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The Effect of Foliar Fertilizer Application on the Growth and Production of Several Varieties of Mustard Plant (*Brassica Juncea* L)

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Abstract
The study aims to determine the effect of foliar fertilizer on the growth and production of several varieties of mustard greens (Brassica juncea L). This study used a Factorial Randomized Block Design (RAK) consisting of two factors. The first factor is mustard greens varieties (V) consisting of 3 levels: V1 = Tosakan variety, V2 = Shinta variety, and V3 = Dora variety. The second factor is foliar fertilizer (P), consisting of 3 levels: P0 = control, P1 = 2 cc / l of water, and P2 = 4 cc / l of water. The parameters observed in this study were plant height and wet and dry Weight of plants. The results showed that the variety treatment significantly affected plant height, wet Weight and dry Weight of mustard greens. The highest growth and production were obtained in variety V1 (Tosakan), followed sequentially by variety V2 (Shinta) and variety V3 (Dora). Foliar fertilizer treatment significantly affected plant height, wet Weight and dry Weight of mustard greens. The higher the concentration of leaf fertilizer given up to 4 cc/l of water, the higher the growth and production of mustard plants. The interaction between variety treatment and leaf fertilizer concentration had no significant effect on all observed variables.

Keywords— : Varieties, Mustard Greens, Leaf Fertilizer, Plants

Introduction

Mustard greens (Brassica juncea L.) are leafy vegetables from the Cruciferae family with high economic value. They originate from China and East Asia. This plant has been cultivated in China since 2500 years ago and spread to the Philippines and Taiwan—the entry of mustard greens into Indonesia, along with the trade of other types of subtropical vegetables. Its central distribution areas include Cipanas (Bogor) and Lembang Pangalengan(Gunawan et al., 2018).

According to data from the Central Statistics Agency (2012), the production of mustard greens in Indonesia from 2008-2011 experienced fluctuations that can be seen in succession (Central Statistics Agency, 2012): 565,636 tons (2008), 562,838 tons (2009), 583,770 tons (2010) and 580,969 tons (2011). The Director of Business Development and Investment of the Directorate General of Agricultural Product Processing and Marketing (PPHP) of the Ministry of Agriculture stated that national fruit and vegetable consumption is currently approximately 40 kg/capita/year. This consumption level is still below the food adequacy standard for fruits and vegetables set by the FAO, namely 65.75 kg/capita/year. The low level of consumption is related to the minimal level of food production experienced by Indonesian farmers.(Pratama et al., 2018) (Shobahiya, 2017).

The use of varieties is a reliable technology, not only in terms of increasing agricultural production, but its impact also increases farmers' income and welfare. Therefore, superior varieties with various desired properties are essential to the intended purpose. Superior varieties

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generally have prominent properties in terms of high yield potential. Resistant to certain pests has advantages in certain echolocations and has other critical agronomic properties. Using superior varieties resistant to pests and diseases is the cheapest way to suppress plant pests without worrying about negative environmental impacts. To continue to increase agricultural production, plant breeders are always trying to create modern superior varieties that have the desired properties and are suitable for specific environmental conditions.(Wahyuni et al., 2018)(Simson et al., 2019). Fertilization plays a vital role in efforts to increase plant growth and production. It provides or fulfils nutrients beneficial for plants. Nitrogen is a critical nutrient in growth.(Hanifa et al., 2022)(Bukhari & Nursayuti, 2022)

One type of leaf fertilizer is the Bayfolan fertilizer. Bayfolan is a complete liquid fertilizer containing N 11%, P 8%, K 6% and micronutrients Fe, Bo, Co, Mn, Zn, and Cu. Bayfolan leaf fertilizer helps accelerate plant growth, stimulating the formation of green leaf grains that play a role in photosynthesis, stimulating the formation of flowers, fruits, and seeds and accelerating the harvest period. The advantage of Bayfolan fertilizer is that the entire surface of the leaf can absorb it and can be mixed with various pesticides except those that are alkaline(Sukmawan et al., 2022)(Ilmiah et al., 2020).

Literature Review

Botany of Mustard Greens

Mustard greens (Brassica juncea L.) are members of the Cruciferae family (Brassicaceae), which includes cabbage, cauliflower, broccoli, and turnips or radishes. Therefore, the plants have almost identical morphological characteristics, especially regarding root system, stem structure, flowers, fruits (pods), and seeds. Mustard greens do not have taproots; their roots are very shallow, growing to a depth of about 5 cm, and have fibrous roots. Mustard greens can grow and develop well with roots in loose, fertile, water-absorbing, and deep enough soil.(Fuad, 2010). The stems of mustard greens are so short and segmented that they can hardly be seen. The stem forms and supports the leaves(Sander, 2021). The saw has oval, smooth, hairless, and non-crop leaves. According to(Susanti Ningsih & Lokot Batubara, 2018), forming the crop becomes difficult because of the uneven leaf growth pattern (rosette).

Mustard greens usually flower naturally everywhere, regardless of the highlands or lowlands. Mustard greens have an elongated and highly branched flower stalk structure. According to(Sunarjono & Nurrohmah, 2018), each flower has four bright yellow petals, four stamens, and one pistil with two cavities. Mustard greens are a vegetable that contains many nutrients, so they are perfect for maintaining body health. The list of food compositions published by the Directorate of Nutrition of the Ministry of Health shows the types of nutrients found in mustard greens.

Mustard Greens Varieties

The use of varieties is a reliable technology, not only in terms of increasing agricultural production but its impact also increases the income and welfare of farmers. Therefore, superior varieties with various desired properties are essential to the intended purpose. Superior varieties generally have prominent properties in terms of high yield potential. Resistant to certain pests has advantages in certain echolocation and other critical agronomic properties. Using superior varieties resistant to pests and diseases is the cheapest way to suppress plant pests without worrying about negative environmental impacts. To continue to increase agricultural production, plant breeders are always trying to create modern superior varieties that have the desired properties and are suitable for specific environmental conditions. A variety is a group of plants of a type or species that is characterized by the shape and growth of plants, leaves, flowers, fruits, seeds, and character expressions or combinations of genotypes that can distinguish from the same

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type or species by at least one determining trait and when propagated does not experience growth(Lestari et al., 2019).

Tosakan variety: This variety has the following characteristics: large plants, semi-open upright shape, stems grow long and have many shoots, long and slender leaf stalks, elliptical leaves and dark green, wide, long and thin, leaf surfaces and leaf edges are flat, it tastes crispy and not fibrous. This variety proliferates, is strong and uniform, and can be planted all year round. Shinta variety: This variety has the following characteristics: upright plant type with attractive leaf shape, flat leaf type and bright green colour, good leaf taste, soft leaf texture, and crispy and non-fibrous stem texture. Shinta variety is suitable for planting in lowlands and medium on various soil types. Harvest age 25 days after planting. Dora variety: This variety has the following characteristics: sturdy plants, broad leaves with bright green colour, very adaptive plants, and can grow in almost all locations. Plants can be harvested 30 days after planting and are tolerant to fungal diseases(Fuad, 2010).

One type of leaf fertilizer is the Bayfolan fertilizer. Bayfolan is a complete liquid fertilizer containing N 11%, P 8%, K 6% and micronutrients Fe, Bo, Co, Mn, Zn, and Cu. Bayfolan leaf fertilizer helps accelerate plant growth, stimulating the formation of green leaf grains that play a role in photosynthesis, stimulating the formation of flowers, fruits, and seeds and accelerating the harvest period. The advantage of Bayfolan fertilizer is that the entire leaf surface can absorb it and can be mixed with various pesticides except those that are alkaline. The concentration of Bayfolan fertilizer for horticultural plants is 1-2 cc / L of water. Giving fertilizer with the wrong concentration will harm the plant. Concentrations that are too high will poison the plant, while concentrations that are too low will not provide a good response for the plant. The content of Bayfolan leaf fertilizer is identical to the nutrient content of compound fertilizers and is often more complete because it is added with several microelements. The advantage of using Bayfolan leaf fertilizer is that the plant's response to the fertilizer is swift because it is directly utilized by the plant(Riyanto, 2019).

The most striking advantage of leaf fertilizer is that it absorbs nutrients faster than fertilizer given through the roots. As a result, plants will grow and shoot faster, and the soil will not be damaged. Therefore, leaf fertilization is more effective than roots(Lingga, 2001).

Spraying Bayfolan foliar fertilizer is ideally done in the morning and evening because it coincides with the opening of the stomata. Spraying is prioritized on the underside of the leaves because there are the most stomata. Weather factors are crucial to success in foliar spraying. Two hours after spraying, do not let it get wet in the rain because it will reduce the effectiveness of fertilizer absorption. It is not recommended to spray Bayfolan foliar fertilizer when the air is hot because the concentration of the fertilizer solution that reaches the leaves increases quickly so that the leaves can burn.(Nurmalasari, 2012).

Research Method

This research was conducted in the Faculty of Agriculture, Methodist University of Indonesia, Jln. Tanjung Sari Pasar II, Medan, with an altitude of ±30 above sea level. This study used a Factorial Randomized Block Design (RAK) consisting of two factors. The first factor is mustard greens varieties (V) consisting of 3 levels: V1 = Tosakan variety, V2 = Shinta variety, V3 = Dora variety. The second factor is leaf fertilizer (P), consisting of 3 levels: P0 = control, P1 = 2 cc / l of water, and P2 = 4 cc / l of water. The parameters observed in this study were plant height, plant wet weight and plant dry Weight. An analysis of variance was used to test the effect of treatment. To test mean differences between treatments, honest significant difference tests, regression, and correlation were carried out at a test level of 5%.

Results and Discussion

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1. Plant Height

Based on the results of the variance analysis, it is known that the treatment of varieties and leaf fertilizers significantly affected the height of mustard plants at the ages of 2, 3, 4, and 5 MST. However, the interaction between varieties and leaf fertilizers had no significant effect on plant height at all observation ages. The test of differences in the average height of mustard plants at the ages of 2, 3, 4 and 5 MST due to the treatment of varieties and concentration of leaf fertilizers can be seen in Table 1.

Table 1. Average Height of Mustard Greens at Ages 2, 3, 4 and 5 MST Due to Variety Treatment and Foliar Fertilizer Concentration

	Average Plant Height (cm) at Age			
Treatment	2 MST	3 MST	4 MST	5 MST
Varieties				
V1	12.36 B	17.39 b	21.64 b	23.82 b
V2	10.42 A	14.98 a	18.82 ab	20.79 ab
V3	10.22 A	14.37 a	17.85 a	19.64 a
Leaf Fertilizer				
P0	9.42 A	13.98 a	17.83 a	19.79 a
P1	11.17 B	15.59 b	19.31 b	21.22 b
P2	12.42 B	17.18 b	21.17 c	23.24 c
Combination				
V1P0	11.33	16.35	20.58	22.75
V1P1	12.00	16.92	21.08	23.22
V1P2	13.75	18.92	23.25	25.50
V2P0	9.58	13.93	17.60	19.47
V2P1	9.50	14.15	18.07	20.08
V2P2	12.17	16.87	20.80	22.83
V3P0	7.33	11.65	15.32	17.17
V3P1	12.00	15.70	18.77	20.37
V3P2	11.33	15.75	19.47	21.38

Note: Numbers followed by the same letter in the same column are not significantly different at the level 0.05 (lowercase) based on Duncan's distance test

From Table 1, it can be seen that the most comprehensive variety is Tosakan (V1), followed sequentially by Shinta (V2) and Dora (V3) varieties. The height of plants at 5 MST in variety V1 is significantly different compared to varieties V2 and V3, but variety V2 is not significantly different compared to variety V3. For more details, the histogram of plant height can be seen in Figure 1.

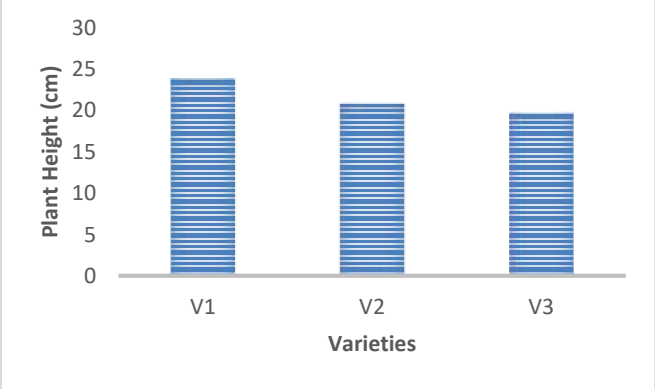

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Figure 1. Histogram of Mustard Greens Plant Height at 5 MST in Several Varieties

In the treatment of leaf fertilizer concentration, the highest plant at 5 MST was P2 (4 cc/l water), significantly different from treatments P1 (2 cc/l water) and P0 (0 cc/l water). Treatments P1 (2 cc/l water) and P0 (0 cc/l water) were also significantly different. The results of the regression analysis of the relationship between leaf fertilizer concentration and plant height can be seen in Figure 2.

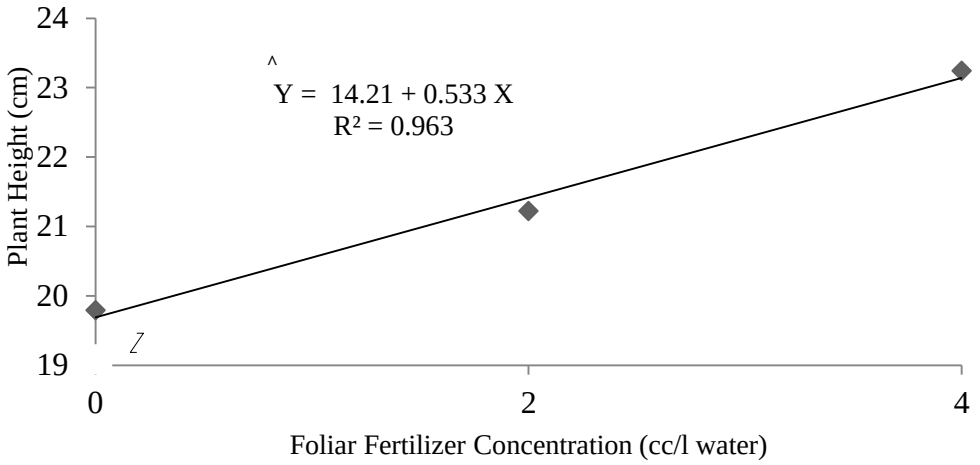

Figure 2. Relationship between Foliar Fertilizer Concentration and Plant Height at 5 MST

Figure 2 shows that the relationship between the concentration of foliar fertilizer and the height of mustard greens at 5 MST is positively linear. This means that the height of mustard greens increases with the increasing concentration of foliar fertilizer given up to 4 cc/l of water.

2. Plant Wet Weight

Based on the results of the analysis of variance, it is known that the treatment of varieties and leaf fertilizers significantly affects the wet Weight of mustard greens, but the interaction between varieties and leaf fertilizers has no significant effect on the wet Weight of plants.

Table 3 shows the difference in the average wet weight of mustard greens due to various treatments and foliar fertilizer concentrations.

Table 3. Average Wet Weight of Mustard Greens Due to Variety Treatment and Foliar Fertilizer Concentration

Treatment	Wet Weight (g)			
Concentration	Varieties			
Leaf Fertilizer	V1	V2	V3	Average
P0	104.42	101.95	90.03	98.80 a
P1	114.50	97.60	98.50	103.53 ab
P2	120.90	110.95	105.60	112.48 b
Average	113.27 b	103.50 ab	98.04 a	104.94

Description: Numbers followed by lowercase letters in the same column are not significantly different at the 5% test level based on the Duncan Distance test.

From Table 3, it can be seen that the variety with the heaviest wet Weight per plant is Tosakan (V1), followed sequentially by Shinta (V2) and Dora (V3) varieties. The wet Weight of variety V1 is significantly different from variety V3, but not significantly different from variety V2, and variety V2 is not significantly different from variety V3. The histogram of plant wet weight can be seen in Figure 3 for more details.

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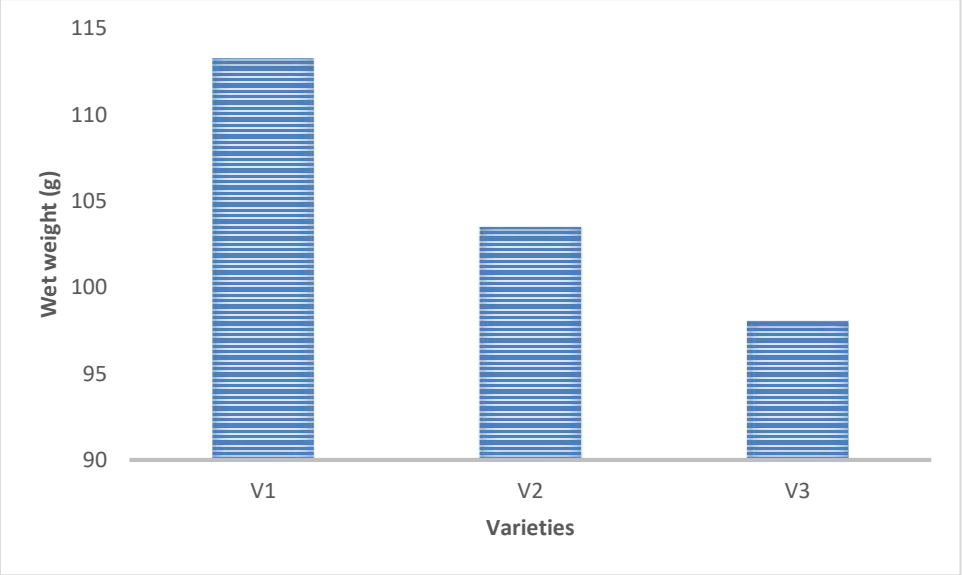

Figure 3. Histogram of Fresh Weight of Mustard Greens at 5 MST in Several Varieties

In the treatment of leaf fertilizer concentration, the highest wet Weight was P2 (4 cc/l water), significantly different from treatment P0 (0 cc/l water) but not significantly different from P1 (2 cc/l water). However, treatments P1 (2 cc/l water) and P0 (0 cc/l water) were not significantly different. The results of the regression analysis of the relationship between leaf fertilizer concentration and plant wet weight can be seen in Figure 4.

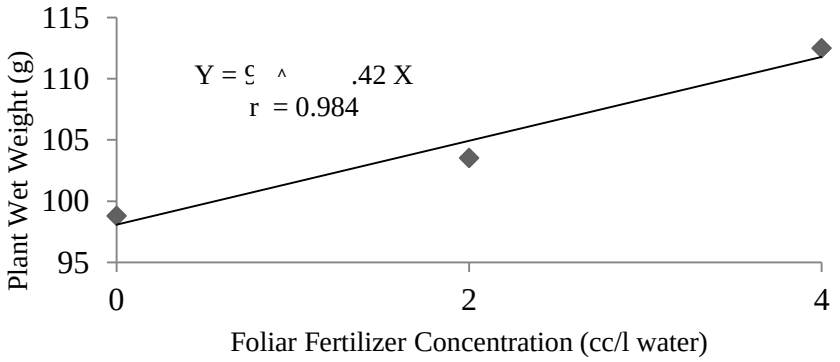

Figure 4. Relationship between Foliar Fertilizer Concentration and Plant Wet Weight

Figure 4 shows that the relationship between the concentration of leaf fertilizer and the wet Weight of mustard plants is positively linear. This means that the wet Weight of mustard plants increases in line with the increasing concentration of leaf fertilizer given up to 4 cc/l of water.

3. Dry Weight of Plants

Based on the variance analysis, the treatment of varieties and leaf fertilizers significantly affects the dry weight of mustard plants. However, the interaction between varieties and leaf fertilizers has no significant effect on the dry weight of plants. Table 3 shows the difference in the average dry weight of mustard plants due to the treatment of varieties and concentration of leaf fertilizers.

Table 3. Average Dry Weight of Mustard Greens Due to Varieties and Foliar Fertilizer Concentration Treatments

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Treatment	Dry Weight (g)			
Concentration	Varieties			
Leaf Fertilizer	V1	V2	V3	Average
P0	35.65	35.83	31.05	34.18 a
P1	38.85	33.75	35.80	36.13 a
P2	40.70	38.15	36.53	38.46 b
Average	38.40 b	35.91 a	34.46 a	36.26

Description: Numbers followed by lowercase letters in the same column are not significantly different at the 5% test level based on the Duncan Distance test.

From Table 4, it can be seen that the variety with the heaviest dry weight of the plant is Tosakan (V1), followed sequentially by Shinta variety (V2) and Dora variety (V3). The dry Weight of the V1 variety is significantly different compared to the V3 and V2 varieties. However, the V2 variety is not significantly different from the V3 variety. For more details, the histogram of the dry Weight of the plant can be seen in Figure 5.

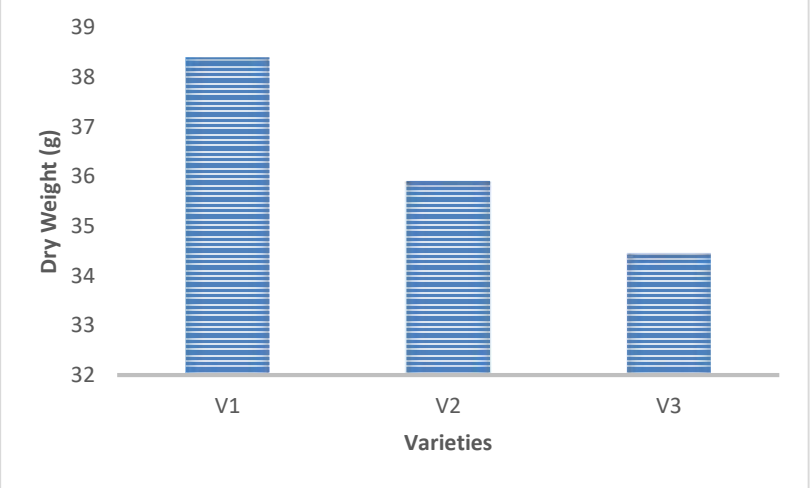

Figure 5. Histogram of Dry Weight of Mustard Greens Plants at 5 MST in Several Varieties

In the treatment of leaf fertilizer concentration, the heaviest dry Weight was P2 (4 cc/l water), significantly different from the treatments P0 (0 cc/l water) and P1 (2 cc/l water). However, the treatments P1 (2 cc/l water) and P0 (0 cc/l water) were not significantly different. The results of the regression analysis of the relationship between leaf fertilizer concentration and plant dry weight can be seen in Figure 6.

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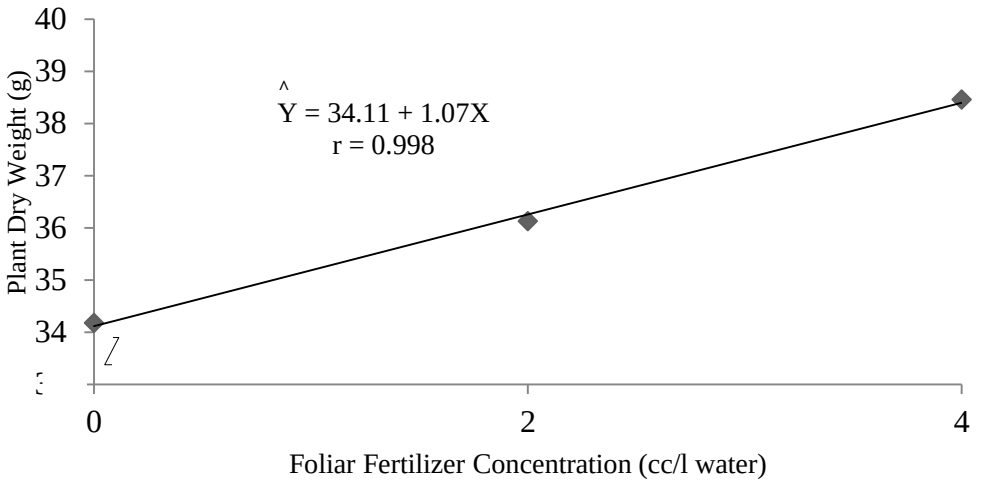

Figure 6. Relationship between Foliar Fertilizer Concentration and Plant Dry Weight

Figure 6 shows that the relationship between the concentration of leaf fertilizer and the dry Weight of mustard plants is positively linear. This means that the dry Weight of mustard plants increases in line with the increasing concentration of leaf fertilizer given up to 4 cc/l of water.

Discussion

1. Effect of Variety Treatment on the Growth and Production of Mustard Greens

The results of the variance analysis show that the variety of treatments significantly affects plant height, wet Weight, and dry Weight. Judging from the average growth, the variety with the best growth and production is the Tosakan variety, followed in sequence by the Shinta and Dora varieties.

The growth of the Tosakan variety is better because it grows genetically better than other varieties. After all, each variety has different growth according to its genetic characteristics. Genetic characteristics are inherited traits inherited from the parent. They are difficult to change or influence by technical treatment or culture, so generally, if each variety is given the same technical culture treatment, each variety will continue to grow according to its inherent characteristics. In contrast, inherently taller varieties will remain taller than inherently shorter varieties. Thus, it can be concluded that when compared to the three varieties, the Tosakan variety grows better with more production than the Dora and Shinta varieties.

2. Effect of Foliar Fertilizer Concentration on the Growth and Production of Mustard Greens

From the research results, it is also known that the treatment of leaf fertilizer concentration significantly affects plant height, wet weight, and dry weight per plant. However, it does not significantly affect the number of mustard green leaves. Plant height, wet weight, and dry weight of mustard greens increase in line with the increasing concentration of leaf fertilizer, which is given up to 4 cc/l of water. This means that at a concentration of 4 cc/l of water, it is still better than the recommended concentration. This is thought to be because the soil (media) used in this study has lower nutrient content than the study conducted by the company producing this leaf fertilizer, so the provision of higher leaf fertilizer still provides the best growth and the optimum concentration has not been found.

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The ability of plants to grow and develop depends on the photosynthesis activity that produces carbohydrates. The photosynthesis activity depends on the substrate or raw materials available. The more substrates available, the more active photosynthesis. Because the raw materials used in photosynthesis are CO2 and H2O, plants absorb water, and the nutrients are dissolved to enter the plant body. In this case, leaf fertilizer contains macro and micronutrients as a substrate(Nitami et al., 2024).

The nutrients contained in fertilizer are N 11%, P 8%, K 6% and micronutrients Fe, Bo, Co, Mn, Zn, and Cu. The increase in plant height is due to the application of foliar fertilizer because foliar fertilizer contains the element N, which has a role in forming protein and amino acids.(Mahardian, 2022). This protein is essential in cell division and elongation for plant growth. Increased protein synthesis will encourage cell division and elongation, increasing plant height. Nitrogen elements also cause plant leaves to become greener. Greener leaves mean that the amount of chlorophyll in the leaves increases, which can increase the availability of photosynthesis results and stimulate cell division. This cell division and elongation occurs in the meristematic tissue at the growing point, causing the plant to grow taller.(Simatupang & Yetti, 2016).

In growth, carbohydrates are broken down through respiration, producing high energy. The remaining carbohydrates will be converteareproteins and fats. Proteins and fats are stored in plant organs such as stems in the form of gas energy, so many foods are stored in the stems, which are then used to develop other plant organs.(Lubis et al., 2019).

Increased cell division due to the availability of macro elements positively affects growth because the plant crown and roots depend on each other. Well-developed roots with phosphorus contained in leaf fertilizer because phosphorus plays a role in stimulating the growth of plant roots so that the roots can absorb water and nutrients from the soil and transport them to the plant crown. In the plant crown, these nutrients are processed into growth compounds and sent back to the roots, causing the plant's wet weight to become heavier.(Niko, 2022).

The carbohydrates formed will be used for plant growth in the shoots and stems, both as a source of energy and as a component for forming new cells. This causes more dry fibres to form, making the plant's dry weight heavier(Suranto, 2011).

3. The Effect of Varieties and Foliar Fertilizer Interaction on the Growth and Production of Mustard Greens

The interaction between varieties and leaf fertilizers had no significant effect on plant height, number of leaves, wet Weight and dry Weight per mustard plant. The absence of this interaction is thought to be due to the concentration of leaf fertilizer given still being able to be increased again where the results of the response curve showed positive linearity so that each mustard variety used had not shown optimum production so that the plants were still able to grow and were not yet at their maximum.

Conclusion

Varieties treatment significantly affected plant height, wet Weight and dry Weight of mustard plants. The highest growth and production were obtained in variety V1 (Tosakan), followed sequentially by variety V2 (Shinta) and variety V3 (Dora). Foliar fertilizer treatment significantly affected plant height, wet Weight and dry Weight of mustard plants. The higher the concentration of foliar fertilizer given up to 4 cc/l of water, the higher the growth and production of mustard plants. The interaction between variety treatment and foliar fertilizer concentration did not significantly affect all observed variables. Suggestion: It is better to choose the Tosakan variety because it grows and produces better than the Shinta and Dora varieties. Then, further

research was conducted to determine the optimum concentration of foliar fertilizer for the growth and production of mustard plants.

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