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Cultivation of Green Mustard Greens (Brassica juncea L.*) on Marginal Land*

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Abstract. *The research aims to determine the type of fertilizer and watering intensity that can provide optimal and effective growth and production of green mustard greens. The study was conducted in the Greenhouse of the Department of Agricultural Engineering, Faculty of Agriculture, Universitas Lampung. It utilized a Completely Randomized Design (CRD) arranged in a factorial 2 x 3 with three replications. The first factor was the application of fertilizer types, consisting of urea and ghally organic fertilizer. The second factor was the application of watering intensity, which included three levels (watering once a day, every two days, and every three days). The study used sand as the planting medium. The results showed that, in general, the treatment of watering once a day and the application of urea fertilizer provided optimum results in the growth and development of green mustard greens. Meanwhile, the application of ghally organic fertilizer was more efficient in terms of water consumption for green mustard greens.*

Keywords: *Fertilizer Type, Green Mustard Greens, Marginal Land, Sand, Watering Intensity*

1. Introduction

Indonesia is a country rich in various food needs such as fruits and vegetables, especially horticultural vegetables. One commonly cultivated vegetable is green mustard greens. Green mustard greens have high economic value and contain various beneficial components for health. Additionally, they have a short harvesting period and a wide-open market with relatively stable prices, making them attractive for cultivation.

The demand for vegetables, particularly green mustard greens, is steadily increasing. To meet consumer needs, both in terms of quality and quantity, there is a need to increase production (Rizka and Anhar, 2022). Production improvement can be achieved through fertilization and irrigation. Water availability is a limiting factor for plant growth. Another component in production

enhancement is irrigation, an essential factor for plants. Doorenbos and Kassam (1979) state that appropriate watering is necessary to accelerate plant growth and increase yields.

The second limiting factor for growth is soil fertility. Overcoming soil fertility issues can be addressed by adding organic and inorganic materials, such as organic fertilizer and urea. According to Pratiwi's research (2008), the application of inorganic fertilizers containing nitrogen, such as urea, can increase green mustard plant production. This is because nitrogen plays a crucial role in the plant's vegetative stage.

Efforts to increase agricultural activities, especially horticulture, in Indonesia face various challenges, such as the narrowing of agricultural land due to the conversion of agricultural land into non-agricultural land (Anugerah, 2005). One solution to address land scarcity is by utilizing marginal land. Considering that Indonesia is an archipelagic country with 60% of its territory being water, there is extensive availability of sandy coastal land suitable for agriculture (Agency for Agricultural Research and Development, 2010). These lands have low fertility, requiring technology to improve productivity (Yuwono, 2009). The utilization of technology in coastal areas includes improving the physical, chemical, and biological properties of the soil to ensure optimal interactions between soil, water, and plants. One such method is the application of organic fertilizer, as coastal sandy soil needs attention to provide sufficient nutrients, sunlight, and wind energy to avoid hindering biomass production.

The purpose of these improvements is to create aggregated sandy soil, capable of retaining water, preventing water loss through percolation or evaporation, providing macro and micro-nutrients for plants, and establishing a rich soil microorganism community that contributes to soil chemical and physical fertility (Istiyanti *et al*., 2015). Based on the above explanations, this research is titled "The Influence of Fertilizer Type and Watering Intensity on the Growth and Yield of Green Mustard Greens (*Brassica juncea* L.) on Sandy Marginal Land." The study aims to determine the suitable combination of watering intensity and fertilizer type for the growth of green mustard greens on sandy marginal land.

2. Research Methods

The research was conducted over a period of 3 months in the Greenhouse of the Department of Agricultural Engineering, Faculty of Agriculture, Universitas Lampung. The tools used in the study included glass pots with dimensions of 20x20x30 cm, a digital scale, a plastic ruler, a shovel, and a digital caliper. The materials used were caisim mustard greens seeds (*Brassica juncea* L.), river sand, water, Ghally Organic fertilizer, and Urea fertilizer (NH_2CONH_2).

The research employed a Completely Randomized Factorial Design. The experiment involved two factors: fertilizer type (urea fertilizer and Ghally organic fertilizer) and watering intensity (once a day, every two days, and every three days). There were 18 experimental units with each treatment repeated three times. The observed variables included leaf count, leaf width (cm), fresh weight (grams), dry weight (grams), and water consumption.

The research process began with the preparation of tools and materials, followed by the sowing of green mustard seeds for 14 days. Subsequently, seedlings aged 14 days or with three to four leaves were planted, and maintenance practices, including fertilization and watering, were carried out. Fertilization was conducted at 2 weeks and 4 weeks after planting, with a dosage of 2.2 grams per pot or equivalent to 200 kg per ha of urea fertilizer and 11 grams of organic fertilizer. Watering was done in three treatments: once a day, every two days, and every three days from 5 days after planting to 40 days after planting. Harvesting took place when the mustard plants were approximately 40 days old. The data obtained from the research results were analyzed assuming Anova (Analysis of Variance) for CRD (Completely Randomized Design). Homogeneity of variance was further tested using the Bartlett test. Once the assumptions for the analysis of variance

were met, further testing was conducted using Orthogonal Polynomial class comparison. Table 1 shows the table of orthogonal polynomial class comparison used for data analysis.

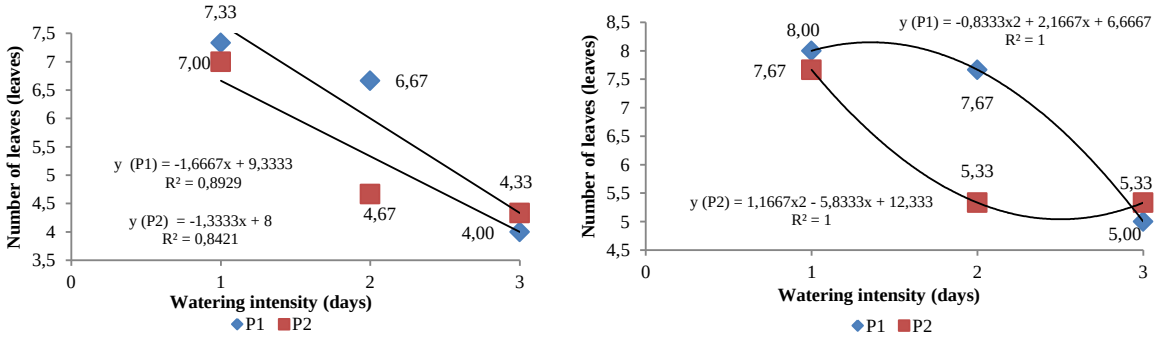
Table 1. Orthogonal polynomial class comparison

Comparison	Treanment and total treatments					
	P1			P2		
	I1	I2	I3	I1	I2	I3
types of fertilizer (p)						
C1 : p1 VS p2	-1	-1	-1	1	1	1
Watering intensity (i)						
C2 : i-Linear	-1	0	1	-1	0	1
C3 : i-Quadratic	1	-2	1	1	-2	1
Interaction p x i						
C4 : C1 X C2	1	0	-1	-1	0	1
C5 : C1 X C3	-1	2	-1	1	-2	1
Response to p						
C6 ; i1; p1 vs p2	-1			1		
C7 : i2; p1 vs p2		-1			1	
C8 : i3; p1 vs p2			-1			1
Response to i						
C10 : p1 ; i - Linear	-1	0	1			
C11 : p2 ; i- Quadratic	1	-2	1			
C12 : p1 ; i - Linear				-1	0	1
C13 : p2 ; i - Quadratic				1	-2	1

3. Results and Discussion

3.1. Effect of Fertilizer Type and Watering Intensity on Leaf Count

Based on the results of the analysis of orthogonal polynomial class comparison on the influence of fertilizer type and watering intensity, a significant effect on the number of leaves per plant at 2 and 3 weeks after planting was observed, as illustrated in Figure 1.



(a) (b)

Figure 1. Graph of the effect of watering intensity and fertilizer type on the number of leaves per plant (a) at 2 WAP and (b) at 3 WAP

Figure 1a shows that the application of organic fertilizer and urea with varying watering intensity indicates a decreasing linear component in the number of leaves of plants at 2 weeks after planting (WAP). This is attributed to the amount of water available to the plants, which influences

the formation of plant organs. In plant physiology, water plays a crucial role as it constitutes the main component of protoplasm. According to Harwati (2007), high water content corresponds to high physiological activity, while low water content results in reduced physiological activity (Kramer and Kozlowksi, 1960).

Figure 1b demonstrates that the application of ghaly organic fertilizer and urea with varying watering intensity significantly influences and shows a quadratic component in the number of leaves per plant at 3 WAP. Optimal points, P1 (Urea) and P2 (ghaly organic), are found at I1 (once a day watering), with 8 leaves and 7 leaves, respectively. The most effective watering treatment occurs at a frequency of once a day, as it provides conditions with sufficient water for the plants (Audina *et al*., 2016).

3.2. Effect of Fertilizer Type and Watering Intensity on Water Consumption

Based on the average weekly results, the influence of watering intensity significantly affects water consumption, showing both linear and quadratic components increasing for each treatment (Figure 2).

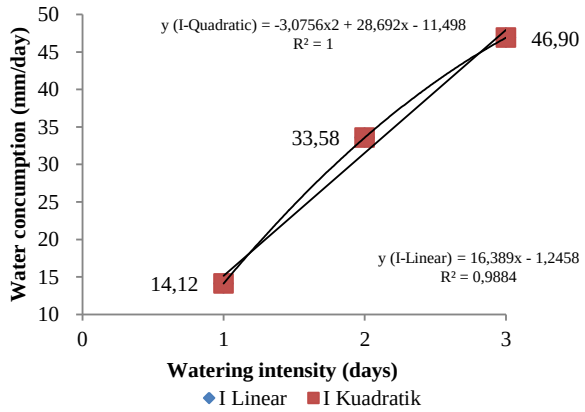


Figure 2. Graph of the effect of watering intensity on water consumption

Observations on water consumption in rice plants from 1 week after planting (MST) to 6 MST reveal that at a watering intensity of once a day, the average water consumption is 14.12 mm/day, at watering intensity every two days, the average water consumption is 33.58 mm/day, and at watering intensity every three days, the average water consumption is 46.90 mm/day. Based on the orthogonal polynomial class comparison, urea fertilizer is capable of increasing water consumption in plants. This is attributed to urea fertilizer's hygroscopic properties, making it easily soluble in water and reacting quickly, thus being rapidly absorbed by plant roots (Pristianingsih *et al*., 2015).

3.3. Effect of Fertilizer Type and Watering Intensity on Leaf Width

Based on the results of the orthogonal polynomial class comparison regarding the influence of fertilizer type and watering intensity, a significant effect on leaf width at 3 MST, 5 MST, and 6 MST is observed, as depicted in Figure 3.

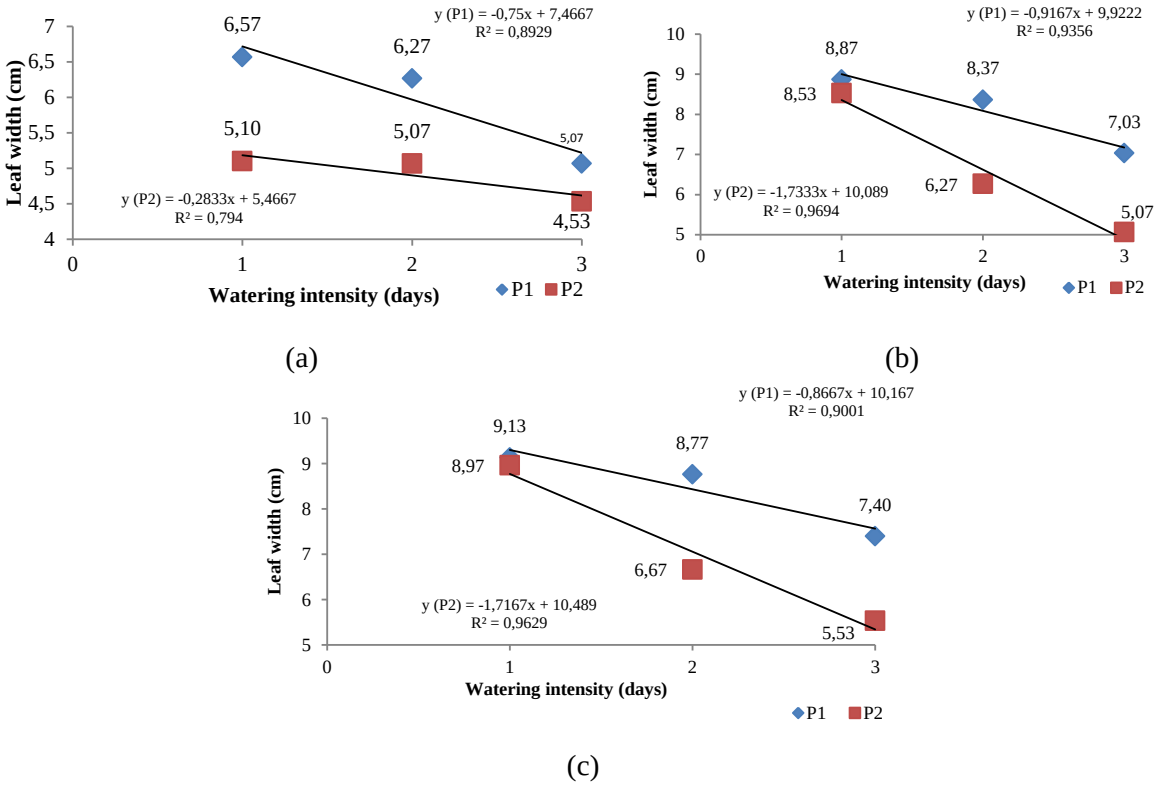


Figure 3. Graph of the effect of watering intensity and fertilizer type on leaf width (a) at 3 MST, (b) at 5 MST, and (c) at 6 MST

Based on Figures 3a, b, and c, it is evident that the application of ghaly organic fertilizer and urea with varying watering intensity significantly influences leaf width, showing a decreasing linear component. The highest leaf width is observed for P1 (Urea) and P2 (ghaly organic) at I1 (once a day watering), with respective widths of 6.57 and 5.10 cm at 3 MST. Subsequently, leaf widths are obtained as 8.87 and 8.53 cm at 5 MST, and finally 9.13 and 8.97 cm at 6 MST. This is attributed to the increased fulfillment of water needs in plants, leading to better cell and tissue formation.

According to Tso (1972), water is utilized to maintain turgor pressure and plays a role in cell elongation. Turgor is a primary determinant of growth, leaf expansion, and various aspects of plant metabolism. The opening and closing of stomata are largely controlled by the availability of water. In well-watered plants, stomata can be kept open to ensure smooth gas exchange in leaves, including the essential CO2 needed for photosynthesis. High metabolic activity also ensures the rapid growth of plants (Bayer, 1976).

3.4. Effect of Fertilizer Type and Watering Intensity on Plant Fresh Weight

Based on the results of the orthogonal polynomial class comparison regarding the influence of fertilizer type and watering intensity, there is a significant effect on the plant's fresh weight, showing a quadratic component (Figure 4).

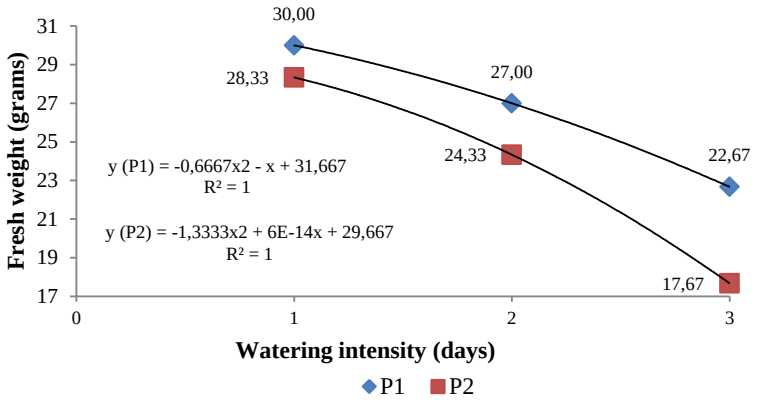


Figure 4. Graph of the effect of fertilizer type and watering intensity on plant fresh weight

Based on the results of the orthogonal polynomial class comparison regarding the influence of fertilizer type and watering intensity, a significant effect on plant fresh weight is observed, showing a quadratic component. The optimal points P1 (Urea) and P2 (ghaly organic) are obtained at I1 (once a day watering), with fresh weights of 30.00 and 28.33 grams, respectively.

The availability of water is related to the solubility of nutrients needed by plants. Available water allows the nutrients in the soil to be mineralized into elements that can be absorbed by plant roots. The more nutrients absorbed, the balanced the plant's metabolic processes, influencing plant growth. Normal plant growth affects plant biomass. This is because the optimal water and nutrient content in the leaves results in the highest plant fresh weight. This aligns with the opinion of Lahadassy *et al*. (2007), stating that to achieve optimal plant fresh weight, plants still need a significant amount of energy and nutrients to ensure the increase in both the number and size of cells reaches an optimum level. This also allows for an optimal increase in plant water content, as most of the plant's fresh weight is caused by water content. Water plays a crucial role in cell turgidity, causing leaf cells to expand.

3.5. Effect of Fertilizer Type and Watering Intensity on Plant Dry Weight

Based on the results of the orthogonal polynomial class comparison regarding the influence of fertilizer type and watering intensity, there is a significant effect on plant dry weight, showing a quadratic component, as depicted in Figure 5.

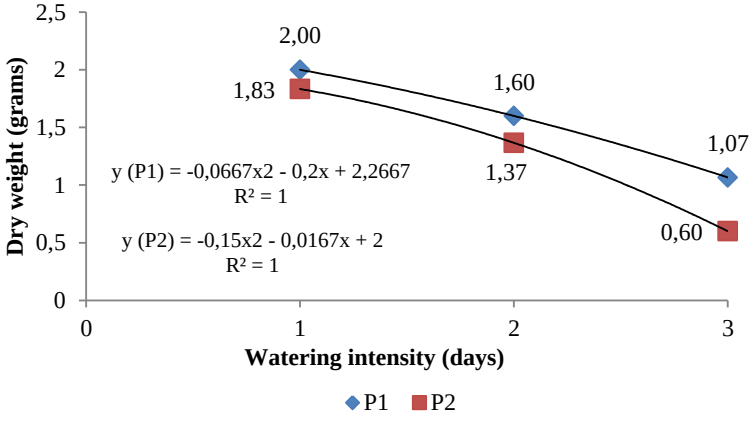


Figure 5. Graph of the effect of fertilizer type and watering intensity on plant dry weight

Based on Figure 5, the influence of fertilizer type and watering intensity has a significant effect on plant dry weight, showing a quadratic component. The optimal points P1 (Urea) and P2

(ghaly organic) are obtained at I1 (once a day watering), with dry weights of 2.00 and 1.83 grams, respectively.

Dry weight represents the accumulation of organic matter in plants without water content. In treatment I1, which involves watering once a day, the highest results are obtained compared to other treatments. This is because faster relative growth leads to better photosynthesis, ultimately affecting the increase in plant dry weight. Photosynthesis is a crucial metabolic process in plants, requiring light, CO2, O2, chlorophyll, and water. Treatment with once-a-day watering (I1) yields high results due to the availability of sufficient water needed in the photosynthesis process, where water significantly affects the turgidity of guard cells in stomata. If there is a lack of water, cell turgidity decreases, causing stomata to close. Stomatal closure inhibits the uptake of CO2 needed for carbohydrate synthesis (Lakitan, 2011).

4. Conclusion

Based on the research data, statistical analysis, and literature review, the following conclusions can be drawn:

1. The use of ghally organic fertilizer in a sand medium has not shown an improvement in the growth of mustard plants (*Brassica juncea* L.) when compared to the use of urea fertilizer.
2. Watering intensity once a day has the most favorable impact on the growth of mustard plants (*Brassica juncea* L.).
3. The use of urea fertilizer with watering intensity once a day has the most beneficial effect on the growth and development of mustard plants (*Brassica juncea* L.).

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