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Growth and Production of Mustards on Various Compositions Growing Media and Types of Fertilization

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Abstract

This study aimed to determine the effect of composition of growing media and types of fertilization on the growth and production of mustard plants. This study was carried out at the Experimental Garden of Uniprima-Sengkang from February to April 2020, using a randomized block design with two treatment factors, namely the growing media consisting of soil (control), manure + soil (1: 1), bokashi + soil (1: 1), and soil + manure + Bokashi (1:1:1) and fertilization, namely: without urea and *Azotobacter*, urea 50 kg ha^{-1} (0.2 g/plant), *Azotobacter*, urea 50 kg ha^{-1} (0.1 g/plant+ *Azotobacter*). The results showed that the composition of the growing medium Soil + Manure + Bokashi (1:1:1) and fertilization with ½ Urea 50 kg ha^{-1} (0.1 g/plant) + *Azotobacter* tended to show higher result in the parameters of plant height, number of leaves, leaf width and plant weight than other treatments, however, it statistically showed no interaction between the composition of the growing media and fertilization

Keywords: *Azotobacter,* growth media, mustard, urea

A. Introduction

Several periods ago, farming activities focused on increasing production with chemicals introduction in the form of inorganic fertilizers and synthetic pesticides. Urea is one type of inorganic fertilizers that is commonly used by farmers. The use of these fertilizers is due to their rapid and visible effect on crops and has been shown to contribute to increasing world food availability. This causes farmers to use this fertilizer a lot and tends to be applied excessively to soil and plants, causing further deterioration of the physical, chemical, and biological properties of the soil, decrease in land productivity, pollution on environment, ground water and surface water, as well as harmful to human and animal health.

The decline in land productivity, environmental pollution, and the high price of fertilizers are the right momentum to further increase efforts to conserve production resources and efficiency in the farming system. The use of synthetic nitrogen fertilizers in plant cultivation is the largest use of urea fertilizer among other food crop sub-sectors, this can be reduced by using natural nitrogen which is abundantly available in the atmosphere (78% of the volume of the atmosphere) as a source of N for plants. Natural nitrogen fixing can be done by utilizing non-symbiotic N-fixing bacteria.

Azotobacter sp. is one of the bacteria that can be used as a biological agent (organic fertilizer) that is able to fix free nitrogen to be available into plants. The ability of *Azotobacter* in fixing N^2 was first known by Beijerinck in 1901 (Page, 1986). *Azotobacter* sp. in addition to being able to fix nitrogen, it also can produce a type of plant growth hormone and inhibit certain types of fungi.

Azotobacter is a non-symbiotic bacteria that is able to live freely in the root area of plants without having symbiosis with certain types of plants (Yuwono, 2006). The use of *Azotobacter* sp. as a biological fertilizer is more environmentally friendly because it can improve or maintain the physical, chemical and biological properties of the soil so as to create a conducive environment for plant growth. The important thing to note in the use of *Azotobacter* is the concentration and volume of the *Azotobacter* solution given during the application.

In addition to nitrogen, the material that plants need for their growth and development is other organic materials such as manure, bokashi, compost and so on. This use is expected to not only add nutrients to the soil but also improve soil texture. Moreover, the presence of organic matter in the soil can increase the development and population of soil microorganisms, including *Azotobacter*.

The use of nitrogen sources is often found during the cultivation of vegetables, especially leaf vegetables. One type of leaf vegetables that is much favored by the people of Indonesia from the lower class to the upper class is mustard.

Mustard is an annual plant that has oval leaves, smooth, hairless, and does not crop. This plant is very useful to overcome the problem of vitamin A deficiency or short-sightedness, can relieve itching in the throat in cough sufferers, heal headaches, as a blood purifier and really help improve kidney function and improve and facilitate digestion (Haryanto E, Tini Suhartini and Estu Rahayu, 2003). Various dishes that use mustard as raw materials are often found on the dining table.

The public's desire to consume mustard greens has recently shown an increase, in accordance with population growth, increasing purchasing power and increasing public nutrition knowledge. Seeing the prospect of mustard plants being feasible to be developed, efforts are needed in their cultivation, including the use of organic matter and *Azotobacter* as non-symbiotic N-fixing microbes.

Based on the description above, an experiment was carried out on "growth and production of mustard plants on various compositions of growing media and types of fertilization".

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B. Methodology

This experiment was carried out in the form of a two-factor factorial experiment arranged in a randomized block design, namely growing media Soil (Control=M_0), Manure + soil (1: 1) (M_1), Bokashi + soil (1: 1) (M_2), Soil + Manure + Bokashi (1: 1: 1) (M_3). and Fertilization without Urea and *Azotobacter* (A_0), Urea 50 kg ha^{-1} (0.2 g/plant) (A_1), *Azotobacter* (A_2), Urea 50 kg ha^{-1} (0.1 g/plant) + *Azotobacter* (A_3). Based on these two factors, sixteen treatment combinations were obtained which were repeated three times as a group, so there were 48 treatment combinations. Each treatment combination consisted of 2 experimental units, then there were 96 experimental units.

Implementation of the experiment was done with sowing the seeds, namely the mustard seeds to be sown soaked in warm water for 30 minutes. After that, the seeds were sown in the nursery plots with a mixture of sand, soil, and manure in a ratio of 1:1:1. Seedling maintenance includes watering in the morning and evening by paying attention to the humidity of the seedling media. After the seedlings have 3-4 leaves, the mustard seeds are ready to be transferred to the growing media in polybags.

Furthermore, the preparation of growing media in polybags was carried out by preparing topsoil soil mixed with manure, bokashi with a comparison composition according to the treatment. After that, the media mixture was put into a 30 cm x 40 cm polybag and then saturated with water and left for one week.

Planting was done by sucking the seeds in the nursery, seedlings that have 3-4 leaves and the media around the roots are carefully transferred into polybags to avoid damage to the roots. The seeds in polybags were placed and labeled and then arranged according to the experimental plan.

Fertilization and microbial inoculation according to the treatment; i.e. urea is applied a week after planting in polybags with a dose of 50 kg/ha (0.2 g/plant) and Urea (0.1 g/plant). *Azotobacter* application had been done with making *Azotobacter* solution by dissolving 1 L

Azotobacter stock in 50 L of water. After that, *Azotobacter* was incubated in a bucket, then stirred evenly 3 times and allowed to stand for 5 hours. Followed by the application of *Azotobacter* solution to the mustard plant with a dose of 2 mL plant^{-1}.

Watering was carried out in the morning and evening by paying attention to the humidity conditions of the growing media. Weeding is done every week by pulling weeds around the plant.

Harvesting was done when the plant was 40 days after planting. With the characteristic that the leaves have started to turn yellow. This plant was harvested by cutting the stem of the plant just above the soil surface without including the roots.

Components of observation included plant height (cm); measured from the base of the stem to the tip of the highest leaf at the end of the experiment, the number of leaves (strands), the measurement was carried out at harvest and counting the leaves that had fully opened, width of leaves (cm), by measuring leaf diameter, the widest at harvest and fresh weight (g) was weighed at the end of the experimen

C. Result and Discussion

The results showed that fertilization had a significant effect on plant height, while the composition of the growing media and the interaction between the two has no significant effect.

Table 1. The average height of the mustard plant

Treatment	Average	Duncan test ά 0.05
A3	38.33a	5.31
A2	36.30a	5.58
A1	35.18ab	5.73
A0	30.13b	

Note : Numbers followed by the same letter indicate no significant difference based on Duncan test at ά 0.05.

Table 2. The average number of leaves of the mustard plant

Treatment	Average	Duncan Test ά 0.05
M3	9.42a	1.32
M2	8.50ab	1.39
M1	7.83b	1.43
M0	7.33b	

Note : Numbers followed by the same letter indicate no significant difference based on Duncan test with ά 0.05.

Table 3. The average widht of leaves of the mustard plant

Treatment	Average	Duncan Test ά 0.05
M3	41.07a	9.71
M2	38.61a	10.22
M1	39.39a	10.49
M0	32.49a	

Note : Numbers followed by the same letter indicate no significant difference based on Duncan test at ά 0.05.

Furthermore, the experimental results on the parameters of observing the number and width of mustard leaves shows that the composition of the growing medium had a significant effect on the number and width of the leaves of mustard plants, while fertilizer application and the interaction between the two has no significant effect.

Furthermore, observations of plant fresh weight at harvest shows that the composition of growing media and fertilization and the interaction between the two has no significant effect.

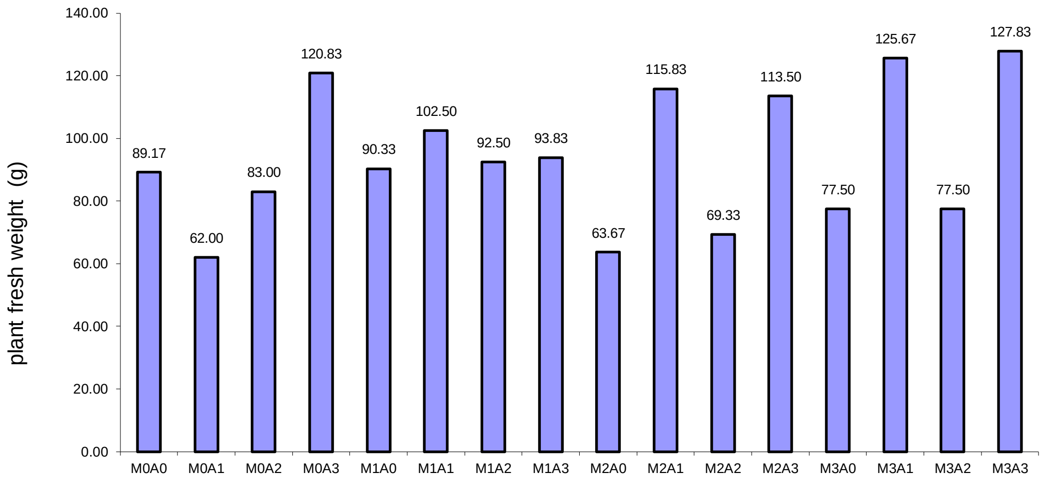

Figure 1. Diagram of lettuce plant height

The experimental results showed that the use of a growing media with composition of 1:1:1 (soil: manure: bokashi) with Urea 50 kg ha^{-1} (0.1 g/plant) + *Azotobacter* showed results tended to be better for plant height, number of leaves, leaf width and plant weight compared to other treatments.

Nitrogen is one of the essential elements for living things that is needed in large quantities as the main component of amino acids, nucleic acids, nucleotides, chlorophyll and other cellular components in plants. In sufficient quantities, nitrogen promotes the division, elongation and enlargement of cells rapidly in the apical meristem so that plants grow taller. Nitrogen needs of plant can be fulfilled by application of urea fertilizer in accordance with the required amount. In addition, plant nitrogen needs can also be fulfilled through the use of non-symbiotic nitrogen-fixing bacteria such as *Azotobacter*. The significant difference in plant height (Table 1), number of leaves (Table 2), width of leaves (Table 3) and plant fresh weight (Figure 1) was due to the sufficient availability of nutrients.

Application 1/2 Urea with dose of 50 kg ha^{-1} (0.1 g/plant)+*Azotobacter* 2 mL plant^{-1} suggested the best results compared to other treatments. This is presumably even though the A3 treatment was only treated with 1/2 dose of the recommended dose of urea, but because the urea was combined with the treatment of 250 mL of *Azotobacter* solution per ha, the nitrogen needs of the plants are sufficient.

Meanwhile, the A2 treatment with *Azotobacter* without urea fertilizer showed lower yields, this may be because the availability of nitrogen has not reached an adequate amount. Likewise, treatment A1 which was treated only with urea fertilizer based on recommended dose showed lower yields than A3 treatment and was higher than treatments of A2 and A0. This is proofed that the use of only inorganic fertilizers (urea) is not efficient in supplying the nitrogen needs of plants.

The above conditions have explained that *Azotobacter* may able provide nitrogen elements in plants. This is in line with the opinion that *Azotobacter* has a complete mechanism as a potential microbe, namely providing nitrogen, phytohormones and antifungals. PGPR *Azotobacter* enhanced plant growth through nitrogen fixation, production of phytohormones and exopolysaccharides (Hindersah and Sudirja, 2004; Hindersah. R ., Marthin Kalay, Abraham Talahaturuson Yansen Lakburlawal., 2018).

Based on economic calculations, *Azotobacter chroococcum* inoculation has the potential to reduce the need for nitrogen fertilizers by 25-50%. Inoculation of *Azotobacter chroococcum* was effective in increasing crop yields of cultivated plants in soil fertilized with sufficient organic matter. Hendersah and Simarmata (2004), explained that in an integrated plant nutrition system, soil health related to nitrogen availability can be achieved by balancing the input of nitrogen sources from inorganic fertilizers and from nitrogen fixing organisms.

Furthermore, the composition of the growing media 1:1:1 (soil: manure: bokashi) also showed better results than other treatments. This is perhaps due to the composition of the growing media, which not only contain nutrients but also create a good soil physical condition thereby stimulating plant growth. This composition causes water aeration and drainage to run smoothly and thus is good for plant growth. This in line with a statement by Pracaya (2002), that the desired or suitable environment for plant survival using growing media as a place for plant growth absolutely requires good air circulation, sunlight, and water. Harjadi (1991) continued, a good growing medium for plant growth and development is a medium that is able to provide water, nutrients, oxygen in sufficient quantities and can be uptaked by plants. Plant growth and development is an important process in the life and reproduction of a species, and is the result of the metabolic activity of cells that may be influenced by genetic and environmental factors. One of the environmental factors that influence plant growth is the soil factor with a role as a medium for plant growth, a source of nutrients and water for plants.

The interaction between the composition of the growing media and fertilization showed not significantly affect in whole observed parameters, but tended to obtain the best results on a 1:1:1 growing media (soil: manure: bokashi) with Urea 50 kg ha-1 (0.1 g/plant) + *Azotobacter*. This is because in these conditions the nutrient content is in sufficient and balanced condition for plant growth. According to Suseno (1988), for optimal growth, a balance of nutrients is needed.

D. Conclusion

Based on the results obtained, it can be concluded that the composition of the growing media 1:1:1 (soil: manure: bokashi) and fertilization ½ Urea 50 kg ha^{-1} (0.1 g/plant) + *Azotobacter* showed the best result on plant height, number of leaves, leaf width, and fresh weight of mustard plants compared to other treatments. There was no interaction between the composition of the growing media and fertilization on the growth and production of mustard plants, however, the combination of 1:1:1 composition of growing media (soil: manure: bokashi) with fertilization of Urea 50 kg ha^{-1} (0.1 g/plant) +*Azotobacter* tended to provide the best results.

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