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The Effect of Onion Soaking Water Concentration (Allium spp.) on the Growth of Pakcoy Mustard (*Brassica rapa* L.) Using a Hydroponic Planting Medium

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Abstract. This study aims to analyze the effect of various concentrations of liquid organic fertilizer (POC) made from shallots (Allium spp.), garlic (Allium sativum), and onions (Allium cepa) on the growth of pak choi (*Brassica rapa* L.) in a hydroponic system. The parameters observed included the number of leaves and leaf area during four weeks of growth. The results showed that shallot POC with a concentration of 15% provided the most significant increase in the number of leaves, from 6 leaves in the first week to 10 leaves in the fourth week, and leaf area from 5.00 cm² to 10.20 cm². However, the results of the one-way ANOVA test on the number of leaves showed a significance value of 0.075 ($p > 0.05$), which means the difference is not statistically significant. On the other hand, the increasing trend indicates a potential positive effect that requires further testing.Garlic POC showed unstable growth results, especially at concentrations of 5% and 10%. Although the 15% concentration showed a slight increase in leaf area (up to 8.91 cm²), the ANOVA test showed a significance value of 0.001 ($p < 0.05$), indicating no significant effect on the number or area of leaves. Meanwhile, onion POC at a concentration of 15% showed more consistent growth, with an increase in the number of leaves up to 8 leaves and leaf area up to 9.37 cm². The ANOVA test on leaf area showed a significance value of 0.128 ($p > 0.05$), indicating that although the increase occurred, it was not statistically significant.Water parameters such as pH and temperature did not show significant differences between treatments, while ppm values tended to increase at higher POC concentrations, indicating an increase in nutrient content. Overall, although not all results were statistically significant, these findings indicate that onion POC, especially at a concentration of 15%, has the potential to be an effective alternative source of natural nutrients to increase the vegetative growth of pak choi plants in hydroponic systems.

Keywords: *Brassica rapa* L., hydroponics, liquid organic fertilizer, Allium spp., concentration, plant growth

INTRODUCTION

Modern agriculture currently faces challenges in increasing crop productivity sustainably, along with limited land and increasing food needs (Febriani et al., 2025; Maulida et al., 2025). One of the approaches that has developed to overcome this problem is the hydroponic cultivation system that allows plant growth without using soil as a planting medium. Hydroponics is one method that can be a solution in carrying out efficient water use, better nutrient control, and cleaner and more hygienic production, so that it is increasingly being applied both on a household and commercial scale (Sabar et al., 2022).

Pak choy mustard greens (*Brassica rapa* L.) is a type of leaf vegetable that has high economic value and is widely consumed by the community (Herawati et al., 2022; Yaldi et al., 2023). This plant has a relatively short harvest period and contains various nutrients that are beneficial to health (Priadi & Nuro, 2017). In the hydroponic system, pak choy growth is greatly influenced by the availability of nutrients provided through nutrient solutions (Banu, 2020; Saputra, 2021). Therefore, it is important to explore various alternative nutrient sources that are environmentally friendly, cheap, and easily accessible to farmers or small-scale hydroponic activists (Tanti et al., 2020).

One of the alternative nutrient sources currently being studied is shallot (Allium spp.) soaking water. Shallots are known to contain phytochemical compounds such as phenolic

compounds, flavonoids, and natural growth hormones such as auxins and gibberellins, which can stimulate root and shoot growth in plants (Rocchetti et al., 2022). The use of shallot soaking water as a natural biostimulant has the potential to support plant growth, especially in hydroponic systems that rely heavily on nutrient solutions.

A number of previous studies have shown that plant extracts or soaking tubers, including shallots, can have a positive effect on the growth and development of horticultural plants (Laely et al., 2022; Pangestuti et al., 2022). However, the effectiveness of this soaking water is greatly influenced by the concentration of its use. Concentrations that are too low may not have a significant effect, while concentrations that are too high can actually cause phytotoxicity in plants. Therefore, research is needed to determine the optimal concentration of shallot soaking water that can support the growth of pak choy mustard greens optimally (Grace Hutasoit, 2023).

In addition, the application of natural biostimulants such as shallot soaking water is in line with the principles of sustainable agriculture that reduce dependence on synthetic chemical fertilizers (Octavia et al., 2022; Yuniarti et al., 2023). The use of natural ingredients sourced from kitchen waste or local agricultural products also supports better environmental management and provides economic solutions for farmers (Ajila et al., 2012; Ghosh et al., 2016; Koul et al., 2022). By utilizing local resources, hydroponic farming can be more inclusive and adaptive to various socio-economic conditions of the community.

However, until now there have been few studies that specifically examine the effect of variations in the concentration of shallot soaking water on the growth of pak choi plants in hydroponic systems (Samiha, 2023). Therefore, this study is important to conduct in order to obtain scientific data that can be used as a basis for recommendations on the use of shallot soaking water as a nutrient or growth supplement in hydroponic pak choi cultivation.

This study is expected to contribute to the development of more efficient and environmentally friendly hydroponic cultivation techniques. The results of this study can provide practical information for hydroponic farmers, urban farming practitioners, and the general public who want to utilize natural ingredients as an alternative in providing plant nutrition.

Based on the explanation above, this study aims to determine the extent to which various concentrations of shallot soaking water influence the growth of pak choi in hydroponic planting media, as well as to determine the most effective concentration in supporting optimal plant growth.

RESEARCH METHODS

This research is an experimental study that examines the growth of pakcoy mustard (*Brassica rapa* L.) cultivated using a hydroponic wick system and treated with liquid organic fertilizer (POC) derived from soaking water of shallots, garlic, and onions. Each type of POC was tested at three concentration levels: 5%, 10%, and 15%, while plain water was used as a control (Ilhamiyah et al., 2023). The total population in this study was 40 pakcoy plants. Each type of POC (shallots, garlic, and onions) had 12 plants, divided evenly into three concentration groups (4 plants per concentration). An additional 4 plants were used as the control group, resulting in a total of 40 samples. Since the entire population was used, the sample size was equal to the population. The samples used are all populations. The data collection technique used, namely (RAK) with the following placement (Table 1):

Table 1. Group Random Design

No.	Session 1	Session 2	Session 3
1	BB2	BM1	BP3
2	BP1	BB3	BM2
3	BM3	BP2	BB1

Information:

BM	: POC Shallots	1: 5% concentration
BP	: POC Garlic	2: 10% concentration
BB	: POC Onion	3: 15% concentration

In this study, the variables observed are, the number of leaves, and the area of leaves, all of which will be measured from all the samples that have been collected. The measurement of leaf area was obtained by measuring length x width x correction factor (p x l x fk), measurement was carried out once a week for four weeks, in the fourth week a sample of 12 leaves was carried out to be re-measured using millimeter blocks, to find the correction factor (FK). After re-measurement, the average correction factor (FK) was obtained of 0.86 (Herawati et al., 2022).

The process to prepare POC from onions or concentrated water is as follows, if the container can hold up to 2 L, then to get the desired concentration 2 L is converted to ml, for example 2000 ml /100, the result will be multiplied by 15%, 10%, 5%, according to how many percent you want, for example to get a concentration of 10% in 2 L then it will be converted to units (ml) will be 2000 ml divided by 100 results multiplied by 10 results 200, So 200 grams of onion and 1800 ml of water are needed, to get a concentration of 10%, as well as other concentration variations, after everything is ready, accommodate all onion water concentrations in each container (Halimatussa'diyah et al., 2023).

The experiment began with seed germination. After the seedlings developed 3–4 true leaves, they were transplanted into hydroponic wick systems that had been prepared with the respective POC treatments and control solution. All other growing conditions were kept consistent across treatments (Sitasi: Hartanti et al., 2023). This research was conducted in Ajok Jaya Hamlet, Tempos Village, West Lombok Regency, West Nusa Tenggara, from August to September 2024.

RESULTS AND DISCUSSION

Pakcoy POC Shallots

Pakcoy Growth with Shallot POC Treatment Based on the data presented in Table 1, the application of shallot-based liquid organic fertilizer (POC) showed a clear trend in the increase of the number of pakcoy mustard leaves over the four-week observation period. It was observed that higher concentrations of shallot POC generally resulted in better vegetative growth, as indicated by an increase in leaf number.

At a concentration of 5%, the number of leaves increased from 4 leaves in the first week to 7 leaves in the fourth week, although the growth plateaued between the second and third weeks. This indicates that while the 5% concentration supports initial growth, it may not be sufficient to sustain consistent development in the later stages.

Higher concentrations, particularly 10% and 15%, demonstrated more significant improvements in leaf number, suggesting that the nutrient content available in shallot POC is more effective at these levels. The 15% concentration was notably the most effective, consistently producing a higher number of leaves throughout the observation period. This supports previous findings that higher concentrations of organic nutrients can accelerate vegetative growth in hydroponic plants (Herawati et al., 2022).

The trend suggests that shallot POC contains compounds beneficial to plant growth, possibly including natural auxins or micronutrients that stimulate leaf development. However, it is also important to monitor for potential nutrient saturation or toxicity, especially at higher concentrations, although no adverse effects were observed in this study.

At a 10% concentration, the number of leaves increased more steadily, starting with 6 leaves in both the first and second weeks, rising to 7 leaves in the third week, and reaching 8 leaves in the fourth week. This consistent growth pattern indicates that the 10% shallot POC provided sufficient nutrients to support continuous vegetative development during the

observation period. At a 15% concentration, the most substantial increase in leaf number was observed. The pakcoy plants began with 6 leaves in the first week and showed a continuous rise, culminating in 10 leaves by the fourth week. This demonstrates that higher concentrations of shallot-based POC had a more pronounced effect on leaf development, likely due to an increased availability of nutrients or growth-promoting substances contained in the extract. These findings suggest a positive correlation between the concentration of shallot POC and the number of pakcoy leaves, with the 15% concentration being the most effective in stimulating leaf growth.

Table 2. Average number of pakcoy leaves of POC Shallots per week (strands)

No.	Concentration	Week 1	Week 2	Week 3	Week 4	Average
1	5%	4	6	6	7	6
2	10%	6	6	7	8	6
3	15%	6	8	9	10	8

The results of the analysis of the Anova one-way test on the number of pakcoy leaves given POC of shallots with different concentrations were found that the variable of the concentration of POC of Shallots. A one-way ANOVA test was conducted to determine the effect of different shallot POC concentrations on the number of pakcoy leaves. The analysis yielded a significance value (p-value) of 0.075. Since $p > 0.05$, the result is not statistically significant at the 5% level, which means that the differences in leaf number among the treatments were not statistically significant. However, the value is relatively close to the threshold, suggesting a potential trend that higher concentrations may influence growth, although further testing or replication with a larger sample size may be needed to confirm this effect with statistical confidence.

Table 3. Average leaf area of POC Shallots per week (cm^2)

No.	Concentration	Week 1	Week 2	Week 3	Week 4	Average
1	5%	3,47	4,80	6,15	7,28	5,420
2	10%	4,43	6,15	8,16	10,27	7,250
3	15%	5,00	8,40	12,49	14,93	10,200

Based on the data on the average area of pakcoy mustard leaves with the use of shallot POC, there was a consistent increase in all concentrations over time. At a concentration of 5%, the leaf area increased from 3.47 cm2 in the first week to 7.28 cm^2 in the fourth week, indicating stable growth. At a concentration of 10%, leaf growth was more significant, with an increase from 4.43 cm^2 in the first week to 7.25 cm^2 in the fourth week. Meanwhile, at a concentration of 15%, the most drastic growth occurred, with the leaf area rising from 5.00 cm^2 in the first week to 10.20 cm^2 in the fourth week. These data indicate that higher concentrations of shallot POCs result in a greater increase in leaf area, with a concentration of 15% indicating the most optimal leaf growth results from week to week.

The results of the analysis of the Anova one-way test on the area of pakcoy leaves given POC shallots with different concentrations were found that the variable of concentration of POC shallots, obtained a sig value of (0.113) > 0.05, then there was an effect of the concentration of POC BM on the area of pakcoy leaves.

Table 3. Average water parameters of POC Saurs

No.	Concentration	Average		
		pH	Temperature (°C)	TDS (ppm)
1	5%	8,3	26,6	279
2	10%	8,1	30,01	313
3	15%	8,5	27,3	355

After measuring water parameters such as pH, temperature, and ppm, the average ppm with higher concentrations has a higher nutrient content, but at pH, and temperature are not bound by the high or low concentration.

Pakcoy POC Garlic

Based on the average data on the number of mustard leaves with the use of garlic POC, it can be seen that the concentration of 5% does not show a change in the number of leaves from the first week to the fourth week, which remains at 4 leaves, although it had decreased in the third week. At a concentration of 10%, the number of leaves was unstable, the number of leaves rose and fell from the first week to the fourth week, without a significant increase.

Table 4. Average number of Garlic POC pakcoy leaves per week (strands)

No.	Concentration	Week 1	Week 2	Week 3	Week 4	Average
1	5%	4	4	3	4	4
2	10%	4	5	6	5	5
3	15%	7	6	7	6	7

Meanwhile, at a concentration of 15%, there was a decrease and increase, from 7 leaves in the first week to 6 leaves in the second week, but the number of leaves increased slightly to 7 leaves in the third week before decreasing again to 6 leaves in the fourth week. These data show that higher concentrations of garlic POCs (15%) have a more varied impact on the growth of leaf counts, although the increase is not always consistent from week to week.

The results of the analysis of the Anova one-way test found that the variable of the concentration of POC of Garlic, obtained H0 value of sig (0.001) < 0.05, so there was no effect of the concentration of POC of Garlic on the number of pakcoy leaves.

Table 5. Average Garlic POC Pakcoy Leaf Area per Week (cm^2)

No.	Concentration	Week 1	Week 2	Week 3	Week 4	Average
1	5%	2,48	3,02	3,27	2,90	2,910
2	10%	3,52	4,43	4,94	4,65	4,380
3	15%	5,32	7,01	8,26	8,91	7,370

Based on the data on the average area of pakcoy mustard leaves with the use of garlic POC, it can be seen that at a concentration of 5%, the growth of leaf area tends to be stagnant. The leaf area decreased slightly from 2.48 cm^2 in the first week to 3.27 cm^2 in the third week, but decreased back to 2.90 cm^2 in the fourth week. At a concentration of 10%, there was a more pronounced increase, from 3.52 cm^2 in the first week to reach 4.94 cm^2 in the third week, but decreased slightly to 4.65 cm^2 in the fourth week. Meanwhile, at a concentration of 15%, the increase in leaf area was more consistent and significant, from 5.32 cm^2 in the first week to 8.91 cm^2 in the fourth week. These results show that the POC of garlic with a higher concentration has a more positive and consistent impact on the growth of the area of mustard leaves compared to the lower concentration.

The results of the analysis of the Anova one-way test found that the variable of the concentration of POC of Garlic, obtained a value of sig (0.001) < 0.05, so there was no significant effect of the concentration of POC Garlic on the area of pakcoy leaves.

Table 6. Average water parameters of POC Garlic

No.	Concentration	Average		
		pH	Temperature (°C)	TDS (ppm)
1	5%	8,4	29,6	103
2	10%	8,2	27,5	138
3	15%	8,3	27,8	212

The water parameters obtained in the average garlic POC at ppm tend to be higher at higher concentrations, in contrast to pH, and the temperature is not bound to the concentration percentage.

Pakcoy POC Onion

The average number of leaves of pakcoy mustard with the use of onion POC, it can be seen that at a concentration of 5%, the number of leaves tends to be stagnant from the first week to the fourth week, with an average of 5 leaves, a slight decrease to 4 leaves in the second week. At a concentration of 10%, the growth of the number of leaves was more stable, with 6 leaves from the first week to the third week, then increased to 7 leaves in the fourth week. Meanwhile, at a concentration of 15%, the number of leaves showed more consistent growth, from 7 leaves in the first week, stable at 7 leaves in the second week, then increased to 8 leaves in the third week and remained at 8 leaves until the fourth week. These data showed that POCs of onions with higher concentrations tended to provide a more consistent increase in leaf count compared to lower concentrations.

Table 7. Average number of POC Onion pakcoy leaves per week (strands)

No.	Concentration	Week 1	Week 2	Week 3	Week 4	Average
1	5%	5	4	5	5	5
2	10%	6	6	6	7	6
3	15%	7	7	8	8	8

The results of the analysis of the Anova one-way test on the number of pakcoy leaves were found that the variable of variation in the concentration of POC of Onion was obtained with a value of sig (0.001) < 0.05, so there was no effect of the concentration of POC of Onion on the number of leaves of pakcoy leaves.

Table 8. Average leaf area of POC Onion pakcoy per week (cm^2)

No.	Concentration	Week 1	Week 2	Week 3	Week 4	Average
1	5%	2,69	4,06	4,33	4,65	3,930
2	10%	3,52	5,15	4,65	7,29	5,150
3	15%	3,83	6,26	8,13	9,37	6,890

The average area of mustard leaves with the use of onion POC, at a concentration of 5%, experienced a slow increase from 2.69 cm^2 in the first week to 4.65 cm^2 in the fourth week, with relatively stable growth from week to week. At a concentration of 10%, the growth of leaf area was more significant, increasing from 3.52 cm^2 in the first week to increasing by 4.65 cm^2 in the third week, but increasing significantly to 7.29 cm^2 in the fourth week. Meanwhile, at a concentration of 15%, the fastest growth was seen, with the leaf area increasing from 3.83 cm^2 in the first week to 9.37 cm^2 in the fourth week, showing a more optimal impact on the highest concentration. This shows that higher POC concentrations of onions give better results in increasing the leaf area of mustard greens.

Table 9. Average water parameters of POC Onion

No.	Concentration	Average		
		(pH)	Temperature (°C)	TDS (ppm)
1	5%	8.2	26.8	295
2	10%	8.0	26.6	301
3	15%	8.2	27.9	323

The results of the analysis of the Anova one-way test on the area of pakcoy leaves were found that the variable of variation in the concentration of POC of Onions, due to the value of

sig (0.128) > 0.05, there was an effect of the concentration of POC of Onions on the area of pakcoy leaves or had a significant influence.

The water parameters in the POC of onions are almost the same as those of onion and garlic, which distinguishes only the average value obtained at ppm is not much different between high and low concentrations.

CONCLUSION

The variation in the concentration of onion-based Liquid Organic Fertilizer (POC) significantly influences the growth of pakcoy mustard (*Brassica rapa* L.). In general, increasing the concentration of POC from 5%, 10%, to 15% led to enhanced leaf area and leaf count across all types of onion-based POC treatments (shallots, garlic, and onions). A concentration of 15% yielded the most optimal growth results in terms of both leaf area and leaf count, particularly with onion-based POCs. There were observable differences in the growth responses between pakcoy plants treated with shallot, garlic, and onion POCs. The onion POC consistently produced the most favorable results in terms of leaf area and number of leaves, followed by the shallot POC. In contrast, garlic POC showed the lowest growth performance when compared to the other two types of onion-based fertilizers.

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