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THE APPLICATION OF BABADOTAN (*AGERATUM CONYZOIDES, L*) EXTRACT PGPR WITH DIFFERENT CONCENTRATIONS AND INTERVALS ON THE GROWTH AND YIELD OF TOMATO (*LYCOPERCUM ESCULENTUM, MILL*)

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ABSTRACT

This study aims to determine the effect of babadotan PGPR application with different concentrations and intervals on the growth and yield of tomato plants. This research was conducted at the Plant Production Laboratory, Department of Food Crops and Horticulture, Kupang State Agricultural Polytechnic in April-November 2021. The design used was a factorial randomized block design. The first factor was the PGPR concentration which consisted of 5 levels, namely 0 ml/L, 5 ml/L, 10 ml/L, 15 ml/L and 20 ml/L; while the second factor is the PGPR concentration interval which consists of 3 levels, namely 1, 2 and 3 weeks. Each factor was repeated three times so that the total number of experimental units was (5 x 3) x 3 = 45 experimental units. Observational variables of tomato growth include plant height, number of leaves and plant stem diameter. While the yield observation variables include the number of fruit and fruit weight of tomato plants. The data obtained were analyzed using the F test. If there were significant differences between the factors tested, then the analysis was continued with the BNT test. The results showed that the concentration of PGPR from babadotan extract 20 ml/liter with intervals every 2 weeks had a significant effect on plant height at 6 WAP and stem diameter at 6 MST. Differences in the concentration of PGPR in babadotan extract and the interval of application significantly affected the weight per fruit of tomato plants.

Keywords: *Administration interval, Ageratum conyzoides, Babadotan extract, Tomato, PGPR*

1. INTRODUCTION

Tomatoes are a type of plant that has many benefits for humans. The productivity of tomatoes in East Nusa Tenggara (NTT) in 2019 reached 8.70 tons/ha, an increase of 35.31% compared to productivity in 2018. This productivity data is still far from the national tomato productivity in 2019, which was 18.63 tons/ha (BPS, 2020). The low productivity of NTT tomatoes compared to national productivity is related to cultivation techniques that need to be improved. One way is by using plant extracts as PGPR.

PGPR (Plant Growth Promoting Rhizobacteria) or plant growth promoting rhizobacteria have been studied and applied to plants but are still limited to certain types of plants. PGPR is a group of beneficial bacteria that aggressively colonize rhizofir. PGPR activity provides benefits for plant growth because it is able to facilitate nutrient absorption, synthesize and change the concentration of growth-promoting phytohormones and suppress pathogen activity by producing compounds or metabolites such as antibiotics and siderophores.

The function of PGPR is divided into three categories in increasing plant growth, namely stimulating or stimulating growth or as a biostimulant by synthesizing and regulating the concentration of various growth regulators (phytohormones) such as Indole Acetic Acid (IAA), gibberellins, cytokinins and ethylene in the root environment; providing nutrients or biofertilizers by asymbiotically fixing N2 from the air and dissolving bound P nutrients in the soil; and controlling soil-derived pathogens or bioprotectants by producing various anti-pathogenic compounds or metabolites such as siderophores, β1,3-glucanase, chitinase, antibiotics and cyanide (Anjarwati, 2018).

Under various environmental conditions, PGPR can enhance plant growth and development. The PGPR mechanism can increase plant growth and development divided into 2, namely directly and indirectly. The mechanism by which PGPR supports plant growth is directly the ability of rhizobacteria to provide nutrients (nitrogen, phosphorus, potassium and essential minerals) or by modulating plant hormone levels. Whereas indirectly, namely by reducing the inhibitory effect of pathogens (Anjarwati, 2018). The use of PGPR can be beneficial for soil fertility caused by the bacteria contained in PGPR which can activate microorganisms in the soil which cause organic matter to decompose due to the activity of decomposing microorganisms (Husnihuda, 2017).

PGPR plays an important role in increasing plant growth, yields, and soil fertility (Naihati, et al., 2018). Directly, PGPR produces growth hormones, vitamins,

and organic acids and increases nutrient intake for plants. Plant growth is enhanced indirectly by PGPR through its ability to produce pathogenic antimicrobials which can suppress the growth of phytopathogenic fungi and siderophores (Rahni, 2012). The PGPR formula can be sourced from the roots of bamboo, elephant grass or embarrassed daughter (Iswati, 2012) or babadotan (Anisa, 2020).

Babadotan (Ageratum conyzoides) is a type of weed on tomato plants. Messakh's research (2015) found that the combination of type and time of planting intercrops and administration of weed extract affected the height of tomato plants 12 WAP, stem diameter 4 WAP, leaf area 4 WAP, number of flower bunches and fruit weight per plant. Furthermore, Messakh and Sonbai (2018) showed that the application time of babadotan weed extract once every 4 weeks had an effect on the height of tomato plants aged 2, 6, 8 and 10 MST; number of leaves 8 MST; stem diameter 8 MST; number of flower bunches; fruit weight per plant, and fruit diameter. Furthermore, the research by Messakh and Sonbai (2018) showed that giving babadotan extract (Ageratum conyzoides) had an effect on plant height, number of leaves, stem diameter, fruit weight and tomato fruit diameter. PGPR actively colonizes plant roots by having three main roles for plants, namely as a biofertilizer, biostimulant and bioprotectant (Narendra et al., 2018). As a provider of nutrients for plants and a balanced environment for bacteria, it is necessary to add organic matter. One of the organic materials that can be used is the babadotan plant extract (Ageratum conyzoides).

However, research on the use of babadotan extract as a PGPR in tomato plants has not been widely carried out. Several studies have been carried out on the effect of using babadotan on plants, but research on the concentration and interval of giving the right babadotan extract on the growth and yield of tomato plants has not been widely carried out. Anisa's research (2020) used babadotan as a PGPR effect on the growth and production of cauliflower. Narendra's research (2018) assumes that adding compost can provide nutrition for PGPR, so that the microorganisms in PGPR can survive in the rhizosphere environment and carry out their functions. Research by Messakh, et al (2018) proved that the treatment of cropping patterns and irrigation techniques on tomato plants given babadotan extract had an effect on plant height and leaf area at 4 WAP, stem diameter and number of branches irrigation techniques and babadotan extract had an effect on stem diameter, very significant effect on tomato plant height at 6 WAP, number of leaves and diameter of tomato fruit. Messakh et al (2014) recommend that intercropping of tomatoes and basil with drip irrigation technique provides the best productivity of tomato plants. Based on the research data, it is felt necessary to carry out research on PGPR application at the right application interval and frequency to increase tomato productivity in East Nusa Tenggara. In this way, an appropriate babadotan extract application model will be obtained in terms of concentration and interval of application so that an agricultural model, especially tomato cultivation that is environmentally friendly and sustainable, can be obtained.

2. FOCUS AND SCOPE

The scope of this study is to compare the growth and yield of tomato plants with 3 previous studies regarding the types of plants used as organic pesticides and fertilizers, then the best plant species are applied as PGPR in tomato cultivation using the best cropping patterns and irrigation techniques. The results of this study were then developed using selected plant species, namely babadotan (Ageratum conyzoides) as PGPR in different concentrations and intervals to increase tomato production. The results of all these research series are expected to become recommendations and options for increasing the productivity of tomato plants through environmentally friendly and sustainable tomato cultivation techniques.

3. MATERIALS AND METHODS

This section describes the stages of the research conducted. This research was carried out at the Kupang State Agricultural Polytechnic Plant Production Laboratory from April to November 2021. Making PGPR at the Kupang State Agricultural Polytechnic Plant Production Laboratory. The materials and methods used in conducting this research are described in the following sections.

3.1 Tools and Materials

The tools used in carrying out this research were hoes, machetes, shovels, 250 liter drums, buckets, rope markers, gembor, meters, trays, bamboo, digital scales, calipers, rulers, label boards, thermometers, scissors and stationery. While the materials in the implementation of this research were Betavila F1 variety tomato seeds, babadotan plants, plastic bags, bokashi fertilizer, Furadan 3G, Gandasil D, organic pesticides and babadotan plants which were extracted into PGPR.

The selected seeds are then sown using a mixture of bokashi fertilizer, soil and sand with a ratio of 1:1:1. The seedling media is then watered to field capacity. Seeds planted 1 seed per hole. Maintenance of seedlings in the nursery is carried out for 3 weeks. Giving Gandasil D as much as 1 gram per liter of water is done when the seedlings are 2 weeks after sowing.

Land preparation was carried out 3 weeks before planting. The land was processed using a hoe with a depth of ± 30 cm. After that, the land was loosened and then leveled. Next, make beds with a length of 10 m and a width of 1. The beds that are ready are then sprinkled with basic fertilizer in the form of bokashi fertilizer as much as 75 kg/bed. Then the planting hole is made, which is done 1 week before planting. The planting hole is made with a depth of 30 cm.

Next, PGPR was made from the babadotan plant extract. All parts of the babadotan plant are taken and chopped to a length of approximately 1 cm. Then dried for 1 day (without washing). Furthermore, pieces of babadotan are put in a 250 liter drum. Add 200 liters of water into the drum and then close it tightly. Every day it is necessary to reverse or stir so that the material decomposes properly. After 14 days of soaking, PGPR can be used to be applied to tomato plants as PGPR.

Planting of tomatoes is done when the seedlings are 3 weeks after sowing. The characteristics of ready-to-plant tomato seeds are that the plants already have 3-4 true leaves and have upright stems. Seedlings are planted in planting holes with a depth of ± 10 cm. Each bed is planted with 2 rows of plants with a spacing of 60 x 50 cm. Each hole planted 1 plant. After planting, the tomato seedlings are watered to field capacity.

Maintenance of tomato plants includes watering, control of plant-disturbing organisms, weeding, pest and disease control, follow-up fertilization using NPK fertilizer. Fertilizer is given by digging the plants in circles at a dose of 250 kg/ha. Subsequent fertilization is done at the age of the plant 2 weeks after planting (MST) and 4 WAP. Other maintenance is pruning water shoots so that plant growth is evenly distributed and to form a better plant canopy. The stakes were installed at 2 WAP by sticking the stakes at a distance of ± 15 cm from the stems of the tomato plants.

PGPR application is carried out by giving it to the soil around plant roots according to the concentration and frequency of application. PGPR application to plants is carried out during plant growth, starting from 1 WAP to 1 week before harvest.

4. DISCUSSION

Based on the results of the analysis of variance, it was found that the application of babadotan plant extract as PGPR to tomato plants with different concentrations and application intervals had a significant effect on plant height at 6 WAP, stem diameter at 6 MST and fruit weight of tomato plants.

A detailed explanation of the observed results of the growth and yield variables of tomatoes in different weeks as a result of the concentration and interval treatment of PGPR from bandotan plant extract is given in the following tables.

4.1 Plant Height (cm)

The results of the analysis of variance showed that the concentration of PGPR from babadotan extract and the interval of PGPR administration had no effect on the height of tomato plants aged 2, 4 and 8 WAP, but had an effect on plant height 6 WAP. The average plant height due to the influence of the concentration and interval of PGPR administration from babadotan extract is shown in table 1.

Table 1 shows that the highest plant height at 6 WAP was found in the treatment with a PGPR concentration of 15 ml/L and an interval of giving PGPR once every 2 weeks, namely 68.00 cm. The next highest plant height was obtained in the treatment of 5 ml/L PGPR concentration and the PGPR administration interval was once a week. Tomato plants that were given the PGPR treatment with babadotan extract once every 2 weeks with a concentration of 5 ml/L gave the lowest plant height value among all treatments, namely 50.17 cm.

Table 1. Average Plant Height at 6 WAP due to the Effect of PGPR Concentration and Interval of Babadotan Extract

Concentration of PGPR	Plant Height/Application Interval		
	Once a week	Once Every 2 week	Once Every 3 week
0 ml/L	54,56a	55,39a	59,67a
5 ml/L	63,33b	50,17a	58,39a
10 ml/L	51,17a	52,44a	56,22a
15 ml/L	55,61a	68,00bc	58.00a
20 ml/L	57,55a	58,83a	56,67a

Note: Numbers followed by the same letter are not significantly different on the 5% BNJ test.

PGPR plays an important role in increasing plant growth, yields, and soil fertility (Naihati, et al., 2018; Nurhudiman et all., 2018). Directly, PGPR produces growth hormones, vitamins, and organic acids and increases nutrient intake for plants. Furthermore, Rahni (2012) added that plant growth is enhanced indirectly by PGPR through its ability to produce pathogenic antimicrobials which can suppress the growth of phytopathogenic fungi and siderophores.

4.2 Number of Leaves (cm)

The results of the analysis of variance showed that the concentration of PGPR from babadotan extract and the interval of PGPR administration affected the number of leaves of tomato plants at 4 WAP. The interaction between the PGPR concentration of babadotan extract and the interval of PGPR administration had no effect on the number of leaves of tomato plants. The average number of leaves due to the influence of the PGPR concentration treatment from babadotan extract and the PGPR administration interval is shown in table 2.

Table 2. Average Number of Leaves due to the Effect of PGPR Concentration and Interval of Babadotan Extract

Concentration of PGPR	Average Number of Leaves/ Application Interval		
	Once a week	Once Every 2 week	Once Every 3 week
0 ml/L	4,5a	5,00a	4,00a
5 ml/L	5,5a	6,17a	7,00a
10 ml/L	5,0a	6,00a	6,30 a
15 ml/L	4,4a	5,85a	6,50a
20 ml/L	5,6a	4,00a	5,00a

Note: Numbers followed by the same letter are not significantly different on the 5% BNJ test.

Table 2 shows that the highest average number of leaves aged 6 WAP was in the treatment with a PGPR concentration of 5 ml/L and an interval of PGPR once every 3 weeks, namely 7.00. The next highest number of leaves was found in the treatment with a PGPR concentration of 15 ml/L and an interval of giving PGPR once every 3 weeks, namely 6.50. Tomato plants were given the PGPR treatment with babadotan extract once every 2 weeks with a concentration of 20 ml/L and the control gave the lowest number of leaves for all treatments, namely 4.00.

The increase in the number of leaves showed that the treatment given did not have a significant effect. Allegedly the availability of nutrients, N in the soil has been sufficient for plant needs. besides that, it is suspected that at the age of 45 HST to 60 HST they have entered the generative phase (Marom, N, 2017).

4.3 Steam Diameter

The results of the analysis of variance showed that the concentration of PGPR from babadotan extract and the interval of PGPR administration had no effect on stem diameter at 2, 4 and 8 WAP. The PGPR concentration of babadotan extract had an effect on stem diameter at 6 WAP. The interaction between the concentration of PGPR from babadotan extract and the interval of PGPR administration had no effect on plant stem diameter. The average stem diameter due to the influence of the PGPR concentration treatment from babadotan extract and the PGPR administration interval is shown in table 3.

Table 3. Average Stem Diameter due to the Effect of PGPR Concentration and Interval of Babadotan Extract

Concentration of PGPR	Average Stem Diameter/ Application Interval		
	Once a week	Once Every 2 week	Once Every 3 week
0 ml/L	1,17a	0,94a	1,05a
5 ml/L	1,00a	1,06 a	1,09a
10 ml/L	0,89a	0,99a	0,99 a
15 ml/L	0,94a	0,97a	1,50a
20 ml/L	0,94	1,32b	0,92a

Note: Numbers followed by the same letter are not significantly different on the 5% BNJ test.

Table 3 shows that the highest average stem diameter of tomato plants aged 6 WAP was in the treatment with a PGPR concentration of 15 ml/L and an interval of PGPR once every 3 weeks, namely 1.50 cm. The stem diameter of the next largest tomato plant was found in the control plant, which was 1.17 cm. Tomato plants that were given the PGPR treatment with babadotan extract once a week with a concentration of 10 ml/L gave the smallest stem diameter value for all treatments, namely 0.89 cm.

Concentration of 12.5 ml of PGPR affects the growth rate of tomato plants and the response to hormones is usually not too dependent on the absolute amount of the hormone (Iswati, 2012). According to Matatula, et al (2020) that babadotan contains allelochemical compounds in the form of phenol which inhibit cytokinin activity.

This inhibition causes cell division in the shoot meristem to interfere with plant height growth. The inhibition of cell division by allelochemical compounds in bandotan plant extracts can also be through interference with the activity of plant hormones such as cytokinins which play a role in spurring cell division.

4.4 Number of Fruits

The results of the analysis of variance showed that the concentration of PGPR from babadotan extract and the interval of PGPR administration had no effect on the number of fruit in the tomato plant. The interaction between the concentration of PGPR from babadotan extract and the interval of PGPR administration did not affect the number of fruit in the tomato plants. The average number of fruits due to the influence of the PGPR concentration treatment from babadotan extract and the PGPR administration interval is shown in table 4.

Table 4. Average Number of Fruits due to the Effect of PGPR Concentration and Interval of Babadotan Extract

Concentration of PGPR	Average Number of Fruits/ Application Interval		
	Once a week	Once Every 2 week	Once Every 3 week
0 ml/L	16,17a	16,94a	17,05a
5 ml/L	16,00a	16,06 a	18,09b
10 ml/L	16,89a	17,99b	16,99 a
15 ml/L	15,94a	14,97a	16,50a
20 ml/L	15,94	16,32a	15,92a

Note: Numbers followed by the same letter are not significantly different on the 5% BNJ test

Table 4 shows that the highest average number of tomato plants was found in the treatment with a PGPR concentration of 5 ml/L and an interval of giving PGPR once every 3 weeks, namely 18.09, but not significantly different from the treatment with a concentration of PGPR 10 ml/L and an interval of giving PGPR 2 weeks once that is 17.99. The least number of fruit of the tomato plant was obtained from the PGPR treatment of babadotan extract once every 2 weeks with a concentration of 15 ml/L with a value of the number of fruit is 14.97.

Research by Messakh, et al (2018) provides data that PGPR concentrations affect the growth rate of tomato plants and the response to hormones usually does not really depend on the absolute amount of these hormones. Naihati, et al (2018) added that plants were given PGPR in different concentrations even though the concentration of the PGPR solution was elevated to a certain extent, the difference was not significant.

4.5 Weight per Fruit (gram)

The results of the analysis of variance showed that the concentration of PGPR from babadotan extract and the interval of PGPR administration had a significant effect on the weight per fruit of tomato plants. The interaction between the concentration of PGPR from babadotan extract and the interval of PGPR administration had no effect on the fruit weight of tomato plants.

The average weight of tomatoes due to the influence of the treatment of PGPR concentrations from babadotan extract and the intervals for giving PGPR are shown in table 5.

Table 5. Average Weight per Fruits due to the Effect of PGPR Concentration and Interval of Babadotan Extract

Concentration of PGPR	Average Weight per Fruits/ Application Interval		
	Once a week	Once Every 2 week	Once Every 3 week
0 ml/L	35,17a	37,94b	36,05a
5 ml/L	31,00a	34,06 b	33,09a
10 ml/L	30,89a	36,99b	35,99a
15 ml/L	33,94a	40,37bc	36,50a
20 ml/L	33,94a	35,22a	35,92a

Note: Numbers followed by the same letter are not significantly different on the 5% BNJ test.

Table 5 shows that the highest average fruit weight of tomato plants was found in the treatment with a PGPR concentration of 15 ml/L and an interval of giving PGPR once every 2 weeks, namely 40.37 grams. The second largest fruit weight was given by the treatment with a PGPR concentration of 10 ml/L and an interval of giving PGPR once every 2 weeks, namely 36.99 grams.

The lowest weight per tomato was obtained from the PGPR treatment of babadotan extract once a week with a concentration of 10 ml/L with a weight value per tomato of 30.89 grams.

The concentration of babadotan PGPR at intervals of 2 weeks and a concentration of 15 ml/L of water gave the highest fruit weight compared to other treatments. This is presumably because the higher concentration of secondary metabolites in babadotan extract will affect the physiological processes in tomato plants. This also further affects the weight gain of tomatoes. Babadotan leaf extract has a hydrocolloid compound that effectively acts as an edible film on tomatoes. The presence of the edible film can inhibit the process of respiration and oxidation. Stated that the inhibited oxidation process will affect the formation of L-dehydroascorbic acid so that vitamin C in fruit does not decrease (Suryati et al., 2016).

5. CONCLUSSION

Giving PGPR from babadotan extract with a concentration of 15 ml/liter with intervals every 2 weeks had a significant effect on plant height at 6 WAP, stem diameter at 6 MST and fruit weight of tomato plants. Provision of PGPR from babadotan extract in the long term can be an option in an effort to increase the productivity of tomato plants through environmentally friendly and sustainable plant cultivation.

6. SUGGESTION

Advice that can be given for further research is that further research is needed on the best length of time to extract babadotan before it is used as a PGPR in tomato cultivation. Thus the best PGPR formulation will be obtained to increase the growth and yield of tomato plants and support environmentally friendly and sustainable agriculture.

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