Agro Bali : Agricultural Journal
Vol. 7 No. 1: 33-43, March 2024
e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

Use of PGPR (Plant Growth Promoting Rhizobacteria) to Increase Yields of Cayenne Pepper (*Capsicum frutescens* L.) in Monoculture Planting Systems and Under the Shade of Mature Citrus Plants

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Article history: submitted: July 25, 2023; accepted: February 20, 2024; available online: March 30, 2024

Abstract. Cayenne pepper is a vegetable commodity, which can be categorized as a commercial commodity and has the potential to be developed. The problem that arises is that more and more agricultural land is getting damaged. One effort to overcome this problem is to use organic fertilizers such as PGPR. The purpose of this study was to obtain the optimum dose of PGPR (Plant Growth Promoting Rhizobacteria) on the growth and yield (quantity and quality) of cayenne pepper in a monoculture cropping system and under the shade of mature citrus trees. The research was conducted in a Citrus Orchard, Tegalgondo Village, Karangploso District, Malang Regency. The time of the research was carried out in December 2022 - March 2023. This study used a Randomized Block Design (RBD) with two factors, namely the concentration of PGPR (Plant Growth Promoting Rhizobacteria) and the planting system. The first factor is the treatment of the application of the planting system which consists of 2 levels, namely MN (Monoculture) TS (Under the Orange Shade). The second factor was the treatment of PGPR concentration consisting of 4 levels, namely, P0 (without PGPR), P10 (10 $ml.^{-1}$ concentration), P20 (20 $ml.^{-1}$ concentration), P30 (30 $ml.^{-1}$ concentration) and Treatment randomized in each group. and cropping system treatment. The results showed that there was no real interaction between the cropping system and PGPR on the growth of cayenne pepper plants. This is because there is a different effect on each treatment.

Keywords: chilli plants; cropping pattern; PGPR concentration

INTRODUCTION

Cayenne pepper is a vegetable commodity, which can be categorized as a commercial commodity and has the potential to be developed. The problem that arises is that more and more agricultural land is getting damaged. The need for food is increasing day by day, one of which is the need for horticultural commodities. The growth rate of plants and the production of cayenne pepper in Indonesia has increased every year.

In 2018 the national production of cayenne pepper was 1,335,608.00 tons and has increased in 2019 to 1,374,217.00 tons and then increased again in 2020 by producing 1,508,404.00 tons (Pusat Data dan Sistem Informasi Pertanian, 2020). Along with the demand for these commodities continuing to increase, productivity and land ownership by farmers have decreased. Considering that the availability of land is increasingly limited, appropriate cultivation techniques or efforts are needed to increase land productivity, reduce the risk of crop failure and increase crop production.

The use of fertilizers in the world continues to increase in accordance with the increase in the area of agriculture, population growth, increase in the level of intensification, and the increasingly diverse use of fertilizers as an effort to increase agricultural yields. Environmental experts are concerned that the use of chemical fertilizers can damage the physical properties of the soil. Poor soil physical properties are characterized by very low organic matter content (Hendriyatno *et al*., 2020).

To overcome this problem, the production of cayenne pepper must be increased, one of which is by using organic fertilizers such as PGPR which consists of several bacteria. In general, PGPR has a function as a growth promoter, nutrient provider, and pathogen controller. Efforts to produce good growth and maximum yield on cayenne pepper in practice must apply the use of superior varieties and their determination in the selection of organic fertilizers and the selection of the right planting system.

The biological organic fertilizers used in this study were PGPR with concentrations of 10 $ml.^{-1}$, 20 $ml.^{-1}$ and 30 $ml.^{-1}$. The choice of

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

PGPR concentration was based on research by (Chandran *et al*., 2021) then it was explained that the higher the concentration of PGPR given also gave higher yields to these plants. As for the use of the cropping system, which is based on research conducted by (Mulu *et al.*, 2020) selection in the use of a cropping system greatly affects the growth and yield of these plants.

The cropping system is also one of the important cultivation techniques to increase production. The cropping system used is a monoculture and intercropping system. Intercropping on citrus plants is a concern and needs to be managed so that the results obtained per square meter and each season can be maximized (Mulu *et al*., 2020).

METHODS

The research was conducted in December 2022 - March 2023 at Citrus Orchard, Tegalgondo Village, Karangploso District, Malang Regency. Materials used in the study included: cayenne pepper seed variety Ori 212 aged 25 days, citrus plants as shade plants aged 2.5 years, pure manure with goat manure, water, and PGPR. The tools used in the study included hoes, shovels, tape measure, analytical scales, buckets, measuring cups, hoses, cameras, rulers, ovens, Leaf Area Meters (LAM), lux meters, and stationery. This study used a split-plot design (RPT) with two factors, namely the concentration of PGPR (Plant Growth Promoting Rhizobacteria) and the planting system. The first factor is the treatment of the planting system application which consists of 2 levels, namely: MN = Monoculture; TS = Under the Orange Shade. The second factor was the treatment of giving PGPR (Plant Growth Promoting Rhizobacteria) concentrations which consisted of 4 levels, namely:

P0 : Without PGPR(Plant Growth Promoting Rhizobacteria)
P10 : Concentration 10 $ml.^{-1}$
P20 : Concentration 20 $ml.^{-1}$
P30 : Concentration 30 $ml.^{-1}$

Treatment was randomized in each group. There were 8 combinations of PGPR concentration treatments and cropping system treatments; each treatment was repeated 4 times, so there were 32 experimental plots. Observations made include observation of vegetative growth parameters, generative parameters, and results of plant growth analysis. Parameters for observing vegetative growth consisted of plant height, number of leaves, and leaf area. Parameters for generative observations and plant yields included: flowering age, number of flowers per plant, number of fruits per plant, fruit weight per plant, and harvested fruit weight per hectare. Observation of plant growth analysis parameters included plant fresh weight, plant dry weight, plant growth rate, and nutrient uptake. Observations were made on each sample plant at the age of 4, 6, 8, 10, and 12 WAP (Week after Planting).

Observational data were then analyzed using analysis of variance (ANOVA) to determine the effect of treatment on plants, significantly or not. Analysis that shows a significant effect will be further tested using the (BNJ) test at the 5% level to see differences between treatments.

RESULTS AND DISCUSSION

Based on the results of the study, it was shown that the results of each observation tended to experience results that were not significantly different for each variable in the growth parameters with various concentrations of PGPR given (Table 1), meaning that increasing the dose of PGPR given did not have a significant effect on the growth of chili plants. The higher the PGPR dose given is not followed, the further the growth of cayenne pepper plants. While the treatment of cropping patterns has more influence on the growth of cayenne pepper plants (Table 1).

The occurrence of this is caused by differences in the growing environment around cayenne pepper plants which can include differences in air, sunlight, and nutrients absorbed by plants. In the

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

intercropping cropping system, the PGPR bacteria will obtain a source of nutrition from the litter (organic matter) that is produced by the main crop. The bacteria that live in the roots of cayenne pepper plants have a reciprocal relationship between plants and PGPR bacteria, namely where the bacteria get food from the litter in the intercropping, and the plants get a good influence from these bacteria (Andriany, 2018).

Plant Fresh Weight

The results of the analysis of variance showed that there was no interaction between the treatment of cropping patterns and the administration of PGPR (Plant Growth Promoting Rhizobacteria) on the fresh weight of chili plants at the age of observation 10 and 20 WAP. Differences in monoculture and intercropping patterns showed a significant effect on the fresh weight of cayenne pepper plants at all ages of observation. Giving PGPR (Plant Growth Promoting Rhizobacteria) did not show a significant effect on the fresh weight of cayenne pepper plants at all ages of observation. The mean fresh weight of chili plants due to significant differences in the mean fresh weight of cayenne pepper plants at the age of 10 and 20 WAP observations was shown to be due to the treatment of cropping patterns. At the age of 10 and 20 WAP the results of the use of the Overlapping cropping pattern had a higher mean fresh weight of cayenne pepper compared to the use of the Monoculture cropping pattern. At the age of 10 observations, the use of the Overlapping cropping pattern resulted in a fresh weight of 45.10 g, this value was 88.54% greater when compared to the use of the Monoculture cropping pattern with a fresh weight of 23.92 g. At the age of 20 WAP the observation of the cropping pattern of the intercropping yielded a plant fresh weight of 96.07 g, this value was 76.37% greater when compared to the use of the monoculture cropping pattern with a fresh weight of 54.47 g, this value is 88.54% greater when compared to the use of the monoculture cropping pattern with a fresh weight of 23.92 g. At the age of 20 WAP the observation of the cropping pattern of the intercropping yielded a plant fresh weight of 96.07 g, this value was 76.37% greater when compared to the use of the monoculture cropping pattern with a fresh weight of 54.47 g. This value is 88.54% greater when compared to the use of the Monoculture cropping pattern with a fresh weight of 23.92 g. At the age of 20 WAP the observation of the cropping pattern of the intercropping yielded a plant fresh weight of 96.07 g, this value was 76.37% greater when compared to the use of the monoculture cropping pattern with a fresh weight of 54.47 g.

Based on the research results, there was no interaction between the treatment of the planting system and the PGPR on fresh weight values, and the resulting Plant Growth Rate (LPT). Cayenne pepper plants grown in intercropping resulted in higher fresh weight values compared to cayenne pepper plants grown by monoculture. This also shows that the cropping system has an effect on the total fresh weight of the plant. Cayenne pepper planted in intercropping has one advantage, namely, it is better at controlling the energy received from sunlight because it is shaded by other plants; this is because chili plants are shade-loving plants. The concentration of PGPR also showed no significant effect on the yield of total plant fresh weight. This is in accordance with the research of (Raka *et al*., 2012) who stated that the application of PGPR did not have a significant effect on the plant's oven-dry weight and fresh root weight per plant. Several groups of rhizobacteria have properties as biological agents because they have the ability to stimulate plant growth which affects the fresh and dry weight values of these plants.

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

Table 1. The effect of planting patterns and PGPR (Plant Growth Promoting Rhizobacteria) on fresh weight of cayenne pepper plants

Planting Pattern	Plant Fresh Weight (g tan-1) at Age (WAP)	
	10	20
Monoculture	23.92 a	54,47 a
Intercropping	45.10b	96.07b
BNJ 5%	12.81	18.51
households (%)	33.00	21.86
PGPR	Plant Fresh Weight (g tan-1) at Age (WAP)	
	10	20
P0	31.80	73,16
P10	33.85	76.55
P20	33,31	74,80
P30	39.07	76.58
BNJ 5%	ns	ns
households (%)	35,64	15,22

Remarks: Numbers followed by the same letter in the same column are not significantly different based on the BNJ 5% test, WAP: weeks after planting, ns: non-significant

The IAA hormone can increase plant dry weight yields because it has functions for plants, including increasing cell development, stimulating the growth of new roots in plants, stimulating flowering in plants, spurring plant growth, and increasing enzyme activity (Rahni, 2012) and fresh root weight per plant. Several groups of rhizobacteria have properties as biological agents because they have the ability to stimulate plant growth which affects the fresh and dry weight values of these plants. The IAA hormone can increase plant dry weight yields because it has functions for plants, including increasing cell development, stimulating the growth of new roots in plants, stimulating flowering in plants, spurring plant growth, and increasing enzyme activity (Rahni, 2012) and fresh root weight per plant. Several groups of rhizobacteria have properties as biological agents because they have the ability to stimulate plant growth which affects the fresh and dry weight values of these plants. The IAA hormone can increase plant dry weight yields because it has functions for plants, including increasing cell development, stimulating the growth of new roots in plants, stimulating flowering in plants, spurring plant growth, and increasing enzyme activity (Rahni, 2012).

Fruit Weight per Plant

The results of the analysis of variance showed that there was no interaction between the treatment of cropping patterns and the administration of PGPR (Plant Growth Promoting Rhizobacteria) on the total fruit weight per plant of cayenne pepper at the ages of 14, 16 and 18 WAP. Differences in monoculture and intercropping patterns showed a significant effect on fruit weight per cayenne pepper plant at all ages of observation. Giving PGPR (Plant Growth Promoting Rhizobacteria) did not show a significant effect on fruit weight per plant of cayenne pepper at all ages of observation. Average fruit weight per chili plant due to the influence of cropping pattern and PGPR (Plant Growth Promoting Rhizobacteria) (Table 2).

The cropping pattern treatment resulted in a significant difference in fruit weight per cayenne pepper plant at all ages of observation (14, 16 and 18 WAP). The results showed that at all ages the intercropping treatment produced a higher average fruit weight per plant when compared to the monoculture cropping pattern. At the age of 14 WAP observations showed the largest difference in fruit weight per plant, where the use of the Overlapping cropping pattern

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

resulted in an average fruit weight per plant of 19.01 g, this value was 221.66% greater when compared to the Monoculture treatment with a fruit weight of 5.91 g. At the age of 16 observations, the intercropping treatment pattern produced an average fruit weight per plant that was 101.38% higher when compared to the monoculture cropping pattern treatment.

Table 2. The effect of planting patterns and PGPR (Plant Growth Promoting Rhizobacteria) on fruit weight per cayenne pepper plant

Planting Pattern	Fruit Weight Per Plant (g tan-1) at Age (WAP)			
	14	16	18	Total
Monoculture	5.91 a	11.61 a	12.77 a	30,29a
Intercropping	19.01b	23.38 b	29.72b	72.11 b
BNJ 5%	3.99	1.76	6,25	5,44
households (%)	20,10	8.96	26,15	9.45
PGPR	Fruit Weight Per Plant (g tan-1) at Age (WAP)			
	14	16	18	Total
P0	9.93	18.54	21.06	49,52
P10	11.15	16,67	20,16	47.97
P20	13,16	14.09	18.54	45.79
P30	15,62	20.68	25,21	61,51
BNJ 5%	ns	ns	ns	ns
households (%)	33,66	29,52	23.60	21.35

Remarks: Numbers followed by the same letter in the same column are not significantly different based on the BNJ 5% test, WAP: weeks after planting, ns: non-significant

Yield Productivity of Chili Plants

The results of the analysis of variance showed that there was no interaction between the treatment of cropping patterns and the administration of PGPR (Plant Growth Promoting Rhizobacteria) on the productivity of cayenne pepper at the age of observation 14, 16 and 18 WAP. Differences in monoculture and intercropping patterns showed a significant effect on the productivity of cayenne pepper at all ages of observation. Giving PGPR (Plant Growth Promoting Rhizobacteria) did not show a significant effect on the productivity of cayenne pepper plants at all ages of observation. The average productivity of chili plants due to the influence of cropping patterns and PGPR (Plant Growth Promoting Rhizobacteria) (Table 3

The cropping pattern treatment resulted in a significant difference in the productivity of cayenne pepper plants at all ages of observation (14, 16 and 18 WAP). The results showed that at all ages of observation the intercropping treatment resulted in a higher average plant productivity when compared to the Monoculture cropping pattern treatment. At the age of 14 WAP observations showed the greatest difference in plant productivity, where the use of the intercropping pattern resulted in an average plant productivity of 1417.45 kg ha-1, this value was 338.87% higher than the monoculture treatment with a plant productivity of 322.98 kg ha-1. At the age of 16 observations, the intercropping cropping pattern treatment resulted in a higher average plant productivity of 125.12% when compared to the monoculture cropping pattern treatment.

The research showed that the yield parameter group of cayenne pepper plants was influenced by cropping pattern and there was no influence by PGPR. In the cropping system, where the cayenne pepper with the intercropping system produces better production (yield) than the cayenne pepper planted in monoculture. This is because chili plants in their growth do not require a lot of sunlight or like shade. Light plays a very large role in physiological processes,

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

especially photosynthesis, respiration, plant growth and development (López-Marín *et al*., 2012). Sunlight as a whole greatly affects the growth, reproduction and yield of plants, light will affect photosynthetic and photosynthetic activity produced by plants so that it affects plant growth organs (Suwarto *et al*., 2006). This is supported by the opinion of (López-Marín *et al*., 2012) which states that shade-loving plants will be stunted when planted in open land, so that it can affect the yield of these plants. The statement above has proven the results of this study where cayenne pepper planted in monoculture produced no better results than intercropping.

Table 3. The effect of planting patterns and PGPR (Plant Growth Promoting Rhizobacteria) on yields of cayenne pepper plants

Planting Pattern	Yield (ton ha-1) at Age (WAP)		
	14	16	18
Monoculture	0.25a	0.48a	0.54 a
Intercropping	0.92 b	0.92 b	1.07b
BNJ 5%	0.21	0.17	0.19
households (%)	32,49	21.77	21,24
PGPR	Yield (ton ha-1) at Age (WAP)		
	14	16	18
P0	0.37a	0.80	0.79
P10	0.65 b	0.69	0.87
P20	0.58b	0.47	0.70
P30	0.73b	0.84	0.85
BNJ 5%	0.17	ns	ns
households (%)	32.04	33.23	22,11

Remarks: Numbers followed by the same letter in the same column are not significantly different based on the BNJ 5% test, WAP: weeks after planting, ns: non-significant

Nutrient Uptake Analysis

The results of the analysis of variance showed that the analysis of nitrogen nutrient uptake of cayenne pepper plants at the age of 10 WAP resulted in a significant relationship due to the treatment of cropping patterns and the application of PGPR. Interaction relationship between cropping pattern and PGPR (Plant Growth Promoting Rhizobacteria) treatment on nitrogen uptake of cayenne pepper plants (Table 4). In the monoculture cropping pattern treatment of cayenne pepper the use of PGPR did not result in a significant difference in nitrogen nutrient uptake in cayenne pepper plants, but when using an intercropping cropping pattern the application of PGPR with a concentration of 30 $ml.^{-1}$e compared to other PGPR treatments (0, 10 and 20 $ml.^{-1}$).

The use of PGPR with a concentration of 30 $ml.^{-1}$ resulted in a greater nutrient uptake of cayenne pepper plants by 90, 67% when compared to the treatment without PGPR. The use of different cropping patterns, namely monoculture and intercropping also did not show a significant difference in the nitrogen uptake of cayenne pepper plants when using PGPR with concentrations of 0, 10 and 20 $ml.^{-1}$. Whereas in the PGPR treatment with a concentration of 30 $ml.^{-1}$ the use of the intercropping cropping pattern resulted in better nitrogen uptake in chili plants compared to the use of the monoculture cropping pattern. The use of an intercropping cropping pattern when PGPR was applied with a concentration of 30 $ml.^{-1}$ resulted in a 165.5% greater uptake of nitrogen by cayenne pepper plants when compared to the monoculture cropping pattern. i.e. monoculture and intercropping also did not show a significant difference in nitrogen uptake of cayenne pepper plants

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

when using PGPR at concentrations of 0, 10 and 20 ml.$^{-1}$.

Whereas in the PGPR treatment with a concentration of 30 ml.$^{-1}$ the use of the intercropping cropping pattern resulted in better nitrogen uptake in chili plants compared to the use of the monoculture cropping pattern. The use of an intercropping cropping pattern when PGPR was applied with a concentration of 30 ml.$^{-1}$ resulted in a 165.5% greater uptake of nitrogen by cayenne pepper plants when compared to the monoculture cropping pattern. i.e. monoculture and intercropping also did not show significant differences in nitrogen uptake of cayenne pepper plants when using PGPR at concentrations of 0, 10 and 20 ml.$^{-1}$. Whereas in the PGPR treatment with a concentration of 30 ml.$^{-1}$ the use of the intercropping cropping pattern resulted in better nitrogen uptake in chili plants compared to the use of the monoculture cropping pattern.

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Table 4. Interaction relationship between planting pattern treatment and Plant Growth Promoting Rhizobacteria (PGPR) on Nitrogen uptake of cayenne pepper plants

Planting Pattern	Plant Nitrogen Nutrient Uptake (g tan-1) at the age of 10 WAP	
	Monoculture	Intercropping
P0	0.26a	0.43 ab
P10	0.33 ab	0.48b
P20	0.32 ab	0.41 ab
P30	0.31 ab	0.82c
BNJ 5%	0.20	
Family Planting Pattern (%)	25.96	
PGPR households (%)	27.96	

Remarks: Numbers followed by the same letter in the same row and column are not significantly different based on the 5% BNJ test, WAP: Weeks After Planting

Based on the results of the study it appears that the cropping system greatly influences plant growth. The existence of competition for nutrients and the receipt of sunlight absorbed by plants will affect the yield of these plants. The more plants receive energy, the better these plants grow and develop. Nutrients and solar energy absorbed by plants will affect the photosynthesis process of a plant. According to (Suhartono. *et al*., 2008) the availability of nutrients such as water which is the transport of nutrients from the soil for plants affects plant growth, nutrients in the soil are transported through water which is absorbed by plants through the process of photosynthesis. Photosynthesis

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

can produce assimilates depending on the photosynthetic process that occurs, if photosynthesis goes well then the resulting assimilate will also increase. High assimilation can affect the yield of these plants. According to (Lidya, 2019) that plant growth is largely determined by external factors such as temperature, light, fertilizer, and water. It can be seen clearly that the intercropping cropping system is better in terms of nutrients.

The use of gaps in citrus cultivation is very suitable for the growth of cayenne pepper plants. Judging from the results of research conducted by (Ambar Dewi *et al*., 2017), cayenne pepper plants can grow well if they get shade compared to cayenne pepper plants which get too full light intensity. High assimilation can affect the yield of these plants. According to (Lidya, 2019) that plant growth is largely determined by external factors such as temperature, light, fertilizer, and water. It can be seen clearly that the intercropping cropping system is better in terms of nutrients. The use of gaps in citrus cultivation is very suitable for the growth of cayenne pepper plants. Judging from the results of research conducted by Dewi et al. (2017), cayenne pepper plants can grow well if they get shade compared to cayenne pepper plants which get too full light intensity. High assimilation can affect the yield of these plants. According to (Lidya, 2019) that plant growth is largely determined by external factors such as temperature, light, fertilizer, and water. It can be seen clearly that the intercropping cropping system is better in terms of nutrients.

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Cropping patterns and PGPR (Plant Growth Promoting Rhizobacteria) can affect plant nutrient uptake. The following shows the effect of cropping patterns and PGPR on plant nutrient uptake. Cropping patterns can affect plant nutrient uptake because different cropping patterns can affect the availability of nutrients in the soil. In the monoculture cropping pattern, plants exploit certain nutrients in the soil, so that there is a shortage of certain nutrients in the soil. Whereas in the intercropping cropping pattern, different plants are planted together so that the nutrients used by each plant are different, and the remaining nutrients from one plant can be utilized by other plants. This can increase the availability of nutrients for plants and increase plant nutrient uptake (Wu *et al.*, 2021)

PGPR can affect plant nutrient uptake through mechanisms such as increasing the efficiency of nutrient use, increasing the production of growth regulators, and increasing resistance to abiotic stress. PGPR can assist plants in accessing the nutrients contained in the soil, so that plants can absorb nutrients more efficiently and effectively. In addition, PGPR can also help plants overcome abiotic stress such as drought or excess water, so that plant nutrient uptake can increase (Kuan *et al*., 2016) In principle, local soil fertility is the key to the success of agricultural systems, both physical, chemical and biological fertility. If the fertility of the soil is good, it will also create good

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

environmental conditions around the plants. Macro and micro nutrients are sufficiently available, and the activities of microorganisms in maintaining soil fertility are going well (Sriwahyuni & Parmila, 2019).

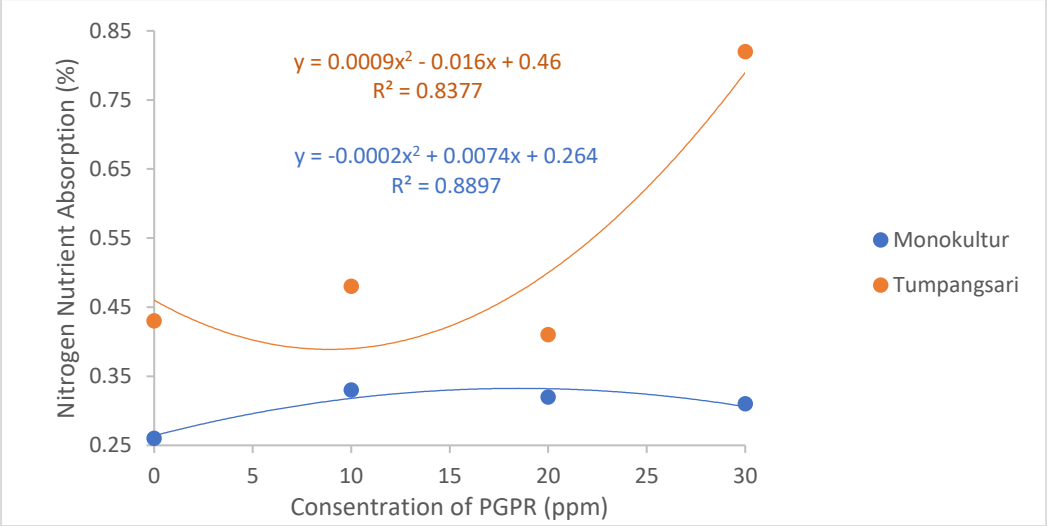

Figure 1. Relationship between PGPR concentration and N nutrient uptake in cayenne pepper with monoculture and intercropping patterns

The results of the regression test in Figure 1 show that the R2 in the monoculture and intercropping cropping patterns due to PGPR concentrations was 0.8897 and 0.8377. These results indicate that the use of PGPR affects N nutrient uptake in monoculture and intercropping chili plants. Several studies have also shown that a combination of cropping patterns and PGPR can significantly increase plant nutrient uptake. For example, research conducted by (Tang et al., 2021) showed that intercropping with PGPR could increase the uptake of nitrogen by soft wheat and faba bean plants.

P nutrient uptake in the study showed results that were not significantly different. PGPR in the nutrient uptake mechanism specifically absorbs the type of nutrient according to the bacterial content. PGPR that helps plants absorb P nutrients are called phosphate solubilizing bacteria (PSB). One of the mechanisms is increasing the availability of P nutrients in the soil. PGPR bacteria can help increase the availability of P nutrients by producing organic acids and phosphatase enzymes that can convert soil-bound organic phosphate into a form that can be taken up by plants (Minaxi *et al.*, 2013). In addition, (Tang *et al.*, 2021) stated that intercropping can also increase nutrient P uptake in plants by increasing the exchange of nutrients between plants that grow together if there is symbiosis with bacteria or P-fixing fungi. K nutrient uptake in the study showed an effect due to cropping pattern and not significantly due to PGPR. Intercropping and PGPR can increase nutrient K uptake in plants through several mechanisms. Several studies have shown that intercropping between different plants can improve nutrient K uptake, where plants grown together can affect pH, physical properties, and soil microorganisms, which in turn affect nutrient K uptake (Agbodjato *et al.*, 2016)

CONCLUSION

The use of intercropping patterns with citrus plants resulted in higher growth and yield of cayenne pepper compared to the use of monoculture cropping patterns. This is in line with the results of the study which showed higher values in the intercropping cropping pattern compared to the monoculture cropping pattern on the observation variables of leaf area, plant fresh weight, treatment without PGPR, both in

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v7i1.1471

monoculture and intercropping patterns. The application of PGPR at a concentration of 30 ml.$^{-1}$ also resulted in an increase in nitrogen uptake by cayenne pepper plants with an intercropping cropping pattern. Juga menghasilkan peningkatan pada serapan nitrogen oleh tanaman cabai rawit

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