

THE EFFICACY OF SEVERAL LEMONGRASS (*Cymbopogon nardus*) FORMULATIONS FOR PAKCOY PEST CONTROL

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Abstract

Pakcoy (*Brassica rapa* sub sp. *chinensis*) or bok choy is not just an ordinary green vegetable. This plant has enormous importance in terms of nutrition, economy, and the environment. The study used a completely randomized design with 12 treatments and 3 replicates, resulting in 36 research units. The twelve treatments were A0B0: no plant-based pesticides + no liquid organic fertilizer, A0B1: no plant-based pesticides + liquid organic fertilizer, A0B2: no plant-based pesticides + manure + liquid organic fertilizer, A1B0: lemongrass + no liquid organic fertilizer, A1B1: Lemongrass simplisia + liquid organic fertilizer, A1B2: Lemongrass simplisia + livestock manure + liquid organic fertilizer, A2B0: Lemongrass powder + no liquid organic fertilizer, A2B1: Lemongrass powder + liquid organic fertilizer, A2B2: Lemongrass powder + manure fertilizer + liquid organic fertilizer, A3B0: Lemongrass oil + No liquid organic fertilizer, A3B1: Lemongrass oil + liquid organic fertilizer, A3B2: Lemongrass oil + manure fertilizer + liquid organic fertilizer. The parameters observed were pest population, natural enemy population, pest attack intensity, and crop yield. Observations were conducted at weekly intervals. Data obtained for each parameter were analyzed using the F-test, and if significant differences were found, the Duncan test was conducted at the 5% level. The data obtained included the number of leaves, pest and natural enemy populations, and the intensity of major pest attacks. Pests that attack pakcoy plants include aphids (*Myzus persicae*), armyworms (*Spodoptera* spp.), leaf miners (*Liriomyza* spp.), thrips (*Thrips* sp), and grasshoppers (*Valanga nigricornis*). The main pests that attack pakcoy plants are leaf miner flies and armyworms. Applying several formulations of lemongrass to pakcoy plants can control the population of leaf miner flies. Natural enemies of pakcoy plants are Coccinellidae beetles. The use of several formulations can reduce the intensity of leaf miner fly and armyworm attacks on pakcoy plants. The highest root weight and pakcoy plant weight were achieved with the combination treatment of goat manure and liquid organic fertilizer.

Keywords: efficacy, formulation, lemongrass, pakcoy

A. Introduction

Pakcoy (*Brassica rapa* sub sp. *chinensis*) or bok choy is not just an ordinary green vegetable. This plant has enormous importance in terms of nutrition, economy, and the environment. Here are some of the important values of pakcoy: it is high in fiber, which is good for digestion; it is easy to cultivate and has a relatively short harvest cycle, making it a good source of income for farmers;

and high market demand makes pakcoy a profitable commodity. In addition, pakcoy can be grown using hydroponics, which reduces water and land use. This plant is also suitable for sustainable agriculture systems as it requires minimal pesticides. Pakcoy can be prepared into various dishes, from stir-fries, soups, to salads, making it highly versatile in the kitchen. With these significant values, pakcoy deserves greater attention in efforts to promote health and support sustainability.

Several factors that trigger pest attacks on pakcoy plants include: environmental conditions such as optimal temperature and humidity can support pest population growth. Monoculture planting patterns or continuous planting of pakcoy in the same field can increase the risk of pest attacks. Excessive or inappropriate use of pesticides can cause pest resistance, making pests more difficult to control. Excessive use of pesticides can also kill the natural enemies of these pests, causing pest populations to increase. The remains of pest-infected plants can be a source of transmission for subsequent pakcoy plants. Natural enemies such as predators and pest parasitoids can help control pest populations. The lack of natural enemies can cause pest populations to increase. By understanding pest problems and their causes, farmers can take appropriate prevention and control measures to protect their pakcoy plants. (Kare et al., 2023) mentioned that in pakcoy harvesting, the taller the plant, the greater the number of leaves and roots, and the greater the fresh weight of the plant.

Lemongrass (*Cymbopogon nardus*) has great potential as a natural insecticide due to its chemical compounds, especially citronellal, geraniol, and linalool. These compounds have effective insecticidal properties against various pests, including those that often attack pakcoy plants such as tritip caterpillars and leaf lice. The mechanism of lemongrass as an insecticide is as follows: repellent, namely its strong aroma can disrupt the olfactory system of insects, causing them to stay away from pakcoy plants; toxicity, namely the compounds in lemongrass can damage the nervous system of insects, causing paralysis and death, and growth inhibitor, namely lemongrass can inhibit the growth of insect larvae, preventing them from reaching adulthood.

The advantages of lemongrass as a natural insecticide are that it is environmentally friendly, easily biodegradable, and leaves no harmful residues on plants or in the environment. Compared to synthetic insecticides, lemongrass is relatively safe for humans and pets. It is easily obtained, as it is easy to cultivate and process into insecticide. Lemongrass can be used for essential oil extraction, and lemongrass essential oil can be extracted and formulated into spray insecticides. Lemongrass

can be used directly in the form of crude extract or powder to be applied to pak choi plants. Further research is needed to optimize the effectiveness of lemongrass as a botanical insecticide. With this potential, lemongrass offers a natural and sustainable solution for pest control in pakcoy plants, reducing dependence on harmful chemical insecticides. Widya *et al.*, (2022) botanical formulations in the form of simplisia have the potential to be used as botanical pesticides.

Based on the percentage of leaf damage, the pesticides that are effective in suppressing pest attacks that damage the leaves of pakcoy plants (*Brassica rapa*. L) can be seen in the final results or fourth observation, namely mimba leaf extract (9,70%), propenofos active ingredient (11,07%), kepayang tree bark extract (12,51%), tobacco leaf extract (12,01%), papaya leaf extract (12,49%), and control at 20,87% (Reno Julian Putera Nalu, Samharinto, 2021). It is hoped that the results of this study can be applied in the community, particularly in the field of pakcoy plant pest management.

B. Literature Review and Hypothesis Development

Lemongrass (*Cymbopogon nardus*) has great potential as a natural insecticide due to its active compounds, such as citronellal, geraniol, and limonene. These compounds have effective insecticidal, fungicidal, and bactericidal properties for controlling various plant pests. The potential for developing lemongrass essential oil formulations can be formulated into environmentally friendly and human-safe botanical insecticides. Effective for controlling pests such as mosquitoes, flies, aphids, and caterpillars. Product development can take the form of developing lemongrass insecticide products in various forms, such as sprays, lotions, and fumigants. The development of lemongrass insecticide products combined with other natural ingredients to increase their effectiveness. Feriyanto *et al.*, (2013) Lemongrass formulations in the form of distilled oil have the potential to be developed. One of them is as a natural pesticide.

Further research on the mechanism of action of lemongrass active compounds as insecticides. Development of efficient extraction and formulation techniques to produce high-quality lemongrass insecticides. Application of lemongrass insecticide in organic and conventional agriculture to reduce the use of synthetic insecticides. Development of a targeted and efficient lemongrass insecticide application system. Lemongrass also has additional benefits as a fungicide and bactericide, thereby protecting plants from various diseases. The distinctive aroma of lemongrass can also function as an insect repellent. The development of lemongrass as a plant-based

insecticide has great potential to support sustainable and environmentally friendly agriculture. Lemongrass has potential as a plant-based pesticide due to its ability to kill rice weevils (Apriliyanto & Suhastyo, 2024).

Pest problems in pakcoy require serious attention from farmers and researchers to develop effective and sustainable control strategies. Asnur & Ramdan, (2023) found that the types of pests encountered were the armyworm *Spodoptera litura*, the diamondback moth *Plutella xylostella*, the green stink bug (*Nezara viridula*), the brown stink bug (*Riptortus linearis* F), beetles (*Phyllotreta* sp.), and leaf miner flies (*Liriomyza brassicae*). Riza Juanda, Apriani & Iswahyudi, (2022) *Crocidolomia pavonana* is also an important pest that damages pakcoy plants. This pest can reduce crop yields. Environmentally friendly efforts are needed to control pakcoy plant pests. It is suspected that some lemongrass formulations can protect pakcoy crops from pest attacks.

C. Research Method

Pakcoy seeds are sown in seed trays with soil medium: compost fertilizer in a ratio of 1:1. The seeds are spread on the seed trays and covered with planting medium. Watering is carried out until the seed medium is sufficiently moist. Sowing is carried out for 2 weeks. Transplanting is carried out in 30 x 30 cm polybags containing soil: compost fertilizer 1:1. Handayani & Elfarisna, (2021) thinning is carried out in the first week after transplanting. Watering is carried out every day, every morning and evening. Powder, simplisia, and lemongrass oil are obtained by purchasing them ready for use (online purchase). Apply liquid organic fertilizer once a week for four applications. This liquid organic fertilizer is made from organic banana stems and rice washing water (Suhastyo and Setiawan, 2024).

The study used a completely randomized block design with 12 treatments: A0B0: no botanical pesticides + no liquid organic fertilizer; A0B1: no botanical pesticides + liquid organic fertilizer; A0B2: no botanical pesticides + manure fertilizer + liquid organic fertilizer; A1B0: lemongrass extract + no liquid organic fertilizer; A1B1: lemongrass simplisia + liquid organic fertilizer; A1B2: lemongrass simplisia + livestock manure + liquid organic fertilizer; A2B0: lemongrass powder + no liquid organic fertilizer; A2B1: lemongrass powder + liquid organic fertilizer; A2B2: lemongrass powder + livestock manure + liquid organic fertilizer; A3B0: lemongrass oil + no liquid organic fertilizer; A3B1: lemongrass oil + liquid organic fertilizer; A3B2: lemongrass oil + livestock manure + liquid organic fertilizer.

The powder formulation consists of 15 g of powder dissolved in 1.000 mL of distilled water. Next, the powder is dissolved in distilled water with a concentration of 30%. The lemongrass oil formulation consists of 70% alcohol with a concentration of 30%. Pukan is manure from goat dung. The lemongrass simplisia formulation is used as a planting medium mulch in polybags. Each treatment uses 3 replicates, resulting in 36 research units. The parameters observed are:

a. Pest population

The number of pests associated with pakcoy plants was counted at weekly intervals after transplanting.

b. Natural enemy population

The number of natural enemies associated with pakcoy plants was counted at weekly intervals after transplanting).

c. Pest attack intensity

The intensity of pest attacks on pakcoy plants was counted at weekly intervals after transplanting. The intensity of attacks can be determined using the formula by Hidayat Natawigena, (1993).

$$P = \frac{\sum nxv}{ZxN} \times 100\%$$

Description:

P : Percentage of attack

N : Number of leaves observed from each attack category

V : Scale value of each attack category

Z : Scale value of the highest attack category

N : Number of leaves observed

Scale values for each attack category:

0 : No attack

1 : Damage $\leq$ 25% of the observed leaf area

2 : Damage $> 25\% - \leq 50\%$ of the observed leaf area

3 : Damage $> 50\% - \leq 75\%$ of the observed leaf area

4 : Damage $> 75\%$ of the observed leaf area

d. Harvest yield

Harvest yield is observed based on the number of leaves and fresh weight of plants, including root weight and plant weight.

The data obtained for each parameter was analyzed using the F test. If there were significant differences, the analysis was continued with Duncan's test at a 5% level.

D. Discussion

Pests that attack pakcoy plants include aphids (*Myzus persicae*), armyworms (*Spodoptera* spp.), leaf miners (*Liriomyza* spp.), thrips (*Thrips* sp), and grasshoppers (*Valanga nigricornis*). The dominant pest that can be observed is the leaf miner fly *Liriomyza* spp. It usually has the habit of resting on the upper surface of pakcoy leaves. The adult leaf miner flies are active during observation. Damage to the leaves in the form of silver or white grooves reduces the quality of the harvested leaves. Mulholland *et al.*, (2022) reported that the leaf miner fly *Liriomyza huidobrensis* is a highly polyphagous insect pest that threatens global vegetable and ornamental horticultural production due to the damage it causes by feeding and laying eggs on plants. Tran and Tran, (2023) reported that the total development time of leaf miner flies from eggs to adults on pakcoy leaves was 18,2 days, while the fecundity of adult flies on pakcoy was 73,3 eggs.

Table 1. Population of *Liriomyza* sp leaf miner flies

Treatment	Population of <i>Liriomyza</i> sp			
	1 wap ^{ns}	2 wap ^{ns}	3 wap ^{ns}	4 wap ^{ns}
A0B0	1	0,33	0,33	0
A0B1	0	0	0,33	0
A0B2	0	0	0,33	0
A1B0	0	0,33	0,67	0
A1B1	0	0	0	0
A1B2	0	0	0,67	0,33
A2B0	0	0,33	0,33	0
A2B1	0	0,33	0,67	0
A2B2	0	0	1	0,33

A3B0	0	0	0	0
A3B1	0	0	0	0,67
A3B2	0	0	1	0

Description: A0B0: no plant-based pesticides + no liquid organic fertilizer, A0B1: no plant-based pesticides + liquid organic fertilizer, A0B2: no plant-based pesticides + manure + liquid organic fertilizer, A1B0: lemongrass + no liquid organic fertilizer, A1B1: Lemongrass simplisia + liquid organic fertilizer, A1B2: Lemongrass simplisia + livestock manure + liquid organic fertilizer, A2B0: Lemongrass powder + no liquid organic fertilizer, A2B1: Lemongrass powder + liquid organic fertilizer, A2B2: Lemongrass powder + manure fertilizer + liquid organic fertilizer, A3B0: Lemongrass oil + No liquid organic fertilizer, A3B1: Lemongrass oil + liquid organic fertilizer, A3B2: Lemongrass oil + manure fertilizer + liquid organic fertilizer. ns = no significant difference, wap = week after planting.

Based on Table 1, observations of the leaf miner fly population *Liriomyza* sp. (Diptera: Agromyzidae) showed varying fluctuations among the different treatments during the four weeks after planting (wap). In the first week, only treatment A0B0 showed a fly population of 1 individual, while no fly population was found in the other treatments. In the second week, several treatments such as A0B0, A1B0, A2B0, A2B1, and A3B2 began to show a fly population of 0,33 individuals, while no fly population was found in the other treatments. In the third week, the highest fly population reached 1 individual in treatments A2B2 and A3B2, indicating an increase in population in several combination treatments. However, in the fourth week of observation, the majority of treatments no longer showed a fly population, except for A1B2, A2B2, and A3B1, which still showed populations of 0,33 and 0,67 individuals. These data indicate the effectiveness of several treatments in suppressing the leaf miner fly population, especially in treatments A0B1, A1B1, A2B0, A3B0, and A3B2, which showed zero populations in the fourth week of observation.

The natural enemy observed was a predator, namely the ladybug (Coccinellidae). Its population could only be observed at 1 mst. Subsequent observations showed no natural enemies. The low presence of natural enemies was thought to be due to environmental conditions that were not conducive to the natural enemy ecosystem. The land around the research site was planted with cassava, lemongrass, and fruit trees (mango, soursop, guava, and orange). These plants generally have different types of pests and natural enemies than those found on pak choi plants. Ladybugs are suspected to prey on aphids on pak choi plants. No parasitoids were found during the observation. According to research by Karthik *et al.*, (2022), the dominant predator on *Brassica campestris* is *Coccinella septempunctata*, which was found to be the most abundant of all predators, followed by

Coccinella transversalis and *Cheilomenes sexmaculata*. Other coccinellid beetles include *Propylea dissecta*, *Brumoides suturalis*, and *Micraspis yasumatsui*.

The results of the analysis in Table 2 show that the intensity of *Liriomyza* sp fly pest attacks in observations 1 and 2 mst were not significantly different. There was a significant difference in observation 3 mst, but no significant difference in observations 1, 2, and 4 mst. In observation 1 mst, only treatments A0B0, A1B1, and A3B1 showed an attack intensity of 3,33%. Observation 2 mst showed a more even attack intensity in several treatments, with the highest intensity in treatment A1B1 at 4,17%. In observation 3 mst, treatment A1B0 had the highest attack intensity at 5,98%, which was significantly different from other treatments. These results indicate that the use of simplisia without liquid organic fertilizer may be less effective in suppressing attack intensity in certain periods. In the 4 mst observation, the highest attack intensity was in treatment A0B2 at 7,22%, indicating that without the use of insecticide, pest attacks can still occur even though fertilizer and liquid organic fertilizer have been applied. Supartha *et al.*, (2023) leaf miner pests, *Liriomyza* spp., have developed into a serious pest in recent years, even reducing the production of several ornamental and food crops.

Table 2. Attack intensity of *Liriomyza* sp (%)

Treatment	Attack intensity of <i>Liriomyza</i> sp (%)			
	1 wap ^{ns}	2 wap ^{ns}	3 wap	4 wap ^{ns}
A0B0	3,33	1,39	1,39 a	0
A0B1	0	0	0 a	0
A0B2	0	1,19	0 a	7,22
A1B0	0	0	5,98 b	1,67
A1B1	3,33	4,17	0 a	0
A1B2	0	1,39	0 a	0,55
A2B0	0	1,19	0 a	0
A2B1	0	2,77	2,38 a	0
A2B2	0	1,19	0,76 a	0
A3B0	0	1,67	0 a	0
A3B1	3,33	2,77	1,04 a	0
A3B2	0	1,39	3,71 ab	3,54

Description: A0B0: no plant-based pesticides + no liquid organic fertilizer, A0B1: no plant-based pesticides + liquid organic fertilizer, A0B2: no plant-based pesticides + manure + liquid organic fertilizer, A1B0: lemongrass + no liquid organic fertilizer, A1B1: Lemongrass simplisia + liquid organic fertilizer, A1B2: Lemongrass simplisia + livestock manure + liquid organic fertilizer, A2B0: Lemongrass powder + no liquid organic fertilizer, A2B1: Lemongrass powder + liquid organic fertilizer, A2B2: Lemongrass powder + manure fertilizer + liquid organic fertilizer, A3B0:

Lemongrass oil + No liquid organic fertilizer, A3B1: Lemongrass oil + liquid organic fertilizer, A3B2: Lemongrass oil + manure fertilizer + liquid organic fertilizer. ns = no significant difference, wap = week after planting.

Based on Table 3, the intensity of armyworm attacks showed no significant difference between treatments during the observation period. In the 1 mst observation, the highest attack intensity was found in treatment A2B0 at 21,67%, indicating that powder treatment without liquid organic fertilizer was less effective at the beginning of the planting period. In contrast, at 2 wap, treatment A0B2 showed a very high spike in attack intensity of up to 15,00%. At 3 mst, treatment A0B2 again showed a very high attack intensity of 23,66%, while several other treatments such as A3B1, A3B2, A1B0, and A1B2 showed an attack intensity of 0%. However, at 4 wap, the highest attacks shifted to treatment A2B1 at 11,46% and A1B0 at 11,31%. Treatments A0B1, A2B2, and A3B1 consistently showed very low attack intensity or even 0% in some observations, indicating their effectiveness in controlling armyworms.

Table 3. Armyworm attack intensity (%)

Treatment	Armyworm attack intensity (%)			
	1 wap ^{ns}	2 wap ^{ns}	3 wap ^{ns}	4 wap ^{ns}
A0B0	3,33	0	3,42	2,78
A0B1	0	0	0	0
A0B2	1,67	15,00	23,66	0
A1B0	0	1,67	0	11,31
A1B1	1,67	1,67	6,94	2,08
A1B2	0	1,67	0	0,62
A2B0	21,67	11,67	1,04	2,35
A2B1	0	1,67	12,5	11,46
A2B2	0	0	0	3,34
A3B0	0	0	2,08	8,33
A3B1	0	0	1,19	0
A3B2	1,67	0	0	0

Description: A0B0: no plant-based pesticides + no liquid organic fertilizer, A0B1: no plant-based pesticides + liquid organic fertilizer, A0B2: no plant-based pesticides + manure + liquid organic fertilizer, A1B0: lemongrass + no liquid organic fertilizer, A1B1: Lemongrass simplisia + liquid organic fertilizer, A1B2: Lemongrass simplisia + livestock manure + liquid organic fertilizer, A2B0: Lemongrass powder + no liquid organic fertilizer, A2B1: Lemongrass powder + liquid organic fertilizer, A2B2: Lemongrass powder + manure fertilizer + liquid organic fertilizer, A3B0: Lemongrass oil + No liquid organic fertilizer, A3B1: Lemongrass oil + liquid organic fertilizer, A3B2: Lemongrass oil + manure fertilizer + liquid organic fertilizer. ns = no significant difference, wap = week after planting.

Leaf number analysis showed varying growth patterns among treatments over the observation period up to 5 weeks after planting. At the beginning of the observation, namely 1 week after planting, most treatments showed a relatively uniform number of leaves, ranging from 4 to 5 leaves. However, at 4 and 5 weeks after planting, treatments with a combination of manure and liquid organic fertilizer (A0B2, A1B2, A2B2, A3B2) showed a significant increase in the number of leaves compared to other treatments. For example, treatment A2B2 reached 21,00 leaves at 35 days after planting, far exceeding treatments without liquid organic fertilizer, such as A0B0, which only had 10,00 leaves. This indicates that liquid organic fertilizer, especially when combined with pukan, plays an important role in promoting pakcoy leaf formation. The results of the study by Widya & Inti, (2022) showed similar results, with a significant difference in the number of leaves in the fourth week.

Table 4. Number of pakcoy leaves in each treatment

Treatment	Number of pakcoy leaves				
	1 wap ^{ns}	2 wap ^{ns}	3 wap ^{ns}	4 wap	5 wap
A0B0	5,00	5,67	7,00	8,33 a	10,00 a
A0B1	4,33	5,33	7,00	8,33 a	10,67 a
A0B2	4,67	6,33	8,33	14,67 b	20,33 b
A1B0	4,67	6,00	6,67	7,67 a	9,00 a
A1B1	4,33	5,67	7,33	8,33 a	11,33 a
A1B2	4,00	6,33	9,00	14,67 b	18,33 b
A2B0	4,67	6,67	8,67	10,33 a	11,33 a
A2B1	4,67	5,67	7,33	8,00 a	10,00 a
A2B2	4,67	6,67	10,00	16,33 b	21,00 b
A3B0	5,00	5,67	7,33	8,33 a	9,67 a
A3B1	5,00	5,33	8,00	9,67 a	10,00 a
A3B2	4,67	6,00	9,67	15,00 b	21,00 b

Description: A0B0: no plant-based pesticides + no liquid organic fertilizer, A0B1: no plant-based pesticides + liquid organic fertilizer, A0B2: no plant-based pesticides + manure + liquid organic fertilizer, A1B0: lemongrass + no liquid organic fertilizer, A1B1: Lemongrass simplisia + liquid organic fertilizer, A1B2: Lemongrass simplisia + livestock manure + liquid organic fertilizer, A2B0: Lemongrass powder + no liquid organic fertilizer, A2B1: Lemongrass powder + liquid organic fertilizer, A2B2: Lemongrass powder + manure fertilizer + liquid organic fertilizer, A3B0: Lemongrass oil + No liquid organic fertilizer, A3B1: Lemongrass oil + liquid organic fertilizer, A3B2: Lemongrass oil + manure fertilizer + liquid organic fertilizer. ns = no significant difference, wap = week after planting.

Furthermore, root weight and plant weight data also reinforce findings regarding the effectiveness of certain treatments. Treatments involving the addition of manure and liquid organic fertilizer consistently resulted in significantly higher root weight and plant weight. For example, treatments A0B2, A2B2, and A3B2 significantly increased plant weight to 145,00 grams, 128,17 grams, and 145,5 grams, respectively, compared to treatments without liquid organic fertilizer such as A0B0, which only reached 9,00 grams. Similarly, root weight in these treatments also increased dramatically, indicating better root system development. These findings highlight the synergistic role of liquid organic fertilizer and manure in supporting the overall biomass of pakcoy plants. Noorhidayah *et al.*, (2022) found that the higher the fresh weight of pakcoy roots, the greater the nutrient content in the soil that can be absorbed by the roots. Chamida Madina & Koesriharti, (2023) found that the variables of total fresh weight and fresh weight for consumption are a form of accumulation from the growth of the plant. The better the plant growth, the higher the final yield of the plant.

Table 5. Root weight and pakcoy plant weight for each treatment

Treatment	Root weight (g)	Crop weight (g)
A0B0	1,00 a	9,00 a
A0B1	1,30 a	10,30 a
A0B2	8,43 c	145,00 c
A1B0	1,37 a	14,77 a
A1B1	1,23 a	14,23 a
A1B2	5,40 b	108,67 b
A2B0	1,63 a	19,20 a
A2B1	1,80 a	13,17 a
A2B2	6,17 b	128,17 bc
A3B0	1,50 a	13,43 a
A3B1	1,70 a	14,23 a
A3B2	7,13 bc	145,5 c

Description: A0B0: no plant-based pesticides + no liquid organic fertilizer, A0B1: no plant-based pesticides + liquid organic fertilizer, A0B2: no plant-based pesticides + manure + liquid organic fertilizer, A1B0: lemongrass + no liquid organic fertilizer, A1B1: Lemongrass simplisia + liquid organic fertilizer, A1B2: Lemongrass simplisia + livestock manure + liquid organic fertilizer, A2B0: Lemongrass powder + no liquid organic fertilizer, A2B1: Lemongrass powder + liquid organic fertilizer, A2B2: Lemongrass powder + manure fertilizer + liquid organic fertilizer, A3B0: Lemongrass oil + No liquid organic fertilizer, A3B1: Lemongrass oil + liquid organic fertilizer,

A3B2: Lemongrass oil + manure fertilizer + liquid organic fertilizer. ns = no significant difference, wap = week after planting.

Overall, the results of this study provide information that liquid organic fertilizer application, especially when combined with compost, is very effective in increasing the vegetative growth and biomass of pakcoy plants. The treatments A0B2, A1B2, A2B2, and A3B2 showed high results in terms of leaf count, root weight, and crop weight compared to treatments without liquid organic fertilizer or with liquid organic fertilizer alone. This indicates that the addition of pukan is a factor that influences the use of liquid organic fertilizer, providing high yields in more productive pakcoy cultivation. Therefore, the recommendation from this study is the use of a combination of liquid organic fertilizer and pukan for optimal pakcoy yields. Yulina & Ambarsari, (2021) the use of organic materials can increase the growth and yield of pakcoy plants.

E. Conclusion

Pests that attack pakcoy plants include aphids (*Myzus persicae*), armyworms (*Spodoptera* spp.), leaf miners (*Liriomyza* spp.), thrips (*Thrips* sp), and grasshoppers (*Valanga nigricornis*). The main pests that attack pakcoy plants are leaf miners and armyworms. Applying several formulations of lemongrass to pakcoy plants can control the population of leaf miner flies. The natural enemy of pakcoy plants is the Coccinellidae beetle. The use of several formulations can reduce the intensity of leaf miner fly and armyworm attacks on pakcoy plants. The highest root weight and pakcoy plant weight were found in the treatment combining goat manure fertilizer and liquid organic fertilizer.

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