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Correlation Analysis of the Application of Three Types of Plant Growth Promoting Rhizobacteria (Mimosa Root, Bamboo Root, and Elephant Grass) Concentrations on the Growth of Shallot Seedlings (*Allium ascalonicum* L.)

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Abstract

The significance and role of shallots in fulfilling human consumption needs have driven farmers to optimize the growth and production of shallot plants. To maximize shallot growth, cultivation can be carried out by applying bio-fertilizers, particularly during the seedling phase. Bio-fertilizers act as specific nutrient binders or providers essential for plant growth and contain various microorganisms that enhance plant development and soil fertility. This study aims to examine the correlation between the application of three types of Plant Growth Promoting Rhizobacteria (PGPR) on the growth of shallot seedlings, with the objective of identifying the most effective type of bio-fertilizer for shallot seedlings. The research employed an experimental method using a factorial Randomized Block Design (RBD) with two factors. The first factor is the PGPR concentration, consisting of K1 = 10 ml/l, K2 = 20 ml/l, and K3 = 30 ml/l. The second factor includes S1 = Mimosa, S2 = Bamboo root, and S3 = Elephant grass. Each treatment combination was repeated three times, resulting in a total of 27 experimental units. The results showed a strong correlation between bulb weight and bulb count, with a correlation coefficient of 0.73. Meanwhile, the correlations between bulb weight and plant height, as well as between leaf length and leaf width, exhibited correlation coefficients of 0.01, indicating a weak relationship between these variables.

Keywords: Shallot Seedlings, PGPR, Correlation Analysis

INTRODUCTION

Shallots are one of the crops with high consumer demand in the market. According to data from the National Food Agency (2024), the average per capita consumption of shallots in Indonesia was 2.86 kilograms per year in 2023, with the total national household consumption of shallots reaching 797.3 thousand tons per year in 2023. Moreover, the average retail price of shallots at the national level was IDR 52,670 per kilogram in April 2024. According to the Agricultural Data and Information System Center (2024), shallot production in 2023 amounted to 2.14 million tons, with household consumption predicted to grow by 1.47% per year between 2023 and 2027, averaging 860.62 thousand tons.

Shallot propagation can be carried out using mini-bulb technology derived from seeds (TSS = True Shallot Seed), which has been developed by the Ministry of Agriculture since 2014 (Utama *et al*., 2023). The advantages of using TSS for shallot cultivation include easier and cheaper seed transportation, disease-free plants, and better bulb quality (Sumarni *et al*., 2012).

The process of vegetative propagation in shallots begins with the seedling stage, which produces plants ready for transplanting. Proper attention is required during seedling propagation, as healthy seedling growth will expedite the shallot cultivation process. In addition, to achieve optimal seedling growth, the application of fertilizers is necessary. One suitable fertilizer for promoting healthy shallot seedling growth is Plant Growth Promoting Rhizobacteria (PGPR). PGPR can be developed using the root systems of various plants, including Mimosa roots, elephant grass roots, and bamboo roots. The application of different concentrations of PGPR is expected to accelerate shallot seedling growth.

Correlation refers to the relationship between two variables, where the strength of the relationship can be classified as strong or weak based on predetermined values. According to Fitriani (2021), the correlation coefficient in analysis is used to determine the strength of the relationship between two variables within the interval $-1 \leq r \leq +1$. The Pearson Correlation Coefficient formula can be used to assess the correlation from observational responses. Riduwan (2016) explains that correlation is symbolized by (r), where r = -1 indicates a perfect negative correlation, r = 0 indicates no correlation, and r = 1 indicates a perfect positive correlation (very strong). The correlation formula is as follows:

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Notation:

r: correlation coefficient value, X: variable, XY: variable, Yn: number of data points

The strength of the correlation is categorized as follows: r = 0.00 – 0.199: Very Weak, r = 0.20 – 0.399: Weak, r = 0.40 – 0.599: Moderate, r = 0.60 – 0.799: Strong, r = 0,80 – 1,000: very strong

METHOD

The research employed an experimental method using a factorial Randomized Block Design (RBD) with two factors. The first factor is the PGPR concentration, consisting of K1 = 10 ml/l, K2 = 20 ml/l, and K3 = 30 ml/l. The second factor includes S1 = Mimosa, S2 = Bamboo root, and S3 = Elephant grass. Each treatment combination was repeated three times, resulting in a total of 27 experimental units

DISCUSSION

Plant Height

The height parameters of shallot seedlings were observed at 7 Days after Planting (DAP) until the seedlings were 35 DAP. PGPR concentration was given every week with different

concentrations of 10 ml/l, 20 ml/l and 30 ml/l. The data which have obtained in the observation of plant height are presented in the form of a bar graph as follows.

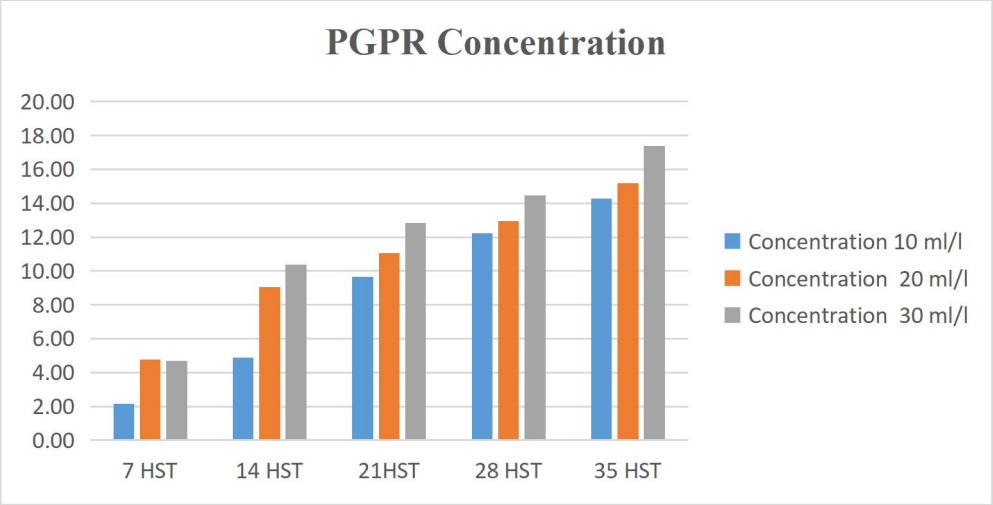

Figure 1. Plant Height (cm) of Shallot Seedlings with PGPR Concentration Treatment

The results of observations in Figure 1 shows that the use of a concentration of 30 ml/l produced the highest average plant height at 14 DAP to 35 DAP. The highest plant height was 17.4 cm at 35 DAP, while the second highest plant height was achived with a 20 ml/l, reaching15.2 cm, followed by a10 ml/l with a height of14.3 cm. The application of a 30 ml/l PGPR concentration produced the best effect on the growth of shallot plants (Kafrawi *et al.*, 2021). The growth of shallot seedling plants is influenced by the availability of nitrogen in the soil. PGPR has the ability to help bind elements or fix nitrogen, there by supporting the nutrient needs of the plants (Zahran, 2001).

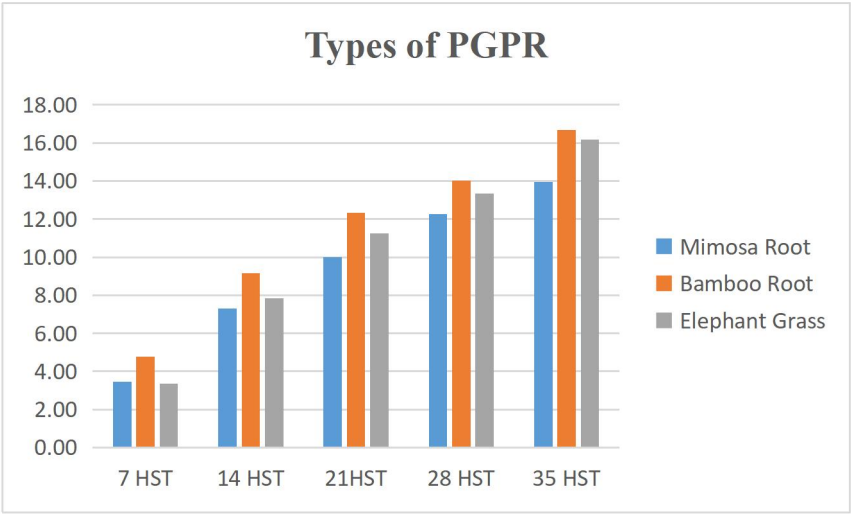

Figure 2. Plant Height (cm) Shallot Seedlings with PGPR Type Treatment

Based on Figure 2, it was found that the treatment with bamboo root types produced the highest average plant height of 16.69 cm at 35 DAP. While for the use of elephant grass root PGPR resulted in a plant heigh of 16.19 cm and the mimosa root PGPR was 13.94 cm. According to Singh (2013) the rhizobacteria group contained in PGPR can enhence plant growth by producing growth hormones, organic acids. Hardiansyah *et al*. (2020) reported that bamboo roots contain organic compounds and minerals which have a positive effect on plant growth. Pereira *et al*. (2020) stated that PGPR is able to induce significant changes in the root system through the phytohormone IAA, such as increasing lateral root branching and enchancing nutrient absorption, which in turn promotes plant growth.

Number of Leaves

Based on Figure 3, it can be seen that the average number of leaves was relatively high with the application of PGPR. Particularly at a concentration of 30ml. where an average of 3 leaves was recorded at 35 DAP. According to Anisa (2019), the higher the dose of PGPR given, the more leaves are formed. This is because the availability of nitrogen for plant growth is well met.

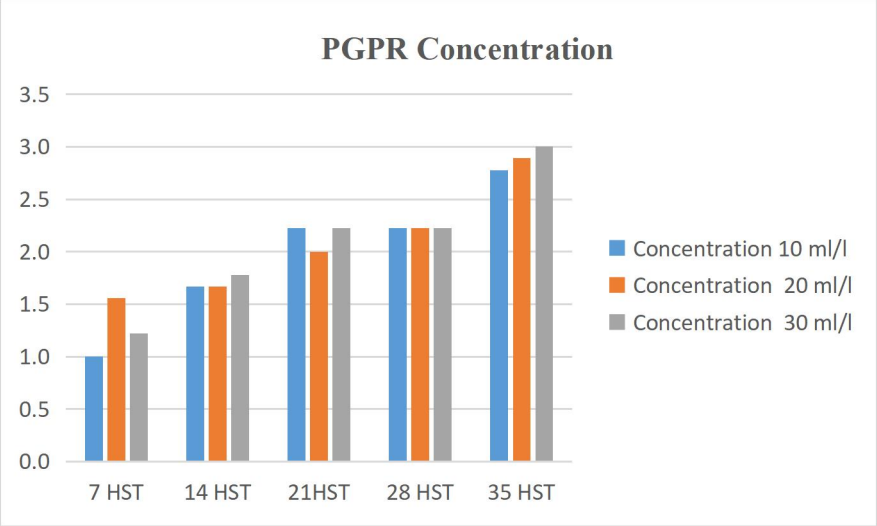

Figure 3. Number of Leaves (Strands) Shallot Seedlings with PGPR Concentration Treatment

In Figure 4, it can be seen that the provision of PGPR types, the highest number of leaves is relatively the same between the provision of PGPR Mimosa roots, bamboo roots and elephant grass roots. The number of leaves for transplanting from ideal seedlings is 3 to 4 leaves with a seedling sowing time of 35 DAP.

In Figure 4, it can be seen that the number of leaves was relatively similar among the different PGPR types, including those derived from mimosa roots, bamboo roots, and elephant

grass roots. The optimal number of leaves for transplanting ideal seedlings is 3 to 4 leaves, with a seedling age of 35 DAP.

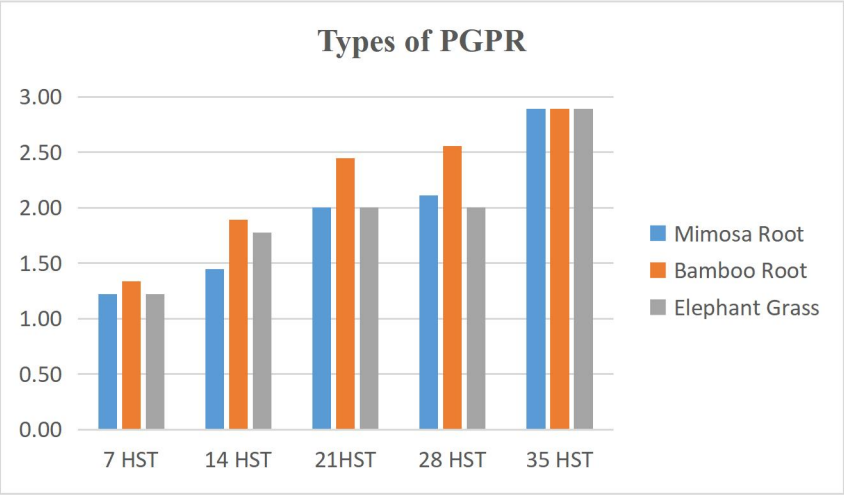

Figure 4. Number of Leaves (Strands) Shallot Seedlings with PGPR Type Treatment

Leaf Length

The leaf length in the PGPR concentration treatment is presented in Figure 5. The highest leaf length was produced at a concentration of 30 ml/l with an average value of 17 cm. In Figure 6, the leaf length in the PGPR type treatment produced the highest average leaf length in the bamboo root PGPR type with an average value of 16.71 cm at 35 DAP. The leaf length in the bamboo root PGPR was not much different from the leaf length in the elephant grass PGPR type, which was 16.6 cm. The increase in leaf length due to PGPR application can be attributed to the presence of hormones such as gibberellins in PGPR, which helps in the transport of metabolites during chloroplast' formation (Vocciante *et al*., 2022). Additionally, PGPR contains indole-3-acetic acid (IAA), which promotes cell development, facilitates leaf formation, and enhances enzyme activity, resulting in improved leaf length quality in plants treated with PGPR (Noor and Nurhadi, 2022).

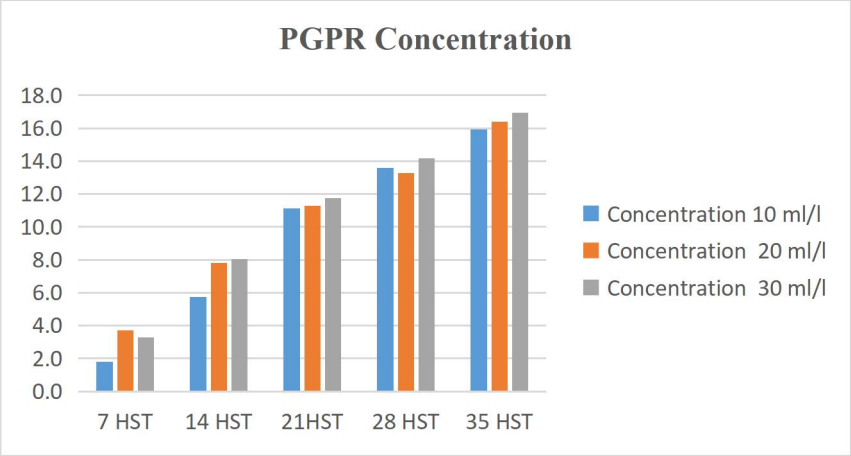

Figure 5. Leaf Length (cm) Shallot Seedlings with PGPR Concentration Treatment

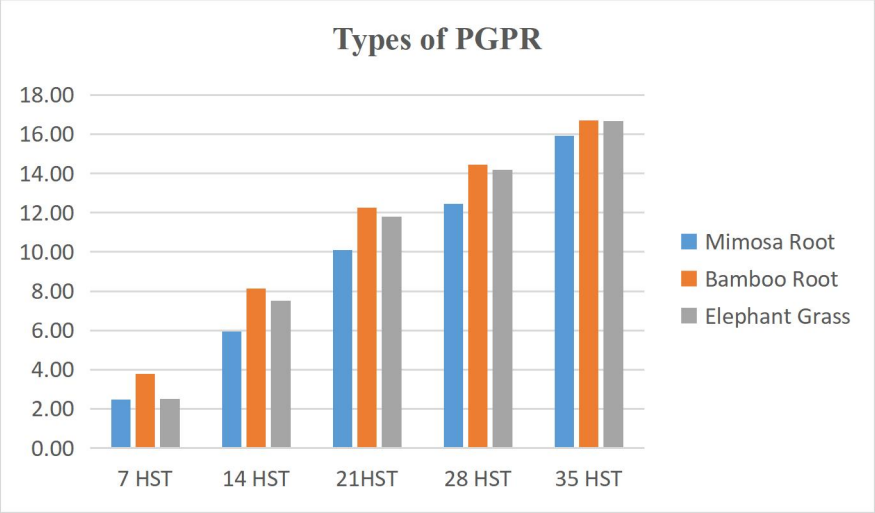

Figure 6. Leaf Length (cm) Shallot Seedlings with PGPR Type Treatment

In Figure 7, the treatment with a PGPR concentration of 30 ml/l and the bamboo root PGPR type resulted in the best rooth length. at a concentration of 30 ml/l the average value produced was 4.6 cm and in the bamboo root PGPR type it was 4.9 cm. Root length is one of the indicators which is used to assess the effectiveness of nutrient absorption in plants (Marom *et al*., 2017) IAA hormone is one of the endogenous auxins that has a major role in stimulating plant root growth which results in an increase in root dry weight (Fathonah & Sugiyarto, 2019).

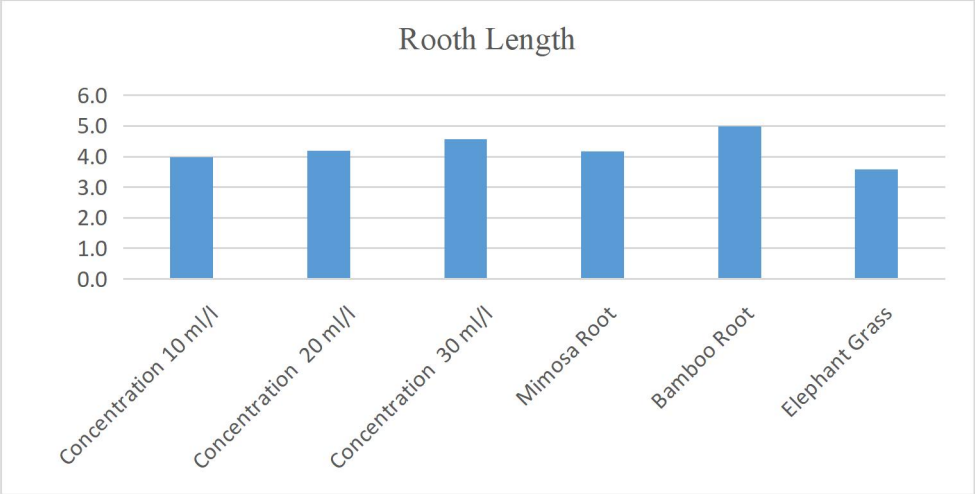

Figure 7. Root Length (cm) Shallot Seedlings with PGPR Concentration and Type Treatments

Correlation Coefficient

The correlation coefficient is a value used to measure the closeness of the relationship between two variables. The formula which is used to calculate the correlation coefficient is the Pearson Correlation Coefficient formula (r). In this study, a correlation analysis was carried out on each parameter of the observation results, so that the results presented in the shallot seed correlation coefficient table in Table 1 can be obtained.

Table 1. Correlation Coefficient Shallot Seedlings

	TT	**JD**	**PD**	**PA**
TT	1			
JD	0.71(4)	1		
PD	0.98(1)	0.78(4)	1	
PA	0.46(3)	0.39(2)	0.4(3)	1

Table 1 shows a very strong relationship between plant height and leaf length, while the number of leaves and root length have a low correlation. A strong correlation indicates that the two variables or parameters have a close relationship between the two variables. For example in the variables of the number of fruits and fruit weight which show a strong correlation value, suggesting that as the number of fruits per plant increases, the weight of the fruit per plant also increases, and vice versa (Zhahira *et al*., 2023).

CONCLUSION

Based on the conducted study, it was found that the use of PGPR at a concentration of 30 ml/L yielded the best results for plant height, leaf length, number of leaves, and root length. The application of bamboo root PGPR produced the highest averages for each observation parameter.

The correlation between the observations was very strong, with a correlation coefficient of 0.98 between plant height and leaf length. Conversely, a very low correlation was observed between the number of leaves and root length, with a correlation coefficient of only 0.39.

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