JPB 12 (1) (2025)

Jurnal Pembelajaran Biologi:
Kajian Biologi dan Pembelajarannya

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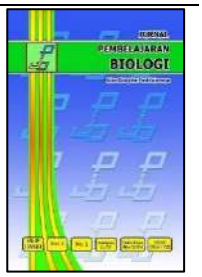

Effect of Compost Fertilizer Combination of Moringa Leaves and Corn Shells on the Growth of Pakcoy Mustard (*Brassica rapa* L.) and Its Implementation in High School Biology Learning

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Article History:
Received: 29 April 2025
Accepted: 21 Mei 2025
Published: 28 Mei 2025

Keywords:
Organic fertilizer, compost, Moringa leaves, corn husk, *Brassica rapa* L.

Abstract:
The use of synthetic fertilizers causes serious environmental problems. So to overcome this, an alternative is needed in the form of organic fertilizer. This study aims to determine the effect of compost fertilizer from Moringa oleifera leaves and corn husk (Zea mays) on the growth of Pakcoy mustard plants (Brassica rapa L.), and determine the best concentration for optimal growth. The method used was a completely randomized design (CRD) with five treatments of compost concentration (0%, 20%, 40%, 60%, and 80%) and five replications. Variables observed included leaf area, number of leaves, wet weight of roots and plant stems. Data were analyzed using ANOVA, and continued with the BJND test to determine differences between treatments. The results showed that the application of Moringa Leaf and Corn Husk compost fertilizer had a significant effect on the growth of Pakcoy mustard. The best concentration of compost fertilizer combination of *Moringa* leaves (*Moringa oleifera*) and corn skin waste (*Zea mays*) for the growth of Pakcoy mustard (*Brassica rapa* L.) is 80%. Thus, compost from Moringa leaves and Corn husk has the potential as an effective and environmentally friendly alternative to organic fertilizer.

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ISSN: 2355-7192
E-ISSN: 2613-993

Introduction

The excessive use of chemical fertilizers in agriculture has had a negative impact on soil fertility and the environment. Research conducted by Widowati et al. (2021) shows that excessive use of chemical fertilizers can cause degradation of soil organic matter, decreased microbial activity, and nutrient imbalances, which ultimately reduce crop productivity. In addition, excessive use of chemical fertilizers can lead to the accumulation of excess salts and nutrients in the soil, which can damage soil structure and reduce the soil's ability to absorb water. Meanwhile, in education, learning biology at the high school level is often still theoretical and does not provide meaningful practical experience for students. According to Solihati (2011), biology learning in many high schools is still dominated by the lecture method and written assignments, while practicum activities and environmental exploration are still very limited. This results in low student learning outcomes in biology subject matter, particularly on plant nutrients and nutrient requirements. In fact, an understanding of fertilizers and nutrients is very important in everyday life and can be linked to environmental issues and sustainable agriculture.

Fertilizer is the main source of nutrients in determining the level of growth and production of a plant (Indah et al., 2021). Macro elements are nutrients that are needed in large quantities with a concentration of 1000 mg/kg dry matter. Meanwhile, microelements are nutrients that are needed in small amounts with a concentration of 100 mg/kg dry matter (Rika, 2022). The types of macro nutrients are carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg). Micro nutrients in the form of zinc (Zn), iron (Fe), manganese (Mn), copper (Cu), molybdenum (Mo), boron (B), chlorine (Cl), sodium (Na), cobalt (Co), and silicon (Si) (Ariandi, 2019).

Appropriate use of fertilizers can replace nutrients lost in the soil and meet the nutrient needs of plants so that plant productivity increases (Mansyur et al., 2021). However, excessive use of fertilizers can cause the natural balance of nutrients in the soil to be disturbed and reduce soil quality, especially the use of inorganic fertilizers. The advantages of inorganic fertilizers are practical, do not smell pungent, and are easy to apply, but

inorganic fertilizers have disadvantages such as relatively expensive prices, can cause pollution to the soil such as chemical residues. Therefore, the use of organic fertilizers is a wiser choice to maintain soil fertility and environmental sustainability.

Organic fertilizers can be in the form of compost and liquid organic fertilizers. Compost fertilizer is a fertilizer that comes from decomposed organic materials and is solid. Meanwhile, liquid organic fertilizer is a liquid fertilizer. The use of compost can save transportation and landfill costs, reduce the volume of waste, have a higher selling value than the original material, improve the quality of crops (taste, nutritional value, and the number of harvests), provide hormones and vitamins for plants, suppress the growth/attack of plant diseases, increase the availability of nutrients in the soil and so on (Idris, 2020). Meanwhile, liquid organic fertilizer has disadvantages such as the microorganisms in it are easily reduced or even die, have the potential to produce gas and cause unpleasant odors and are not durable. The advantages are that it can be produced easily and is very easy to apply and does not require large costs (Sitanggang et al., 2022). The use of compost fertilizers is safer for the environment than synthetic fertilizers. Therefore, the type of fertilizer used in this study is compost because it can provide nutrients in the long term and can also improve soil quality.

The use of moringa leaf liquid organic fertilizer in previous studies showed that moringa leaf liquid fertilizer had a significant effect on the growth of purple eggplant plants (Tomia et al., 2021). Then the application of moringa leaf fertilizer to lettuce plants can give a real response to the growth and yield of lettuce plants (Pratiwi et al., 2023). Furthermore, the application of moringa leaf fertilizer with the extract filtration method has an effect on the growth of mustard plants (*Brassica juncea* L.) (Ihsan et al., 2020). The application of moringa leaf fertilizer to tomato plant growth also has a significant effect on height, number of leaves, number of fruits, and fruit weight on tomato plants (Nurfadila et al., 2022). From the research that has been done before, it is still limited and no one has used the utilization of moringa leaf compost combined with corn husk. Related to the utilization of Moringa leaves conducted by (Reyni & Binawati, 2023) showed that liquid organic fertilizer from banana stump and Moringa leaves affects the growth of mustard greens (*Brassica juncea L.*) in plant height, wet weight, number of leaves, and total chlorophyll content. Then in research on the effectiveness of moringa leaf liquid organic fertilizer on onion growth showed a significant effect with a concentration of 120 mL (Mare et al., 2023). Research on the combination of POC banana stump and moringa leaves on pakcoy mustard plants showed effectiveness in all growth parameters (Anzila & Asngad, 2022). In research (Widyarti & Tambing, 2023) on the growth and yield of cucumber plants showed the results that moringa leaf POC had a significant effect on the components of plant growth and yield. Then in the research of moringa leaf POC and coconut fiber applied to corn plant growth, the results showed that there was a healthy growth of corn plant height and optimal under these treatment conditions (Kartika, Susanti, 2016).

Previous research on corn husk waste conducted by (Sumatra et al., 2022), by socializing corn husk as compost fertilizer applied to kale plants. Then in research conducted by (Herlinawati et al., 2022), by utilizing corn husk waste as POC by applying it to sweet corn plants. The results obtained show that 142.5 cc of corn waste given to sweet corn plants is the best corn waste POC. Moringa leaf fertilizer can absorb more nutrients in plants and corn husk waste can loosen the soil because it is high in fiber. Research generally uses POC and is not combined with corn husk. So, in this study, further research was carried out by utilizing Moringa leaves with a mixture of corn husk waste as an ingredient in making compost. The mixture of Moringa leaves and corn husk waste can help supply nutrients and increase the content of other nutrients needed by plants. To test the effectiveness of the fertilizer, Pakcoy mustard greens were used.

Moringa (*Moringa oleifera*) is one of the plants that can be used as fertilizer. Moringa leaves are plants that come from the Moringaceae family. Moringa leaves can be used as fertilizer, because moringa leaves contain nutrients such as Nitrogen 4.02%, Phosphorus 1.17%, Potassium 1.80%, C-Organic 11.1% (Adiaha, 2017). Apart from moringa plants, organic waste derived from corn husks can also be used as fertilizer. Based on observations of corn husk waste being thrown away, it turns out to have many benefits for soil growth and fertility. In addition to Moringa leaves which are used as fertilizer, data shows that corn has mineral content such as 0.7% Potassium, 0.68% Nitrogen, 0.62% Phosphorus, and C-Organic 21.4% (Chan et al., 2023). In addition to plants that are given this organic fertilizer can be nourished, fertilizer from corn husk waste can also loosen the soil.

Pakcoy mustard plants were chosen as test plants in this study because according to (Yuniarti et al., 2018), the benefits of pakcoy are numerous, including good for pregnant women because they contain high folic acid, contain vitamin A, can reduce cholesterol, and can also maintain healthy skin and delay aging. The results of this study are expected to be developed in the form of Learner Worksheets (LKPD) in biology learning SMA Class XII semester 1 in Phase F of Plant Growth and Development material. From this background, the focus of this research is "The Effect of Mixed Compost Fertilizer of *Moringa* Leaves (*Moringa oleifera*) and Corn Husk Waste (*Zea mays*) on the Growth of Pakcoy Mustard (*Brassica rapa L.*) and its Contribution to High School Biology Learning".

Method

This research was conducted at Sriwijaya University, South Sumatra in January-February 2025. The tools and materials used were buckets, shovels, polybags measuring 30x30 cm, sprayers, cameras, scissors, stationery, Moringa leaves, corn husks, soil, Pakchoy mustard seeds, brown sugar, water, EM4. This study used a completely randomized design (CRD) which consisted of 5 treatments and 5 repetitions so that the total research was 25 experiments. Concentration P0 (0 grams), P1 (20 grams), P2 (40 grams), P3 (60 grams), and P4 (80 grams). The working procedures included (i) making compost made from a mixture of moringa leaves and corn husks, (ii) preparing mustard seeds, (iii) seeding, (iv) planting, and (v) fertilizing. Parameters observed included the number of leaves, leaf area, wet weight of roots, and wet weight of Pakchoy mustard. Data analysis used F test, with Duncan's multiple range test (BJND). The results of this study will be developed into a learning resource in learning Biology high school class XII in the form of LKPD.

Result

The results of the study using Pakcoy mustard (*Brassica rapa* L.) test plants for 45 days with a combination of moringa leaves and corn husk compost fertilizer on the number of leaves, leaf area, and wet weight of plants. The data showed that the highest growth parameters were found at 80% concentration (P4) both in the number of leaves, leaf area, root wet weight, and taruk wet weight (Figure 1). The results of analysis of variance showed that the combination of moringa leaves and corn husk compost fertilizer had a very significant effect on the number of leaves, leaf area, root wet weight, and taruk wet weight (Table 1).

Figure 1. Growth of Mustard Pakcoy aged 45 days at Each Concentration

Table 1. Recapitulation of Ansira Results of the Effect of Compost Fertilizer Combination of Moringa Leaves and Corn Husk on the Growth of Pakcoy Mustard (*Brassica rapa* L.)

Parameters	Average Treatment					F Count	F Table
	P0	P1	P2	P3	P4		
Number of leaves	5,6	9,8	14,4	16,4	17	7,80**	2,87
Leaf area (cm^2)	48,20	299,50	235,75	402,32	688,60	12,34**	2,87
Root wet weight (gram)	0,18	2,22	1,48	2,38	2,84	6,18**	2,87
Taruk wet weight (gram)	2,42	13,6	12,32	22,50	35,54	15,90**	2,87

Notes: ** (significantly different)

F count and F table are two important components of the F statistical test, which is often used in analysis of variance (ANOVA) to test for differences in means between groups. F count is the value obtained from the calculation of research data based on the ANOVA formula, which is then compared with the F table value. The F table itself is the critical value obtained from the F distribution based on certain degrees of freedom, and is used as a benchmark to determine the significance of differences between treatments (Marpaung et al., 2017).

1. Number of Leaves

The observation of the number of leaves showed that the highest number of leaves was found at a concentration of 80% (P4), namely 17 leaves and the lowest number of leaves was found in the control, namely 6 leaves. The number of leaves increased with increasing concentration (Figure 2). Based on the results of statistical analysis using the F test, the application of compost fertilizer with a combination of moringa leaves and corn husks has a very significant effect on the number of leaves (Table 2).

The results of the analysis of variance showed that the calculated F value was greater than the F table value of 7.80, so the hypothesis (h1) was accepted. This means that the combination of moringa leaves and corn husk compost fertilizer gives a very significant effect on the number of leaves (Table 2).

DOI: https://doi.org/10.36706/jpb.v12i1.120

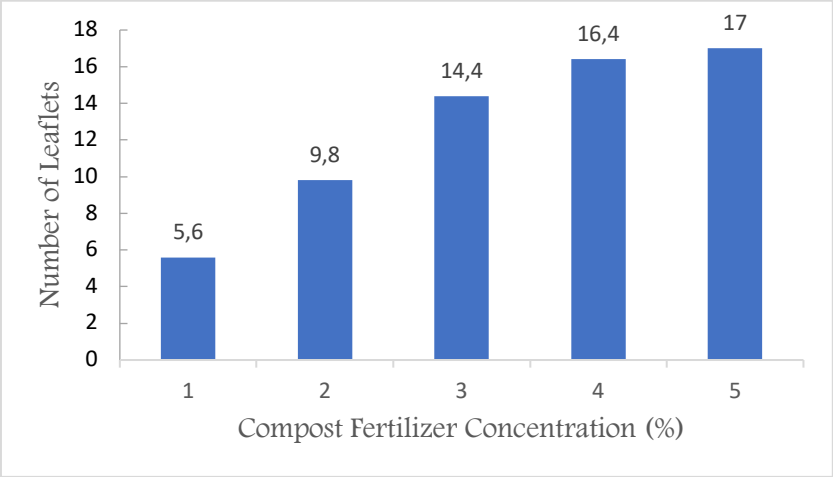

Figure 2. Average number of leaves (strands) of pakcoy plants aged 45 days at each concentration

Table 2. Results of Analysis of Variance of the Effect of Combination Compost Fertilizer of Moringa Leaves and Corn Skin on the Number of Leaves of Pakcoy Plants

Source of Diversity	Free Degree	Sum of Squares	Center Square	Fcount	f Table	
					5%	1%
Treatment	4	259,6	64,9	7,80**	2,87	4,43
Error	20	166,4	8,32			
Total	24	426				

Description: ** = significantly different

To see the most effective concentration, the BJND further test was conducted. The results of the further test can be seen in Table 3. Differences in fertilizer concentration effectiveness can affect plant physiological processes such as photosynthesis and nutrient absorption. An optimal concentration will support leaf growth, root development, and biomass accumulation more efficiently.

Table 3. BJND Test Results of the Effect of Combination Compost Fertilizer of Moringa Leaves and Corn Shells on the Number of Leaves of Pakcoy Plants

Treatment	Average	BJND
P0	5,6	a
P2	9,8	b
P1	14,4	c
P3	16,4	c
P4	17	c

Description: Numbers followed by letters and in the same column mean not significantly different.

Based on Table 3, the BJND test results show that the highest number of leaves is found at 80% concentration (P4). However, the treatments at P3 (60%) and P4 (80%) concentrations were not significantly different from the P1 (20%) concentration. Therefore, the recommended concentration of fertilizer for increasing the number of leaves is P1 (20%).

2. Leaf Area

Observations of leaf area showed that the highest leaf area was found at 80% concentration (P4) which was 688.6 $cm^2$and the lowest number of leaves was found in the control which was 48.^{2}$cm^{(2)}$ (Figure 3). Based on the results of statistical analysis using the F test, the application of compost fertilizer with a combination of moringa leaves and corn husks has a very significant effect on leaf area (Table 4).

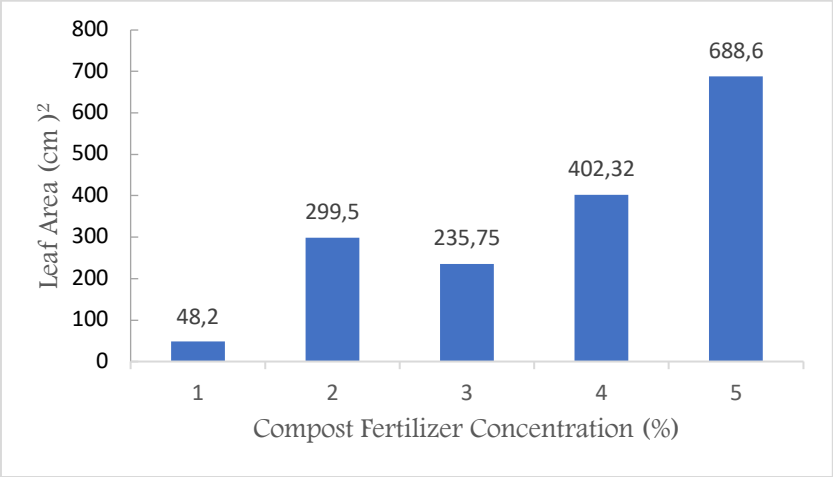

Figure 3. Average leaf area of pakcoy plants

The results of the analysis of variance showed that the calculated F value was greater than the F table value of 12.34, so the hypothesis (h1) was accepted. This means that the combination of moringa leaves and corn husk compost fertilizer gives a very significant effect on the number of leaves (Table 4). This shows that the compost fertilizer treatment is able to increase the growth of pakcoy mustard leaf area compared to the treatment without fertilizer or low concentration. The increase in the number of leaves has the potential to increase the ability of plants to carry out photosynthesis, thus supporting overall plant growth and productivity.

Table 4. Results of Analysis of Variance of the Effect of Compost Fertilizer Combination of Moringa Leaves and Corn Skin on Leaf Area of Pakcoy Plants

Source of Diversity	Free Degree	Sum of Squares	Center Square	Fcount	f table	
					5%	1%
Treatment	4	1114650	278662,4	12,34**	2,87	4,43
Error	20	451718,4	22585,92			
Total	24	1566368				

Description: ** = significantly different

To see the most effective concentration, the BJND further test was conducted. The results of the further test can be seen in Table 5.

Table 5. BJND Test Results of the Effect of Combination Compost Fertilizer of Moringa Leaves and Corn Husk on Leaf Area of Pakcoy Plants

Treatment	Average	BJND
P0	48,2	a
P2	235,75	ab
P1	299,5	bcd
P3	402,32	bcd
P4	688,6	e

Description: Numbers followed by letters and in the same column mean not significantly different.

Based on Table 5, the BJND test results show that the highest leaf area is found at 80% concentration (P4). However, treatments at P1 (20%) and P3 (60%) concentrations were not significantly different from P2 (40%) concentration. Therefore, the recommended concentration of fertilizer for increasing leaf area is P4 (80%).

3. Wet Weight of Roots and Stakes

Observations of root wet weight showed that the highest root wet weight was found at 80% concentration (P4) which was 2.84 grams and the lowest root wet weight was found in the control which was 0.18 grams (Figure 4). Based on the results of statistical analysis using the F test, the application of compost fertilizer with a combination of moringa leaves and corn husks has a very significant effect on the wet weight of the roots (Table 6). Root wet weight is measured because it functions as the main organ in the absorption of water and nutrients from the soil. The greater the wet weight of the roots, indicating that the plant has a more developed and healthy root system, which has the potential to increase the efficiency of nutrient absorption.

Research conducted by Li et al. (2023) showed that increasing root biomass can increase the absorption capacity of nutrients, such as nitrogen and phosphorus, which are essential for plant growth.

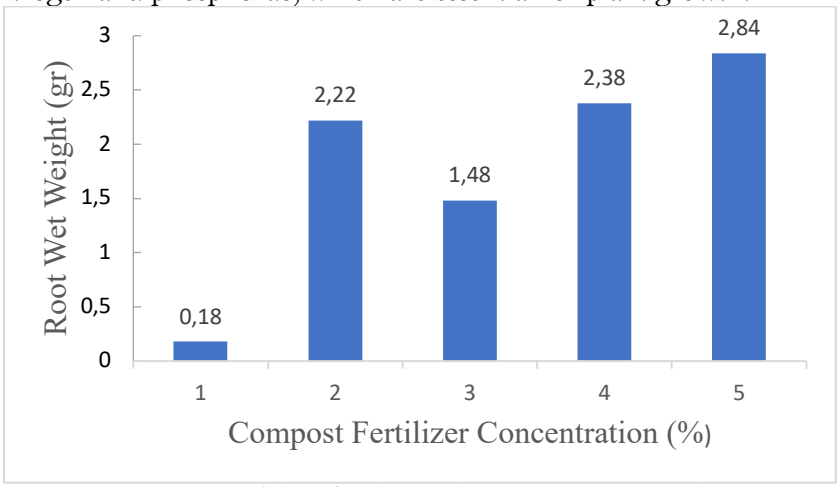

Figure 4. Average wet weight of pakcoy plant roots (gr) at each concentration

The results of the analysis of variance showed that the calculated F value was greater than the F table value of 6.18, so the hypothesis (h1) was accepted. This means that the combination of moringa leaves and corn husk compost fertilizer gives a very significant effect on the wet weight of the roots (Table 6).

Table 6. Results of Analysis of Variance of the Effect of Combination Compost Fertilizer of Moringa Leaves and Corn Husks on the Wet Weight of Pakcoy Roots

Source of Diversity	Free Degree	Sum of Squares	Center Square	Fcount	Ftable	
					5%	1%
Treatment	4	22,7704	5,6926	6,18**	2,87	4,43
Error	20	18,428	0,9214			
Total	24	41,1984				

Description: ** = significantly different

To see the most effective concentration, the BJND further test was conducted. The results of further tests can be seen in Table 7.

Table 7. BJND Test Results of the Effect of Combination Compost Fertilizer of Moringa Leaves and Corn Husk on the Wet Weight of Pakcoy Roots

Treatment	Average	BJND
P0	0,18	a
P2	1,48	b
P1	2,22	bc
P3	2,38	bcd
P4	2,84	e

Description: Numbers followed by letters and in the same column mean not significantly different.

Based on Table 7, the results of the BJND test showed that the highest wet weight was found at 80% concentration (P4). However, the treatments at P1 (20%) and P3 (60%) concentrations were not significantly different from P2 (40%) concentration. Therefore, the recommended fertilizer for increasing root wet weight concentration is P2 (40%).

Observations on the wet weight of taruk showed that the highest wet weight of taruk was found at 80% concentration (P4) which was 35.54 grams and the lowest wet weight of taruk was found in the control which was 2.54 grams (Figure 6). Based on the results of statistical analysis using the F test, the application of compost fertilizer with a combination of moringa leaves and corn husks had a very significant effect on the wet weight of taruk (Table 8).

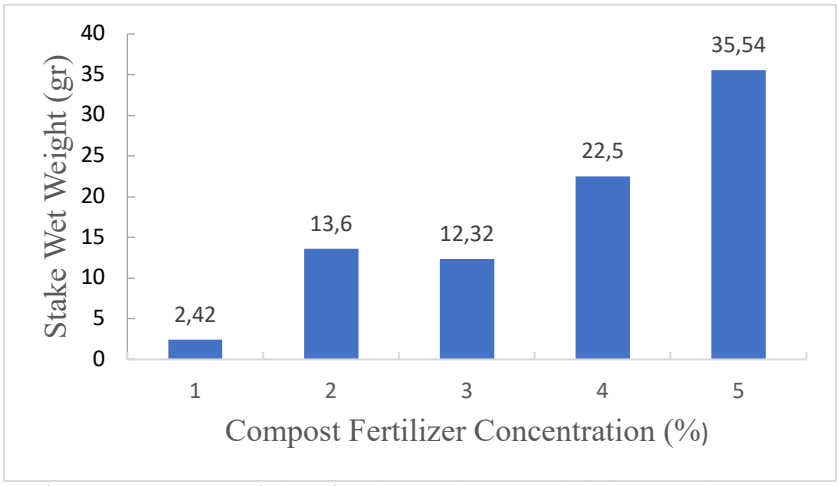

Figure 5. Average wet weight of pakcoy plant taruk (gr) at each concentration

The results of the analysis of variance showed that the calculated F value was greater than the F table value of 15.90, so the hypothesis (h1) was accepted. This means that the combination of compost fertilizer of moringa leaves and corn husk gives a very significant effect on the wet weight of taruk (Table 8).

Table 8. Results of Analysis of Variance of the Effect of Compost Fertilizer Combination of Moringa Leaves and Corn Husks on the Wet Weight of Taruk

Source of Diversity	Free Degree	Sum of Squares	Center Square	Fcount	f table	
					5%	1%
Treatment	4	3098,20	774,55	15,90**	2,87	4,43
Error	20	974,25	48,71			
Total	24	4072,446				

Description: ** = significantly different

To see the most effective concentration, the BJND further test was conducted. The results of the further test can be seen in Table 9.

Table 9. BJND Test Results of the Effect of Combination Compost Fertilizer of Moringa Leaves and Corn Skin on Leaf Area of Pakcoy Plants

Treatment	Average	BJND
P0	2,42	a
P2	12,32	b
P1	13,6	bc
P3	22,5	cd
P4	35,54	e

Notes: Numbers followed by letters and in the same column mean not significantly different.

Based on Table 9, the BJND test results showed that the highest wet weight was found at 80% concentration (P4). However, treatments at P1 (20%) and P2 (40%) concentrations were not significantly different and P1 (20%) concentration was significantly different from the control. Therefore, the recommended fertilizer for increasing the wet weight of taruk concentration is P1 (20%).

4. Implementation of i Research Results in High School Biology Learning

The implementation of research on the effect of compost fertilizer from a combination of moringa leaves and corn husks on the growth of pakcoy mustard (*Brassica rapa* L.) was developed into LKPDs that integrate the effect of compost fertilizer from moringa leaves and corn husks on pakcoy mustard growth. LKPD was validated by 2 Biology Education Lecturers. The results of LKPD validation are visualized in the form of table 10. Making LKPD as an implementation of research results is used as a learning resource in learning high school biology Class XII Phase F Independent Curriculum. The LKPD description of plant growth and development is in Figure 6 below.

Table 10. LKPD Validation Results

Expert 2	Expert 1		Total
	Agree	Disagree	
Agree	11	0	11
No	1	1	2
Total	12	1	13

Proportion of Observed Agreement (Po)	Proportion of Observed Agreement (Pe)
$PO = \frac{A+D}{N}$ $= \frac{11+1}{13}$ $= \frac{12}{13}$ $= 0{,}92$	$Pe = \frac{N1xM1}{N^2} + \frac{N2xM2}{N^2}$ $= \frac{12x11}{13^2} + \frac{1x2}{13^2}$ $= \frac{132}{169} + \frac{2}{169}$ $= \frac{134}{169}$ $= 0{,}79$
So, kappa coefficient $= \frac{PO-Pe}{1-Pe} = \frac{0{,}92-0{,}79}{1-0{,}79} = 0{,}61$ (Baik)	

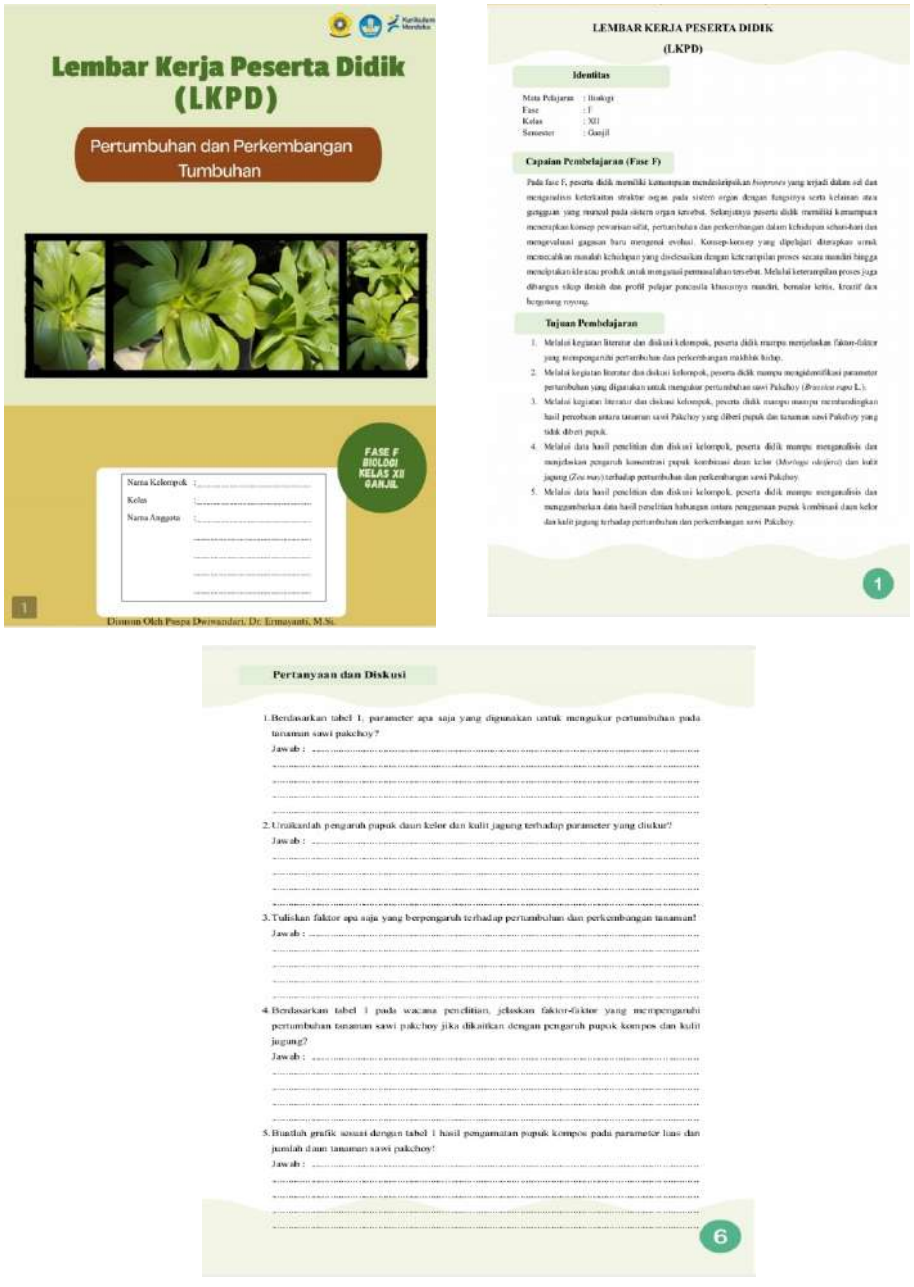

Figure 6. Learner Worksheet

Discussion

In this study, the application of moringa leaf and corn husk fertilizer to Pakchoy mustard plants gave an effect on the growth of Pakchoy mustard (number of leaves, leaf area, root wet weight, and taruk wet weight). This happens because the combination of moringa leaves and corn husk compost fertilizer provides a better quality of fertilizer elements. Moringa leaves are high in nitrogen and corn husk is high in C-Organic. So that the combination of the two makes the quality of fertilizer better. According to (Adiaha, 2017) Moringa leaves contain nutrients such as Nitrogen 4.02%, Phosphorus 1.17%, Potassium 1.80%, C-Organic 11.1%. While corn husk contains 0.7% Potassium, 0.68% Nitrogen, 0.62% Phosphorus, and C-Organic 21.4% (Chan et al., 2023).

1. Number of Leaves

Observation of the number of leaves is done by counting the number of leaves of each plant. Leaves are plant organs where food is synthesized. The results showed that the number of leaves increased with increasing concentration. Fertilizers can affect the number of leaves because the nutrient content in them plays an important role in supporting the physiological processes of plants, especially those related to leaf growth. One of the main nutrients that have a significant effect is nitrogen. Nitrogen functions in the formation of chlorophyll, proteins, and amino acids that are essential in the process of photosynthesis and the growth of new tissues, including leaves (Marschner, P. 2012). According to (Lakitan, 1996) nitrogen is the nutrient that most influences the growth and development of leaves. High nitrogen can produce a large number of leaves. In addition, compounds found in moringa leaves such as magnesium, phosphorus, iron, calcium, and sulfur can increase the efficiency of plants (Tomia et al., 2021). Research conducted by Soepriyanto et al. (2021) showed that the application of various types of nitrogen fertilizers to peanut plants significantly increased the chlorophyll content of leaves, which plays an important role in the process of photosynthesis and leaf growth. In addition, research by Ramadhan et al. (2022) on gandarusa plants showed that a dose of nitrogen fertilizer of 270 kg/ha produced the highest number of leaves, namely 45.8 strands per plant, compared to the treatment without nitrogen fertilizer. In addition to the content of nitrogen elements, there is also a high C-Organic content in corn husks. According to Sari et al. (2023) C-Organic levels can increase soil friability, resulting in better absorption of nutrients and water. This indirectly affects plant growth.

2. Leaf Area

Compost fertilizer has a real effect on leaf area, which is 688.6 cm at a concentration of 80%. However, there was a decrease in leaf area in treatment 2 with 40% concentration caused by pests. Compost fertilizer can affect the leaf area of plants because compost contains nutrients that are important for plant growth, such as potassium, phosphorus, and nitrogen, as well as organic matter that improves soil structure. Potassium, in particular, plays an important role in increasing the rate of photosynthesis, which in turn increases photosynthate production and enlarges leaf area. Setya et al. (2019) explained that potassium can enlarge leaf area because it increases photosynthetic efficiency, which causes more chlorophyll to be formed in the leaves. In addition, organic matter in compost also contains carbon that enriches the soil with C-Organic, which is important for improving soil fertility and increasing the soil's capacity to store water and nutrients. Soil rich in C-Organic can better support plant growth, increasing the number and quality of leaves (Rahardjo and Widodo, 2018). Sutardi and Wijaya (2020) also revealed that organic fertilizers containing C-Organic function to improve soil fertility, increase water retention capacity, and support optimal plant growth, including increasing the number and quality of leaves. Therefore, compost fertilizer not only increases leaf area directly, but also through improving soil quality and nutrient availability.

3. Wet Weight of Roots and Stakes

In the parameter of wet weight of roots, the application of compost fertilizer has a real effect, namely 2.84 grams. Compost fertilizers increase the content of soil organic matter, including C-Organic, which plays an important role in improving soil structure, increasing water retention capacity, and providing an environment that supports root growth (Patra et al., 2019). In addition, macronutrients such as nitrogen (N), phosphorus (P), and potassium (K) contained in compost also contribute significantly to root growth. Nitrogen plays a role in stimulating vegetative growth and the formation of plant tissues, including roots (Hafiz et al., 2020). Phosphorus is important for the formation and development of a strong root system and increases the efficiency of water and nutrient absorption (Sari et al., 2023). Potassium supports photosynthetic activity and the distribution of photosynthetic products to all parts of the plant, including the roots, thus accelerating growth and increasing root wet weight (Kurniawan et al., 2022). This occurs by increasing the absorption of water and nutrients, which contributes to the formation of greater root biomass. In addition, optimal environmental conditions can stimulate cellular activity and cell division in roots, thereby increasing their wet weight. Therefore, changes in environmental factors or certain treatments can have a direct impact on root wet weight as an indicator of plant growth.

The application of compost fertilizer has a significant effect on the wet weight of pakchoy plant taruk, which is 35.54 grams. The wet weight of taruk consists of leaves, stalks, and stems. The wet weight of the taruk was weighed after harvesting the plants and before the plants wilted. Because if the plant wilts, it will make the plant lose a lot of water content. The application of compost fertilizer is proven to have a significant effect on the wet weight of plants, including pakchoy plants. Compost fertilizer contains important nutrients such as organic carbon (C-organic), nitrogen (N), phosphorus (P), and potassium (K), which play a role in supporting plant growth. C-organic in compost functions as an energy source for soil microorganisms that accelerate the decomposition process of organic matter and increase soil fertility (Wahyuni et al., 2021). These elements work synergistically to increase the plant's ability to absorb water, which is very important to maintain plant wet weight and reduce water loss (Hidayat et al., 2022). Plant wet weight is related to the ability of plants to absorb water. Water is needed in plant growth and development. With the fulfillment of sufficient water needs in plants

will make plants heavier and less susceptible to disease. The need for water in plants can be done by absorbing water by the roots.

4. Implementasi Research Results in High School Biology Learning

This research was contributed in the form of LKPD for class XII SMA phase F on analyzing the relationship between internal and external factors with the process of growth and development in living things based on the results of experiments prepared with the use of language that has been adjusted based on the analysis of the needs of students who are communicative, simple, and still maintain scientific terms for Biology literacy. This LKPD is prepared by considering the learning style of students, discussion, and reflection. LKPD has been declared feasible to be tested based on the validator's feasibility analysis. Validation was carried out using 3 aspects that were assessed. The first aspect is the construct validation aspect which consists of 9 criteria, namely the title page, learning instructions, learning outcomes (CP) and learning objectives (TP), learning objectives, supporting information and discourse, work steps, questions, conclusions, and reference lists. The second aspect is graphics, the criteria assessed are illustration. The third aspect is language which consists of three criteria including readability, effectiveness, and EYD suitability. Based on the results of the word coefficient analysis that has been carried out, the result obtained is 0.61 with a good interpretation. Based on these results, the LKPD is feasible to be tested as a learning resource in phase F of class XII SMA.

Conclusion

The conclusion of this research is that the combination of compost fertilizer of Moringa leaves (Moringa oleifera) and corn husk waste (Zea mays) has a very significant effect on the growth (number of leaves, leaf area, root wet weight, and taruk wet weight) of Pakcoy mustard greens (Brassica rapa L.). The best concentration of combined compost fertilizer of Moringa leaves (Moringa oleifera) and corn husk waste (Zea mays) for the growth of Pakcoy mustard greens (Brassica rapa L.) is 80%. The recommended concentration of combined compost fertilizer of Moringa leaves (Moringa oleifera) and corn husk waste (Zea mays) for the number of leaves, leaf area, wet weight of roots, and wet weight of mustard Pakcoy (Brassica rapa L.) is 20%.

Acknowledgment

The author would like to express his deepest gratitude to Mrs. Sri Untari and Mr. M. Ridwan who have provided endless encouragement, prayers, and support during his education and completing this final project. As well as thanks to the author's Supervisor Mrs. Dr. Ermayanti, S.Pd., M.Si. for her patience and dedication in guiding the author's thesis. Thank you for everything.

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