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The Effect of PGPR (*Plant Growth Promoting Rhizobacteria*) and Amino Acids on The Productivity of Eggplant Crop

Pengaruh PGPR ((Plant Growth Promoting Rhizobacteria) dan Asam Amino Terhadap Produktivitas Tanaman Terung

Moh Ardani[1*]

[1] Jurusan Agroteknologi, Fakultas Pertanian, Universitas Moch Sroedji Jember, Indonesia
*email: moh.ardani05@gmail.com

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ABSTRAK

Buah terung mengandung zat gizi yang cukup penting, seperti vitamin A, B, C, kalium, fosfor, protein, lemak, karbohidrat dan zat besi, sehingga tanaman terung sangat potensial dikembangkan secara intensif sebagai penyumbang yang cukup besar terhadap keanekaragaman bahan pangan bergizi bagi penduduk. Penelitian bertujuan mengetahui pengaruh interaksi antara perlakuan konsentrasi PGPR dan asam amino serta pengaruh masing-masing perlakuan konsentrasi PGPR dan asam amino terhadap produktivitas tanaman terung. Metode penelitian menggunakan Rancangan Acak Kelompok (RAK) faktorial, dengan dua faktor perlakuan dan 3 (tiga) kali ulangan. Faktor pertama konsentrasi PGPR (P), P1: 5 ml/liter, P2: 10 ml/liter, P3: 15 ml/liter. Faktor kedua konsentrasi Asam Amino (A), A1: 2 ml/liter, A2: 4 ml/liter, dan A3: 6 ml/liter. Perlakuan tersebut dikombinasikan dan diperoleh 9 kombinasi perlakuan. Analisis data menggunakan Analysist of Varians (Anova) dengan taraf signifikan 5%. Perlakuan yang berpengaruh nyata diuji lanjut dengan Duncan's New Multiple Range Test α 5% (DNMRT). Variabel yang diamati tinggi tanaman, diameter batang, jumlah buah, diameter buah dan bobot buah. Hasil penelitian diperoleh tidak terjadi interaksi antara perlakuan konsentrasi PGPR dan asam amino terhadap produktivitas tanaman terung. Perlakuan tunggal pemberian PGPR dan asam amino diperoleh pemberian PGPR 15 ml/liter dan asam amino 4 ml/liter merupakan perlakuan yang berpengaruh paling baik terhadap produktivitas tanaman terung.
Kata Kunci: Asam amino, PGPR, Tanaman terung.

ABSTRACT

Eggplant contains quite important nutrients, such as vitamins A, B, C, potassium, phosphorus, protein, fat, carbohydrates and iron, so that eggplant plants have great potential to be developed intensively as a significant contributor to the diversity of nutritious food for the population. The study aims to determine the effect of interaction between PGPR and amino acid concentration treatments and the effect of each PGPR and amino acid concentration treatment on eggplant plant productivity. The research method used a factorial Randomized Block Design (RAK), with two treatment factors and 3 (three) replications. The first factor is PGPR concentration (P), P1: 5 ml/liter, P2: 10 ml/liter, P3: 15 ml/liter. The second factor is Amino Acid concentration (A), A1: 2 ml/liter, A2: 4 ml/liter, and A3: 6 ml/liter. These treatments were combined and 9 treatment combinations were obtained. Data analysis used Analysis of Variance (Anova) with a significance level of 5%. The treatments that had a significant effect were further tested using Duncan's New Multiple Range Test α 5% (DNMRT). The variables observed were plant height, stem diameter, number of fruits, fruit diameter and fruit weight. The results of the study showed that there was no interaction between the treatment of PGPR concentration and amino acids on eggplant plant productivity. The single treatment of PGPR and amino acids obtained PGPR 15 ml/liter and amino acids 4 ml/liter were the treatments that had the best effect on eggplant plant productivity.
Keywords: *Amino acids, Eggplant crops, PGPR.*

INTRODUCTION

Eggplant (*Solanum melongena* L.) is a type of vegetable plant that is easy to cultivate, generally planted for its fruit. Eggplant fruit contains quite important nutrients, such as vitamins A, B, C, potassium, phosphorus, iron, protein, fat, and carbohydrates, but is cheap (Nazari *et al.*, 2023). Excessive use of synthetic fertilizers and pesticides disrupts the life of soil microorganisms, causes degradation of soil structure, and higher susceptibility to drought. Globally, the continuous use of synthetic fertilizers and pesticides has detrimental effects on the soil matrix and soil ecology. As a result of these problems, an effective strategy is needed, especially in the management of phosphorus nutrients in the soil. PGPR is a type of bacteria that lives around plant roots that can increase plant growth and protection against certain pathogens. Soil microorganisms in the form of rhizobacteria provide various benefits to plants during their growth and development cycle (Raza *et al.*, 2016). The use of PGPR as an alternative technology to develop environmentally friendly agriculture. Previous research results according to Ichwan *et al.* (2021) that the provision of PGPR can increase plant growth and red chili yields in the form of plant height (2.12% -9.69%), total number of plant branches (5.25% -54.97%), number of fruits (13.55% -51.40%) and fruit weight (54.19% -180.53%).

Amino acids are proteins that have been broken down through the metabolic process into small molecules as basic materials for the biosynthesis process. The provision of amino acids is used for the purpose of enlarging the fruit, tubers, stems of plants in both food crops, horticulture and plantation commodities. The need for amino acids in essential amounts in plants can increase overall yields and quality. Amino acids can directly or indirectly affect the physiological activity of plants. The need for amino acids in essential amounts in plants can increase overall yields and quality (Syukur, 2021). Based on the results of previous studies, researchers are interested in conducting broader research related to the use of PGPR combined with the addition of amino acids to eggplant crops.

RESEARCH METHODOLOGY

Place and Time of Research

The research was conducted in Cangkring Hamlet, Patrang Village, Patrang District, Jember Regency. The research was conducted for 4 months starting from October 2022 to February 2023. Patrang District is located at coordinates 8°8′20″S 113°41′59″E with an altitude ranging from 0–3,300 meters above sea level (asl).

Research Materials and Tools

The main materials needed are Milano eggplant seeds, PGPR biological agents, amino acids with raw materials of moringa leaves produced from PPAH (Biological Agent Service Post) Ambulu District, Jember Regency, top soil, compost, insecticide sand with active ingredients abamectin and thiamethoxam. The equipment used were hoes, polybags, sickles, wood, watering cans, buckets, books, ballpoint pens, digital scales, rulers, cellphone cameras and calipers.

Research Design

The experimental design used in the study used a factorial Randomized Block Design (RBD), with two treatment factors and 3 (three) replications. The treatment factors

include:
1. PGPR concentration factor (P) with 3 treatment levels.
P1: 5 ml/liter of water
P2: 10 ml/liter of water
P3: 15 ml/liter of water
2. Amino acid concentration factor (A) with 3 treatment levels.
A1: 2 ml/liter of water
A2: 4 ml/liter of water
A3: 6 ml/liter of water
The treatments were combined and 9 treatment combinations were obtained. The combination of treatments between PGPR concentration (P) and amino acid concentration (A) is presented in Table 1, as follows:

Table 1. Combination of treatments between PGPR concentration (P) and amino acid concentration (A)

ConcentrationPGPR (P)	Amino acid concentration (A)		
	A1	A2	A3
P1	P1A1	P1A2	P1A3
P2	P2A1	P2A2	P2A3
P3	P3A1	P3A2	P3A3

Data Analysis

The resulting data were analyzed using Analysis of Variance (Anova) with a significance level of 5%. Treatments that had a significant effect were further tested using Duncan's New Multiple Range Test α 5% (DNMRT). Further testing was conducted to determine the effect of each level of treatment, both on the effect of the interaction of the two treatments and the single factor.

Stages of Research Implementation

Seedlings

The seedling media used a mixture of top soil mixed with compost and sand in a ratio of 1:1:1. Before the seeds were sown, they were first soaked in warm water at a temperature of 550 C for 15 minutes. The transfer of seedlings to polybags was carried out when they had 3-4 leaves with good growth.

Planting

Planting was carried out by inserting 1 seedling per polybag with a depth of 2-3 cm from the soil surface and then covering it with a thin layer of soil. Before the seedlings were planted in polybags, the planting media was watered first to facilitate planting.

PGPR and Amino Acid Application

PGPR application is given by dissolving the PGPR solution into water and given by pouring it on the soil around the plant stem with a concentration of 5 ml/liter, 10 ml/liter and 15 ml/liter for 1 liter of water with an interval of 10 days once from the age of 15 days after planting (dap) to 50 dap, while the application of amino acid

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concentration is done by pouring it with a concentration of 2 ml/liter, 4 ml/liter and 6 ml/liter for 1 liter of water with an interval of every 2 weeks.

Maintenance

Plant maintenance includes watering, replanting, weeding, pest and disease control and the provision of stakes. Watering is done every day. Replanting is done at the age of 7 dap by replacing dead plants. Weeding is done when weeds grow around the plants. Pest and disease control is carried out if there are pests and diseases that attack eggplant plants. Stakes are given when the plants are 7 dap. Harvesting

The first harvest is carried out at the age of 50-60 hst. Plants that are ready to be harvested have the characteristics of being large and young, shiny fruit skin and having a bright color.

Observation Variables

The variables observed include plant height, stem diameter, number of fruits and fruit weight per plant. Observations of plant height and stem diameter were measured when the plants were 10, 20, 30 and 40 hst old. Observations of the number of fruits and fruit weight were carried out at harvest time.

RESULTS AND DISCUSSION

The results of the analysis of variance obtained the effect of treatment on the observation variables are listed in Table 2. Furthermore, the observation variables that had a significant effect were tested using the DNMRT test analysis at the 5% level.

Table 2. Results of the analysis of variance of the effect of treatment on observation variables

Variable Observation	Treatment		
	PGPR (P)	Amino Acid (A)	Interaction (PxA)
Plant height at 10 dap	**	*	ns
Plant height at 20 dap	**	*	ns
Plant height at 30 dap	**	*	ns
Plant height at 40 dap	**	*	ns
Stem diameter at 10 dap	ns	ns	ns
Stem diameter at 20 dap	ns	ns	ns
Stem diameter at 30 dap	ns	ns	ns
Stem diameter at 40 dap	ns	ns	ns
Number of fruits per plant	**	*	ns
Fruit weight per plant	**	*	ns

*Description: ** = very significantly different * = significantly different ns = not significantly different*

Plant Height

The results of the analysis of variance (Table 2), the combination of PGPR and amino acid treatments had no significant effect (no interaction) on the variable of plant height. The inability to interact between the two treatments is suspected because the provision of amino acids that are small has not been able to provide nutrients for PGPR

bacteria that are utilized in the process of bacterial life, as a result the role of PGPR in the process of plant growth is less than optimal.

Table 3. Average plant height due to the influence of PGPR and amino acid treatments

Treatment	Observation age			
	10 hst	20 hst	30 hst	40 hst
PGPR Concentration (P)				
P1 = 5 ml/liter of water	8.55 a	19.06 a	33.47 a	44.71 a
P2 = 10 ml/liter of water	9.06 a	19.59 a	33.96 a	45.23 a
P3 = 15 ml/liter of water	9.65 b	20.16 b	34.59 b	45.90 b
Amino Acid Concentration (A)				
A1 = 2 ml/liter of water	8.73 a	19.24 a	33.66 a	44.91 a
A2 = 4 ml/liter of water	9.56 b	20.07 b	34.50 b	45.79 b
A3 = 6 ml/liter of water	8.97 a	19.50 a	33.86 a	45.14 a

Description: The same letter notation in the same column indicates no significant difference in the DNMRT test.

The results of the analysis of variance (Table 2), the administration of PGPR had a very significant effect on the variable of plant height at the ages of 10, 20, 30 and 30 days after planting. The PGPR treatment (Table 3) with a concentration of 15 ml/liter of water (P3) had a higher average plant height value and its effect was significantly different compared to PGPR 5 ml/liter (P1) and PGPR 10 ml/liter (P2). The lowest average plant height occurred in the PGPR 5 ml/liter water treatment (P1). These results indicate that the role of bacteria contained in PGPR is able to stimulate plant height growth. These results are in line with the results of research by Ichwan *et al.* (2021), that the administration of PGPR can increase plant growth in the form of plant height by 2.12% - 9.69%. Furthermore, the results of research by Constantia & Ferniah (2020), obtained that PGPR had an effect on increasing plant height compared to controls that were not given PGPR. According to Gupta *et al.* (2015), the administration of PGPR to the soil can increase soil fertility, encourage plant growth and suppress phytopathogens.

The results of the analysis of variance (Table 2), the administration of amino acids had a significant effect on the variable of plant height at the ages of 10, 20, 30 and 30 days after planting. The treatment of PGPR amino acids (Table 3) with an amino acid concentration of 4 ml/liter (A2) had a higher average plant height value compared to amino acids 2 ml/liter (A1) and amino acids 6 ml/liter (A3) and the lowest average plant height occurred in the treatment of amino acids 2 ml/liter of water (A1). These results indicate that the A2 treatment is the optimal concentration in influencing the physiology of eggplant plants. The use of amino acids increases the chlorophyll content in the leaves so that the rate of photosynthesis becomes higher (Syukur, 2021). Plants carry out photosynthesis to produce carbohydrates. Low levels of photosynthesis will result in reduced carbohydrate synthesis (photosynthate). Chlorophyll content plays a very important role in the process of photosynthesis towards the absorption of sunlight energy. The higher the chlorophyll, the higher the rate of photosynthesis.

Stem Diameter

The results of the study (Table 2), the provision of PGPR and amino acids and the interaction between PGPR and amino acids had no significant effect on the variable of

stem diameter at the ages of 10, 20, 30 and 40 hst. Such conditions indicate that the provision of PGPR and amino acids to eggplant plants has not been able to provide a prominent effect on the variable of stem diameter, it is suspected that the concentration of amino acids has not been able to activate bacteria in PGPR so that the role of PGPR has not been optimal in the absorption and utilization of nutrients needed by plants in the vegetative phase. In addition, the inability to interact between the two treatments is suspected that the provision of amino acids has not been able to optimize the role of PGPR in producing growth hormones so that the function of hormones has not been optimal in stimulating cell division, regulating cell enlargement and will stimulate root growth and stimulate the absorption of water and nutrients that affect. On the growth of plant stems.

Number of Fruits

The results of the analysis of variance (Table 2), the combination of PGPR and amino acid treatments had no significant effect on the variable of the number of fruits. It is suspected that the provision of amino acids has not been able to provide nutrients for PGPR bacteria, resulting in the role of PGPR in stimulating plant growth and development not being optimal.

Table 4. Average number of fruits due to the influence of PGPR administration and amino acids

Treatment	Average value
PGPR Concentration (P)	
P1 = 5 ml/liter of water	17.19 a
P2 = 10 ml/liter of water	17.73 a
P3 = 15 ml/liter of water	18.38 b
Amino Acid Concentration (A)	
A1 = 2 ml/liter of water	17.42 a
A2 = 4 ml/liter of water	18.25 b
A3 = 6 ml/liter of water	17.63 a

Description: The same letter notation in the same column indicates no significant difference in the DNMRT test.

The results of the study (Table 2), the administration of PGPR had a very significant effect on the variable number of fruits. PGPR treatment (Table 4) with a concentration of 15 ml/liter (P3) had a higher average number of fruits and its effect was significantly different from PGPR 5 ml/liter (P1) and PGPR 10 ml/liter (P2). The lowest average plant height occurred in the PGPR 5 ml/liter (P1) treatment. These results indicate that the role of bacteria in PGPR is able to stimulate plant growth. These results are in line with the research of Ichwan *et al.* (2021) that the administration of PGPR can increase the yield of red chilies in the form of the number of fruits by 13.55% -51.40%. According to Anand *et al.* (2016), PGPR plays a role in dissolving phosphorus nutrients bound in the soil. Phosphorus plays an important role in almost all major metabolic processes including energy transfer, respiration, macromolecular biosynthesis, and photosynthesis. The results of the analysis of variance (Table 2), the provision of amino acids had a significant effect on the variable number of fruits. The treatment of amino acid administration (Table 4) with an amino acid concentration of 4 ml / liter (A2) had a higher average value of the number of fruits and its effect was significantly different from amino acid 2 ml / liter (A1) and amino acid 6 ml / liter (A3), and the lowest average number of fruits occurred in the

treatment of amino acid 2 ml / liter (A1). These results indicate that the provision of amino acid 4 ml / liter (A2) is at an optimal concentration in helping plant growth and development. It is suspected that amino acids can increase soil microbial activity and support the process of nutrient assimilation for plant roots so that the process of nutrient absorption runs optimally.

Fruit Weight

The results of the analysis of variance (Table 2), the combination of PGPR and amino acid treatments did not have a significant effect on the variable weight of the fruit. These results suggest that the addition of amino acid concentration is still relatively minimal, so it is not optimal in providing nutrients for PGPR bacteria, as a result the role of PGPR in helping the process of nutrient absorption and producing growth hormones is not optimal.

Table 5. Average fruit weight per plant (grams) due to the influence of PGPR and amino acid administration

Treatment	Average value
PGPR Concentration (P)	
P1 = 5 ml/liter of water	2137.82 a
P2 = 10 ml/liter of water	2213.31 a
P3 = 15 ml/liter of water	2302.01 b
Amino Acid Concentration (A)	
A1 = 2 ml/liter of water	2169.67 a
A2 = 4 ml/liter of water	2283.61 b
A3 = 6 ml/liter of water	2199.85 a

Description: The same letter notation in the same column indicates no significant difference in the DNMRT test.

The results of the analysis of variance (Table 2), the provision of PGPR had a very significant effect on the fruit weight variable. Provision of PGPR (Table 5), PGPR treatment 15 ml/liter (P3) was the best treatment with a higher average fruit weight value of 2302.01 grams and its effect was significantly different from PGPR 15 ml/liter (P1) and PGPR 15 ml/liter (P2). It is suspected that the bacterial content in PGPR affects its ability to provide and mobilize the absorption of various nutrients so that it has an impact on the development of eggplant fruit weight. These results are in line with the results of research by Ichwan *et al.* (2021) that the provision of PGPR can increase red chili yields in the form of fruit weight by 54.19% -180.53%). According to Etesami & Maheshwari (2018); Ullah *et al.* (2015), that PGPR bacteria generally produce phytohormones such as auxin, cytokinin, and gibberellin. Auxin is the main hormone in plants that controls various physiological processes including cell growth and division, tissue differentiation, root formation initiation, apical dominance, flowering, fruit ripening. The results of the analysis of variance (Table 2), the provision of amino acids had a significant effect on the fruit weight variable. The provision of amino acids 4 ml / liter (Table 4) was the best amino acid treatment with a higher average fruit weight value of 2283.61 grams and its effect was significantly different from amino acids 2 ml / liter (A1) and amino acids 6 ml / liter (A3). These results suggest that the addition of amino acids at a concentration of 4 ml / liter has an effect on increasing soil fertility, considering that amino acids are a basic component of protein which is one of the important nutrients for plants and soil microbes.

Application of amino acids to the soil will increase the activity and population of beneficial microbes. The balance and high microbial activity in the soil will improve the mineralization of organic matter in the soil, thereby increasing soil fertility.

CONCLUSION

There was no interaction between the treatment of PGPR concentration and amino acids on eggplant plant productivity. The single treatment of PGPR and amino acids obtained PGPR 15 ml/liter and amino acids 4 ml/liter is the treatment that has the best effect on eggplant plant productivity.

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