and enlargement, thereby promoting the rate of plant growth. The liquid organic fertiliser obtained from moringa leaves contains 1327 ppm, meaning that the nutrient content of this liquid organic fertiliser significantly influences the growth of pak choi plants. This is consistent with Erma (2023), who states that the application of moringa leaf liquid organic fertiliser at a moderate concentration, such as 80 ml/L or equivalent to 1000 ppm, results in the fastest growth and the most beneficial effects on all parameters, one of which is the fresh weight of the plants.

Based on the findings of Eldo (2023), the application of moringa leaf extract at a concentration of 9% (90 ml/L) had a positive effect on leaf growth, plant dry weight and stem diameter in pak choi plants. The optimal concentration for plant growth was found to be 40 ml/L, as this dose is likely appropriate and ensures stability in nutrients such as nitrogen and potassium. This is consistent with Nurhasanah et al. (2015), who stated that sufficient nitrogen can play a role in accelerating overall plant growth. According to Waruwu et al. (2018), potassium plays a vital role in accelerating or stimulating the growth of plant meristematic tissues and strengthening the stems, whilst significantly supporting the process of photosynthesis. Consequently, the presence of nitrogen and potassium is crucial for the growth of pak choi plants.

CONCLUSIONS

Based on the research discussion on the analysis of the use of liquid organic fertiliser (POC) made from moringa leaves (*Moringa oleifera*) on the growth and yield of pak choi (*Brassica rapa* L.), the research findings can be summarised as follows:

1. The application of liquid organic fertiliser (LOF) made from moringa leaves had no significant effect on plant height during the growth and yield of pak choi. The insufficient concentration of the fertiliser prevented the plants from growing to their full potential
2. The application of liquid organic fertiliser (LOF) made from moringa leaves had no significant effect on the number of leaves during the growth and yield of pak choi. A deficiency in absorbed nitrogen nutrients thus hindered the ability to stimulate new leaf growth
3. The application of liquid organic fertiliser (LOF) made from moringa leaves has a significant effect on root volume parameters in the growth and yield of pak choi. This effect is due to the phosphorus content, which supports the development of the root system
4. The application of liquid organic fertiliser (LOF) made from moringa leaves had no significant effect on the fresh weight parameters of pak choi plant growth and yield. The concentration of the application must be appropriate to aid the development of the pak choi plants
5. The application of liquid organic fertiliser (LOF) made from moringa leaves had no significant effect on growth rate parameters in the growth and yield of pak choi. The use of inappropriate concentrations may inhibit the growth rate of these plants.

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