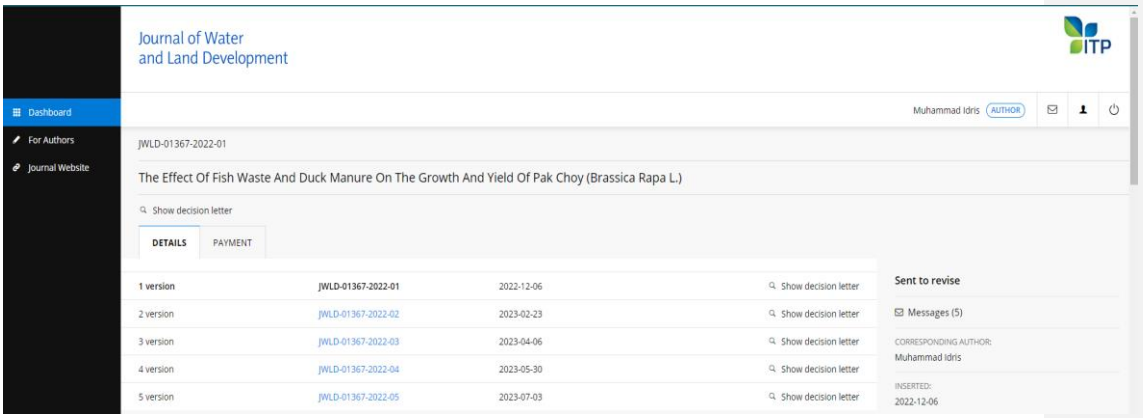
BUKTI DUKUNG CORRESPONDING AUTHOR THE EFFECT OF FISH WASTE AND DUCK MANURE ON THE GROWTH AND YIELD OF PAKCHOY (*BRASSICA RAPA* L. VAR. NAULI F1)



1. Submitted Manuscript (06-12-22)

A report for: **JWLD-01367-2022-01 The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.)**

I have reviewed the manuscript in which the authors try to determine the effect of growth and yield of pak choy plants on the application of liquid organic fertilizer from fish waste and duck manure and the interaction between the two. It is a very interesting case describing that application of duck manure showed a significant effect on plant height, number of leaves, fresh weight, and plant root length. The manuscript is not well-written. The results match the objectives. Here are some suggestions to back up my idea and help the author improve the quality of the paper:

-Keywords Fish waste, Growth and yield, Liquid organic fertilizer, Manure, Pak choy (Brassica Rapa L.. Change some keywords. Not use the words of the title as keywords.

-Line 42. As in line 32 have already appeared nitrogen (N), phosphorus (P), and potassium (K), then are not needed here; just put N, O and K.

Line 55. Provide more information on the site: soil type…

-Line 58. Also proiude more information.

-Line 61. Research method. Sperimental design?.

Line 74 Data analysis. Statistical methods?.

-Line 76. Is the formula your own?.

-In my opinion the Research Implementation, Plant Maintenance, Harvest and Observation Variable are part of the experimental design. Therefore they must be rewritten

-The beginning of several sentences is the same, it should be changed, i.e. line 151, 164, 177…: Based on the results.

-I suggest to include some photos of the area/experiment.

I wish those changes will contribute to improve your paper.

Title of paper: The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (*Brassica Rapa* L.)

Authors: Muhammad Idris[1*], Imam Hartono Bangun[2], Nurma Ani[3], Dermawan Hutagaol[3], Fajar Siddik[3]

For citation: Idris. M., Bangun. I. H., Ani. N., Hutagaol, D., and Siddik, F.

Affiliation:

[1)] North Sumatera State Islamic University, Faculty of Science and Technology Department of Biology, Deli Serdang, North Sumatera, 20353, Indonesia.

[2)] Universitas Muhammadiyah Sumatera Utara, Department of Agrotechnology, , Medan, North Sumatera, Indonesia.

[3)] Al Azhar University Medan, Department of Agriculture, Medan, North Sumatera, Indonesia.

✉ **Corresponding author: midris@uinsu.ac.id**

Abstract (200–250 words)**:** Indonesia is expected to see an 8.2% increase in mustard plant production in 2021, but this may not meet the growing population's needs. Using chemical fertilizers, which can harm soil microorganisms and disrupt the ecological balance and other fertilization issues, has impeded the expected growth. This research aimed to investigate how liquid organic fertilizer produced from fish waste and duck manure fertilizer and their interaction influence the growth and yield of pak choy plants. The study utilized a Factorial Randomized Block Design with two factors and three repetitions to investigate the effects of liquid organic fertilizer from fish waste (LOF) and duck manure fertilizer (DmF) on pak choy plants. The first factor was liquid organic fertilizer from fish waste (LOF), (LOF_0 = control, LOF_1 = 25 ml liter $water^{-1}$, LOF_2 = 50 ml liter $water^{-1}$), the second factor was duck

manure fertilizer (DmF), (DmF0 = control, DmF1 = 3.7 kg plot^{-1}, DmF2 = 5.55 kg plot^{-1}, DmF3 = 7.4 kg plot^{-1}). Using LOF can enhance the growth and yield of pak choy plants, with a dosage of 25 ml liter water^{-1} increase of 4.3% plant height and yield in terms of 27% wet weight. On the other hand, using DmF0 (without DmF) showed better results than all doses. Finally, the combination of LOF (25 ml liter water^{-1}) and DmF (without DmF) improved the growth and yield pak choy plants, increasing 4.6% plant height, 8.4% number of leaves and yield increased by 32% wet weight compared to plants without fertilizer.

Keywords (5–8)**:** Biofertilizer, Poultry, Muck, Eco-Friendly, Vegetable, Nutrient

INTRODUCTION

Pak choy mustard is a plant that can be planted in the lowlands and highlands with the condition that it gets enough sunlight, has good soil aeration, and soil pH is 6.5 – 7 (Sarido and Junia 2017).

In Indonesia, mustard production, including pak choy, reached 727.47 tons in 2021, an 8.2% increase from 2020's 667.47 tons (BPS, 2021b). However, this increase may not be enough to meet the needs of the growing population. The Indonesian population increased by 0.9% in 2021 and 1.12% in 2022 (BPS, 2022). Therefore, it is highly anticipated to increase pak choy production to ensure adequate vegetable supply for Indonesians. Although inorganic fertilizer application is the quickest solution, it also causes environmental pollution, ecological damage, and higher production costs (Purba et al., 2020; Keshavarz Mirzamohammadi et al., 2021). In addition, global climate change has negatively impacted soil organic matter quality. In line with the circular economy, agro-industrial, livestock, and agricultural waste with suitable physicochemical composition for fertilizer production can be utilized (Ma, Shen and Liu, 2020). Therefore, organic fertilization technology can improve farmers' livelihoods and promote environmental health. Organic amendments provide several benefits, including reducing farmers' dependency on fertilizers. Farmers can cut costs and contribute to environmental sustainability using organic waste (Pellejero et al., 2022).

The growing population with increasing demand for food and nutritional security strengthens the need for economic organic fertilizers (Kiruba N and Saeid, 2022). Organic fertilizers can add nutrients to the soil, such as N, P, and K, and improve the soil's ability to absorb nutrients and enhance its chemical properties (Chen, 2006). Organic fertilizers can replace 25% to 50%, or even up to 75%, of chemical fertilizers used for vegetables, resulting in higher yields and meeting the nutritional demands of the tested vegetables (Thanh et al.,

2023). Applying compost from onion residues in a mixture with bovine manure positively affected the plant's growth and tomato yield (Pellejero et al., 2021). The organic fertilizers used in this research are liquid organic fertilizers from fish waste (LOF) and duck manure fertilizer (DmF). For example, in Jatinangor, Sumedang Regency, West Java, Indonesia, there is a potential source of raw organic material from animal waste, such as duck waste (182.25 kg/day) (Mulyani et al., 2019). Meanwhile, official data on the total quantity of fish waste and discarded fish in Indonesia is unavailable in fisheries statistics. Nonetheless, the substantial production of marine fish in Indonesia, which was 6.22 million tons in 2015 (Sofia, 2018) and 6.71 million tons in 2018 (FAO, 2020), suggests the amount of fish waste generated in Indonesia is considerable. Thus the amount of fish waste generated can be utilized as liquid fertilizer. The results of the previous study by (Ahuja et al., 2021) showed that organic fertilizer derived from fish waste contained significant amounts of essential nutrients such as N, P, K, calcium, magnesium, and sulfur.

The research by (Fahlivi, 2015) resulted in using liquid organic fertilizer derived from fish waste, which has a high macronutrient, namely 2.11% N, 0.22% P, and 0.25% K. The study showed that duck manure fertilizer could be an effective alternative to increase the productivity of sugarcane (Ratanarak and Prachuabmoh, 1991). These findings indicate that using organic fertilizers, such as duck manure, could be a viable option for farmers to maintain and improve soil health and microbial diversity, thereby contributing to more sustainable agricultural practices as an alternative to synthetic fertilizers (Wang et al., 2014). The researchers are interested in using liquid organic fertilizers from fish waste (LOF) and duck manure fertilizer (DmF) materials in this study because they are readily available and underutilized by the community, even though they can provide nutrients such as N, P, and K for plant growth when used correctly.

This study aims to investigate the impact of utilizing liquid organic fertilizer from fish waste (LOF) and duck manure fertilizer (DmF) and the potential interaction between the two on the growth and yield of pak choy (Brassica rapa. L. var. Nauli F1.).

MATERIALS AND METHODS

Study site

The experiment was performed at a farmer's land, Jl. Perjuangan, Babalan - Langkat, North Sumatra, Indonesia (98°.29’76’.16” N; 4°01’07’.02” E; 4 m elevation) during the growth season (October – December) 2020. During an experimental period, the rainfall range was 1953 mm, and the rainy day was 110 days (BPS, 2021a).

Materials and Tools

The tools used in this study were ropes, polybags, knapsacks, gloves, analytical scales, hand sprayer (5 liter), container (50 liter), hoes, rake, and scissors. The material used is fish waste (±10 kg), dried duck waster (±150 kg), decis 25 EC (*deltamethrin* - $C_{22}H_{19}Br_2NO_3$), analytical scale (HENHERR BL-H2), molasse, brown sugar, effective microorganisms (EM_4), pakchoi seeds (*var* Nauli F1) and water.

Research Implementation

This research was conducted using a factorial Randomized Complete Block Design (RCBD), and the experiment consisted of two factors and three repetitions. The first factor was liquid organic fertilizer from fish waste (LOF), with three levels (LOF0 = control, LOF1 = 25 mL liter water-1, LOF2 = 50 mL liter water-1). In contrast, the second factor was duck manure (DmF), with four levels (DmF0 = control, DmF1 = 3.7 kg plot-1, DmF2 = 5.55 kg plot-1, DmF3 = 7.4 kg plot-1), so it becomes a total of 12 treatment combinations and 36 total trial plots (150 cm x 150 cm).

Plant Maintenance

Liquid organic fertilizer (LOF) production: mix 30 liters of water with 10 kilograms of finely ground fish waste, 1 liter of molasses, 250 grams of brown sugar, and 1 liter of EM4 until everything is well combined. Stir the mixture slowly until it is homogenous, and during the incubation process (30 days), keep the container tightly closed and stir it gently every morning. The perfect liquid organic fertilizer (LOF) will have a pleasant smell. An area of 100 square meters was cleared of weeds, and the soil was manually tilled using a hoe and rake. Thirty-six plots were created with 150 cm x 150 cm dimensions, arranged in a factorial randomized block design. Each plot was given an equal amount of compost fertilizer as the base before planting. Dried DmF was applied at the treatment dosage one week before planting and mixed with the soil until entirely homogeneous. The seven-day-old seedlings of pak choy were transplanted into all research plots and watered. The polybags were arranged in a 30 cm x 30 cm pattern, with 12 plants per plot. Liquid organic fertilizer (LOF) was applied to the soil gradually during the early planting stage, two weeks, and four weeks after planting. Daily watering using a hand sprayer (2 liter water plot-1) is conducted in the morning and afternoon. At the same time, weed, pest, and disease control measures are taken to protect the pak choy plants from crocidolomia binotalis and plutella maculipennis. The pests are managed by applying Decis 25 EC with 0.4 cc L-1 of water every two days. Pak choy is harvested 45 days after transplanting (DAT) and cleaned for production component observation. The parameters observed in this study include

both growth and yield parameters. The growth parameters consist of (a) Plant height (measured from the growing media surface to the highest leaf at 14, 28, and 45 DAT), (b) Number of leaves (counted only for fully opened leaves at 14, 28, and 45 DAT). The yield parameters consist of (a) Wet weight (of the cleaned pak choy measured using an analytical scale (at harvest), (b) Root length (measured on cleaned roots at harvest, from the base of the stem to the tip of the root).

Data analysis

Data from the research will be statistically analyzed using ANOVA (analysis of variance). The significant variables will be further tested using DMRT (Duncan Multiple Range Test) 5% (Skillings, 2018) using Microsoft Excel 2016 and R-Studio (Version 3.2.1) applications. This study's linear and quadratic polynomial regression models were developed based on (Agresti, 2015).

Linear models:

$$Y_{ijk} = \mu + LOF_i + DmF_j + B_k + E_{ijk}$$

Note:

Y_{ijk} : response value of the variable for unit j in block i

μ : overall mean of all data

LOF_i : treatment effect of the LOF factor at level i (i = 1, 2, ..., t)

DmF_j : treatment effect of the DmF factor at level j (j = 1, 2, ..., t)

B_k : block effect of the unobserved factor in block k (k = 1, 2, ..., b)

E_{ijk} : measurement error or noise that the factors in the model cannot explain.

Quadratic models:

$$Y = a + bX + cX^2 + \varepsilon$$

Note:

Y : dependent variable

X : independent variable

a, b, c : regression coefficients to be estimated

ε : random error

RESULTS AND DISCUSSION

Effects of LOF and DmF on Growth

The statistical analysis showed that applying liquid organic fertilizer (LOF) positively impacted plant growth. However, liquid organic fertilizer (LOF) did not have a significant impact on observing plant height. In contrast, the observation of the number of leaves, it had a significant impact ($P \leq 0.05$) 45 DAT (Figure 1). Liquid organic fertilizer (LOF) and DmF significantly

(P≤0,05) affected the number of leaves in pak choy plants 45 days after planting but differed from the plant height at the same observation.

Figure 1. Applications LOF and DmF on the growth of pak choy at 45 DAT.

Note: Separate symbols (at mean and standard deviation).

The utilization of DmF had an adverse effect on the growth of pakcoy plants, leading to a decline in their height at 45 DAT, as depicted in Figure 1. The highest plant height was achieved by the DmF0 treatment (17.08 cm), followed by DmF2 (14.77 cm), DmF3 (14.62 cm), and DmF1 (14.56 cm) at 45 DAT. Liquid organic fertilizer (LOF) treatment exhibited the maximum number of leaves, as evident from Figure 1, followed by LOF_0 (20.74 sheets), LOF_1 (20.42 sheets), and LOF_2 (20.31 sheets). As indicated in Table 1, DmF significantly (P≤0.01) influenced the number of leaves at 45 DAT, with the DmF0 application (21.59 sheets) resulting in the maximum number of leaves, followed by DmF1 (20.17 sheets), DmF2 (20.19 sheets), and DmF3 (20.02 sheets). Although applying organic fertilizers like LOF and DmF can be advantageous for plant growth, the concentration or application rate of DmF employed in this study may not be ideal for pakcoy plants.

Therefore, it is necessary to investigate alternative methods since the nutrients in DmF may not be easily accessible or may be released slowly, causing a scarcity of nutrients for the plants. The findings mentioned in the statement suggest that incorporating LOF at a concentration of 25 mL per liter of water had a beneficial effect on plant growth, as demonstrated by the rise in plant height and the number of leaves observed between 14 to 45 days after planting, as presented in Table 1. As a result, it is worth considering the use of LOF as a potential method to improve pak choy growth.

Effects of LOF and DmF on Yield

The wet weight and root length observations indicate that LOF and DmF have a noteworthy impact (P≤0.01) on the yield components of pak choy plants, as illustrated in Figure 2. Overall, incorporating LOF_1 (25 mL liter water-1) could be viewed as a potential way to enhance the plant's yield components, as presented in Table 1.

Figure 2. Application of LOF and DmF on the yield of pak choy at 45 DAT.

Note: Separate symbols (at mean and standard deviation).

The findings presented in Figure 2 indicate that when applied at a rate of 25 ml per liter of water, liquid organic fertilizer from fish waste (LOF_1) led to the highest wet weight in pak

choy plants. The LOF_1 treatment resulted in a wet weight of 67.16 g, while the control treatment without applying duck manure fertilizer (DmF0) produced 69.81 g. The LOF_2 treatment yielded 56.01 g, and the LOF_0 treatment produced 52.87 g. The application of duck manure fertilizer (DmF) at doses of 3.7 kg and 5.55 kg also demonstrated promising results, producing wet weights of 55.02 g and 57.02 g, respectively. Furthermore, using liquid organic fertilizer from fish waste (LOF) resulted in the longest root length in all treatments, with the LOF_0 treatment producing the longest root length of 15.88 cm and the LOF_1 and LOF_2 treatments producing shorter root lengths of 14.12 cm and 14.56 cm, respectively. Applying the DmF0 treatment resulted in the longest root length of 17.28 cm ($P \leq 0.01$), followed by the DmF1 treatment at 15.36 cm, the DmF2 treatment at 13.27 cm, and the DmF3 treatment at 13.50 cm. The results indicate that when used at a rate of 25 ml per liter of water, the most effective liquid organic fertilizer from fish waste (LOF) in enhancing the yield of pak choy plants is LOF_1.

Effects of a Mixture of LOF and DmF on Growth and Yield

The statistical evaluation indicated that using LOF and DmF in combination positively affected plant growth. However, the effect was insignificant during the 45 DAT (Figure 3). The recorded data regarding plant growth, comprising plant height and the number of leaves, can be examined in (Table 1).

Figure 3. Application combinations of LOF and DmF on the growth of pak choy.

Note: Separate symbols (at mean and standard deviation).

The study found that the combination of LOF and DmF positively affected plant growth, with an increase in plant height observed over 45 days after planting. The LOF_1DmF0 treatment had the highest plant height at 18.42 cm, while the LOF2DmF1 treatment had the lowest at 13.74 cm. However, the combination did not significantly affect the number of leaves on the plants. Surprisingly, the absence of LOF and duck manure fertilizer (LOF_0 and DmF0) resulted in the highest number of leaves at 22.22. This contradicts the expectation that applying organic fertilizers would promote plant growth. Furthermore, the growth of all pak choy plants was observed to increase with an increase in the dose of LOF without DmF at all stages of plant growth (Table 1). The measurement of pak choy plant yield, including wet weight and root length, after applying a combination of LOF and DmF fertilizers can be seen in Figure 4.

Figure 4. Application combinations LOF and DmF on the yield of pak choy.

Note: Separate symbols (at mean and standard deviation).

Using a combination of LOF and DmF resulted in a positive outcome in pak choy plant yield. The study showed that using both organic fertilizers can increase the wet weight of pak choy plants. Although not statistically significant, it is important to note that the combination of 25 ml of liquid organic fertilizer from fish waste (LOF) per liter of water and no duck manure fertilizer (LOF_1DmF0) yielded the highest wet weight of 78.87 g, which was 41.8% higher than the lowest wet weight observed in the treatment (LOF_2DmF1). However, the use of both fertilizers did not have a significant effect on root length in all combinations. The combination without either fertilizer showed the longest root length of 17.87 cm, followed by (LOF_2DmF0) with a root length of 17.34 cm, (LOF_0DmF1) with a root length of 17.11 cm, and the shortest root length was observed in the (LOF_1DmF2) treatment with a length of 11.84 cm. The study suggests that the limited nutrient uptake by pak choy plants may lead to root elongation in search of water and nutrients.

It is highly recommended to use LOF to boost the growth and productivity of pak choy plants by determining the optimal dosage. Figure 5 displays the results of the LOF regression analysis conducted on variables such as plant height at 45 DAT, number of leaves at 45 DAT, wet weight, and root length. The regression analysis indicated that the most effective amount of LOF for improving the growth and productivity of pak choi plants is 25 ml/L water. This dosage led to noticeable improvements in variables like plant height at 45 DAT, number of leaves at 45 DAT, wet weight, and root length compared to other dosage treatments. The regression analysis shows that the connection between LOF and plant height can be represented by a quadratic regression equation $\hat{Y} = 14.72 + 2.845x - 0.705x^2$ with an $R^2 = 1$.

Figure 5 Regression analysis between LOF and plant height at 45 DAT (cm), number of leaves at 45 DAT (pieces), wet weight (grams), and root length (cm) of Pak Choy.

Similarly, the relationship between LOF and the number of leaves can be expressed in a linear regression equation $\hat{Y} = 20.92 - 0.0215x$ with an $r = 0.9264$. The relationship between LOF and wet weight can be described by a quadratic regression equation $\hat{Y} = 13.14 + 52.45x - 12.72x^2$ with an $R^2 = 1$. Lastly, the correlation between LOF and root length observation is demonstrated by the quadratic regression equation $\hat{Y} = 19.84 - 5.06x + 1.1x^2$ with an $R^2 = 1$. Thus, applying LOF at a concentration of 25 ml/L water is recommended to enhance the growth and productivity of pak choy plants. This dosage was the optimal amount through the LOF regression analysis. This amount can significantly improve plant growth parameters,

producing higher wet weight and better-quality produce. By following this recommendation, growers can expect to see positive results in the growth and productivity of their pak choi crops. Table 1 provides a comprehensive summary of the data collected for all parameters in every observation of pak choy plants. This table contains valuable information for anyone analyzing the characteristics and growth patterns of pak choy plants. Researchers and experts in the field can use this data to draw conclusions and make informed decisions regarding pak choy plants.

Table 1 Summary the LOF and DmF applications in observing the height of plants and the number of leaves (14, 28, 45 DAT), wet weight, and root length (45 DAT).

Figure 6 Experimental design details: (A). Research plot (LOF_1 DmF0), (B). All research plots,

Effects of LOF and DmF on Growth

The study results indicate that using LOF at a dosage of 25 ml per liter of water can increase the growth of pak choy plants. Although the observed plant height did not show a significant difference at all observation ages, the use of LOF still had a better positive impact than without LOF. In addition, LOF application significantly affected the number of pak choy leaves, with a dosage of 25 ml LOF per liter of water providing the best results. This differs from a previous study by (Munar, Bangun and Lubis, 2018), who found that using liquid organic fertilizer made from kepok banana peels with a dosage of 75 ml per polybag could increase the growth of pak choy plants. LOF treatment with high N content showed an increased number of leaves. Thus treatment with high N application resulted in better performance. Fishbone waste also increases N and K uptake in pak choy plants during a 2-year study (Reppun et al., 2021). Other factors that affect the results include water availability, soil nutrition (Savvides, Fanourakis and van Ieperen, 2012), and environmental factors such as temperature (Kalisz et al., 2012).

The application of duck manure fertilizer (DmF) significantly differed in terms of plant height ($P \leq 0.05$), and the number of leaves ($P \leq 0.01$). This indicates that DmF has not been able to respond to the growth of pak choy based on the observed parameters, and plant growth still depends on the existing soil nutrients. Another possible consideration is that the high rainfall intensity in the research area may cause nutrient leaching carried by surface erosion (Hagedorn et al., 1997). Rainfall can indirectly influence mineralization by affecting soil moisture levels. High rainfall can lead to the leaching of nutrients, reducing nutrient availability for

mineralization. However, if rainfall is followed by adequate soil moisture, it can also stimulate microbial activity and increase mineralization rates (Brady, Weil and Weil, 2008). The mineralization of the organic N fraction of farm manures, both in the year of application and subsequent seasons, can significantly contribute to the availability of N for plants, which must be considered in fertilizer recommendations to reduce environmental losses. Temperature after the application is also essential, and superficial relationships have been derived for each group of manures for the amount of N mineralized and thermal time (Bhogal et al., 2016).

Another study compared to this one showed that using inorganic fertilizer (NPK) at a dose of 450 kg ha-1 can make the pak choy plants grow to a height of 28.06 cm with 16.00 leaves at 49 days after planting (Silitonga et al., 2018). In a study by Tripathi et al., (2015), using inorganic fertilizer with 100 kg N2, 60 kg P2O5, and 60 kg K2O ha-1 resulted in the best growth treatment with a height of 22.69 cm and 16.09 leaves at 45 DAT. However, using LOF and DmnF fertilizers resulted in more leaves than inorganic fertilizers. Therefore, LOF fertilizer can help pak choy plants grow better than inorganic fertilizers.

Effects of LOF and DmF on Yield

The application of organic farming using liquid organic fertilizer from fish waste (LOF) can increase the yield of pak choy. This trend corresponds with the increased plant height and number of leaves during the experiment. Based on the observation of wet weight, the use of LOF positively increased the yield of pak choy compared to without LOF. Furthermore, the observation of root length also showed that applying LOF can affect the root length of pak choy plants. Using LOF at all doses resulted in shorter root lengths than without LOF. This is due to nutrient stress that causes plants to elongate their roots more than usual. The optimal treatment for increasing the yield of pak choy is 25 ml of LOF per liter of water, considering the efficiency factor of the displayed regression value in Figure 5. The increase in pak choy yield is likely due to the N content in LOF, which can supply nutrients to the plant. Nutrient N has been confirmed to affect leaf differentiation speed and growth (Poinkar et al., 2006). Additionally, LOF can assist in absorbing P in plant roots as a biostimulant. Applying high-level fish bone waste resulted in an 88% increase in total P uptake and a 33% increase in average P concentration (Reppun et al., 2021). Another study yielded similar results, as using LOF significantly improved the growth and yield of pak choy, as evidenced by the increased root length and dry weight of roots and shoots after each harvest (Riddech and Van, 2019). Furthermore, another study on the use of LOF from fish waste found that high doses of LOF can significantly improve the growth and yield of pumpkin (Lubis et al., 2021).

The application of duck manure fertilizer (DmF) significantly differed in terms of wet weight at 45 days after sowing ($P \leq 0.05$) and root length at 45 days after sowing ($P \leq 0.01$), but the higher treatment was found in the control group (without DmF). This is thought to be because the DmF used has not been fully decomposed. Traditional organic waste processing has several problems, such as long processing duration, nutrient loss during long composting, frequent need for aeration, and heterogeneous final products (Nair, Sekiozoic and Anda, 2006). The solution to optimizing the composting process while reducing greenhouse gas emissions combines compost and vermicompost to process poultry manure. However, this process can cause greenhouse gas and ammonia emissions, including nitrous oxide (N2O), carbon dioxide (CO2), and methane (CH4), which can lead to stratospheric ozone depletion and global warming (Crutzen, 2016). A study conducted by (Wang et al., 2014) aimed to reduce failures in compost production and greenhouse gas emissions by utilizing earthworms and various organic materials in the composting process of duck manure. The results showed that earthworms positively reduced the total combined N2O-CH4 emissions equivalent to CO2 and a marginal effect on CO2 emissions during the pre-composting and combined composting of duck manure. Therefore, pre-composting and combined composting with the addition of weed straw and zeolite are recommended as a method for disposing of duck manure, reducing NH3 and greenhouse gas emissions, as well as providing nutrient-rich products as fertilizers.

Several studies on inorganic fertilizer compare its effectiveness with LOF and DmF in this research. Using 100 kg N2, 60 kg P2O5, and 60 kg K2O ha-1 of inorganic fertilizer resulted in a root length of 11.63 cm in pak choy plants (Tripathi et al., 2015). Another study by Mohd Din, Cheng and Sarmidi, (2017) found that combining inorganic fertilizer (NPK 15:15:15) with aerated compost extract at a dose of 150 mg kg-1 improved the yield of pak choy plants, producing a wet weight of 59.89 g, which was the best treatment. However, both studies show that LOF at a dose of 25 ml per liter of water can increase pak choy production more than inorganic fertilizer. This finding is important, as it provides practical guidance for applying LOF in enhancing the growth and yield of pak choy. Obtaining the optimal dosage is a strength of this study, which adds to the knowledge base of sustainable and effective agricultural practices.

Effects of a Mixture of LOF and DmF on Growth and Yield

The study found that the combination of LOF from fish waste and DmF did not significantly impact the observed parameters. The need for proper interaction between the nutrients from LOF and DmF could be attributed to various factors. The two treatments did

not complement each other to enhance plant growth and yield, leading to the absence of any interaction. Additionally, the plant's response to the treatments during the exponential phase could have limited the optimal development of the plants (Ridwan, 2019). The insignificant effect on the interaction of the two treatments is thought to be caused by environmental factors. These factors must be controlled for good plant growth and production. As mentioned by (Safrida, Ariska and Yusrizal, 2019), for plants to exhibit optimal vegetative growth, there needs to be compatibility between their genetic traits, nutritional requirements, growing media, and environmental conditions. Driesen et al., (2020) support this perspective by stating that internal factors do not solely determine plant growth. Still, it is affected by many external factors, such as water availability in plant tissues, air temperature, etc., and sunlight intensity in the plant's surroundings. If adequate, applied treatments would not significantly impact plant growth and productivity.

The importance of identifying factors contributing to plant growth and productivity and how these factors can interact (Lakitan, 2010). It is crucial to note that the absence of support between two treatments can significantly impact the plant's ability to absorb essential nutrients, leading to decreased growth and productivity. Therefore, it is essential to understand the roles and functions of each treatment to ensure that they complement each other and promote plant growth optimally. Additionally, that plant growth is a complex process that involves multiple factors that can influence the plant's response to treatments. Hence, it is essential to consider all external factors, such as environmental conditions, soil type, and nutrient availability, to ensure that external factors do not limit the plant's growth and productivity. Doing so can create a favorable environment that promotes plant growth and productivity, leading to higher yields and better-quality produce. Furthermore, the lack of positive interaction between the two treatments, as observed in the study, can be due to similar functions and roles. If the two treatments have the same impact on plant growth, it is unlikely that their interaction will result in a significant increase in growth and yield. Therefore, it is crucial to identify treatments with different functions that can complement each other, synergizing plant growth and productivity.

CONCLUSIONS

Based on the findings of the study, the following conclusions can be drawn:

1. Applying liquid organic fertilizer from fish waste (LOF) can enhance the growth and yield of pak choy plants. LOF at a dosage of 25 ml per liter of water can increase growth by

increasing plant height (4.3%) compared to without LOF and increase yield through an increase in wet weight (27%) compared to without LOF.

2. The application of duck manure fertilizer (DmF) showed significantly different effects on the growth and yield observations of pak choy plants. However, the higher treatment was found in control (without DmF) with better results than the application of DmF at all treatment doses.
3. The combination of liquid organic fertilizer from fish waste (LOF) and duck manure fertilizer (DmF) did not significantly affect the observed growth and yield of pak choy plants. However, the use of the LOF treatment (25 ml per liter of water) in combination with DmF (without DmF) improved growth by increasing plant height (4.6%) at 45 DAT and the number of leaves (8.4%) at 28 DAT compared to plants without either fertilizer. The combination treatment also increased the yield of pak choy plants by increasing the fresh weight (32%).

REFERENCES

Agresti, A. (2015) *Foundations of linear and generalized linear models*. John Wiley & Sons.

Ahuja, I. *et al.* (2021) 'Fish waste as fertiliser-effect of drying methods on fish waste and supplementing fish waste with other residual raw materials to form an organic fertiliser'.

Bhogal, A. *et al.* (2016) 'Mineralization of organic nitrogen from farm manure applications', *Soil Use and Management*, 32, pp. 32–43.

BPS (2021a) 'Langkat Regency in Figures 2021'. Badan Pusat Statistik. Available at: https://langkatkab.bps.go.id/publication/2021/02/26/2271d90a1a1612724ee8e506/kabupaten-langkat-dalam-angka-2021.html. (Accessed: 10 March 2023).

BPS (2021b) 'Statistik Hortikultura 2021'. Badan Pusat Statistik. Available at: https://www.bps.go.id/publication/2022/06/08/44e935e8c141bcb37569aed3/statistik-hortikultura-2021.html (Accessed: 23 April 2023).

BPS (2022) 'Jumlah Penduduk Pertengahan Tahun Menurut Provinsi'. Badan Pusat Statistik. Available at: https://www.bps.go.id/indicator/12/1975/1/jumlah-penduduk-pertengahan-tahun.html (Accessed: 26 March 2023).

Brady, N.C., Weil, R.R. and Weil, R.R. (2008) *The nature and properties of soils*. Prentice Hall Upper Saddle River, NJ.

Chen, J.-H. (2006) 'The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility', in. *International workshop on sustained management of the soil-rhizosphere system for efficient crop production and fertilizer use*, Citeseer, pp. 1–11.

Crutzen, P.J. (2016) 'The influence of nitrogen oxides on atmospheric ozone content', *Paul J. Crutzen: A Pioneer on Atmospheric Chemistry and Climate Change in the Anthropocene*, pp. 108–116.

Driesen, E. *et al.* (2020) 'Influence of environmental factors light, CO2, temperature, and relative humidity on stomatal opening and development: A review', *Agronomy*, 10(12), p. 1975.

Fahlivi, M.R. (2015) 'Physicochemical characteristics of liquid fertilizer from fish viscera', *United Nations University Fisheries Training Programme, Iceland* [Preprint].

FAO (2020) 'World Fisheries and Aquaculture', *Food and Agriculture Organization*, 2020, pp. 1–244.

Hagedorn, F. *et al.* (1997) 'Effect of rainfall pattern on nitrogen mineralization and leaching in a green manure experiment in South Rwanda', *Plant and Soil*, 195, pp. 365–375.

Kalisz, A. *et al.* (2012) 'Yield and nutritional quality of several non-heading Chinese cabbage (Brassica rapa var. chinensis) cultivars with different growing period and its modelling', *Horticultural Science & Technology*, 30(6), pp. 650–656.

Keshavarz Mirzamohammadi, H. *et al.* (2021) 'Irrigation and fertilizer treatments affecting rosmarinic acid accumulation, total phenolic content, antioxidant potential and correlation between them in peppermint (Mentha piperita L.)', *Irrigation Science*, 39, pp. 671–683.

Kiruba N, J.M. and Saeid, A. (2022) 'An Insight into Microbial Inoculants for Bioconversion of Waste Biomass into Sustainable "Bio-Organic" Fertilizers: A Bibliometric Analysis and Systematic Literature Review', *International Journal of Molecular Sciences*, 23(21), p. 13049.

Lakitan, B. (2010) 'Dasar-dasar fisiologi tumbuhan'.

Lubis, E. *et al.* (2021) 'Use Of Liquid Organic Fertilizer Fish Waste And Chicken Manure Fertilizer On The Production Of Pumpkin (Cucurbita Moschata)', *International Journal of Science, Technology & Management*, 2(5), pp. 1775–1779.

Ma, Y., Shen, Y. and Liu, Y. (2020) 'Food waste to biofertilizer: a potential game changer of global circular agricultural economy'.

Mohd Din, A.R.J., Cheng, K.K. and Sarmidi, M.R. (2017) 'Assessment of compost extract on yield and phytochemical contents of Pak Choi (Brassica rapa cv. chinensis) grown under different fertilizer strategies', *Communications in Soil Science and Plant Analysis*, 48(3), pp. 274–284.

Mulyani, O. *et al.* (2019) 'Potential of local organic matters in Jatinangor West Java Indonesia as raw materials for organic fertilizer', in. *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, p. 012048.

Munar, A., Bangun, I.H. and Lubis, E. (2018) 'Pertumbuhan Sawi Pakchoi (Brassica rapa L.) Pada Pemberian Pupuk Bokashi Kulit Buah Kakao Dan Poc Kulit Pisang Kepok', *AGRIUM: Jurnal Ilmu Pertanian*, 21(3), pp. 243–253.

Nair, J., Sekiozoic, V. and Anda, M. (2006) 'Effect of pre-composting on vermicomposting of kitchen waste', *Bioresource technology*, 97(16), pp. 2091–2095.

Pellejero, G. *et al.* (2021) 'Effect of the application of compost as an organic fertilizer on a tomato crop (Solanum lycopersicum L.) produced in the field in the Lower Valley of the Río Negro (Argentina)', *International journal of recycling organic waste in agriculture*, 10(2), pp. 145–155.

Pellejero, G. *et al.* (2022) 'Agronomic application effects of organic wastes on a squash crop production', *International journal of recycling organic waste in agriculture*, 11(1), pp. 143–151.

Poinkar, M. *et al.* (2006) 'Effect of organic manure and biofertilizers on growth and yield of turmeric (Curcuma longa L.).', *Journal of Soils and Crops*, 16(2), pp. 417–420.

Purba, K.F. *et al.* (2020) 'Technical efficiency and factors affecting rice production in tidal lowlands of South Sumatra province Indonesia.', *Potravinarstvo*, 14(1).

Ratanarak, U. and Prachuabmoh, P. (1991) ‘Effect of chemical fertilizer and duck manure on yield and quality of sugarcane in Eastern region [Thailand]’, in. *29th Kasetsart University Annual Conference, Bangkok (Thailand), 4-7 Feb 1991*.

Reppun, F. *et al.* (2021) ‘Effects of fresh and anaerobically digested algae (G. salicornia) as soil amendments on yield and nutrient concentrations of Pak Choy’, *Agroecology and Sustainable Food Systems*, 45(9), pp. 1270–1299.

Riddech, N. and Van, T.T.A. (2019) ‘Effect of Effective Microorganisms (EM) with Liquid Organic Fertilizer on the Growth of Pak Choy (Brassica rapa var. chinensis) Seedlings’.

Ridwan, M. (2019) ‘Produktivitas Tumpangsari Beberapa Varietas Caisim dan Takaran Pupuk Kandang Ayam Dalam Pola Tumpangsari Tanaman Caisim dan Bawang Daun’, *Jurnal Sains Agro*, 4(1).

Safrida, S., Ariska, N. and Yusrizal, Y. (2019) ‘RESPON BEBERAPA VARIETAS PADI LOKAL (Oryza sativa L.) TERHADAP AMELIORAN ABU JANJANG SAWIT PADA LAHAN GAMBUT’, *Jurnal Agrotek Lestari*, 5(1), pp. 28–38.

Sarido L., Junia, 2017. Test the growth and yield of pak choy plants (Brassica rapa L.) by administering liquid organic fertilizer in a hydroponic system. *Agrifor*, *16*(1), pp.65-74. Doi: https://doi.org/10.31293/af.v16i1.2591

Savvides, A., Fanourakis, D. and van Ieperen, W. (2012) ‘Co-ordination of hydraulic and stomatal conductances across light qualities in cucumber leaves’, *Journal of Experimental Botany*, 63(3), pp. 1135–1143.

Silitonga, M. *et al.* (2018) ‘The effect of biochar dose and NPK fertilizer on the production and growth of pak choi plant’, in. *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, p. 012028.

Skillings, J.H. (2018) *A first Course in the Design of Experiments: A linear Models Approach*. Routledge.

Sofia, F. (2018) ‘The State of World Fisheries and Aquaculture 2018-Meeting the sustainable development goals’, *Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations, Rome* [Preprint].

Thanh, D.T. *et al.* (2023) 'Effects of organic fertilizers produced from fish pond sediment on growth performances and yield of Malabar and Amaranthus vegetables', *Frontiers in Sustainable Food Systems*, 7, p. 31.

Tripathi, K. *et al.* (2015) 'Evaluation of vermicompost and chemical fertilizers on performance of Pak choi (Brassica rapa cv. Hong Tae) and soil biological process', *Journal of the Institute of Agriculture and Animal Science*, pp. 243–250.

Wang, J. *et al.* (2014) 'Emissions of ammonia and greenhouse gases during combined pre-composting and vermicomposting of duck manure', *Waste management*, 34(8), pp. 1546–1552.

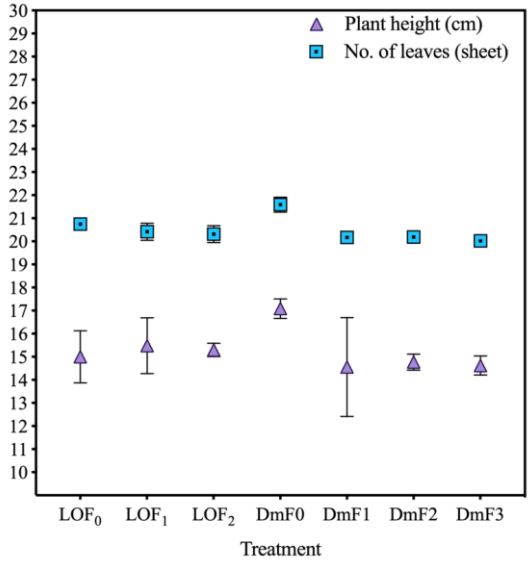


Figure 7. Applications LOF and DmF on the growth of pak choy at 45 DAT.

Note: Separate symbols (at mean and standard deviation).

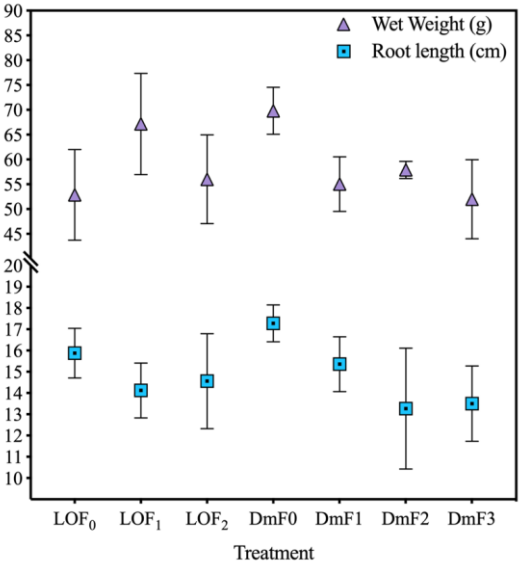


Figure 8. Application of LOF and DmF on the yield of pak choy at 45 DAT.

Note: Separate symbols (at mean and standard deviation).

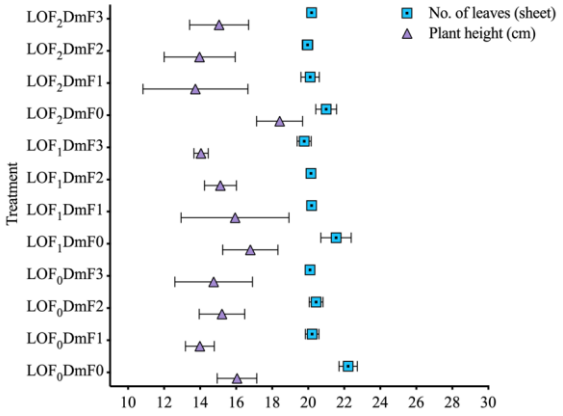


Figure 9. Application combinations of LOF and DmF on the growth of pak choy.

Note: Separate symbols (at mean and standard deviation).

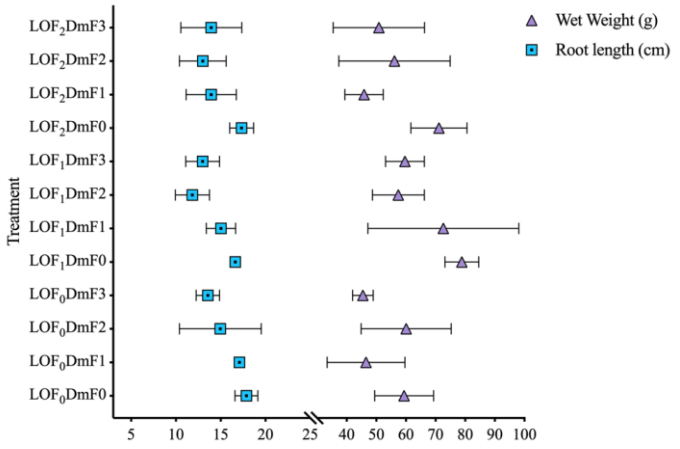


Figure 10. Application combinations LOF and DmF on the yield of pak choy.

Note: Separate symbols (at mean and standard deviation).

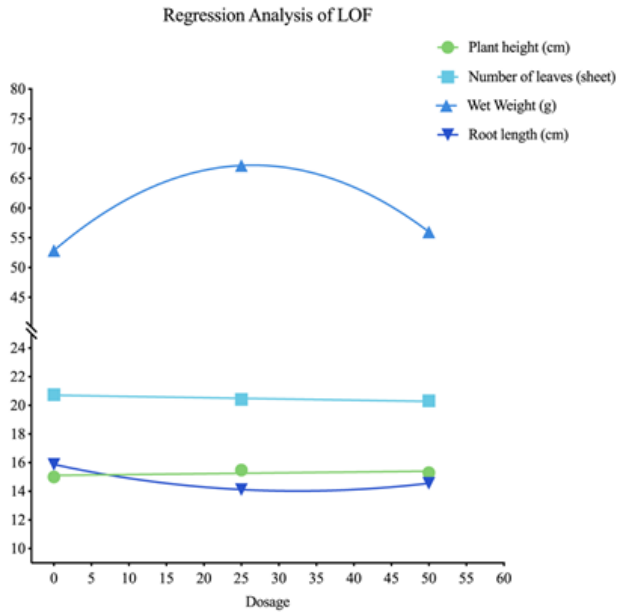


Figure 11 Regression analysis between LOF and plant height at 45 DAT (cm), number of leaves at 45 DAT (pieces), wet weight (grams), and root length (cm) of Pak Choy.

Table 1 Summary the LOF and DmF applications in observing the height of plants and the number of leaves (14, 28, 45 DAT), wet weight, and root length (45 DAT).

Treatment	**Plant height (cm)**			**Number of leaves (sheet)**			**Wet weight (g)**	**Root of length (cm)**
	14 DAT	28 DAT	45 DAT	14 DAT	28 DAT	45 DAT	45 DAT	45 DAT
LOF_0	11.57	15.00	16.86	8.17	16.86	20.74 a	52.87 b	15.88
LOF_1	12.19	15.48	17.59	8.08	17.59	20.42 ab	67.16 a	14.12
LOF_2	11.89	15.30	16.91	8.39	16.91	20.31 b	56.01 b	14.56
DmF0	13.89aA	17.08a	19.53aA	9.26 aA	19.53 aA	21.59 aA	69.81 a	17.28 aA
DmF1	11.12bB	14.56b	16.04 bB	7.92bAB	16.04 bAB	20.17 bB	55.02 bc	15.36 bB

DmF2	11.21b B	14.77b	16.56 bB	7.74 bB	16.56 bB	20.19 bB	57.89 b	13.27 cC
DmF3	11.30b B	14.62b	16 .35 bB	7.92ba B	16.35 bB	20, 02 bB	51.99 c	13.50 cC
LOF_0 DmF0	13.13	18.35	16.05	9.00	18.35	22.22	59.40	17.87
LOF_0 DmF1	11.02	15.96	13.99	8.11	15.96	20.22	46.54	17.11
LOF_0 DmF2	11.44	16.9	15.22	6.89	16.9	20.44	60.09	14.96
LOF_0 DmF3	10.70	16.23	14.75	8.67	16.23	20.10	45.45	13.57
LOF_1 DmF0	14.14	19.9	16.79	9.11	19.9	21.55	78.87	16.63
LOF_1 DmF1	11.93	16.78	15.94	8.44	16.78	20.19	72.65	15.03
LOF_1 DmF2	11.82	17.25	15.13	8.00	17.25	20.15	57.44	11.84
LOF_1 DmF3	10.85	16.44	14.05	6.77	16.44	19.78	59.66	12.99
LOF_2 DmF0	14.41	20.33	18.42	9.66	20.33	21.00	71.16	17.34
LOF_2 DmF1	10.42	15.39	13.74	7.22	15.39	20.11	45.85	13.94
LOF_2 DmF2	10.38	15.53	13.97	8.33	15.53	19.96	56.14	13.01
LOF_2 DmF3	12.36	16.39	15.05	8.33	16.39	20.19	50.86	13.95
CV (%)	6.78%	9.70%	11.20%	12.00%	9.70%	1.81%	22.53%	12.49%

The Duncan's test indicates that numbers followed by different letters in the same column are statistically significant at the 5% level (indicated by lowercase letters) and highly significant at the 1% level (indicated by capital letters).

Figure 12 Experimental design details: (A). Research plot (LOF_1 DmF0), (B). All research plots,

2. Revision Manuscript Round 1 (23 Februari 2023)

The effect of fish waste and duck manure on the growth and yield of pak choy (*Brassica rapa* L.)

Muhammad Idris[1)] ✉ 0000-0002-7847-4615, Imam H. Bangun[2)] 0000-0001-9977-664X, Nurma Ani[3)] 0000-0001-6451-4041, Dermawan Hutagaol[3)] 0000-0003-4478-1622, Fajar Siddik[3)]

[1)] North Sumatera State Islamic University, Faculty of Science and Technology, Department of Biology, Deli Serdang, North Sumatera, 20353, Indonesia

[2)] Universitas Muhammadiyah Sumatera Utara, Faculty of Agriculture, Department of Agrotechnology, …, …,

[3)] Al Azhar University Medan, …, Department of Agriculture, Medan, North Sumatera, Indonesia

✉ midris@uinsu.ac.id idris.juki1@gmail.com

Received 07.12.2022

Accepted 16.08.2023

Available online --.--.2023

Abstract: This study aims to determine the effect of the growth and yield of pak choy plants on the application of liquid organic fertiliser (LOF) from fish waste and duck manure and the interaction between the two. The method used was a factorial randomised block design (RBD) consisting of two factors and three replications. Where the first factor is LOF nutrition of fish waste (I) consisting of three levels, namely I0 – without LOF, I1 – 25 $cm^3 \cdot dm^{-3}$ of water, I2 – 50 $cm^3 \cdot dm^{-3}$ of water, and the second factor is duck manure (N) which consists of four levels, namely N0 – without duck manure, N1 – 3.7 $kg \cdot plot^{-1}$, N2 – 5.55 $kg \cdot plot^{-1}$, N3 – 7.4 $kg \cdot plot^{-1}$. The results showed that the application of fish waste liquid organic fertiliser did not significantly affect the parameters of plant height, number of leaves, fresh weight, and root length. Application of duck manure showed a significant effect on plant height, number of leaves, fresh weight, and plant root length. Meanwhile, the interaction of liquid organic fertiliser from fish manure and duck manure had no significant effect on the parameters of plant height, number of leaves, leaf length, leaf width, leaf area, plant wet weight and root length.

Keywords: fish waste, growth and yield, liquid organic fertiliser, manure, pak choy (*Brassica rapa* L.)

INTRODUCTION

Pak choy mustard is a plant that can be grown in the lowlands and highlands with the condition that it gets enough sunlight, has good soil aeration, and soil pH is 6.5 – 7 (Sarido and Junia, 2017).

The ebb and flow of pak choy production are due to the continuous use of chemical fertilisers as a source of nutrients which results in damage to soil organisms so that the environmental balance is not maintained. So, efforts to increase pak choy production can be made by using organic fertilisers derived from agricultural waste, manure, green manure, human waste, and compost as a substitute for nutrient

Commented [A1]: Kindly use one of these possible variants of spelling in British English: bok choy or pak choi. Kindly edit it throughout the whole article

Commented [A2]: Kindly check, in the Editorial System you added the name as Fajjar, and here it's Fajar. Which one is correct?

Commented [A3]: Is the address for this faculty: Jalan IAIN No.1 Medan 20235? Kindly add a street and street number, and check the post code (I found another one on the website of the university) and write a correct address

Commented [A4]: Kindly add a city and a country as well

Commented [A5]: Kindly add a faculty

Commented [A6]: Kindly choose, which e-mail are we supposed to use as of a Corresponding author?

sources. Through the application of organic farming, it is hoped that the balance between organisms and the environment will be maintained (Ernanda, Indrawati and Mardiana, 2022).

One of the factors that influence success in the cultivation of mustard greens is the application of fertiliser. Plants need fertiliser as a source of nutrients, namely nitrogen (N), phosphorus (P), and potassium (K) which function for plant growth and development. There are two types of fertilisers namely, organic fertilisers and inorganic fertilisers. According to Sapareng, Mudaffar and Rahim (2019), excessive use of inorganic fertilisers harms the environment. The negative impact is that inorganic fertilisers can damage soil fertility and suppress the growth of microbes in the soil.

One way to overcome this is to use organic fertilisers that are more environmentally friendly. One of the organic fertilisers that can be used is compost. Compost is a fertiliser that comes from the remains of organic matter. Sources of organic matter can come from household waste, livestock manure, plant residues, charcoal, husks, and kitchen ashes. The use of compost can add nutrients to the soil, especially nitrogen (N), phosphorus (P), and potassium (K) which function for plant growth and development, improve the chemical properties of the soil so that the nutrients available in the soil can be more easily absorbed. by plants, and enhances soil binding capacity to nutrients so that they dissolve easily in water (Hadisuwito, 2012).

The organic fertiliser to be used in this study is manure made from duck manure and fish waste. Researchers are interested in using these materials in this study because these materials are easy to obtain and are underutilised by the community even though these basic materials can provide nutrients such as N, P, and K for plant growth if used properly.

This study aims to determine the effect of applying liquid organic fertiliser (LOF) on fish waste and duck manure and the interaction between the two on the growth and production of mustard greens (*Brassica rapa* L.)

MATERIALS AND METHODS

PLACE AND TIME OF RESEARCH

This research was conducted on Jalan Perjuangan, Babalan District, Langkat Regency, North Sumatra Province. This research was conducted from October to December 2020.

MATERIALS AND TOOLS

Pak choy seeds, fish waste, duck manure, EM-4, and brown sugar. Hoes, raking grass, tripe machetes, tape measure, scales, stationery, calculators, ropes, hoops, buckets, and cameras.

RESEARCH METHOD

This research was conducted using a factorial randomised block design (RBD).

The number of treatment combinations is 4 · 3 = 12

number of repetitions : 3 replications,

number of trial plots : 36 plots

Experimental plot area : 100 cm × 150 cm

Spacing : 30 cm × 30 cm

Commented [A7]: What do you mean by kitchen ashes? Ash from oven?

Commented [A8]: Maybe on some land or farm by this street?

Commented [A9]: Kindly explain what means EM-4

Commented [A10]: Kindly write this part of the article in whole sentences and make them fuller or add a little more information.
This kind of writing style doesn't appear to be of a scientific article, looks more like a conspect

Number of plants per plot : 8 plants

Number of sample plants per plot : 4 plants

Total number of plants : 288 plants

Total number of samples : 144 plants

Distance between plots : 50 cm

Distance between repetitions : 100 cm

DATA ANALYSIS

The mathematical model used in this research data analysis is:

$$Yijk = \mu + \alpha 1 + \beta j + (\alpha\beta)ij + \rho k + \varepsilon ijk \quad (1)$$

where: Yij = observations from the experimental unit administering liquid organic fertiliser fish waste level (i), duck manure (j) level and repeat level (k); μ = the mean population value; α = effect of liquid organic fertiliser application of fish waste level (i), βj = effect of application of duck manure level (j); $(\alpha\beta)ijk$ = effect of interaction of liquid organic fertiliser application of level (i) fish waste and duck manure j-th level; εijk = the effect of error from an experiment given i-th liquid organic fertiliser fish waste, j-level duck manure, and k-th level replicates.

If the results of the Variety Sidik List (DSR) of the treatments tested have a significant effect, an honest significant difference test (HSD) is carried out at the 5% level.

Research implementation

Research implementation includes: soil preparation, plot making, manure application, fish waste LOF production, fertiliser application, seed planting.

Plant maintenance

Plant maintenance includes: watering, insertion, weeding, eradication of pests and diseases.

Harvest

Pak choy harvesting is typically done at around 40 days after planting. When harvesting pak choy, it is important to remove the entire mustard plant and its roots carefully to avoid breaking off any of the plant roots.

Observation variable

a. Plant height (cm)

b. Number of leaves/plants (strands)

c. Plant/sample wet weight

d. Root length (cm)

RESULTS AND DISCUSSION

PLANT HEIGHT

The results of statistical analysis showed that the application of liquid organic fertiliser (LOF) fish waste had no significant effect and the application of duck manure had a very significant effect while the interaction had no significant effect at 14 DAP ….. (Tab. 1).

Commented [A11]: Kindly transform it into a usual sentence form in a paragraph.
This list won't probably fit into one column (width of one column is 8 cm in the pdf), so it won't look nice with all the endings moved into the next line)

Commented [A12]: Is it a number 1?

Commented [A13]: Is that correct $(\alpha\beta)ijk$?

Commented [A14]: What does ρk mean?

Commented [A15]: Did you mean $Yijk$?

Commented [A16]: Is this correct $(\alpha\beta)ij$?

Commented [A17]: Kindly explain what Variety Sidik List means? The main being Sidik, maybe it is from Indonesian? Or is it a title of the list of everything in this variety?

Commented [A18]: DSR means Direct seeded rice?

Commented [A19]: Kindly write this part of the article in whole sentences and make them fuller or add a little more information.

Commented [A20]: Same, kindly write this part of the article in whole sentences and make them fuller or add a little more information.

Commented [A21]: Same, kindly write this part of the article in whole sentences and make them a bit fuller.

Commented [A22]: Kindly explain what means DAP? If it is dose per acre, then kindly explain here, how much is 1 acre in m^2

Table 1. The average plant height (cm) at 14 DAP due to the liquid organic fertiliser (LOF) treatment of fish waste and duck manure

Treatment	N0	N1	N2	N3	Average
I0	13.13	11.02	11.44	10.70	11.57
I1	14.14	11.93	11.82	10.85	12.19
I2	14.41	10.42	10.38	12.36	11.89
Average	13.89 aA	11.12 bB	11.21 bB	11.30 BB	–

Explanations: N0 = without duck manure LOF, N1 = 3.7 kg·plot^{-1}, N2 = 5.55 kg·plot^{-1}, N3 = 7.4 kg·plot^{-1}, I0 = without fish waste LOF, I1 = 25 cm^{3}·dm^{-3} of water, I2 = 50 cm^{3}·dm^{-3} of water, numbers followed by different notations are significant at the 5% level (lowercase letters) and very significantly different at the 1% level (capital letters) according to Duncan's test.

Source: own study.

FROM TABLE 1 IT CAN BE SEEN THAT THE ADMINISTRATION OF FISH WASTE LIQUID ORGANIC FERTILISER (LOF) IN TREATMENT I1 (12.19 CM) SHOWED THE HIGHEST PLANT HEIGHT FOLLOWED BY TREATMENTS I0 (11.57 CM), I2 (11.89 CM), AND I0 (11.57 CM) INDICATED THE LOWEST PLANT HEIGHT. APPLICATION OF DUCK MANURE TO TREATMENT N0 (13.89 CM) SHOWED THE HIGHEST PLANT HEIGHT, FOLLOWED BY TREATMENTS N1 (11.12 CM), N2 (11.21 CM) AND N3 (11.30 CM). THE INTERACTION OF LOF FOR

Commented [A23]: It cannot be written like that because N0 is without any application of duck manure, it basically means that you've added some duck manure to the control. It should be written as :
The treatment N0 (13.89 cm) without duck manure LOF showed the highest plant height ….

FISH WASTE (I) AND DUCK MANURE (N) FOR ALL COMBINATIONS HAD NO SIGNIFICANT EFFECT.

BASED ON THE RESULTS OF THE REGRESSION ANALYSIS, IT IS KNOWN THAT THE RELATIONSHIP BETWEEN DUCK MANURE AND PLANT HEIGHT IS EXPRESSED BY A QUADRATIC REGRESSION EQUATION, NAMELY:

$$\hat{Y} = 19.293 - 0.6724X + 0.0328X^2;\ R^2 = 0.8575 \quad (2)$$

WHERE: $\hat{Y}$ = …, R^2 = DETERMINATION COEFFICIENT, X = …, X^2 = …;

Commented [A24]: Kindly write the explanations

THE RESULTS OF STATISTICAL ANALYSIS SHOWED THAT THE APPLICATION OF LOF FOR FISH WASTE HAD NO SIGNIFICANT EFFECT AND THE APPLICATION OF DUCK MANURE HAD A VERY SIGNIFICANT EFFECT, WHILE THE INTERACTION HAD NO SIGNIFICANT EFFECT AT 28 DAP (TAB. 2).

Table 2. The average plant height (cm) at 28 DAP due to the liquid organic fertiliser (LOF) treatment of fish waste and duck manure

Treatment	N0	N1	N2	N3	Average
I0	16,05	13.99	15.22	14.75	15.00
I1	16.79	15.94	15.13	14.05	15.48
I2	18.42	13.74	13.97	15.05	15.30
Average	17.08 a	14.56 b	14.77 b	14.62 b	–

Commented [A25]: I will change all the commas here to dots, I suppose it's not dividing hundreds

Explanations: N0, N1, N2, N3, I0, I1, I2 as in Tab. 1, numbers followed by different notations are significant at the 5% level (lowercase letters) and very significantly different at the 1% level (capital letters) according to Duncan's test.

Source: own study.

FROM TABLE 2 IT CAN BE SEEN THAT THE APPLICATION OF LOF FISH WASTE IN TREATMENT I1 (15.48 CM) SHOWED THE HIGHEST PLANT HEIGHT FOLLOWED BY TREATMENTS I0 (15.00 CM), I2 (15.30 CM) AND I0 (15.00 CM) SHOWED THE LOWEST PLANT HEIGHT. APPLICATION OF DUCK MANURE

TO TREATMENT N0 (17.08 CM) SHOWED THE HIGHEST PLANT HEIGHT FOLLOWED BY TREATMENTS N1 (14.56 CM), N2 (14.77 CM) AND N3 (14.62 CM).

The interaction of liquid organic fertiliser (LOF) for fish waste (I) and duck manure (N) for all combinations had no significant effect. The I2N0 combination showed the highest plant height (18.42 cm) and the lowest combination was in the M3A1 treatment (13.74 cm).

Based on the results of the regression analysis it is known that the relationship between duck manure and plant height is expressed by a quadratic regression equation, namely:

$$\hat{Y} = 16.92 + 0.499A - 0.023A^2;\ R^2 = 0.8928 \quad (3)$$

where: $\hat{Y}$ = …, R^2 = determination coefficient, A = …, A^2 = …;

The results of statistical analysis showed that the application of LOF fish waste had no significant effect and the application of duck manure had a very significant effect while the interaction had no significant effect at 45 DAP. (Tab. 3).

Table 3. The average plant height (cm) at age 45 DAP due to the treatment of liquid organic fertiliser (LOF) fish waste and duck manure

Treatment	**N0**	**N1**	**N2**	**N3**	**Average**
I0	18.35	15.96	16.90	16.23	16.86
I1	19.90	16.78	17.25	16.44	17.59
I2	20.33	15.39	15.53	16.39	16.91
Average	19.53 aA	16.04 bB	16.56 bB	16.35 bB	–

Explanations: N0, N1, N2, N3, I0, I1, I2 as in Tab. 1, numbers followed by different notations are significant at the 5% level (lowercase letters) and very significantly different at the 1% level (capital letters) according to Duncan's test.

Source: own study.

From Table 3 it can be seen that the administration of fish waste LOF in treatment I1 (17.59 cm) showed the highest plant height followed by treatments I0 (16.86 cm), I2 (16.91

Commented [A26]: It cannot be written like that because N0 is without any application of duck manure
It should be written as :
The treatment N0 (17.08 cm) without duck manure LOF showed the highest plant height ….

Commented [A27]: What is M?

Commented [A28]: Kindly write the explanations

Commented [A29]: Plant height age?

cm), and I0 (16.86 cm) indicating the lowest plant height. Application of duck manure to treatment N0 (19.53 cm) showed the highest plant height followed by treatments N1 (16.04 cm), N2 (16.56 cm) and N3 (16.35 cm). The interaction of LOF for fish waste (I) and duck manure (N) for all combinations had no significant effect.

Based on the results of the regression analysis it is known that the relationship between duck manure and plant height is expressed by a quadratic regression equation, namely:

$$\hat{Y} = 19.293 + 0.6724x - 0.0328x^2;\ R^2 = 0.9243 \quad (4)$$

WHERE: $\hat{Y}$ = …, R^2 = DETERMINATION COEFFICIENT, X = …, X^2 = …;

NUMBER OF LEAVES

The results of the statistical analysis showed that the administration of liquid organic fertiliser (LOF) fish waste had no significant effect and duck manure had a significant effect while the interaction had no significant effect at 14 DAP (Tab. 4).

Table 4. The average number of leaves (strands) at 14 DAP due to the treatment of liquid organic fertiliser (LOF) fish waste and duck manure

Treatment	**N0**	**N1**	**N2**	**N3**	**Average**
I0	9.00	8.11	6.89	8.67	8.17
I1	9.11	8.44	8.00	6.77	8.08
I2	9.66	7.22	8.33	8.33	8.39
Average	9.26 aA	7.92 chapters	7.74 bB	7.92 chapters	–

Explanations: N0, N1, N2, N3, I0, I1, I2 as in Tab. 1, numbers followed by different notations are significant at the 5% level (lowercase letters) and very significantly different at the 1% level (capital letters) according to Duncan's test.

Source: own study.

Commented [A30]: It cannot be written like that because N0 is without any application of duck manure
It should be written as :
The treatment N0 (19.53 cm) without duck manure LOF showed the highest plant height ….

Commented [A31]: Kindly write the explanations

Commented [A32]: What do you mean by strands? A cabbage head? I don't think there are any strands in pak choi (except for the strands in DNA)
Kindly delete if that is a mistake

Commented [A33]: What means "chapters" here?

Based on the results of the regression analysis, it is known that the relationship between fish waste LOF usage and the number of leaves is expressed by a linear regression equation, namely:

$$\hat{Y} = 9.22 - 0.312x + 0.0152x^2;\ R^2 = 0.9785 \quad (5)$$

WHERE: $\hat{Y}$ = …, R^2 = DETERMINATION COEFFICIENT, X = …, X^2 = …;

The results of statistical analysis showed that the application of fish waste LOF had no significant effect and the usage of duck manure had a very significant effect while the interaction had no significant effect at the age of 28 DAP (Tab. 5).

Table 5. The average number of leaves (strands) at 28 DAP due to the treatment of liquid organic fertiliser (LOF) fish waste and duck manure

Treatment	N0	N1	N2	N3	Average
I0	18.35	15.96	16.90	16.23	16.86
I1	19.90	16.78	17.25	16.44	17.59
I2	20.33	15.39	15.53	16.39	16.91
Average	19.53 aA	16.04 bAB	16.56 bB	16.35 bB	–

Explanations: N0, N1, N2, N3, I0, I1, I2 as in Tab. 1, numbers followed by different notations are significant at the 5% level (lowercase letters) and very significantly different at the 1% level (capital letters) according to Duncan's test.

Source: own study.

From Table 5 it can be seen that the application of fish waste LOF to treatment I1 (17.59 leaves) showed the highest number of leaves followed by treatment I0 (16.86 leaves), I2 (16.91 leaves). Application of duck manure to treatment N0 (19.53 leaves) showed the highest number of leaves followed by N1 (16.04 leaves), N2 (16.56 leaves) and N3 (16.35 leaves) but N1 (16.04 leaves). The interaction of fish waste LOF (I) and duck manure (N) for all combinations had

Commented [A34]: Why is it linear? Isn't it a quadratic equation?

Commented [A35]: Kindly write the explanations

Commented [A36]: Age of DAP? Isn't DAP – doses per acre? Or is it days after planting?

Commented [A37]: It cannot be written like that because N0 is without any application of duck manure
It should be written as :
The treatment N0 (19.53 leaves) without duck manure LOF showed the highest ….

Commented [A38]: But N1 …? Kindly finish the sentence

no significant effect. The I0N0 combination showed the highest number of leaves (20.33 leaves).

Based on the results of the regression analysis it is known that the relationship between fish waste LOF and the number of leaves is expressed by a linear regression equation, namely:

$$\hat{Y} = 12.23 - 0.2311x + 0.0091x^2;\ R^2 = 0.7705 \quad (6)$$

where: $\hat{Y}$ = …, R^2 = determination coefficient, x = …, x^2 = …;

The results of statistical analysis showed that the application of fish waste LOF had a significant effect and duck manure had a very significant effect, while the interaction had no significant effect at the age of 45 DAP (Tab. 6).

Table 6. The average number of leaves (strands) at 45 DAP due to the treatment of liquid organic fertiliser (LOF) fish waste and duck manure

Treatment	N0	N1	N2	N3	Mean
I0	22.22	20.22	20.44	20.10	20.74 a
I1	21.55	20.19	20.15	19.78	20.42 ab
I2	21.00	20.11	19.96	20.19	20.31 b
Average	21.59 aA	20.17 bB	20.19 bB	20.02 bB	–

Explanations: N0, N1, N2, N3, I0, I1, I2 as in Tab. 1, numbers followed by different notations are significant at the 5% level (lowercase letters) and very significantly different at the 1% level (capital letters) according to Duncan's test.

Source: own study.

From Table 6 it can be seen that the application of fish waste LOF to treatment I0 (20.74 leaves) showed the highest number of leaves followed by treatment I1 (20.42 leaves) and I2 (20.31 leaves). Application of duck manure to treatment N0 (21.59 leaves) showed the highest number of leaves followed by N1 (20.17 leaves), N2 (20.19 leaves) and N3 (20.02 leaves). The interaction of fish waste LOF (I) and duck manure (N) for all combinations had no significant effect. The I0N0 combination showed the highest number of leaves (22.22 leaves).

Commented [A39]: Why is it linear? Isn't it a quadratic equation?

Commented [A40]: Kindly write the explanations

Commented [A41]: As higher

Commented [A42]: It cannot be written like that because I0 is without any application of fish waste
It should be written as :
the treatment I0 (20.74 leaves) without fish waste LOF showed the highest ….

Commented [A43]: It cannot be written like that because N0 is without any application of duck manure
It should be written as :
The treatment N0 (21.59 leaves) without duck manure LOF showed the highest ….

Based on the results of the regression analysis it is known that the relationship between fish waste LOF and the number of leaves is expressed by a linear regression equation, namely:

$$\hat{Y} = 20.922 - 0.0002M;\ R^2 = 0.9264 \quad (7)$$

where: R^2 = determination coefficient, $\hat{Y}$ = …, M = … .

Based on the results of the regression analysis it is known that the relationship between duck manure and the number of leaves is expressed by the cubic regression equation, namely:

$$\hat{Y} = 21.509 + 0.2813x - 0.0.0125x^2;\ R^2 = 0.9182 \quad (8)$$

where: $\hat{Y}$ = …, R^2 = determination coefficient, x = …, x^2 = …

WET WEIGHT

The results of statistical analysis showed that the application of fish waste liquid organic fertiliser (LOF) and duck manure had a significant effect while the interaction had no significant effect (Tab. 7).

Table 7. The average wet weight (g) due to the treatment of liquid organic fertiliser (LOF) fish waste and duck manure

Treatment	N0	N1	N2	N3	Average
I0	59.40	46.54	60.09	45.45	52.87 b
I1	78.87	72.65	57.44	59.66	67.16 a
I2	71.16	45.85	56.14	50.86	56.01 b
Average	69.81 a	55.02 bc	57.89 b	51.99 c	–

Explanations: N0, N1, N2, N3, I0, I1, I2 as in Tab. 1, numbers followed by different notations are significant at the 5% level (lowercase letters) and very significantly different at the 1% level (capital letters) according to Duncan's test.

Source: own study.

From Table 7 it can be seen that the administration of fish waste LOF in treatment I1 (67.16 g) showed the heaviest wet weight followed by treatments I2 (56.01 g) and I0 (52.87 g). Application of duck manure to treatment N0 (69.81 g) showed the heaviest wet weight, followed by N1 (55.02 g), N2 (57.02 g) and N3 (51.99 g). The interaction of LOF fish waste

Commented [A44]: Kindly write the explanations

Commented [A45]: Why is it cubic? Isn't it a quadratic equation?

Commented [A46]: Kindly write the explanations

Commented [A47]: It cannot be written like that because N0 is without any application of duck manure
It should be written as :
The treatment N0 (21.59 leaves) without duck manure LOF showed the highest ….

(I) and duck manure (N) for all combinations had no significant effect. The I1N0 combination showed the heaviest wet weight (78.87 g) and the I0N3 treatment (45.45 g) combination showed the lightest.

Based on the results of the regression analysis it is known that the relationship between fish waste LOF ….. on fresh weight is expressed by the quadratic regression equation, namely:

$$\hat{Y} = 13.14 + 0.0524x - 1E - 05x^2;\ R^2 = 0.9768 \quad (9)$$

where: $\hat{Y}$ = …, R^2 = determination coefficient, x = …, x^2 = …, E = ….

Based on the results of the regression analysis it is known that the relationship between duck manure and wet weight is expressed by the linear regression equation, namely:

$$\hat{Y} = 66.265 - 1.0117A;\ r = 0.7006 \quad (10)$$

where: $\hat{Y}$ = …, r = …, A = … .

ROOT LENGTH

The results of the statistical analysis showed that the application of fish waste liquid organic fertiliser (LOF) had no significant effect and the application of duck manure had a very significant effect but the interaction had no significant effect on … (Tab. 8).

Table 8. The average root length (cm) due to the liquid organic fertiliser (LOF) treatment of fish waste and duck manure

Treatment	N0	N1	N2	N3	Average
10	17,87	17.11	14.96	13.57	15.88
I1	16.63	15.03	11.84	12.99	14.12
I2	17.34	13.94	13.01	13.95	14.56
Average	17.28 aA	15.36 bB	13.27 cC	13.50 cC	–

Explanations: N0, N1, N2, N3, I0, I1, I2 as in Tab. 1, numbers followed by different notations are significant at the 5% level (lowercase letters) and very significantly different at the 1% level (capital letters) according to Duncan's test.

Source: own study.

From Table 8 it can be seen that the application of fish waste LOF to all treatments for the longest root length was found in treatment I0 (15.88 cm) and the shortest root length was observed in treatment

Commented [A48]: Between fish waste LOF and …? Duck manure? Or fresh weight?

Commented [A49]: If you are using this letter everywhere, not Y, then kindly edit all the figures as well, there are these Equations as well. The letter should be written the same way throughout the whole article if it means the same everywhere. Kindly check it throughout the article

Commented [A50]: Kindly write the explanations

Commented [A51]: Effect on root length?

Commented [A52]: I will change all the commas here to dots, I suppose it's not dividing hundreds

Commented [A53]: It cannot be written like that because I0 is without any application of fish waste
It should be written as :
the treatment I0 (15.88 cm) without fish waste LOF showed the longest root length ….

I1 (14.12 cm) following by I2 (14.56 cm). Application of duck manure to treatment N0 (17.28 cm) showed the longest root length followed by treatments N1 (15.36 cm), N2 (13.27 cm) and N3 (13.50 cm).

The interaction of fish waste LOF (I) and duck manure (N) for all combinations had no significant effect. The I0N0 combination showed the longest root length (17.87 cm) and the shortest root length was found in the I1N2 treatment (11.84 cm).

Based on the results of the regression analysis it is known that the relationship between duck manure and root length is expressed by a linear regression equation, namely:

$$\hat{Y} = 16.323 - 0.1176A;\ R^2 = 0.8602 \quad (11)$$

where: $\hat{Y}$ = …, R^2 = determination coefficient, A = …

THE EFFECT OF LIQUID ORGANIC FERTILISER NUTRITION FROM FISH WASTE ON THE GROWTH OF PAK CHOY (*BRASSICA RAPA* L.)

From the results of the study it can be explained that the nutrition with fish waste liquid organic fertiliser (LOF) had no significant effect on the parameters of plant height, number of leaves and root length, but significantly different in the number of leaves at 45 … (HST) and plant wet weight.

The number of leaves that are formed is influenced by genetics and the availability of essential elements such as nitrogen contained in the nutrients given. This is because element N is the main component of various important substances in the formation of plant leaves (Novizan, 2007).

This is in accordance with the previous number of leaves parameter, where the average number of leaves from different times of data collection also supports the results of the generative phase so that it contributes to the wet weight of the plant which is influenced by the nutrients and water contained in the plant (Fatma, 2009). The more the number of leaves on a plant will affect the weight of the plants produced by the leaves.

There is no significant effect of the provision of fish waste LOF nutrition on the parameters observed because the concentration of fish waste LOF nutrients given is still not in accordance with plant needs. that the provision of nutrients can increase plant growth in large quantities according to plant needs (Lawalata, 2011). Inaccurate application of fertiliser concentrations, especially the N nutrient which plays a role in plant vegetative growth, results in lower osmotic pressure around plant roots so that the roots experience physiological drought, which results in lower absorption of nutrients (Sujinah and Jamil 2016).

Loss of nutrients given along with water loss in plants due to transpiration is influenced by many factors including temperature. In accordance with Oogathoo's *et al*. (2022) statement, transpiration activities are affected by many factors, both external factors such as radiation, temperature, air humidity, air pressure, and the presence of water in the planting medium.

Temperature is an environmental factor that influences plant growth and development. Air temperature is affected by the radiation received on the earth's surface while the high and low temperatures around plants are determined by solar radiation, plant density and light distribution in the

Commented [A54]: It cannot be written like that because N0 is without any application of duck manure
It should be written as :
The treatment N0 (17.28 cm) without duck manure LOF showed the longest ….

Commented [A55]: Kindly write the explanations

Commented [A56]: Kindly write an explanation

Commented [A57]: This source is not in the list of references, kindly add it to the list of references or delete it from text including with a citation

Commented [A58]: Kindly re-phrase this sentence, it is not clear. Did you mean: The weight of a plant is affected by the number of its leaves?

Commented [A59]: This is unclear. Did you mean: As a result, the provision of nutrients may not be able to significantly improve plant growth in large quantities?

Commented [A60]: Both external and …? Should there be the ending of the thought?

plant canopy (Pioh *et al.*, 2013). In line with the statement of Qaderi, Martel and Dixon (2019), the impact of increasing temperature on plants is an increase in transpiration which can slow down/suppress growth and yield and even cause death.

The relationship between the thermal unit and ambient temperature is directly proportional while inversely proportional to the age of the plant, meaning that the higher the temperature, the shorter the life of the plant, which in turn has an impact on the time for photosynthate accumulation and the formation of lower biomass (Perwitasari, Tripatmasari and Wasonowati, 2012).

THE EFFECT OF DUCK MANURE ON THE GROWTH OF PAK CHOY (*BRASSICA RAPA* L.)

From the results of the study it can be explained that the application of duck manure had a significant impact on the parameters of plant height and wet weight of plants 45 DAP, and a very significant impact on the parameters of number of leaves and root length 45 DAP. This shows that the parameters observed were that the concentration of liquid organic fertiliser duck manure applied to the planting medium was insufficient to be absorbed by plants, so that plant growth still depended on food reserves from seeds. Even though the application of duck manure independently can increase the available N and P content, the absorption of these elements by plants is not optimal, which is influenced by factors, namely the method and time of application that is not appropriate and the condition of the place that does not support it (Setiawati, 2014). This is supported by the statements of Basundari and Krisdianto (2020), that a good plant fertilisation strategy must refer to the concept of maximum effectiveness and efficiency including: type of fertiliser, time and frequency of fertilisation and method of placing fertiliser. According to Yosephine, Effendi and Lestari (2021), applying fertiliser to plants very clearly has an effect on growth and production, the excessive application will suppress growth, while applying a little fertiliser can cause a nutrient deficiency for the plant. In line with Ernanda's statement (2017), the treatment given has no effect because the plant lacks nutrients from the still insufficient amount of fertiliser g given as the condition of the plant is getting bigger so that the amount of nutrients needed is increasing. The availability of the amount of fertiliser given in the growing media is decreasing causing the process of plant photosynthesis to run slowly.

In line with the statement of Satwiko, Lahay and Damanik (2013), individuals are the result of interactions between genotype (natural inheritance) and their environment. Although the characteristics of a particular phenotype cannot be forever determined by phenotypic differences, it is possible that the phenotypic differences between separated individuals are caused by environmental differences. Non-uniform plant growth indicates that the ability of each plant to carry out metabolism is different. The ability of plants to carry out photosynthesis will cause growth differences in each plant. Photosynthesis is very closely related to the availability of nutrients. In this study the fertiliser given had no effect on the plants because the plants lacked sufficient nutrients needed from the fertiliser given. the conditions of the plants are getting bigger, the amount of nutrients needed also increased, which caused the process of plant photosynthesis to run slowly. Although the application of duck pinnata manure can increase

Commented [A61]: This sentence is unclear, did you mean: This shows that the concentration of duck manure liquid organic ferliliser applied to the planting medium was insufficient for plant absorption, so plant growth still depended on stored food reserves from the seeds.
?

Commented [A62]: Did you mean (Ernanda, Indrawati and Mardiana, 2022)?
There is no such source as (Ernanda, 2017) in the list of the references. Kindly add it to the list or delete the citation from the text

Commented [A63]: ?

Commented [A64]: What do you mean by that? Condition is getting better or the plant is getting bigger in size?

Commented [A65]: I suggest: As the plants grew bigger,

Commented [A66]: Is it a mixture of duck manure and Azolla pinnata?

the available N and P content, the absorption of elements by plants is not optimal because it is not supported by the conditions in which plants grow (Setiawati, 2014).

In line with Hartanti (2014), plant growth is strongly influenced by environmental factors such as light and temperature, where these factors play an important role in the production and transportation of food ingredients. Supported by the statement of Os, Yetti and Ariani (2015), apart from nutrients, other factors that affect the growth of pak choy plants to be stunted are environmental conditions that are not supportive. Intake of sunlight is not optimal, thus inhibiting the process of photosynthesis.

Temperature is an environmental factor that influences plant growth and development. Air temperature is affected by the radiation received on the earth's surface, while the high and low temperatures around plants are determined by solar radiation, plant density and light distribution in the plant canopy (Pioh *et al.*, 2013). In line with Parthasarathi's *et al.* (2022) statement, the impact of increasing temperature on plants is an increase in transpiration which can slow down/suppress growth, yield and even cause death.

NUTRITIONAL INTERACTION OF FISH WASTE LIQUID ORGANIC FERTILISER AND DUCK MANURE LIQUID ORGANIC FERTILISER ON THE GROWTH AND PRODUCTION OF PAK CHOY PLANTS (*BRASSICA RAPA* L.)

The interaction of fish waste liquid organic fertiliser (LOF) and duck manure LOF had no significant effect on all parameters observed. Many factors cause LOF nutrients from fish waste and duck manure not to interact properly. The interaction did not occur because the two treatments did not support each other to increase plant growth and yield. This can also be due to the plant's response to very good treatment in the exponential phase of the plant so that plant development cannot occur optimally (Ridwan 2019).

The insignificant effect on the interaction of the two treatments is thought to be caused by environmental factors, if these factors cannot be controlled then good plant growth and production will not be achieved. In line with Safrida, Ariska and Yusrizal (2019), good vegetative growth can be shown by plants if genetic traits, nutritional suitability, media and environmental conditions are quite compatible.

This opinion is supported by Prawoto and Hartatik (2019) who state that plant growth is not only influenced by internal factors, but is interrelated with many other factors, including the status of water in plant tissues, air temperature in plant areas and sunlight intensity. If one of these factors is not supported, then something given will not be meaningful for plant growth and production.

In line with the statement of Lakitan (2008) in his book, an interaction can occur if one factor specifically contributes to another factor that plays a role in plants and vice versa, a deficiency will also lead to decreased absorption of the main factor. If such conditions are met, then the interaction between the two treatments can also occur. The absence of support between these two treatments can be suspected as the cause of no positive interaction. In most of the changes observed in plant growth, the

Commented [A67]: Did you mean (Setiawati, 2018)? There is no such source from 2014

Commented [A68]: Maybe better to specify? The fertiliser?

Commented [A69]: This source is not in the list of references, kindly add it to the list of references or delete it from text including with a citation

two treatments tended to have a parallel effect with almost the same function and role so it was impossible to create a positive interaction.

It is also suspected that between the nutritional treatment of fish waste LOF and duck manure LOF there is no mutually supportive relationship for the growth and production of pak choy plants. Hakim *et al*. (1986) stated that better growth can be shown when genetic and environmental factors support each other .

CONCLUSIONS

1. The application of fish waste liquid organic fertiliser (LOF) nutrition showed no significant effect on the parameters of plant height and root length, but showed significant difference on such parameters as number of leaves at 45 … (HSPT) and plant wet weight. The best … (POC) fertiliser application was in treatment I1 (25 $cm^3 \cdot dm^{-3}$ of water) because it showed better results than I0 (control) and I2 (50 $cm^3 \cdot dm^{-3}$ of water).
2. Application of duck manure showed a significant difference on the parameters of plant height and fresh weight of plants at 45 HSPT, … significant difference on the parameters of the number of leaves and root length at 45 HSPT. The best application of duck manure was in treatment N0 (control) because it showed better results than N1 (3.70 $kg \cdot plot^{-1}$), N2 (5.55 $kg \cdot plot^{-1}$) and N3 (7.40 $kg \cdot plot^{-1}$).
3. The interaction of fish waste LOF and duck manure LOF had no significant effect on the parameters of plant height, number of leaves, plant wet weight and plant root length.

REFERENCES

Basundari, F.R.A. and Krisdianto, A.Y. (2020) "Pengaruh Dosis Pupuk dan Jarak Tanam pada Budidaya Bawang Merah di Luar Musim Tanam di Desa Klaigit Kabupaten Sorong [Fertiliser rate and plant spacing effects on off-season shallot cultivation in Klaigit Village District of Sorong]," *Jurnal Pangan*, 29(1), pp. 13–24.

Ernanda, M.Y., Indrawati, A. and Mardiana, S. (2022) "Respon Pertumbuhan Dan Produksi Tanaman Pakcoy (*Brassica rapa* L.) Terhadap Pemberian Pupuk Organik Kandang Ayam Dan Pupuk Organik Cair (Poc) Urin Sapi [Responses to growth and production of pak choy (*Brassica rapa* L.) plants on the administration of chicken cage organic fertiliser and cow urine liquid organic fertiliser (LOF)]," *Jurnal Ilmiah Pertanian (JIPERTA)*, 4(1), pp. 10–19. Available at: https://doi.org/10.31289/jiperta.v4i1.1191.

Hadisuwito, S. (2012) *Membuat Pupuk Organik Cair [Making liquid organic fertiliser]*. Jakarta: Jakarta Agro Media Pustaka.

Lawalata, I.J. (2011) "Pemberian Beberapa Kombinasi ZPT Terhadap Regenerasi Tanaman Gloxinia (Siningia speciosa) dari Eksplan Batang dan Daun Secara In Vitro [Administration of several ZPT

Commented [A70]: This source is not in the list of references, kindly add it to the list of references or delete it from text including with a citation

Commented [A71]: Kindly explain this abbreviation, here it is used for the first time

Commented [A72]: Kindly explain this abbreviation, here it is used for the first time

Commented [A73]: But/And/As well as?

Commented [A74]: This repetition can be deleted if before was a significant difference as well, just can be written after a comma

Commented [A75]: It cannot be written like that because N0 is without any application of duck manure
It should be written as :
The treatment N0 (control) without duck manure LOF showed the best results beacuse ….

combinations on the regeneration of gloxinia plants (Siningia speciosa) from stem and leaf explants in vitro]," *The Journal of Experimental Life Science*, 1(2), pp. 83–87.

Novizan (2007) *Petunjuk pemupukan yang efektif [Instructions for effective fertilisation]*. Jakarta: AgroMedia Pustaka.

Oogathoo, S. *et al.* (2022) "Tree transpiration well simulated by the Canadian Land Surface Scheme (CLASS) but not during drought," *Journal of Hydrology*, 604, 127196. Available at: https://doi.org/10.1016/j.jhydrol.2021.127196.

Os, O.N., Yetti, H. and Ariani, E. (2015) "Pemberian Kombinasi Pupuk Hijau Azolla Pinnata Dengan Pupuk Guano Terhadap Pertumbuhan Dan Produksi Tanaman Pakchoy (Brassica Chinensis L.) [Combination of Azolla Pinnata Green Fertiliser with Guano fertiliser on the growth and production of pakchoy plants (Brassica Chinensis L.)]," *Jurnal Online Mahasiswa Fakultas Pertanian Universitas Riau*, 2(1), pp. 1–12.

Parthasarathi, T. *et al*. (2022) "Effects of high temperature on crops," in Josphert N. Kimatu (ed.) *Advances in Plant Defense Mechanisms*. London: IntechOpen. Available at: https://doi.org/10.5772/intechopen.105945.

Perwitasari, B., Tripatmasari, M. and Wasonowati, C. (2012) "Pengaruh media tanam dan nutrisi terhadap pertumbuhan dan hasil tanaman pakchoi (brassica juncea l.) dengan sistem hidroponik [The effect of growing media and nutrition on the growth and yield of pak choy (Brassica juncea L.) with a hydroponic system]," *Agrovigor*, 5(1), pp. 14–25. Available at: https://doi.org/10.21107/agrovigor.v5i1.304.

Prawoto, T.Y. and Hartatik, S. (2019) "Respon pertumbuhan dan hasil beberapa varietas bunga kol (Brassica oleracea var. Botrytis l.) terhadap penggunaan pupuk majemuk npk di dataran rendah [Growth and yield responses of several varieties of cauliflower (Brassica oleracea Var. Botrytis L.) to the use of NPK compound fertiliser in the lowlands]," *UNEJ e-Proceeding*, pp. 718–731.

Pioh, D.D. *et al.* (2013) "Analisis suhu tanah di kawasan Wisata Alam Danau Linow Kota Tomohon Sulawesi-Utara [Analysis of soil temperature in the Lake Linow nature tourism area, Tomohon City, North Sulawesi]," *Journal of Indonesian Tourism and Development Studies*, 1(2), pp. 62–67. Available at: https://doi.org/10.21776/ub.jitode.2013.001.02.03.

Qaderi, M.M., Martel, A.B. and Dixon, S.L. (2019) "Environmental factors influence plant vascular system and water regulation," *Plants*, 8(3), 65. Available at: https://doi.org/10.3390/plants8030065.

Ridwan, M. (2019) "Produktivitas tumpangsari beberapa varietas caisim dan takaran pupuk kandang ayam dalam pola tumpangsari tanaman caisim dan bawang daun [Productivity of the intercropping

of several caisim varieties and the dosage of chicken manure in the intercropping pattern of caisim and scallion plants]," *Jurnal Sains Agro*, 4(1). Available at: https://doi.org/10.36355/jsa.v4i1.248.

Sapareng, S., Mudaffar, R.A. and Rahim, R. (2019) "Efektifitas pupuk organik hayati pada pre nursery bibit kelapa sawit [Effectiveness of biological organic fertilisers in oil palm seed pre nursery]," *Prosiding Seminar Nasional*, 4(1), pp. 162–168.

Safrida, S., Ariska, N. and Yusrizal, Y. (2019) "Respon beberapa varietas padi lokal (*Oryza sativa* L.) Terhadap amelioran abu janjang sawit pada lahan gambut [Responses of several local rice varieties (Oryza sativa L.) to ameliorants of palm oil ash in peatlands]," *Jurnal Agrotek Lestari*, 5(1), pp. 28–38. Available at: https://doi.org/10.35308/jal.v5i1.1964.

Sarido, L. and Junia (2017) "Uji pertumbuhan dan hasil tanaman pakcoy (*Brassica rapa* L.) Dengan pemberian pupuk organik cair pada system hidroponik [Test the growth and yield of pak choy plants (*Brassica rapa* L.) by administering liquid organic fertiliser in a hydroponic system]," *Agrifor: Jurnal Ilmu Pertanian Dan Kehutanan*, 16(1), pp. 65–74. Available at: https://doi.org/10.31293/af.v16i1.2591.

Satwiko, T., Lahay, R.R. and Damanik, B.S.J. (2013) "Anggap pertumbuhan dan produksi beberapa varietas kedelai (*Glycine max* L.) terhadap perbandingan komposisi pupuk [Response of growth and production of several soybean varieties (*Glycine max* L.) to the ratio of fertiliser composition]," *Jurnal Agroekoteknologi Universitas Sumatera Utara*, 1(4), p. 96255. Available at: https://doi.org/10.32734/jaet.v1i4.4446.

Setiawati, M.R. (2018) "Peningkatan Kandungan N Dan P Tanah Serta Hasil Padi Sawah Akibat Aplikasi Azolla pinnata Dan Pupuk Hayati *Azotobacter chroococcum* Dan *Pseudomonas cepaceae* [Increased soil N and P content and lowland rice yields due to the application of Azolla pinnata and biological fertilisers *Azotobacter chroococcum* and *Pseudomonas cepaceae*]," *Agrologia*, 3(1). Available at: https://doi.org/10.30598/a.v3i1.257.

Sujinah and Jami, A. (2016) "Mekanisme Respon Tanaman Padi terhadap Cekaman Kekeringan dan Varietas Toleran [Response mechanisms of rice plants to drought stress and tolerant varieties]," *Respon Varietas Toleran Terhadap Kekeringan*, 11(1), pp. 1–7.

Ali, K., Sumampow, D.M.F. and Paulus, J.M. (2021) "Respons tanaman kailan (*Brassica oleracea* var. Alboglabra) pada berbagai konsentrasi ab mix dengan sistem hidroponik sumbu (wick system) [Response of kailan plants (*Brassica oleracea* Var. Alboglabra) to various ab mix concentrations with the wick system]," *Agri-SosioEkonomi Unsrat*, 17(3), pp. 1023–1030.

Wijiyanti, P., Hastuti, E.D. and Haryanti, S. (2019) "Pengaruh Masa Inkubasi Pupuk dari Air Cucian Beras Terhadap Pertumbuhan Tanaman Sawi Hijau (Brassica juncea L.) [The effect of the

Commented [A76]: There is no such source cited in the text of the article. Kindly cite it or delete the position from the list of references

Commented [A77]: There is no such source cited in the text of the article. Kindly cite it or delete the position from the list of references

incubation period of fertiliser from rice washing water on the growth of mustard greens (Brassica juncea L.)],” *Buletin Anatomi Dan Fisiologi*, 4(1), pp. 21–28.

Yosephine, I.O., Effendi, Z.M. and Lestari, W.T. (2021) “Pengaruh pupuk organik cair dari bonggol pisang terhadap kadar hara nitrogen total dan C-organik pada bibit kelapa sawit (*Elaeis guineensis* Jacq.) [The effect of liquid organic fertiliser from banana weevils on total nitrogen and C-organic nutrients in oil palm seeds (*Elaeis guineensis* Jacq.)],” *Jurnal Agro Estate*, 5(2), pp. 89–109.

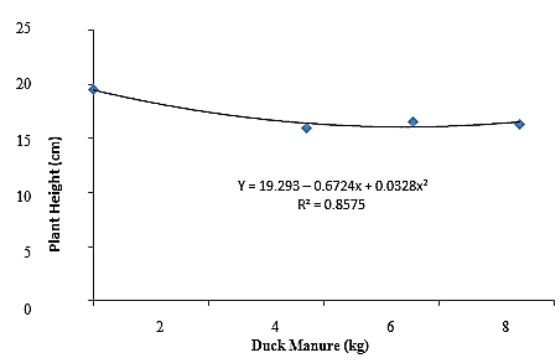


Fig. 1. Relationship between duck manure and pak-choy plant height; Y = …, R^2 = …, x = …, x^2 = …; source: own study

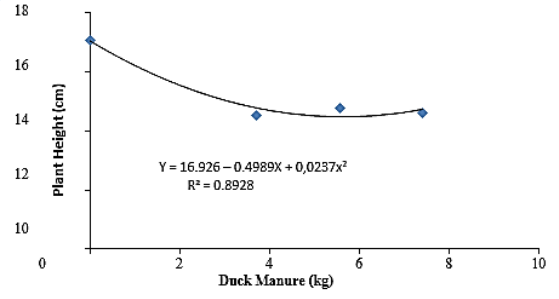


Fig. 2. The relationship between duck manure and pak choy plant height; Y, R^2, x, x^2 as in Fig. 1; source: own study

Commented [A78]: Kindly edit the figure:
- Write all the letters in the equation (*Y, R², x,…*) using italics
- On the titles of axes x and y, kindly write only first letter starting with the capital letter (eg.: Duck manure)

Commented [A79]: This comment regards all the figures Fig. 1–Fig. 10.
None of the figures is cited in the text of the article. All the figures must be cited in the text and placed right after the paragraph where each of them was first mentioned.

Commented [A80]: Should it be $\hat{Y}$ or Y?

Commented [A81]: Kindly write the explanations

Commented [A82]: Kindly edit the figure:
- Write all the letters in the equation (*Y, R², x,…*) using italics
- On the titles of axes x and y, kindly write only first letter starting with the capital letter (eg.: Duck manure)

Commented [A83]: Or should it be a capital letter X? Why is there a capital letter X on the figure? Is it a mistake or does it have a different meaning?

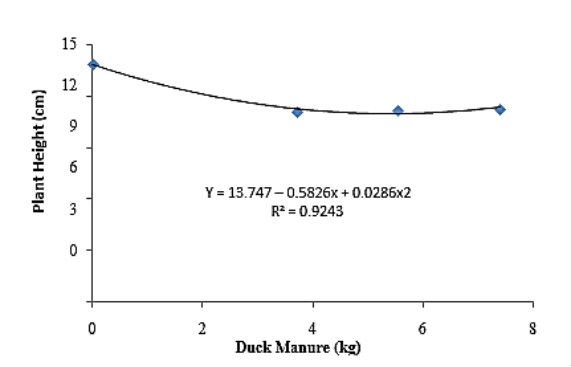


Fig. 3. Relationship between duck manure and pak choy plant height; *Y*, R^2, *x*, x^2 as in Fig. 1; source: own study

Commented [A84]: Kindly edit the figure:
- Write all the letters in the equation (*Y*, R^2, *x*,...) using italics
- On the titles of axes x and y, kindly write only first letter starting with the capital letter (eg.: Duck manure)

Commented [A85]: Correct the figure, there is x2, not x^2. Or if it was not a mistake, write what x2 means

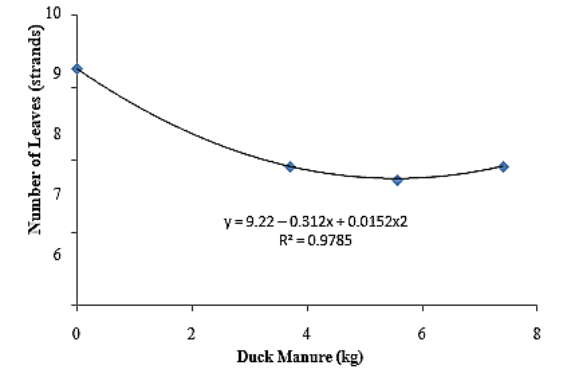
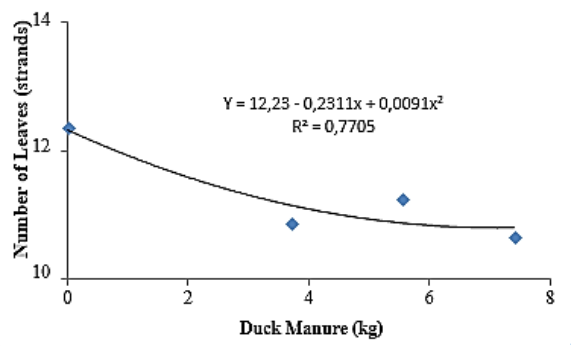


Fig. 4. Nutritional relationship of fish waste liquid organic fertiliser with the number of pak choy plant leaves; *Y*, R^2, *x*, x^2 as in Fig. 1; source: own study

Commented [A86]: Kindly edit the figure:
- Write all the letters in the equation (*Y*, R^2, *x*,...) using italics
- On the titles of axes x and y, kindly write only first letter starting with the capital letter (eg.: Duck manure)

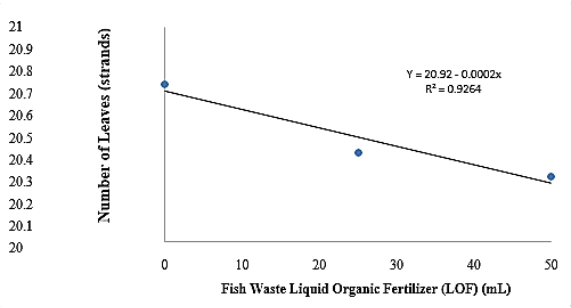
Commented [A87]: On the figure it is y, not Y, is it a mistake? If not, kindly explain what y means

Commented [A88]: Correct the figure, there is x2, not x^2. Or if it was not a mistake, write what x2 means



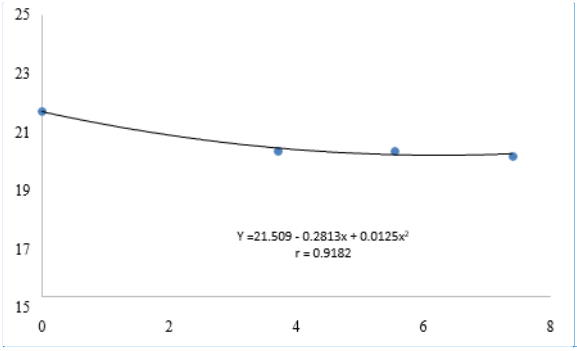
Commented [A89]: Kindly edit the figure:
- Write all the letters in the equation (*Y, R², x,…*) using italics
- On the titles of axes x and y, kindly write only first letter starting with the capital letter (eg.: Duck manure)

Fig. 5. The nutritional relationship of duck manure with the number of pak-choy plant leaves; *Y*, R^2, *x*, x^2 as in Fig. 1; source: own study



Commented [A90]: Kindly edit the figure:
- Write all the letters in the equation (*Y, R², x,…*) using italics
- On the titles of axes x and y, kindly write only first letter starting with the capital letter (eg.: Duck manure)
- Kindy change mL to ml

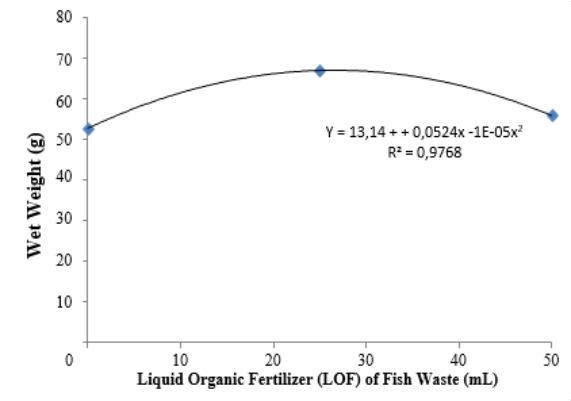
Fig. 6. Nutritional relationship of fish waste liquid organic fertiliser with the number of pak choy plant leaves; *Y*, R^2, *x*, as in Fig. 1; source: own study



Commented [A91]: Kindly edit the figure:
- Write all the letters in the equation (*Y, R², x,…*) using italics
- On the axes x and y, kindly write the description (titles)

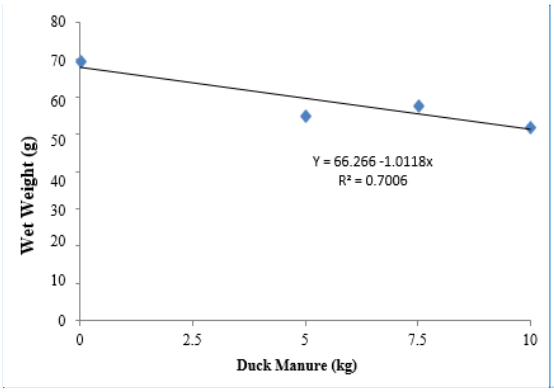
Fig. 7. The relationship between duck manure and the number of leaves of the pak choy plant; r = …, Y, x, x^2 as in Fig. 1; source: own study

Commented [A92]: Kindly write an explanation



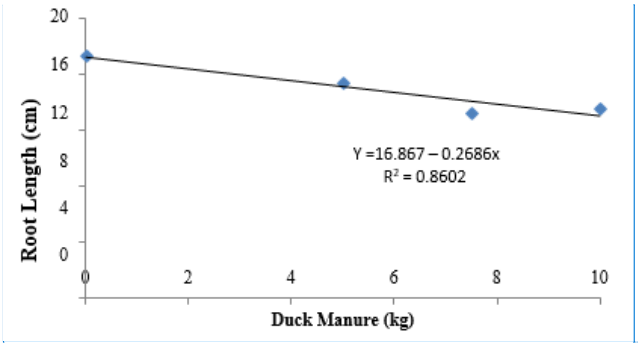
Commented [A93]: Kindly edit the figure:
- Write all the letters in the equation (*Y, R², x,…*) using italics
- On the titles of axes x and y, kindly write only first letter starting with the capital letter (eg.: Duck manure)
- Kindy change mL to ml
- In the Equation there is repetition of ++

Fig. 8. The nutritional relationship of liquid organic fertiliser of fish waste with the wet weight of pak choy plants; Y, R^2, x, x^2 as in Fig. 1; source: own study



Commented [A94]: Kindly edit the figure:
- Write all the letters in the equation (*Y, R², x,…*) using italics
- On the titles of axes x and y, kindly write only first letter starting with the capital letter (eg.: Duck manure)

Fig. 9. The relationship between duck manure and wet weight of pak choy plants; Y, R^2, x as in Fig. 1; source: own study



Commented [A95]: Kindly edit the figure:
- Write all the letters in the equation (*Y, R², x,...*) using italics
- On the titles of axes x and y, kindly write only first letter starting with the capital letter (eg.: Duck manure)

Fig. 10. Relationship between duck manure and pak choy plant root length; *Y*, R^2, *x* as in Fig. 1; source: own study

3. Revision Round 2 (06-04-2023)

plant height at 45 DAT, number of leaves at 45 DAT, wet weight, and root length. The regression analysis indicated that the most effective amount of LOF for improving the growth and productivity of pak choi was 25 $cm^3 \cdot dm^{-3}$ of water. This dosage led to noticeable improvements in variables, such as plant height at 45 DAT, number of leaves at 45 DAT, wet weight, and root length compared to other dosages. The connection between LOF and plant height can be represented by a quadratic regression equation:

$$\hat{Y} = 14.72 + 2.845x - 0.705x^2;\ R^2 = 1 \quad (3)$$

where: $\hat{Y}$ = plant height?? ~~the predicted or estimated value of the dependent variable~~, x = LOF?? ~~independent variable~~, R^2 = determination coefficient.

4. Revision Round 3 (30-05-2023)

Meanwhile, the quadratic regression analysis was used to examine whether the relationship between the fertiliser dosage and the growth/yield was non-linear, indicating the existence of an optimal fertiliser dosage.¶

Linear models follow the formula prescribed by Agresti (2015):¶

$$Y_{ijk} = \mu + LOF_i + DMF_j + B_k + E_{ijk} \quad (1)$$¶

where: Y_{ijk} = response value of the variable for unit j in block i and k, μ = overall average of the dependent variable, LOF_i = treatment effect of the LOF factor at the level i (i = 1, 2, ..., t), DMF_j = treatment effect of the DMF factor at level j (j = 1, 2, ..., t), B_k = block effect of the unobserved factor in block k (k = 1, 2, ..., b), E_{ijk} = measurement error or noise that the factors in the model cannot explain, t, b = last variable in the sequence.¶

Quadratic models follow the formula prescribed by Agresti (2015):¶

Autor
Do you agree with such explanation?¶

5. Last Revision Article for Author

Title of paper: The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pakchoy (*Brassica Rapa* L. var. Nauli F1)

Authors: Muhammad Idris[1*], Imam Hartono Bangun[2], Nurma Ani[3], Dermawan Hutagaol[3], Fajar Siddik[3]

For citation: Idris. M., Bangun. I. H., Ani. N., Hutagaol, D., and Siddik, F.

Affiliation:

[1)] North Sumatera State Islamic University, Faculty of Science and Technology Department of Biology, Deli Serdang, North Sumatera, 20353, Indonesia.

[2)] Universitas Muhammadiyah Sumatera Utara, Department of Agrotechnology, ,Medan, North Sumatera, Indonesia.

[3)] Al Azhar University Medan, Department of Agriculture, Medan, North Sumatera, Indonesia.

✉ **Corresponding author: midris@uinsu.ac.id**

Abstract (200–250 words)**:** In Indonesia, pakcoy production reached 727.47 tons in 2021, an increase of 8.2% from 2020 of 667.47 tons, but this is inversely proportional to the productivity of mustard plants which fluctuated from 10.23 t/ha to 9.92 t/ha and increased again to 10.27 t/ha. Therefore, cultivation improvement including by applying organic fertilizers. This study aims to find out the effect of liquid organic fertilizer from fish waste and duck manure fertilizer and interaction on the growth and yield of Pakchoy plants(*Brassica rapa*. L. var. Nauli F1). The study used Randomized Block Design Factorial with two factors and three replications. The first factor is liquid organic fertilizer from fish waste (LOF); which consists of (LOF_0 = control; LOF_1 = 25 ml $liter^{-1}$ water; LOF_2 = 50 ml $liter^{-1}$ water), the second factor is duck manure fertilizer (DmF) which consists of (DmF_0 = control; DmF_1 = 3.7 kg $plot^{-1}$, DmF_2 = 5.55 kg $plot^{-1}$, DmF_3 = 7.4 kg $plot^{-1}$). The results of the study found : The application of liquid organic fertilizer from fish waste (LOF) can increase the growth and yield of Pakchoy plants with the best treatment LOF_1, application of duck manure fertilizer (DmF) did not significantly different effect on the growth and yield of Pakchoy plant observations, the best treatment in the control (DmF_0) and the combination of liquid organic fertilizer from fish manure and duck manure fertilizer has no significant effect on the growth and yield of Pakcoy plants, with the best results in the LOF $_2DmF_0$ treatment (50 ml $liter^{-1}$ and control).

Keywords (5–8)**:** Biofertilizer, Poultry, Muck, Eco-Friendly, Vegetable, Nutrient

INTRODUCTION

Pakcoy plants (*Brassica rapa* L.) are vegetable plants that belong to the Brassicaceae family. Pakcoy plants are in great demand because they have wider stems and leaves than ordinary green mustard, making this type of mustard more widely cultivated by farmers. Thus this plant has a fairly bright business prospect for Pakcoy mustard farmers (Baiq Parasmita, et al, 2022). This plant can be grown in the lowlands and highlands on the condition that it gets enough sunlight, has good soil aeration, and soil pH 6.5 - 7 (Sarido and Junia, 2017).

In Indonesia, mustard production, including Pakchoy, reached 727.47 tons in 2021, an 8.2% increase from 2020's 667.47 tons (BPS, 2021b). However, this increase may not be enough to meet the needs of the growing population. The Indonesian population increased by 0.9% in 2021 and 1.12% in 2022 (BPS, 2022). Therefore, it is highly anticipated to increase Pakchoy production to ensure adequate vegetable supply for Indonesians. Although inorganic fertilizer application is the quickest solution, it also causes environmental pollution, ecological damage, and higher production costs (Purba *et al*., 2020; Keshavarz Mirzamohammadi *et al*., 2021). In addition, global climate change has negatively impacted soil organic matter quality. In line with the circular economy, agro-industrial, livestock, and agricultural waste with suitable physicochemical composition for fertilizer production can be utilized (Ma, Shen and Liu, 2020). Therefore, organic fertilization technology can improve farmers' livelihoods and promote environmental health. Organic amendments provide several benefits, including reducing farmers' dependency on fertilizers. Farmers can cut costs and contribute to environmental sustainability using organic waste (Pellejero *et al*., 2022).

Organic fertilizers can add nutrients to the soil, such as N, P, and K, and increase the soil's ability to absorb nutrients and improve its chemical properties (Chen, 2006). Organic fertilizers can replace 25% to 50%, or even up to 75%, of chemical fertilizers used for vegetables, resulting in higher yields and meeting the nutritional needs of the vegetables tested (Thanh et al., 2023). Application of compost from onion residues mixed with cow dung had a positive impact on plant growth and yield of tomatoes (Pellejero et al., 2021). Some examples of organic fertilizers include liquid organic fertilizer from fish waste and duck manure fertilizer. According to Mulyani, et al. (2019), in Jatinangor, Sumedang Regency, West Java, Indonesia, there are potential sources of organic raw materials from animal waste, such as duck waste (182.25 kg/day). Furthermore, based on data on Indonesia's marine fish production, which is quite large, namely 6.22 million tons in 2015 (Sofia, 2018) and 6.71

million tons in 2018 (FAO, 2020). This condition shows the amount of fish waste produced in Indonesia is quite large. Thus the amount of fish waste produced can be used as liquid fertilizer. Previous research results by (Ahuja et al., 2021) showed that organic fertilizers derived from fish waste contain essential nutrients such as N, P, K, calcium, magnesium, and sulfur in significant amounts.

The research by (Fahlivi, 2015) resulted in using liquid organic fertilizer derived from fish waste, which has a high macronutrient, namely 2.11% N, 0.22% P, and 0.25% K. The study showed that duck manure fertilizer could be an effective alternative to increase the productivity of sugarcane (Ratanarak and Prachuabmoh, 1991). These findings indicate that using organic fertilizers, such as duck manure, could be a viable option for farmers to maintain and improve soil health and microbial diversity, thereby contributing to more sustainable agricultural practices as an alternative to synthetic fertilizers (Wang et al., 2014). The researchers are interested in using liquid organic fertilizers from fish waste (LOF) and duck manure fertilizer (DmF) materials in this study because they are readily available and underutilized by the community, even though they can provide nutrients such as N, P, and K for plant growth when used correctly.

This study aims to find out the effect of liquid organic fertilizer from fish waste and duck manure fertilizer and interaction on the growth and yield of Pakchoy plants (*Brassica rapa*. L. var. Nauli F1.).

MATERIALS AND METHODS

Study site

The experiment was performed at a farmer's land, Jl. Perjuangan, Babalan - Langkat, North Sumatra, Indonesia (98°.29’76’.16” N; 4°01’07’.02” E; 4 m elevation) during the growth season (October – December) 2020. During an experimental period, the rainfall range was 1953 mm, and the rainy day was 110 days (BPS, 2021).

Materials and Tools

The tools used in this study were ropes, polybags, knapsacks, gloves, analytical scales, hand sprayer (5 liter), container (50 liter), hoes, rake, and scissors. The material used is fish waste (±10 kg), dried duck waster (±150 kg), decis 25 EC (*deltamethrin* - $C_{22}H_{19}Br_2NO_3$), analytical scale (HENHERR BL-H2), molasse, brown sugar, effective microorganisms (EM_4), Pakchoyseeds (*var* Nauli F1) and water.

Research Implementation

This research was conducted using Randomized Block Design (RBD) factorial and the experiment consisted of two factors and three replications. The first factor was liquid organic fertilizer from fish waste (LOF), with three levels (LOF_0 = control, LOF_1 = 25 mL liter^{-1} water, LOF_2 = 50 mL liter^{-1} water). The second factor was duck manure (DmF), with four levels (DmF_0 = control, DmF_1 = 3.7 kg plot^{-1}, DmF_2 = 5.55 kg plot^{-1}, DmF_3 = 7.4 kg plot^{-1}), so it becomes a total of 12 treatment , with three replications and 36 trial unit.

Plant Maintenance

Liquid organic fertilizer (LOF) production: mix 30 liters of water with 10 kilograms of finely ground fish waste, 1 liter of molasses, 250 grams of brown sugar, and 1 liter of EM4 until everything is well combined. Stir the mixture slowly until it is homogenous, and during the incubation process (30 days), keep the container tightly closed and stir it gently every morning. The perfect liquid organic fertilizer (LOF) will have a pleasant smell. An area of 100 square meters was cleared of weeds, and the soil was manually tilled using a hoe and rake. Thirty-six plots were created with 150 cm x 150 cm dimensions, arranged in a factorial randomized block design. The spacing used is 30 cm x 30 cm, so there are 12 plants plot^{-1}. Each plot was given an equal amount of compost fertilizer as the base before planting. Duck manure (DmF) was applied at the treatment dosage one week before planting and mixed with the soil until entirely homogeneous. Liquid Organic Fertilizer (LOF) was applied to the soil gradually during the early planting stage, two weeks, and four weeks after planting The seven-day-old seedlings of Pakchoy were transplanted into all research plots and watered. . Daily watering using a hand sprayer (2 liter water plot^{-1}) is conducted in the morning and afternoon. At the same time, weed, pest, and disease control measures are taken to protect the Pakchoy plants from Crocidolomia binotalis and Plutella maculipennis. The pests are managed by applying Decis 25 EC with 0.4 cc L^{-1} of water every two days. Pakchoy is harvested 45 days after transplanting (DAP) and cleaned for production component observation. The parameters observed in this study include both growth and yield parameters. The growth parameters consist of (a) Plant height (measured from the growing media surface to the highest leaf at 14, 28, and 45 DAP), (b) Number of leaves (counted only for fully opened leaves at 14, 28, and 45 DAP). The yield parameters consist of (a) Wet weight (of the cleaned Pakchoy measured using an analytical scale (at harvest), (b) Root length (measured on cleaned roots at harvest, from the base of the stem to the tip of the root).

Data analysis

Data from the research will be statistically analyzed using ANOVA (analysis of variance). The significant variables will be further tested using DMRT (Duncan Multiple Range Test) 5% (Skillings, 2018) using Microsoft Excel 2016 and R-Studio (Version 3.2.1) applications. This study's linear and quadratic polynomial regression models were developed based on (Agresti, 2015).

Linear models:

$$Y_{ijk} = \mu + LOF_i + DmF_j + B_k + E_{ijk}$$

Note:

Y_{ijk} : Response value of the variable for unit j in block i

μ : Overall mean of all data

LOF_i : Treatment effect of the LOF factor at level i (i = 1, 2, ..., t)

DmF_j : Treatment effect of the DmF factor at level j (j = 1, 2, ..., t)

B_k : Block effect of the unobserved factor in block k (k = 1, 2, ..., b)

E_{ijk} : Measurement error or noise that the factors in the model cannot explain.

Quadratic models:

$$Y = a + bX + cX\text{^}2 + \varepsilon$$

Note:

Y : Dependent variable

X : Independent variable

a, b, c : Regression coefficients to be estimated

ε : Random error

RESULTS AND DISCUSSION

Result

1. Effect of liquid organic fertilizer from fish waste (LOF) and duck manure (DmF) on Pakcoy Plant Growth

The statistical analysis showed that applying liquid organic fertilizer (LOF) positively impacted plant growth. However, liquid organic fertilizer (LOF) did not have a significant impact on observing plant height. In contrast, the observation of the number of leaves, it had a significant impact ($P \leq 0.05$) 45 DAP (Figure 1). Liquid organic fertilizer (LOF) and DmF significantly ($P \leq 0,05$) affected the number of leaves in Pakchoy plants 45 DAP but differed from the plant height at the same observation.

Figure 13. Applications LOF and DmF on the growth of pak choy at 45 DAP.
Note: Separate symbols (at mean and standard deviation).

The utilization of duck manure fertilizer (DmF) did not affect the growth of Pakcoy plants, namely a decrease in plant height at the age of 45 DAP, as illustrated in Figure 1. The highest plant height was achieved in the DmF_0 treatment (17.08 cm), followed by DmF_2 (14.77 cm), DmF_3 (14.62 cm), and the lowest in the DmF_1 treatment (14.56 cm) at 45 DAP.

The treatment of liquid organic fertilizer from fish waste (LOF) showed the maximum number of leaves, as shown in Figure 1, the highest number of leaves in the LOF_0 treatment (20.74 pieces), followed by LOF_1 (20.42 pieces), and the lowest in LOF_2 (20.31 pieces).

As shown in Table 1, duck manure fertilizer (DmF) had a significant effect ($P \leq 0.01$) on the number of leaves at 45 DAP, with the application of DmF_0 (21.59 sheets) producing the highest number of leaves, followed by DmF_1 (20.17 sheets), DmF_2 (20.19 sheets), and DmF_3 (20.02 sheets). Although the application of organic fertilizers such as liquid organic fertilizer from fish waste (LOF) and duck manure fertilizer (DmF) does not show a significant effect on plant growth, it can be beneficial for plant growth. Therefore, it is necessary to find alternative methods of using these two organic materials because they contain many nutrients, although they cannot be absorbed by plants immediately but are released slowly (Slow release fertile) so that they cause nutrient deficiencies for plants at the beginning of their growth.

The findings obtained on plant growth are that the addition of liquid organic fertilizer from fish waste (LOF) at a concentration of 25 mL $liter^{-1}$ of water has a beneficial effect on plant growth, as indicated by the increase in plant height and number of leaves observed at

the age of 14 to 45 DAP. as presented in Table 1. Consequently, the use of liquid organic fertilizer from fish waste (LOF) is suitable to be considered as a potential method to enhance the growth of Pakchoy.

2. Effect of liquid organic fertilizer from fish waste (LOF) and duck manure (DmF) on Pakcoy Yields

The wet weight and root length observations indicate that LOF and DmF have a noteworthy impact ($P \leq 0.01$) on the yield components of Pakchoy plants, as illustrated in Figure 2. Overall, incorporating LOF_1 (25 mL liter^{-1} water) could be viewed as a potential way to enhance the plant's yield components, as presented in Table 1.

Figure 14. Application of LOF and DmF on the yield of pak choy at 45 DAP.

Note: Separate symbols (at mean and standard deviation).

The findings presented in Figure 2 indicate that when applied at a rate of 25 ml liter^{-1} of water, liquid organic fertilizer from fish waste (LOF_1) led to the highest wet weight in Pak choy plants. The LOF_1 treatment resulted in a wet weight of 67.16 g, while the control treatment without applying duck manure fertilizer (DmF_0) produced 69.81 g. The LOF_2 treatment yielded 56.01 g, and the LOF_0 treatment produced 52.87 g. Furthermore, for the treatment of duck manure (DmF), it produced the highest wet weight in the treatment without duck manure (DmF0 = control) weighing 69.81 g. The application of duck manure fertilizer (DmF) at doses of 3.7 kg and 5.55 kg also demonstrated promising results, producing wet weights of 55.02 g and 57.02 g, respectively. Furthermore, using liquid organic fertilizer from fish waste (LOF) resulted in the longest root length in all treatments, with the LOF_0 treatment producing the longest root length of 15.88 cm and the LOF_1 and LOF_2 treatments producing shorter root lengths of 14.12 cm and 14.56 cm, respectively. Applying the DmF_0 treatment resulted in the longest root length of 17.28 cm ($P \leq 0.01$), followed by the DmF_1 treatment at 15.36 cm, the DmF_2 treatment at 13.27 cm, and the DmF_3 treatment at 13.50 cm. The results indicate that when used at a rate of 25 ml liter^{-1} of water, the most effective liquid organic fertilizer from fish waste (LOF) in enhancing the yield of Pakchoy plants is LOF_1.treatment

3. Effect of Combination of Liquid Organic Fertilizer from Fish Waste (LOF) and Duck Manure (DmF) on Growth and Yield of Pakcoy Plants

The statistical evaluation indicated that using LOF and DmF in combination positively affected plant growth. However, the effect was nonsignificant during the 45 DAP (Figure 3). The recorded data regarding plant growth, comprising plant height and the number of leaves, can be examined in (Table 1).

Figure 15. Application combinations of LOF and DmF on the growth of Pakchoy.

Note: Separate symbols (at mean and standard deviation).

The study found that the combination of LOF and DmF positively affected plant growth, with an increase in plant height observed over 45 days after planting. The LOF_1DmF_0 treatment had the highest plant height at 18.42 cm, while the LOF_2DmF_1 treatment had the lowest at 13.74 cm. However, the combination did not significantly affect the number of leaves on the plants. Surprisingly, the absence of LOF and duck manure fertilizer (LOF_0 and DmF0) resulted in the highest number of leaves at 22.22 sheet. This contradicts the expectation that applying organic fertilizers would promote plant growth. Furthermore, the growth of all Pakchoy plants was observed to increase with an increase in the dose of LOF and without DmF at all stages of plant growth (Table 1). The measurement of Pakchoy plant yield, including wet weight and root length, after applying a combination of LOF and DmF fertilizers can be seen in Figure 4.

Figure 16. Application combinations LOF and DmF on the yield of Pakchoy.

Note: Separate symbols (at mean and standard deviation).

Using a combination of LOF and DmF resulted in a positive outcome in Pakchoy plant yield. The study showed that using both organic fertilizers can increase the wet weight of Pakchoy plants. Although notsignificant statistically , it is important to note that the combination of 25 ml $liter^{-1}$ of water of liquid organic fertilizer from fish waste (LOF) and no duck manure fertilizer (LOF_1DmF_0) yielded the highest wet weight of 78.87 g, which was 41.8% higher than the lowest wet weight observed in the treatment (LOF_2DmF_1). However, the use of both fertilizers did not have a significant effect on root length in all combinations. The combination without either fertilizer showed the longest root length of 17.87 cm, followed by (LOF_2DmF_0) with a root length of 17.34 cm, (LOF_0DmF_1) with a root length of 17.11 cm,

and the shortest root length was observed in the (LOF_1DmF_2) treatment with a length of 11.84 cm. The study suggests that the limited nutrient uptake by Pakchoy plants may lead to root elongation in search of water and nutrients.

It is highly recommended to use LOF to boost the growth and productivity of Pakchoy plants by determining the optimal dosage. Figure 5 displays the results of the LOF regression analysis conducted on variables such as plant height at 45 DAP, number of leaves at 45 DAP, wet weight, and root length. The regression analysis indicated that the most effective amount of LOF for improving the growth and productivity of Pakchoi plants is 25 ml liter^{-1} water. This dosage led to noticeable improvements in variables like plant height at 45 DAP, number of leaves at 45 DAP, wet weight, and root length compared to other dosage treatments. The regression analysis shows that the connection between LOF and plant height can be represented by a quadratic regression equation $\hat{Y} = 14.72 + 2.845x - 0.705x^2$ with $R^2 = 1$.

Figure 17 Regression analysis between LOF and plant height at 45 DAP (cm), number of leaves at 45 DAP (pieces), wet weight (grams), and root length (cm) of Pakchoy.

Similarly, the relationship between LOF and the number of leaves can be expressed in a linear regression equation $\hat{Y} = 20.92 - 0.0215x$ with $r = 0.9264$. The relationship between LOF and wet weight can be described by a quadratic regression equation $\hat{Y} = 13.14 + 52.45x - 12.72x^2$ with $R^2 = 1$. Lastly, the correlation between LOF and root length observation is demonstrated by the quadratic regression equation $\hat{Y} = 19.84 - 5.06x + 1.1x^2$ with an $R^2 = 1$. Thus, applying LOF at a concentration of 25 ml liter^{-1} water is recommended to enhance the growth and productivity of pak choy plants. This dosage was the optimal amount through the LOF regression analysis. This amount can significantly improve plant growth parameters, producing higher wet weight and better-quality produce. By following this recommendation, growers can expect to see positive results in the growth and productivity of their Pakchoy plants. Table 1 provides a comprehensive summary of the data collected for all parameters in every observation of Pakchoy plants. This table contains valuable information for anyone analyzing the characteristics and growth patterns of Pakchoy plants. Researchers and experts in the field can use this data to draw conclusions and make informed decisions regarding Pak choy plants.

Table 1 Summary the LOF and DmF applications in observing the height of plants and the number of leaves (14, 28, 45 DAP), wet weight, and root length (45 DAP).

Figure 18 Experimental design details: (A). Research plot (LOF_1 DmF0), (B). All research plots,

Discussion

1. **Effect of liquid organic fertilizer from fish waste (LOF) and duck manure (DmF) on Pakcoy Plant Growth**

The study results indicate that using LOF at a dosage of 25 ml $liter^{-1}$ of water can increase the growth of Pakchoy plants. Although the observed plant height did not show a significant difference at all observation ages, the use of LOF still had a better positive impact than without LOF. In addition, LOF application significantly affected the number of Pakchoy leaves, with a dosage of 25 ml $liter^{-1}$ of water LOF providing the best results. This differs from a previous study by Munar, Bangun and Lubis, (2018), who found that using liquid organic fertilizer made from kepok banana peels with a dosage of 75 ml $polybag^{-1}$ could increase the growth of Pakchoy plants. LOF treatment with high N content showed an increased number of leaves. Thus treatment with high N application resulted in better performance. Fishbone waste also increases N and K uptake in Pakchoy plants during a 2-year study (Reppun et al., 2021). Other factors that affect the results include water availability, soil nutrition (Savvides, Fanourakis and van Ieperen, 2012), and environmental factors such as temperature (Kalisz et al., 2012).

The application of duck manure fertilizer (DmF) significantly differed in terms of plant height ($P \leq 0.05$), and the number of leaves ($P \leq 0.01$). This indicates that DmF has not been able to respond to the growth of pak choy based on the observed parameters, and plant growth still depends on the existing soil nutrients. Another possible consideration is that the high rainfall intensity in the research area may cause nutrient leaching carried by surface erosion (Hagedorn et al., 1997). Rainfall can indirectly influence mineralization by affecting soil moisture levels. High rainfall can lead to the leaching of nutrients, reducing nutrient availability for

mineralization. However, if rainfall is followed by adequate soil moisture, it can also stimulate microbial activity and increase mineralization rates (Brady, Weil and Weil, 2008). The mineralization of the organic N fraction of farm manures, both in the year of application and subsequent seasons, can significantly contribute to the availability of N for plants, which must be considered in fertilizer recommendations to reduce environmental losses. Temperature after the application is also essential, and superficial relationships have been derived for each group of manures for the amount of N mineralized and thermal time (Bhogal et al., 2016).

Another study compared to this one showed that using inorganic fertilizer (NPK) at a dose of 450 kg ha^{-1} can make the Pakchoy plants grow to a height of 28.06 cm with 16.00 leaves at 49 days after planting (Silitonga et al., 2018). In a study by Tripathi et al., (2015), using inorganic fertilizer with 100 kg N, 60 kg P_2O_5, and 60 kg K_2O ha^{-1} resulted in the best growth treatment with a height of 22.69 cm and 16.09 leaves at 45 DAP. However, using LOF and DmnF fertilizers resulted in more leaves than inorganic fertilizers. Therefore, LOF fertilizer can help Pakchoy plants grow better than inorganic fertilizers.

2. Effect of liquid organic fertilizer from fish waste (LOF) and duck manure (DmF) on Pakcoy Yields

The application of organic farming using liquid organic fertilizer from fish waste (LOF) can increase the yield of Pakchoy. This trend corresponds with the increased plant height and number of leaves during the experiment. Based on the observation of wet weight, the use of LOF positively increased the yield of Pakchoy compared to without LOF. Furthermore, the observation of root length also showed that applying LOF can affect the root length of Pakchoy plants. Using LOF at all doses resulted in shorter root lengths than without LOF. This is due to nutrient stress that causes plants to elongate their roots more than usual. The optimal treatment for increasing the yield of Pakchoy is 25 ml $liter^{-1}$of water LOF, considering the efficiency factor of the displayed regression value in Figure 5. The increase in Pakchoy yield is likely due to the N content in LOF, which can supply nutrients to the plant. Nutrient N has been confirmed to affect leaf differentiation speed and growth (Poinkar et al., 2006). Additionally, LOF can assist in absorbing P in plant roots as a biostimulant. Applying high-level fish bone waste resulted in an 88% increase in total P uptake and a 33% increase in average P concentration (Reppun et al., 2021). Another study yielded similar results, as using

LOF significantly improved the growth and yield of Pakchoy, as evidenced by the increased root length and dry weight of roots and shoots after each harvest (Riddech and Van, 2019). Furthermore, another study on the use of LOF from fish waste found that high doses of LOF can significantly improve the growth and yield of pumpkin (Lubis et al., 2021).

The application of duck manure fertilizer (DmF) significantly differed in terms of wet weight at 45 days after Plants ($P \leq 0.05$) and root length at 45 days after Plants ($P \leq 0.01$), but the higher treatment was found in the control group (without DmF). This is thought to be because the DmF used has not been fully decomposed. Traditional organic waste processing has several problems, such as long processing duration, nutrient loss during long composting, frequent need for aeration, and heterogeneous final products (Nair, Sekiozoic and Anda, 2006). The solution to optimizing the composting process while reducing greenhouse gas emissions combines compost and vermicompost to process poultry manure. However, this process can cause greenhouse gas and ammonia emissions, including nitrous oxide (N_2O), carbon dioxide (CO_2), and methane (CH_4), which can lead to stratospheric ozone depletion and global warming (Crutzen, 2016). A study conducted by (Wang et al., 2014) aimed to reduce failures in compost production and greenhouse gas emissions by utilizing earthworms and various organic materials in the composting process of duck manure. The results showed that earthworms positively reduced the total combined N_2O-CH_4 emissions equivalent to CO_2 and a marginal effect on CO_2 emissions during the pre-composting and combined composting of duck manure. Therefore, pre-composting and combined composting with the addition of weed straw and zeolite are recommended as a method for disposing of duck manure, reducing NH_3 and greenhouse gas emissions, as well as providing nutrient-rich products as fertilizers.

Several studies on inorganic fertilizer compare its effectiveness with LOF and DmF in this research. Another study by Mohd Din, Cheng and Sarmidi, (2017) found that combining inorganic fertilizer (NPK 15:15:15) with aerated compost extract at a dose of 150 mg kg^{-1} improved the yield of Pakchoy plants, producing a wet weight of 59.89 g, which was the best treatment. However, both studies show that LOF at a dose of 25 ml $liter^{-1}$ of water can increase Pakchoy production more than inorganic fertilizer. This finding is important, as it provides practical guidance for applying LOF in enhancing the growth and yield of Pakchoy. Obtaining the optimal dosage is a strength of this study, which adds to the knowledge base of sustainable and effective agricultural practices.

3. Effect of Combination of Liquid Organic Fertilizer from Fish Waste (LOF) and Duck Manure (DmF) on Growth and Yield of Pakcoy Plants

The study found that the combination of LOF from fish waste and DmF did not significantly impact the observed parameters. The need for proper interaction between the nutrients from LOF and DmF could be attributed to various factors. The two treatments did not complement each other to enhance plant growth and yield, leading to the absence of any interaction. Additionally, the plant's response to the treatments during the exponential phase could have limited the optimal development of the plants (Ridwan, 2019). The nonsignificant effect on the interaction of the two treatments is thought to be caused by environmental factors. These factors must be controlled for good plant growth and production. As mentioned by (Safrida, Ariska and Yusrizal, 2019), for plants to exhibit optimal vegetative growth, there needs to be compatibility between their genetic traits, nutritional requirements, growing media, and environmental conditions. Driesen et al., (2020) support this perspective by stating that internal factors do not solely determine plant growth. Still, it is affected by many external factors, such as water availability in plant tissues, air temperature, etc., and sunlight intensity in the plant's surroundings. If adequate, applied treatments would not significantly impact plant growth and productivity.

The importance of identifying factors contributing to plant growth and productivity and how these factors can interact (Lakitan, 2010). It is crucial to note that the absence of support between two treatments can significantly impact the plant's ability to absorb essential nutrients, leading to decreased growth and productivity. Therefore, it is essential to understand the roles and functions of each treatment to ensure that they complement each other and promote plant growth optimally. Additionally, that plant growth is a complex process that involves multiple factors that can influence the plant's response to treatments. Hence, it is essential to consider all external factors, such as environmental conditions, soil type, and nutrient availability, to ensure that external factors do not limit the plant's growth and productivity. Doing so can create a favorable environment that promotes plant growth and productivity, leading to higher yields and better-quality produce. Furthermore, the lack of positive interaction between the two treatments, as observed in the study, can be due to similar functions and roles. If the two treatments have the same impact on plant growth, it is unlikely that their interaction will result in a significant increase in growth and yield. Therefore, it is

crucial to identify treatments with different functions that can complement each other, synergizing plant growth and productivity.

CONCLUSIONS

Based on the findings of the study, the following conclusions can be drawn:

1. Applying liquid organic fertilizer from fish waste (LOF) can enhance the growth and yield of Pakchoy plants. LOF at a dosage of 25 ml liter^{-1} of water can increase growth by increasing plant height (4.3%) compared to without LOF and increase yield through an increase in wet weight (27%) compared to without LOF.
2. Application of duck manure fertilizer (DmF) showed significantly different effects on the growth and yield of Pakchoy plants. However, the higher treatment was found in the control (DmF_0) with better results than the application of DmF at all treatment doses.
3. The combination of liquid organic fertilizer from fish waste (LOF) and duck manure fertilizer (DmF) did not significantly affect the observed growth and yield of Pakchoy plants. However, the use of the LOF treatment (25 mlliter^{-1} of water) in combination with DmF (without DmF) improved growth by increasing plant height (4.6%) at 45 DAP and the number of leaves (8.4%) at 28 DAP compared to plants without either fertilizer. The combination treatment also increased the yield of Pakchoy plants by increasing the fresh weight (32%).

REFERENCES

Agresti, A. (2015) *Foundations of linear and generalized linear models*. John Wiley & Sons.

Ahuja, I. *et al.* (2021) 'Fish waste as fertiliser-effect of drying methods on fish waste and supplementing fish waste with other residual raw materials to form an organic fertiliser'.

Baiq, Parasmita, Tri Anjani, Bambang Budi Santoso, and Sumarjan. (2022). Growth And Yield Of Mustard Pakcoy (Brassica rapa L.) With Container Planting System At Various Doses Of Vermicompost. Growth And Yield Of Mustard Pakcoy (*Brassica rapa* L.) With Container Planting System At Various Doses Of Vermicompost. *Scientific Journal of Agrokomplek Students*. Vol. 1, No. 1, pp: 1 - 9.

Bhogal, A. *et al.* (2016) 'Mineralization of organic nitrogen from farm manure applications', *Soil Use and Management*, 32, pp. 32–43.

BPS (2021a) ‘Langkat Regency in Figures 2021’. Badan Pusat Statistik. Available at: https://langkatkab.bps.go.id/publication/2021/02/26/2271d90a1a1612724ee8e506/kabupaten-langkat-dalam-angka-2021.html. (Accessed: 10 March 2023).

BPS (2021) ‘Statistik Hortikultura 2021’. Badan Pusat Statistik. Available at: https://www.bps.go.id/publication/2022/06/08/44e935e8c141bcb37569aed3/statistik-hortikultura-2021.html (Accessed: 23 April 2023).

BPS (2022) ‘Jumlah Penduduk Pertengahan Tahun Menurut Provinsi’. Badan Pusat Statistik. Available at: https://www.bps.go.id/indicator/12/1975/1/jumlah-penduduk-pertengahan-tahun.html (Accessed: 26 March 2023).

Brady, N.C., Weil, R.R. and Weil, R.R. (2008) *The nature and properties of soils*. Prentice Hall Upper Saddle River, NJ.

Chen, J.-H. (2006) ‘The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility’, in. *International workshop on sustained management of the soil-rhizosphere system for efficient crop production and fertilizer use*, Citeseer, pp. 1–11.

Crutzen, P.J. (2016) ‘The influence of nitrogen oxides on atmospheric ozone content’, *Paul J. Crutzen: A Pioneer on Atmospheric Chemistry and Climate Change in the Anthropocene*, pp. 108–116.

Driesen, E. *et al.* (2020) ‘Influence of environmental factors light, CO2, temperature, and relative humidity on stomatal opening and development: A review’, *Agronomy*, 10(12), p. 1975.

Fahlivi, M.R. (2015) ‘Physicochemical characteristics of liquid fertilizer from fish viscera’, *United Nations University Fisheries Training Programme, Iceland* [Preprint].

FAO (2020) ‘World Fisheries and Aquaculture’, *Food and Agriculture Organization*, 2020, pp. 1–244.

Hagedorn, F. *et al.* (1997) ‘Effect of rainfall pattern on nitrogen mineralization and leaching in a green manure experiment in South Rwanda’, *Plant and Soil*, 195, pp. 365–375.

Kalisz, A. *et al.* (2012) ‘Yield and nutritional quality of several non-heading Chinese cabbage (Brassica rapa var. chinensis) cultivars with different growing period and its modelling’, *Horticultural Science & Technology*, 30(6), pp. 650–656.

Keshavarz Mirzamohammadi, H. *et al.* (2021) ‘Irrigation and fertilizer treatments affecting rosmarinic acid accumulation, total phenolic content, antioxidant potential and correlation between them in peppermint (Mentha piperita L.)’, *Irrigation Science*, 39, pp. 671–683.

Kiruba N, J.M. and Saeid, A. (2022) ‘An Insight into Microbial Inoculants for Bioconversion of Waste Biomass into Sustainable “Bio-Organic” Fertilizers: A Bibliometric Analysis and Systematic Literature Review’, *International Journal of Molecular Sciences*, 23(21), p. 13049.

Lakitan, B. (2010) ‘Dasar-dasar fisiologi tumbuhan’.

Lubis, E. *et al.* (2021) ‘Use Of Liquid Organic Fertilizer Fish Waste And Chicken Manure Fertilizer On The Production Of Pumpkin (*Cucurbita Moschata*)’, *International Journal of Science, Technology & Management*, 2(5), pp. 1775–1779.

Ma, Y., Shen, Y. and Liu, Y. (2020) ‘Food waste to biofertilizer: a potential game changer of global circular agricultural economy’.

Mohd Din, A.R.J., Cheng, K.K. and Sarmidi, M.R. (2017) ‘Assessment of compost extract on yield and phytochemical contents of Pak Choi (Brassica rapa cv. chinensis) grown under different fertilizer strategies’, *Communications in Soil Science and Plant Analysis*, 48(3), pp. 274–284.

Mulyani, O. *et al.* (2019) ‘Potential of local organic matters in Jatinangor West Java Indonesia as raw materials for organic fertilizer’, in. *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, p. 012048.

Munar, A., Bangun, I.H. and Lubis, E. (2018) ‘Pertumbuhan Sawi Pakchoi (Brassica rapa L.) Pada Pemberian Pupuk Bokashi Kulit Buah Kakao Dan Poc Kulit Pisang Kepok’, *AGRIUM: Jurnal Ilmu Pertanian*, 21(3), pp. 243–253.

Nair, J., Sekiozoic, V. and Anda, M. (2006) ‘Effect of pre-composting on vermicomposting of kitchen waste’, *Bioresource technology*, 97(16), pp. 2091–2095.

Pellejero, G. *et al.* (2021) ‘Effect of the application of compost as an organic fertilizer on a tomato crop (Solanum lycopersicum L.) produced in the field in the Lower Valley of the Río Negro (Argentina)’, *International journal of recycling organic waste in agriculture*, 10(2), pp. 145–155.

Pellejero, G. *et al.* (2022) ‘Agronomic application effects of organic wastes on a squash crop production’, *International journal of recycling organic waste in agriculture*, 11(1), pp. 143–151.

Poinkar, M. *et al.* (2006) ‘Effect of organic manure and biofertilizers on growth and yield of turmeric (Curcuma longa L.).’, *Journal of Soils and Crops*, 16(2), pp. 417–420.

Purba, K.F. *et al.* (2020) ‘Technical efficiency and factors affecting rice production in tidal lowlands of South Sumatra province Indonesia.’, *Potravinarstvo*, 14(1).

Ratanarak, U. and Prachuabmoh, P. (1991) 'Effect of chemical fertilizer and duck manure on yield and quality of sugarcane in Eastern region [Thailand]', in. *29th Kasetsart University Annual Conference, Bangkok (Thailand), 4-7 Feb 1991*.

Reppun, F. *et al.* (2021) 'Effects of fresh and anaerobically digested algae (*G. salicornia*) as soil amendments on yield and nutrient concentrations of Pak Choy', *Agroecology and Sustainable Food Systems*, 45(9), pp. 1270–1299.

Riddech, N. and Van, T.T.A. (2019) 'Effect of Effective Microorganisms (EM) with Liquid Organic Fertilizer on the Growth of Pak Choy (Brassica rapa var. chinensis) Seedlings'.

Ridwan, M. (2019) 'Produktivitas Tumpangsari Beberapa Varietas Caisim dan Takaran Pupuk Kandang Ayam Dalam Pola Tumpangsari Tanaman Caisim dan Bawang Daun', *Jurnal Sains Agro*, 4(1).

Safrida, S., Ariska, N. and Yusrizal, Y. (2019) 'Respon Beberapa Varietas Padi Lokal (Oryza Sativa L.) Terhadap Amelioran Abu Janjang Sawit Pada Lahan Gambut', *Jurnal Agrotek Lestari*, 5(1), pp. 28–38.

Sarido L., Junia, 2017. Test the growth and yield of pak choy plants (*Brassica rapa* L.) by administering liquid organic fertilizer in a hydroponic system. *Agrifor*, *16*(1), pp.65-74. Doi: https://doi.org/10.31293/af.v16i1.2591

Savvides, A., Fanourakis, D. and van Ieperen, W. (2012) 'Co-ordination of hydraulic and stomatal conductances across light qualities in cucumber leaves', *Journal of Experimental Botany*, 63(3), pp. 1135–1143.

Silitonga, M. *et al.* (2018) 'The effect of biochar dose and NPK fertilizer on the production and growth of pak choi plant', in. *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, p. 012028.

Skillings, J.H. (2018) *A first Course in the Design of Experiments: A linear Models Approach*. Routledge.

Sofia, F. (2018) 'The State of World Fisheries and Aquaculture 2018-Meeting the sustainable development goals', *Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations, Rome* [Preprint].

Thanh, D.T. *et al.* (2023) 'Effects of organic fertilizers produced from fish pond sediment on growth performances and yield of Malabar and Amaranthus vegetables', *Frontiers in Sustainable Food Systems*, 7, p. 31.

Tripathi, K. *et al.* (2015) 'Evaluation of vermicompost and chemical fertilizers on performance of Pak choi (Brassica rapa cv. Hong Tae) and soil biological process', *Journal of the Institute of Agriculture and Animal Science*, pp. 243–250.

Wang, J. *et al.* (2014) 'Emissions of ammonia and greenhouse gases during combined pre-composting and vermicomposting of duck manure', *Waste management*, 34(8), pp. 1546–1552.

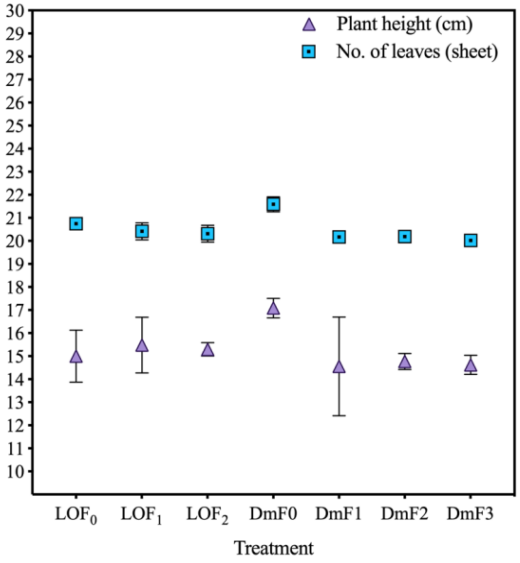


Figure 19. Applications LOF and DmF on the growth of Pakchoy at 45 DAP.

Note: Separate symbols (at mean and standard deviation).

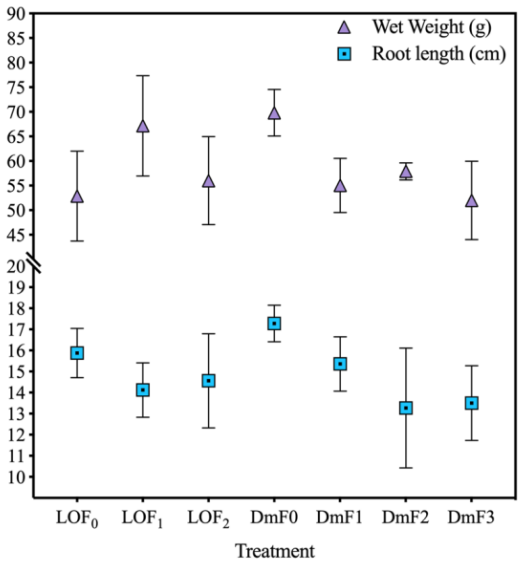


Figure 20. Application of LOF and DmF on the yield of Pakchoy at 45 DAP.

Note: Separate symbols (at mean and standard deviation).

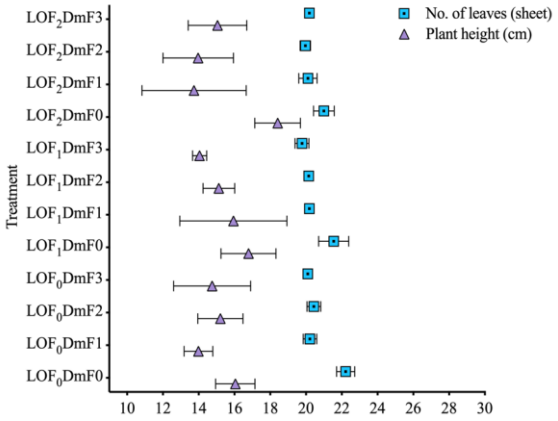


Figure 21. Application combinations of LOF and DmF on the growth of Pakchoy.

Note: Separate symbols (at mean and standard deviation).

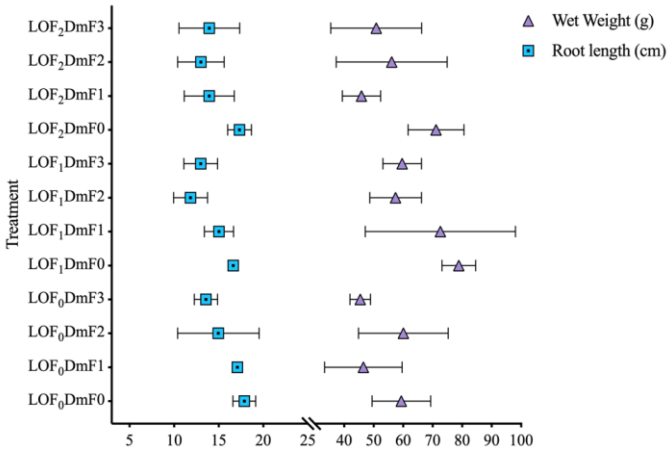


Figure 22. Application combinations LOF and DmF on the yield of Pakchoy.

Note: Separate symbols (at mean and standard deviation).

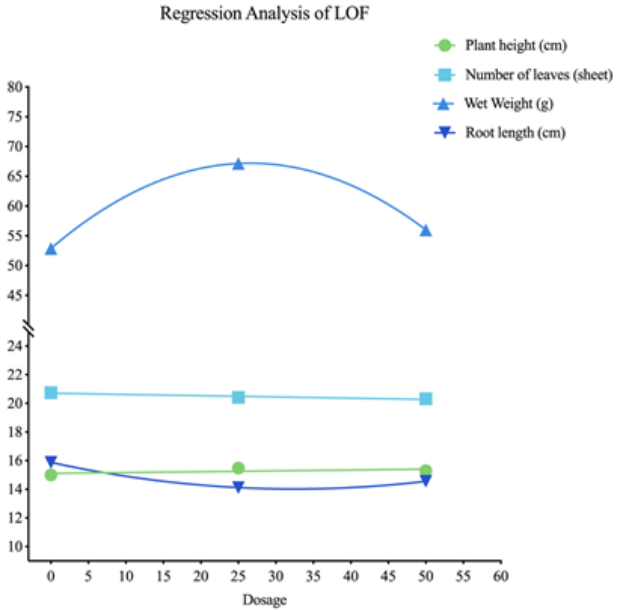


Figure 23 Regression analysis between LOF and plant height at 45 DAP (cm), number of leaves at 45 DAP (pieces), wet weight (grams), and root length (cm) of PakChoy.

Table 1 Summary the LOF and DmF applications in observing the height of plants and the number of leaves (14, 28, 45 DAP, wet weight, and root length (45 DAP).

Treatment	Plant height (cm)			Number of leaves (sheet)			Wet weight (g)	Root of length (cm)
	14 DAP	28 DAP	45 DAP	14 DAP	28 DAP	45 DAP	45 DAP	45 DAP
LOF_0	11.57a	15.00a	16.86a	8.17a	16.86a	20.74 a	52.87 b	15.88a
LOF_1	12.19a	15.48a	17.59a	8.08a	17.59a	20.42 ab	67.16 a	14.12a
LOF_2	11.89a	15.30a	16.91a	8.39a	16.91a	20.31 b	56.01 b	14.56a
DmF_0	13.89a A	17.08a	19.53a	9.26 a	19.53 a	21.59 a	69.81 a	17.28 a
DmF_1	11.12b	14.56b	16.04 b	7.92b	16.04 b	20.17 b	55.02 bc	15.36 b
DmF_2	11.21b	14.77b	16.56 b	7.74 b	16.56 b	20.19 b	57.89 b	13.27 c
DmF_3	11.30b	14.62b	16 .35 b	7.92ba	16.35 b	20, 02 b	51.99 c	13.50 c
LOF_0 DmF_0	13.13a	18.35a	16.05a	9.00a	18.35a	22.22a	59.40a	17.87a
LOF_0 DmF_1	11.02a	15.96a	13.99a	8.11a	15.96a	20.22a	46.54a	17.11a
LOF_0 DmF_2	11.44a	16.9a	15.22a	6.89a	16.9a	20.44a	60.09a	14.96a
LOF_0 DmF_3	10.70a	16.23a	14.75a	8.67a	16.23a	20.10a	45.45a	13.57a
LOF_1 DmF_0	14.14a	19.9a	16.79a	9.11a	19.9a	21.55a	78.87a	16.63a
LOF_1 DmF_1	11.93a	16.78a	15.94a	8.44a	16.78a	20.19a	72.65a	15.03a
LOF_1 DmF_2	11.82a	17.25a	15.13a	8.00a	17.25a	20.15a	57.44a	11.84a
LOF_1 DmF_3	10.85a	16.44a	14.05a	6.77a	16.44a	19.78a	59.66a	12.99a
LOF_2 DmF_0	14.41a	20.33a	18.42a	9.66a	20.33a	21.00a	71.16a	17.34a
LOF_2 DmF_1	10.42a	15.39a	13.74a	7.22a	15.39a	20.11a	45.85a	13.94a
LOF_2 DmF_2	10.38a	15.53a	13.97a	8.33a	15.53a	19.96a	56.14a	13.01a

LOF_2 DmF_3	12.36a	16.39a	15.05a	8.33a	16.39a	20.19a	50.86a	13.95a
CV (%)	6.78%	9.70%	11.20%	12.00%	9.70%	1.81%	22.53%	12.49%

The Duncan's test indicates that numbers followed by different letters in the same column are statistically significant at the 5% level (indicated by lowercase letters) and highly significant at the 1% level (indicated by capital letters).

Figure 24 Experimental design details: (A). Research plot (LOF_1 DmF_0), (B). All research plots

6. Has Been Finally Accepted For Publication In Our Journal.

ITP PUBLISHING

Journal of Water and Land Development

Institute of Technology and Life Sciences – National Research Institute (ITP-PIB)
and Polish Academy of Science (PAS)

Instytut Technologiczno-Przyrodniczy
– Państwowy Instytut Badawczy
Institute of Technology and Life Sciences
– National Research Institute
Dział Wydawnictw / Editorial Office
Falenty, al. Hrabska 3, 05-090 Raszyn, Polska
e-mail: wydawnictwo@itp.edu.pl

Falenty, 16.08.2023.

Certificate of acceptance of publication

The publisher of „Journal of Water and Land Development" is confirming that paper no. JWLD-01367-2022-05 entitled "The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (*Brassica Rapa* L.)" authors: Dr. Muhammad Idris, Imam Hartono Bangun, Nurma Ani, Dermawan Hutagaol and Fajjar Siddik is accepted and will be published in our journal in 59 Issue 2023.

KIEROWNIK DZIAŁU WYDAWNICTW
Instytut Technologiczno-Przyrodniczy
Państwowy Instytut Badawczy
Dr inż. Adam Bryśiewicz

Decision: **rate manuscript once again after major changes and another review**

February 23, 2023
JWLD-01367-2022-01
The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.)

Dear Dr. Muhammad Idris,

We have carefully evaluated your manuscript, entitled: The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.), and feel that as it stands we cannot accept it. We might, however, be able to accept it if you could respond adequately to the points that have been raised during the review process (see below).

Please revise your manuscript strictly according to the attached Reviewers' comments. Your manuscript won't be taken into consideration without the revisions made according to the recommendations.

Statement 1 should be filled again only if there have been significant changes.

Authors are requested to prepare a revised version of their manuscript as soon as possible. This may ensure fast publication if an article is finally accepted.

View editorial guidelines:
https://journals.pan.pl/dlibra/journal/98710
and JWLD sample article:
http://academiapan.pl/journals/template_jwld.pdf

Thank you for submitting your work to our journal.

Yours sincerely,
Dr Adam Brysiewicz
Managing Editor
Journal of Water and Land Development,
Institute of Technology and Life Sciences
National Research Institute
Falenty, al. Hrabska 3 05-090 Raszyn, POLAND
tel. +48 22 243 52 32; +48 22 243 54 56
e-mail:journal@itp.edu.pl
http://journals.pan.pl/dlibra/journal/98710
https://www.itp.edu.pl/JWLD/

Review 1:

Evaluation form:

General value of the paper
satisfactory

The paper is a contribution to the development of science
yes

The paper contains new information
yes

The paper correspond to the journal's profile
yes

Does the title correspond to the content?
yes

Is the introduction relevant to the study objectives
yes

Experimental material and study methods
insufficient since

Results elaborated
in a way acceptable after considering referees comments

Statistical processing
sufficient

Photos
unnecessary (comment in *Information for Authors*)

Tables
appropriate

Figures
appropriate

Mathematical formulae
need correction (comment in *Information for Authors*)

References
proper, including recent country and foreign publications

Units
agree with recommendations of the Editorial Office (SI system)

Conclusions and summary
appropriate

Summary and key words
do not reflect the content (need corrections)

Language and style
needs major revision

See attached file

Attachment
JWLD-01367-2022-01 RV1.docx

Review 2:

Evaluation form:

General value of the paper
mean

The paper is a contribution to the development of science
yes

The paper contains new information
yes

The paper correspond to the journal's profile
no

Does the title correspond to the content?
yes

Is the introduction relevant to the study objectives
must be changed or supplemented

Experimental material and study methods
insufficient since

Results elaborated
in a way acceptable after considering referees comments

Statistical processing
insufficient (acceptable after considering referee's remarks)

Photos
bad quality (comment in *Information for Authors*)

Tables
need correction (comment in *Information for Authors*)

Figures
need correction (comment in *Information for Authors*)

Mathematical formulae
appropriate

References
incomplete, missing important positions

Units
agree with recommendations of the Editorial Office (SI system)

Conclusions and summary
acceptable after considering referee's remarks

Summary and key words
appropriate

Language and style
needs major revision

The strength of the paper stands on the use of duck waste for Pak Choy production. The author(s) is correct to mention that this waste is abundant on duck farms, but it is rarely used for (leafy or fruit) vegetable production. However, the paper has many weaknesses: language (poor grammar; e.g., methodology should be described in detailed and in past tenses), introduction (fail to justify clearly the need for the research), materials and methods (insufficient: this section is not well explained; experimental setup is not clear -- e.g., were the vegetables planted on the ground or farmed using a soilless culture technique? the treatments are also not described, et cetera -- up to the point that the research cannot be repeated; the reason for performing the regression analysis is also unclear), results and discussion (the results can actually be summarised in only one table; the results of the regression analysis can be summarised in a Table and the figure can be constructed nicely and compact), conclusion (it is fine, but the writing requires a significant editorial work), and references (there are missing references in the texts and in the list: please correct). At least there is one picture of the experimental plot(s) included.

Review 3:

Evaluation form:

General value of the paper
good

The paper is a contribution to the development of science
yes

The paper contains new information
yes

The paper correspond to the journal's profile
yes

Does the title correspond to the content?
yes

Is the introduction relevant to the study objectives
must be changed or supplemented

Experimental material and study methods
properly chosen and described

Results elaborated
in a way acceptable after considering referees comments

Statistical processing
sufficient

Photos
sufficient

Tables
appropriate

Figures
appropriate

Mathematical formulae
appropriate

References
proper, including recent country and foreign publications

Units
do not agree (need corrections)

Conclusions and summary
acceptable after considering referee's remarks

Summary and key words
do not reflect the content (need corrections)

Language and style
needs minor revision

Paper aimed to determine the effect of applying liquid organic fertilizer (LOF) on Fish
Waste and duck manure and the interaction between the two on the growth and production
of
Mustard Greens (Brassica rapa L.). This subject is interesting and worthy of the attention of scientists. On the one hand, the Authors show (Introduction) which fertilizers have already been used to support plant growth. On the other, they indicate new possibilities, i.e. fertilizers
Fish
Waste. The idea is right due to the desire to use the possible resources of the environment.

The work is prepared carefully; however, it requires some work.
1. Introduction
- it is worth indicating what results were obtained for the tested species using other fertilizers,
2. STUDY MATERIALS AND METHODS
The chapter is a bit "school".
- it should be reworded with the deletion of the gardening tools mentioned (57-60);
- the characteristics of fertilizers, e.g. their chemical composition, are missing;
- the experimental scheme is expected instead of listing (64-73);

- whether it is possible to standardize the units in which the concentration of fertilizers is expressed;
- the mathematical model used in this research data analysis is:

$$Yijk = \mu + \alpha 1 + \beta j + (\alpha\beta)ij +$$

Decision: **rate manuscript once again after major changes and another review**

April 06, 2023
JWLD-01367-2022-02
The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.)

Dear Dr. Muhammad Idris,

We have carefully evaluated your manuscript, entitled: The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.), and feel that as it stands we cannot accept it. We might, however, be able to accept it if you could respond adequately to the points that have been raised during the review process (see below).

Please revise your manuscript strictly according to the attached Reviewers' comments. Your manuscript won't be taken into consideration without the revisions made according to the recommendations.

Statement 1 should be filled again only if there have been significant changes.

Authors are requested to prepare a revised version of their manuscript as soon as possible. This may ensure fast publication if an article is finally accepted.

View editorial guidelines:
https://journals.pan.pl/dlibra/journal/98710
and JWLD sample article:
http://academiapan.pl/journals/template_jwld.pdf

Thank you for submitting your work to our journal.

Yours sincerely,
Dr Adam Brysiewicz
Managing Editor
Journal of Water and Land Development,
Institute of Technology and Life Sciences
National Research Institute
Falenty, al. Hrabska 3 05-090 Raszyn, POLAND
tel. +48 22 243 52 32; +48 22 243 54 56
e-mail:journal@itp.edu.pl
http://journals.pan.pl/dlibra/journal/98710
https://www.itp.edu.pl/JWLD/

Review 1:

Evaluation form:

General value of the paper
satisfactory

The paper is a contribution to the development of science
yes

The paper contains new information
yes

The paper correspond to the journal's profile
yes

Does the title correspond to the content?
yes

Is the introduction relevant to the study objectives
must be changed or supplemented

Experimental material and study methods
sufficient

Results elaborated
in a way acceptable after considering referees comments

Statistical processing
sufficient

Photos
unnecessary (comment in *Information for Authors*)

Tables
appropriate

Figures
appropriate

Mathematical formulae
appropriate

References
incomplete, missing important positions

Units
agree with recommendations of the Editorial Office (SI system)

Conclusions and summary
acceptable after considering referee's remarks

Summary and key words
need major revision

Language and style
needs major revision

See attached file

Attachment
JWLD-01367-2022-02 rev 1.docx

Review 2:

Evaluation form:

General value of the paper
good

The paper is a contribution to the development of science
yes

The paper contains new information
yes

The paper correspond to the journal's profile
yes

Does the title correspond to the content?
yes

Is the introduction relevant to the study objectives
yes

Experimental material and study methods
insufficient since

Results elaborated
in a way acceptable after considering referees comments

Statistical processing
insufficient (acceptable after considering referee's remarks)

Photos
sufficient

Tables
appropriate

Figures
appropriate

Mathematical formulae
appropriate

References
incomplete, missing important positions

Units
agree with recommendations of the Editorial Office (SI system)

Conclusions and summary
acceptable after considering referee's remarks

Summary and key words
do not reflect the content (need corrections)

Language and style
needs minor revision

The comments below are based on the manuscript file named: JOURNAL M.IDRIS LOF FISH WASTE_REVISION.

1. Introduction
The introduction has been revised to be much better, but it can still be improved:
a. Please revise "to increase by 8.2% from ..." by stating the current production of Pak Choy? How much actually is the demand of Pak Choy?
b. Some sentences require citation. E.g., DmF has enhanced soil quality and promoted microbial communities in paddy fields (Ref.?).
c. Revise 25 to 50% to 25% to 50%.
d. Please check format: (Sharma and Chetani, 2017) should be Sharma and Chetani (2017).
e. Please check incomplete sentences. E.g., The research by (Fahlivi, 2015) The research ...; the citation also wrongly written.
f. Language: improve paragraph coherency.
g. The last paragraph: What are the "these materials"? Please specify. How much are the current productions of LOF and DmF? Please provide some general knowledge about the productions of LOF and DmF to support the statement "readily available and underutilized".
h. It should be written "liquid organic fertilizer from fish waste (LOF)"; the LOF is at the end. Please check for the whole paper.
i. Please download the latest journal article in JWLD and check how the introduction was written in order to meet the quality of paper introduction expected by JWLD.

2. Materials and Methods
The materials and methods have been revised to be much better, but it can still be improved:
a. RCBD: what factor is being blocked?
b. DmF: is it dried DmF or fresh DmF?
c. How many Pak Choy were planted per plot?
d. What is the dry matter of the Pak Choy? The watering was carried out manually, which means the amount of water is uncontrolled; in other words, this will markedly affect the water uptake of the vegetables and create variation in fresh weight (then affect the yield data).
e. In the Results and Discussion part, there was description on combinative effects of LOF and DmF, but there was no description in the Materials and Methods that this was carried out. Please describe the experimental design clearly.
f. Is there a positive treatment? E.g., the Pak Choy was planted and added with chemical fertiliser. By this way, the growth and yield effects of LOF and DmF are better understood. How far higher or lower are the effects? If there was no positive treatment, at least there is a discussion on this thing based on the growth of the Pak Choy reported by other studies using chemical fertilisers.
g. Divide the description of parameters into growth (plant height, etc.) and yield (fresh weight & dry matter weight, etc.) parameters.
h. In Data Analysis, please describe the regression analysis applied in the study; there are

results reported but the analytical process is missing.

3. Results and Discussion
Generally, it has been revised to be much better, but it can still be improved:
a. Please divide the results and discussion into two sections: growth section and yield section.
Effects of LOF and DmF on Growth
Effects of LOF and DmF on Yield
Effects of a mixture of LOF and DmF on Growth and Yield
b. What are the growth and yield of Pak Choy Nauli F1 when added with chemical fertiliser and how much different are those things from the data obtained in the present study?
c. The third last (starting with "Traditional organic waste ...) and the last (starting with "Lakitan (2010) ...) paragraphs of the Results and Discussion section are a little unclear. Both paragraphs were written like notes in a text book rather than being coined well to the findings of the study.

4. Conclusion
a. What is the yield of the best LOF treatment?
b. What is the yield of the best DmF treatment? (Revise the sentences of the current writing. The use of comma was wrong).
c. Which one is better LOF or DmF?
d. In this study, is there a positive control where the vegetables are grown using chemical fertiliser? What is the yield and how far different is it from that of LOF and DmF? That comparison can provide a better understanding about LOF & DmF versus Chemical fertiliser (hydroponic solution A&B) in terms of vegetable (Pak Choy) yield.

5. References
There were references cited in the texts but missing in the list of references.

6. Summary and keywords
Please spell out LOF and DmF, because both acronyms are not common terms. (e.g., DNA is a common term or a widely known acronym).

Decision: **accept after changes**

May 30, 2023
JWLD-01367-2022-03
The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.)

Dear Dr. Idris,

I am pleased to inform you that your manuscript, entitled: The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.), might be accepted for publication in our journal, pending some minor changes suggested by reviewers (see below).

Please revise your paper strictly according to the attached Reviewers comments. Your manuscript won't be taken into consideration without the revisions made according to the recommendations.

Statement 1 should be filled again only if there have been significant changes.

Authors of our journal are requested to prepare a revised version of their manuscript as soon as possible. This may ensure fast publication if an article is finally accepted.

View editorial guidelines:
https://journals.pan.pl/dlibra/journal/98710
and JWLD sample article:
http://academiapan.pl/journals/template_jwld.pdf

Thank you for submitting your work to us.

Yours sincerely,
Dr Adam Brysiewicz
Managing Editor
Journal of Water and Land Development,
Institute of Technology and Life Sciences
National Research Institute
Falenty, al. Hrabska 3 05-090 Raszyn, POLAND
tel. +48 22 243 52 32; +48 22 243 54 56
e-mail:journal@itp.edu.pl
http://journals.pan.pl/dlibra/journal/98710
https://www.itp.edu.pl/JWLD/

Review 1:

Evaluation form:

General value of the paper
satisfactory

The paper is a contribution to the development of science
yes

The paper contains new information
yes

The paper correspond to the journal's profile
yes

Does the title correspond to the content?
yes

Is the introduction relevant to the study objectives
must be changed or supplemented

Experimental material and study methods
incorrectly described (need supplementation)

Results elaborated
in a way acceptable after considering referees comments

Statistical processing
sufficient

Photos
unnecessary (comment in *Information for Authors*)

Tables
appropriate

Figures
appropriate

Mathematical formulae
need correction (comment in *Information for Authors*)

References
proper, including recent country and foreign publications

Units
agree with recommendations of the Editorial Office (SI system)

Conclusions and summary
appropriate

Summary and key words
appropriate

Language and style
needs major revision

See attached file

Attachment
JWLD-01367-2022-03 rev 1.docx

Review 2:

Evaluation form:

General value of the paper
good

The paper is a contribution to the development of science
yes

The paper contains new information
yes

The paper correspond to the journal's profile
yes

Does the title correspond to the content?
yes

Is the introduction relevant to the study objectives
yes

Experimental material and study methods
sufficient

Results elaborated
in a way acceptable after considering referees comments

Statistical processing
insufficient (acceptable after considering referee's remarks)

Photos
sufficient

Tables
appropriate

Figures
appropriate

Mathematical formulae
appropriate

References
do not conform to the authors' guide

Units
agree with recommendations of the Editorial Office (SI system)

Conclusions and summary
appropriate

Summary and key words
appropriate

Language and style
needs major revision

Overall comments
Please revise the language and writing style. Ask a native English speaker to help in this aspect.

Data Analysis
1. It should be written in past tense.
2. Please briefly provide an explanation for carrying out the regression analysis. What is the purpose of carrying out the regression analysis in the context of your study?

Results
In the Result Section, please report only the results. Please do not mix with a discussion. (Report only the results. Do not yet provide an explanation or evaluation for the results). The discussion should be transferred to the Discussion Section.

Discussion
For the results in the Result Section, please discuss systematically in the Discussion Section. (Provide an explanation or evaluation for the results in the Discussion Section systematically).

References
Please check the format recommended by the journal. Find the latest paper in the journal and see the reference format.

Decision: **accept after changes**

July 03, 2023
JWLD-01367-2022-04
The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.)

Dear Dr. Idris,

I am pleased to inform you that your manuscript, entitled: The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.), might be accepted for publication in our journal, pending some minor changes suggested by reviewers (see below).

Please revise your paper strictly according to the attached Reviewers comments. Your manuscript won't be taken into consideration without the revisions made according to the recommendations.

Statement 1 should be filled again only if there have been significant changes.

Authors of our journal are requested to prepare a revised version of their manuscript as soon as possible. This may ensure fast publication if an article is finally accepted.

View editorial guidelines:
https://journals.pan.pl/dlibra/journal/98710
and JWLD sample article:
http://academiapan.pl/journals/template_jwld.pdf

Thank you for submitting your work to us.

Yours sincerely,
Dr Adam Brysiewicz
Managing Editor
Journal of Water and Land Development,
Institute of Technology and Life Sciences
National Research Institute
Falenty, al. Hrabska 3 05-090 Raszyn, POLAND
tel. +48 22 243 52 32; +48 22 243 54 56
e-mail:journal@itp.edu.pl
http://journals.pan.pl/dlibra/journal/98710
https://www.itp.edu.pl/JWLD/

Review 1:

Evaluation form:

General value of the paper
good

The paper is a contribution to the development of science
yes

The paper contains new information
yes

The paper correspond to the journal's profile
yes

Does the title correspond to the content?
yes

Is the introduction relevant to the study objectives
yes

Experimental material and study methods
properly chosen and described

Results elaborated
correctly

Statistical processing
sufficient

Photos
sufficient

Tables
appropriate

Figures
appropriate

Mathematical formulae
appropriate

References
proper, including recent country and foreign publications

Units
agree with recommendations of the Editorial Office (SI system)

Conclusions and summary
appropriate

Summary and key words
appropriate

Language and style
proper

See later

Review 2:

Evaluation form:

General value of the paper
good

The paper is a contribution to the development of science
yes

The paper contains new information
yes

The paper correspond to the journal's profile
yes

Does the title correspond to the content?
yes

Is the introduction relevant to the study objectives
yes

Experimental material and study methods
sufficient

Results elaborated
correctly

Statistical processing
sufficient

Photos
sufficient

Tables
appropriate

Figures
appropriate

Mathematical formulae
appropriate

References
proper, including recent country and foreign publications

Units
agree with recommendations of the Editorial Office (SI system)

Conclusions and summary
appropriate

Summary and key words
appropriate

Language and style
needs minor revision

(1) Please improve the language and writing style. Ask English native speaker to help in proofreading and editing the paper.
(2) Please correct the typo, for example, Pak choy is the correct spelling. Also, please italicise scientific names.
(3) The third conclusion is a little confusing. Probably, it can be revised, "A combination of the liquid fish waste (LOF) and duck manure (DmF) fertilisers did not significantly affect the observed growth and yield of the Pak choy compared to only LOF or DmF application. However, LOF application at 25 ml liter-1 of water with or without DmF addition improved plant height by 4.6% at 45 DAT and leaf number by 8.4% at 28 DAT compared to without any fertiliser application. The LOF+DmF application also increased the yield of the Pak choy by 32% compared to without any fertiliser addition."

Decision: **accept without changes**

August 16, 2023
JWLD-01367-2022-05
The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.)

Dear Dr. Idris,

I am pleased to inform you that your manuscript, entitled: The Effect Of Fish Waste And Duck Manure On The Growth And Yield Of Pak Choy (Brassica Rapa L.), has been finally accepted for publication in our journal.

Thank you for submitting your work to us.

Yours sincerely,
Dr Adam Brysiewicz
Managing Editor
Journal of Water and Land Development,
Institute of Technology and Life Sciences
National Research Institute
Falenty, al. Hrabska 3 05-090 Raszyn, POLAND
tel. +48 22 243 52 32; +48 22 243 54 56
e-mail:journal@itp.edu.pl
http://journals.pan.pl/dlibra/journal/98710
https://www.itp.edu.pl/JWLD/