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Research Article

The Effect of Pearl Oyster (Pinctada maxima L.) Biofouling Waste Organic Fertilizer and Watering Interval on The Growth and Results of Mustard Greens (Brassica juncea L.)

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ABSTRACT

This research was conducted in Pelita Jaya Village, Pohon Batu Hamlet, West Seram Regency from June to July 2022. The research was conducted to study the effect of the interaction of doses of organic fertilizer from pearl oyster biofouling waste and intervals of water administration on the growth and yield of mustard plants. The design used in this study was a factorial randomized group trial design (RAK) with two treatments as follows: Factor I: Pearl Oyster Biofouling Waste Fertilizer (L) with 4 levels, namely L0 = Control, L1 = Dosage of 50 gr/tan, L = 100 g/tan and L3 = 150 gr/tan Factor II : Watering Time Interval (W) namely W1 = 1 day, W2 = 2 days and W3 = 3 days. Each treatment was combined to obtain 12 treatments with 3 replications, resulting in 36 experimental plots. In each plot, 4 sample plants were taken so that in total there were 144 sample plants. The results of this study indicate that the interaction of organic fertilizer from pearl oyster biofouling waste with intervals of watering has a very significant effect on the growth and yield of mustard plants (number of leaves, leaf area, plant fresh weight and plant dry weight). The best treatment interaction was the combined dose of pearl oyster biofouling waste fertilizer 150 g/tan with an interval of watering once every three days for mustard greens (*Brassica juncea* L.)

Keywords: *Mustard Greens, Organic Fertilizer, Pearl Oyster Biofuling, Watering Interval*

Introduction

Mustard greens (Brassica juncea L.) are leaf vegetables from the cruciferae family which have high economic value. Mustard plants can grow both in places with hot and cold air, so they can be cultivated from the lowlands and highlands. Mustard greens can withstand rain water so they can be planted throughout the year. During the dry season, what needs to be considered is regular watering because

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mustard plants need cool air (Adzigbli, Hao, et al., 2020).

The part of the mustard plant that has economic value is the leaf, so efforts to increase production are sought to increase vegetative products, so that to support these efforts, fertilization is carried out. Mustard plants require sufficient and available nutrients for their growth and development to produce maximum production. One of the nutrients that plays a very important role in leaf growth is Nitrogen. This nitrogen functions to increase vegetative growth, so that plant leaves become wider, greener in color and of better quality (Adzigbli, Wang, et al., 2020).

One of the factors that support high mustard production is fertilization. Fertilization is the addition of nutrients to the soil so that plants can use them to support their nutrient needs. Nutrients are one of the supporting factors for plant growth and development. The use of chemical fertilizers not only has a positive impact but also has a negative impact if used continuously and for a relatively long time. The negative effects include that the soil hardens quickly, the soil is less able to store water and becomes acidic (Lodeiros et al., 2018).

Fertile soil, will grow a variety of plants well. The process of plant growth is greatly influenced by the level of soil fertility, so that the plants grow well and the yields are abundant. The use of organic fertilizers can be a solution in increasing soil fertility (Hamzah et al., 2019). The weakness of organic fertilizers in general is the low nutrient content and slow availability for plants (Latchere et al., 2018). Organic fertilizers can be in solid or liquid form. The advantage of liquid organic fertilizer is that the nutrients it contains are more readily available and easily absorbed by plant roots. Apart from pouring liquid fertilizer, it can be used directly by spraying it on the leaves or stems of plants (Le Moullac et al., 2018). Organic fertilizers come from plant, animal or human remains, such as manure, green manure, and compost in liquid or solid forms. Common types of organic fertilizers are goat manure, cow compost manure, chicken manure manure, vermicompost manure. Suparhun stated that giving goat manure at a dose of 30 tons/ha had the best effect on the growth and production of green mustard plants with a production of 24.11 tons/ha (Han et al., 2022).

Based on preliminary research conducted by Nendissa, JI and Leimena, HP suggested that pearl oyster biofouling waste can be developed as organic fertilizer because it contains very high organic matter, namely 24.96%, 0.92% total nitrogen, 0.25% phosphorus. %, total potassium is 1.02% and also contains nitrogen fixing bacteria which can fertilize the soil such as Azotobacter sp. Aside from being an organic fertilizer, pearl oyster biofouling can also be processed into animal feed (Erasito et al., 2022).

To increase the growth and yield of mustard plants, watering is needed at the right time. Provision of water through proper and correct watering. Excess watering can cause leaching of plant nutrients, compaction of the soil surface and surface erosion. Infrequent watering can cause plants to become stressed due to lack of water. Watering is influenced by several factors, namely: replacing water that has evaporated, providing additional water needed by plants, and restoring plant strength (Johnston et al., 2022).

Water has an important role and function for plants, including as a constituent of the plant body (70-90%), a solvent and medium for biochemical reactions, a transport medium for compounds, a solvent and transporter of minerals and nutrients, provides turgor for cells and maintains plant turgor, a material for raw materials in photosynthesis and keep the plant temperature constant (Andréfouët et al., 2022). Cell turgor in plants is very important for the process of cell division and cell enlargement, so that kailan (Brassica juncea L.) with optimum turgor will have a good metabolism because water needs and nitrogen absorption are met. Thus, the synthesis of proteins and carbohydrates as constituents of leaf organs can take place well too (Lake-Thompson, 2018).

This study aims to study the effect of interaction doses of pearl oyster biofouling waste fertilizer with watering intervals on the growth and yield of mustard plants (Ahmad et al., 2021). The benefit of this research is to provide information about the effect of various doses of pearl oyster biofouling waste fertilizer combined with watering time intervals on the growth and yield of mustard plants (Gordon et al., 2019).

Methods

The materials used in this study were mustard seeds (*Brassica juncea* L.), pearl oyster biofouling waste, manure and water. The tools used in this study were hoes, machetes, gembor, rapia ropes, tape measure, scissors, sample boards, scales, calculators, stationery, millimeter blocks, cellphone cameras. This research was conducted in Pelita Jaya Village, Dusun Pohon Batu, West Seram Regency from June to July 2022. The design used in this study was a Factorial Randomized Group Experiment (RBD) design with two treatments as follows:

Factor I: Pearl Oyster Biofouling Waste Fertilizer (L) with 4 levels, namely L0 = Control, L1 = Dosage of 50 gr/tan, L = 100 g/tan and L3 = 150 gr/tan

Factor II: Watering Time Interval (W) namely W1 = 1 day, W2 = 2 days and W3 = 3 days.

Each treatment was combined to obtain 12 treatments with 3 replications, resulting in 36 experimental plots. In each plot, 4 sample plants were taken so that in total there were 144 sample plants.

Preparation of Seeds and Nurseries

Mustard seeds that will be sown first are soaked in warm water for 30 minutes, the seeds that float are removed and the seeds that sink are taken. This aims to speed up the germination process. The seeds are sown in the nursery media (Chen et al., 2019). The nursery media consists of a mixture of soil and manure in a ratio of 2: 1. Before the seeds are planted, the media is doused with water until moist and left for a day. The method of seeding in the nursery is that the seeds are sown, then covered with soil 1-2 cm thick, then watered with a sprayer. Mustard seeds are sown in the afternoon to avoid excessive evaporation. Furthermore, the shaded paranet roof with a position facing east for 2 weeks in the nursery before being transferred to the field (Thompson et al., 2020).

Preparation of Planting Media

Preparation of planting media is done 2 weeks before planting. The area of land used in this study was 24.5 m x 4.5 m and the land was cleared of weeds and then continued with plowing. Then a map with a size of 147 cm x 120 cm was made, with 36 experimental plots with a spacing between rows of 30 cm and a distance between replicates of 40 cm. then given chicken manure as basic fertilizer at a dose of 15 tons/ha.

Planting

Planting is done directly by inserting the seeds into the planting holes provided with a spacing of 25 x 30 cm then the holes are covered with soil. Each planting hole contains 1 plant. Seeds that are planted are selected for good growth, upright, fresh, pest and disease free.

Fertilizer Treatment

The application of Pearl Oyster Biofouling fertilizer is given according to a predetermined dose or according to the treatment. The application of organic fertilizer from pearl oyster biofouling waste is carried out by immersing it in the soil. Watering is given at intervals of 1, 3 and 5 days.

Maintenance

Maintenance activities are carried out, namely: Watering is carried out according to treatment in the morning and evening. At the beginning of growth, stitching is done by replacing damaged/dead plants with healthy seeds which are reserve seeds. The purpose of replanting is to keep the number of plants maintained, weeding is done once a week manually by pulling weeds that grow around the mustard greens, pest and disease control is done by spraying soursop leaf extract vegetable pesticides if there is an attack.

Harvest

In terms of harvesting mustard plants, that is when they are 30 days old. First, by looking at the color of the plant, it is fresh green and the shape of the leaves widens. How to harvest is to remove the entire plant along with the roots.

Observational Variables

The variables observed in this study were: number of leaves (strands), leaf area (cm^2). Measurements of the number of leaves and leaf area were carried out on fully opened leaves, calculated at 2 WAP and 4 MST. Leaf area was measured using the LD = P x L x K method. The fresh weight of the mustard plants (grams) was weighed, starting from the roots to the tips of the leaves at harvest using an analytical balance, the dry weight (grams) of the mustard plants were weighed, starting from the roots. to the tip of the leaf after baking for 3 days at 80°C with an analytical balance.

Data Analysis.

To find out the effect of treatment on the observational variables, each observation is analyzed F (ANOVA).

Results and Discussion

Interaction between Pearl Oyster Biofouling Waste Fertilizer Dosage and Water Giving Interval

The mean results showed that the treatment of pearl oyster biofouling waste fertilizer doses and the intervals of watering the mustard plants (Brassica juncea L.) interacted with the mean number of leaves, leaf area, plant fresh weight and plant dry weight. The interaction between the doses of pearl oyster biofouling waste fertilizer and the water application intervals is presented in Table 1 and Table 2. This is presumably due to a match between the water treatment intervals and the doses of pearl oyster biofouling waste fertilizer and can be caused by suitable environmental conditions.

Table 1. Number of leaves and leaf area of mustard greens applied organic fertilizer from pearl oyster biofouling waste and watering time intervals at 2 MST and 4 MST

Treatment	Number of Leaves (Streams)		Leaf area (cm^2)	
	2 MST	4 MST	2 MST	4 MST
L0W1	5.75 d	9.17c	295.84b	1078.39 e
L0W2	5.83bcd	9.25c	300.11b	1133.36 de
L0W3	5.83bcd	9.67c	315.79b	1165.16 de
L1W1	6.00 bcd	10.58 bc	382.88 ab	1469.42 cdes
L1W2	6.00 bcd	10.92 bc	421.85 ab	1536.40 cds
L1W3	6.16 abcd	11.08 bc	464.35 ab	1546.38 cds
L2W1	6.41 abcd	11.17 bc	481.51 ab	1719.20 bc
L2W2	6.50 abcd	11:25 abc	504.69 ab	1752.14 bc
L2W3	6.75 abc	11:33 abc	551.51a	1795.76 bc
L3W1	6.83 ab	12.75 ab	569.31a	1996.93 ab
L3W2	7.08a	12.83 ab	580.67 a	2105.94 ab
L3W3	7.08a	13.50 a.m	585.00 a	2230.55 a

Pearl Oyster Biofouling Waste Fertilizer Dosage

The average results showed that the treatment of pearl oyster biofouling waste fertilizer doses on mustard greens (Brassica juncea L.) had very significant differences in the mean number of leaves, leaf area, plant fresh weight and plant dry weight (Tables 1 and 2). This is because the pearl oyster biofouling waste fertilizer contains high organic matter so that it can change the primary metabolism and secondary metabolism. According to Nendissa *et al* (2021), the organic matter contained in pearl oyster biofouling waste is 14.48% and a C/N ratio of 15.72 fulfills the fertilization criteria according to the Indonesian National Standard. The C/N ratio is defined as the ratio of the mass of Carbon (C) to the mass of Nitrogen (N) in a substance. If the carbon content is too high, the composting process will take a long time, otherwise if the nitrogen content is too high, the composting process will take place quickly, but some of the nitrogen will be released/evaporated into the air. In the composting process various microorganisms are involved which in their activities require carbon and nitrogen as a source of energy and cell formation. For this reason, the C/N ratio is an important factor in the composting process. The value of C/N depends on the type of material to be composted. A good composting process will produce an ideal C/N ratio of 10 – 25.

Based on the results of the 5% BNJ test in Table 1, it shows that the interaction of the organic fertilizer treatment of pearl oyster biofouling waste with a dose of 150 g/ta (L3) with an interval of watering once every 3 days (W3) in 2 WAP gave the highest number of leaves, namely 7.08 strands but not significantly different from L3W2 (7.08 strands), L3W1 (6.83 strands), L2W3 (6.75 strands), L2W2 (6.50 strands), L2W1 (6.41 strands) and L1W3 (6.16 strands). In the treatment without organic fertilizer, Mutira oyster biofouling waste combined with once a day watering interval (L0W1) resulted in the lowest number of leaves of 5.75 strands (Ahmed et al., 2022). At 4 WAP, the application of pearl oyster biofouling waste fertilizer 150 g/tan combined with watering once every 3 days (L3W3) gave the highest number of leaves 13.50 leaves and the lowest number of leaves in the L0W1 treatment of 9.17 leaves. It is suspected that when the plants were 2 MST and 4 MST, the organic fertilizer from pearl oyster waste contained high organic matter so that it was able to change primary metabolism and secondary metabolism (Qiu & Duan, 2019).

This shows that the dose of pearl oyster biofouliung waste fertilizer 150 g/tan is able to supply nitrogen elements according to the amount needed for the growth and development process in mustard plants, because the nitrogen nutrients contained therein play a very important role in plant vegetative growth, for example plant height and number of leaves. mustard plant. This is in line with the opinion of Novizan (in Hasanpour & Hatami, 2020) that the nutrients contained in pearl oyster biofouling waste fertilizer are very useful for plants for growth and development, including: (1) making plants more fresh green and containing lots of green leaf grains (Chlorophyil) which has a role in the process of photosynthesis, (2) accelerating plant growth (height, number of leaves, tillers, branches and others), (3) increasing the protein content of plants, (4) can be used for all types of plants both food crops, horticulture, plantation crops, livestock business and fishery business. Optimal provision of nitrogen can increase plant growth, increase protein synthesis, chlorophyll formation which causes leaf color to become greener and increases the ratio of shoots to roots (Racha et al., 2022).

The occurrence of significant differences between treatments was probably due to the treatment of the dose of 0.g/tan pearl oyster biofouling waste fertilizer that had met the nitrogen nutrient requirements of the mustard plants which had previously been given chicken manure. Treatment of pearl oyster biafouling waste fertilizer doses of 50 g/tan, 100 g/tan and 150 g/tan gave very significant results.

Pearl oyster biofouling waste fertilizer has several functions, including developing several nutrients such as phosphorus, nitrogen, sulfur and potassium; increasing the cation exchange capacity of the soil; releasing P nutrients and Fe and Al oxidation; improve the physical, chemical and biological properties of soil where the soil structure can form complex compounds with macro and micro elements so as to reduce the leaching process of macro and micro elements so as to reduce the leaching process of elements. Wigati, et al (in Saravanan et al., 2022) suggested that manure is solid and liquid manure from animals or cattle in cages, which can be mixed with food waste. The decomposition of manure into humus is important in improving soil chemical properties.

In addition, pearl oyster biofouling waste fertilizer can increase the availability and absorption of nutrients in the formation of organic compounds (carbohydrates, proteins and lipids). These compounds function in the formation of plant cells. This is in line with the opinion of Ariyanti (2019), if the needs for Nitrogen, Phospor and Potassium are fulfilled, it can increase plant growth in the formation of leaves so that the leaves will become many in number (Das et al., 2021).

One of the other factors that can cause significant differences between treatments may be due to a decrease in soil pH which can affect the absorption of nutrients. This is supported by the statement of Engelstad which stated that ZA fertilizer has properties including N levels of around 20-21%, has an acidic physiological reaction and has the ability to expel Ca from adsorption complexes (Sabin, 2021).

According to Smillie and Gershuny who argued that soil pH affects the availability of nutrients in the soil. Nutrients in the soil are widely available at a pH of 6.2-6.8. In acid soils with a pH below 5.5 and in alkaline soils (pH above 7.0), most of the nutrients (which are in the form of cations) change form to become unavailable for plants. This is reinforced by the opinion of Nugroho et al (2000) that nutrient uptake by plants is strongly influenced by the levels and availability of nutrients in the soil. Although nitrogen content is closely related to nitrogen uptake by plants, from the stepwise regression test it is known that the most influential factor on nitrogen uptake by soil is soil pH. According to Lingga and Marsono (2003) manure will be readily absorbed by plants if decomposition by microbes has stopped and the smell of ammonia does not smell from the fertilizer.

Water Feeding Intervals

Treatment of different watering time intervals gave very significant results on the parameters of the number of leaves, leaf area, plant fresh weight and plant dry weight. This is due to the relationship of nutrient absorption by roots and leaves. This can be seen in the number of leaves of mustard plants aged 2 MST and 4 MST which had the highest number and in the 2 and 3 day treatment compared to daily watering. This is presumably because soil that is watered too often is anaerobic and suffers from oxygen deficiency. The roots will be disturbed if the application of water in large quantities causes a change in soil pH and a decrease in oxygen levels in the soil. when inundation occurs, water fills the entire soil volume and causes physical and chemical changes in the soil. Under normal conditions, roots absorb oxygen from the soil and then use it in the respiration process. Oxygen as a limiting factor causes the production of ATP from respiration to be disrupted. that giving too much water causes a decrease in the number of chili plant leaves (Qian et al., 2020).

Changes in the growth component due to treatment were caused by morphological changes in plants experiencing drought stress, including inhibition of root growth, plant height, stem diameter, leaf area, and number of leaves. When there is a shortage of water, the plant will extend its roots to the soil layer which has sufficient water availability so that the plant can survive. This is an adaptation to water shortages. Plants that have long roots will have a better ability to absorb water than plants with short roots (Mariuzza et al., 2022). lack of water can reduce the number of tillers, changes in root patterns, and delay flowering. Sujinah and Jamil (2016) stated that drought stress can inhibit root growth resulting in a decrease in the root loss ratio. Water is also an important factor for plant growth which plays a role in cell expansion or enlargement thereby increasing leaf area.

Intervals of watering once every three days give the best results, because the possibility of water needs is not too stagnant nor too dry so that the need for water to be used for growth is in optimum condition. Under these conditions, it can affect the division of plant cells and the transport of nutrients from the soil to the plants as well as the continued use and expenditure of water which in turn stimulates metabolic activity which is used for the growth of plant parts such as stems, longer roots and wider leaves. The longer the period of giving water to plants, the ground water will affect the growth of plants as a whole (Syeda et al., 2022).

Water has an important role and function for plants, including as a constituent of the plant body (70-90%), a solvent and medium for biochemical reactions, a transport medium for compounds, a solvent and transporter of minerals and nutrients, provides turgor for cells and maintains plant turgor, a material for raw materials in photosynthesis and keep the plant temperature constant (Askari, 2012). Cell turgor in plants is very important for the process of cell division and cell enlargement, so that kailan (Brassica juncea L.) with optimum turgor will have a good metabolism because water needs and nitrogen absorption are met. Thus, the synthesis of proteins and carbohydrates as constituents of leaf organs can take place well too.

Adequate and balanced water availability can increase the number of leaves. This is in accordance with the opinion of Mappanganro, that leaf formation is related to stem growth where the stem is composed of segments that stretch between the stem nodes where the leaves are attached. The number of nodes and nodes is the same as the number of leaves, so that by increasing the length of the stem, the number of leaves formed will also increase. Internode elongation occurs as a result of cell division activity which in turn causes the number of cells to increase. This process is inseparable from physiological activities in the plant body which are influenced by hormones.

Plant growth is very limited by the amount of water available in the soil, so it is necessary to add water. The better the soil in carrying out nutrient transport, the need for nutrients will also be more fulfilled, so that the plants are able to provide a better average leaf area. This is in accordance with the opinion of Tisdale and Nelson who argued that the availability of water is influenced by the ability of the soil to bind water. The amount of water that can be held by the soil depends on the organic matter and soil texture. By fulfilling the needs of water used by plants, there will be a continuity of use and expenditure of water which in turn stimulates metabolic activity which is used for the growth of plant parts (Ghodszad et al., 2022).

Based on the analysis of diversity, it was shown that the dose treatment of pearl oyster biofouling waste fertilizer combined with watering time intervals had a very significant effect on plant fresh weight and plant dry weight. The average plant fresh weight and plant dry weight are presented in Table 2.

Table 2. Plant fresh weight and dry weight of mustard plants applied organic fertilizer pearl oyster biofouling waste and watering time intervals

Treatment	**Plant Fresh Weight (g)**	**Plant Dry Weight (g)**
L0W1	126.00 c	5.75e
L0W2	129.58c	5.92 e
L0W3	134.33 bc	6.59 de
L1W1	159.58 abc	9.58 cds
L1W2	162.17 abc	9.67 cd
L1W3	163.42 abc	10.25 bc
L2W1	167.58 abc	10.92 abc
L2W2	178.67 ab	11.67 abc
L2W3	181.75a	13.17 ab
L3W1	186.75a	13.17 ab
L3W2	190.83a	13.33 ab
L3W3	196.58a	13.83 a

Based on the results of the 5% BNJ test in Table 2, it shows that the interaction of the organic fertilizer treatment of pearl oyster biofouling waste with a dose of 150 g/ta (L3) with an interval of watering once every 3 days (W3) at 2 WAP gave the highest amount of plant fresh weight, namely 196 g compared with no fertilizer treatment and mustard plant watering every day of 126 g (L0W1) (Sabin, 2021).

This is because evaporation at the frequency of watering once every 3 days is very high which causes the soil to lose a lot of water so that the water intake for the plants will increase. Watering once a day can cause decay of plant roots in the soil because the roots absorb more water, causing the plants to grow stunted and wilt. Because the excess water causes the color of the leaves to turn yellow easily, leaf chlorosis occurs, and the leaves dry out so that they are not active in growth and eventually fail (Nendissa et al., 2021). Excess and lack of water will be detrimental to a plant. If the plant lacks water it will get a little supply of oxygen and excess water will cause rot in the plant's root area.

This is in accordance with Arifin's opinion (in Haque et al., 2021) which states that plants that lack water will trigger the formation of abscisic acid inhibiting hormones and growth stimulating hormone inhibitors. The longer the frequency of watering the roots of the plants the less. Water requirements for plants vary, depending on the type of plant and its growth phase. Plant roots grow into the moist soil and draw in water until a critical water potential is reached in the soil. Lack of water can inhibit the rate of photosynthesis, mainly because of its effect on the turgidity of the stomata guard cells. If there is a shortage of water, the turgidity of the guard cells will decrease (Sabin, 2021).

Kramer (in Hamzah et al., 2019)suggested that in plants that experience water shortages, their stomata close earlier to reduce water loss, but closing stomata and reduced stomata opening also inhibit CO2 entry so that the rate of photosynthesis decreases. A reduced rate of photosynthesis causes photosynthate yields to decrease as well, resulting in stunted plant growth. Such photosynthetic activity will inhibit the growth rate of plants and can also cause decreased plant growth. Plants that lack water can cause plants to become stunted and small plant parts. Plants that suffer from lack of water have a smaller size compared to plants that grow normally.

Conclusion

Interaction Administration of organic fertilizer from pearl oyster biofouling waste at a dose of 150 g/tan with watering intervals of 3 days once had a very significant effect on the number of leaves, leaf area, plant fresh weight and plant dry weight for mustard greens (Brassica Juncea *L.*)

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