ISSN 3031-0571

PGPR Suppresses Herbivore Attacks and Promotes The Growth Of Common Bean (*Phaseolus vulgaris* L.)

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ABSTRACT

Plant defense against herbivores can be constitutive or inducible. One of these defense inducers is a group of rhizobacteria known as PGPR. In general, apart from stimulating plant growth, PGPR can induce systemic resistance to pathogens and herbivores in many crops. Therefore, in this study, we tested the ability of PGPR from elephant grass *Pennisetum purpureum* to increase the defense of the common bean *Phaseolus vulgaris* L. against herbivores. The research was carried out using a randomized complete block design (RCBD), consisting of five of treatments each repeated five times. The data has been analyzed using analysis of variance, and further tests with the LSD test at the 5% level. The results showed that the application of PGPR at a concentration of 20 mL-1 could significantly reduce the intensity of insect herbivore attacks on leaves and pods. Apart from that, PGPR has also increased plant growth, both plant height and number of leaves, accelerated the flowering phase, and increased pod weight per plant. It can be concluded that giving PGPR to common bean plants can improve growth performance and increase defense responses against herbivores.
Keywords: Plant defense, PGPR, Herbivores, Common beans

INTRODUCTION

Chickpeas (Phaseolus vulgaris L.) are a source of vegetable protein that is cheap and easy to grow. Its potential socio-economic value is very high, it can improve the household and national economy, provide nutritious food for the population, efficiently maintain soil fertility, and be used as an export commodity. However, chickpea production has fluctuated due to the reduction in the area of land planted and the high intensity of pest attacks.

Efforts to maintain the stability of crop production can be done by intensification, including fertilization. To achieve this goal, farmers usually use inorganic fertilizers, which have a faster effect. However, continuous application of mineral fertilizers, especially in excessive amounts, can reduce soil fertility, stimulate the development of pathogens, cause nutrient poisoning, and reduce crop resistance to pests, diseases, and the elements.

The application of inorganic fertilizers can be replaced by the use of biological fertilizers, one of the biological fertilizers that can be used is PGPR. It is a fertilizer that contains a group of beneficial bacteria that reside in the rhizosphere zone (a thin layer of soil 1-2 mm around the root zone). A thin layer of soil that covers the root surface and positively affects plant growth.

Plant Growth Promoting Rhizobacteria as an alternative environmentally friendly technology in the field. PGPR is a type of bacteria that lives around plant roots. The bacteria live in colonies covering the roots of plants. For plants, the presence of these microorganisms will be very good. These bacteria provide benefits in the process of plant physiology and growth. PGPR plays a role in increasing plant growth, yield and soil fertility. PGPR directly increases plant growth because it produces hormones, nutrients, organic acids and mobilizes nutrients to be easily absorbed by plants.

Plant Growth Promoting Rhizobacteria from elephant grass roots have two forms of bacteria, namely bacteria with a rod shape with another name Bacillus and bacteria with a round shape with another name Coccus. It is known that PGPR bacteria from the roots of elephant grass have gram-positive blue color and gram-negative red color.

Previous research conducted by A'yun et al. (2013) showed that the application of PGPR with a concentration of 10 ml/L on cayenne pepper plants can reduce the intensity of TMV (Tobacco Mosaic Virus) attacks by 89.92%, increase the production of chili plants, and can increase the height of cayenne pepper plants. Iswati's research (2012) showed that PGPR application with a concentration of 12.5 ml/L had a significant effect on plant height and root length of tomato plants, and a concentration of 7.5 ml/L could maximize the number of leaves and the number of roots in tomato plants.

The application of Plant Growth Promoting Rhizobacteria (PGPR) to bean plants gives a very different effect with bean plants that are not treated with PGPR (control). Chickpea plants treated with PGPR had the lowest pest attack intensity, pod attack intensity, number of branches, plant age at flowering, plant age at harvest, number of plant pods and pod weight per plant.

ISSN 3031-0571

The purpose of this study was to examine the effect of PGPR application of elephant grass roots (Pennisetum purpureum) on the resistance of upright chickpea plants to pest attacks and to see the concentration of PGPR that provides resistance to upright chickpea plants to pest attacks.

MATERIALS AND METHODS

Place and Time

The research was conducted for four months (December 2022 to March 2023), from the preparation of the research until the last data collection. The research was conducted in the Green House/Field and Laboratory of Plant Pests and Diseases, Faculty of Agriculture, Mulawarman University, Samarinda.

Materials and Tools

The materials used consisted of upright chickpea seeds, kepok banana roots, whiting, sugar, shrimp paste, water and bran. The tools used in the research consisted of hoes, polybags, machetes, buckets, filters, pans, scales, meters, and documentation tools.

Research Methods

This research was arranged in a group randomized design with 6 treatments and repeated 4 times. The treatments given in this study used PGPR kepok banana root with the concentration in each treatment as follows.

P_0 = Kontrol
P_1 = 10 mL PGPR L^{-1}
P_2 = 20 mL PGPR L^{-1}
P_3 = 30 mL PGPR L^{-1}
P_4 = 40 mL PGPR L^{-1}
P_5 = 50 mL PGPR L^{-1}

Observation Parameters

Pest Attack Intensity

Observations were made by calculating the intensity of pest attacks every 1 week. The observation variable is the category of damage scale on the leaves/plants based on qualitative observations which are then made into a scale value (score). This scale number will be used to calculate the intensity of pest attack on upright chickpea plants. The formula used to calculate the intensity of attack is as follows:

$$IS = \frac{\sum(n \times v)}{Z \times N} x\ 100\%$$

Pod Attack Intensity

Observations were made by calculating the intensity of attack on plant pods from the first harvest to the fourth harvest of each plant. The formula used to calculate the intensity of attack on plant pods is as follows:

$$IS = \frac{\sum(n)}{N} x\ 100\%$$

Type of Pests and Symptoms of Attack

These observations were only made on biting and chewing pests with damage criteria such as perforated leaves, tears, etc. Symptoms of piercing and sucking pests are also observed although it is rather difficult to distinguish the symptoms of pests and plant diseases. Identify stabbing and sucking pests found in the field.

Plant Height (cm)

Plant height was measured when the plants were 2, 4, 6 and 8 mst old. Measurement of plant height was carried out from the lower base of the stem at the same point to the growing point of the plant using a ruler.

Number of plantlets per plant (stems)

The number of branches is determined by counting the number of branches that grow on the main stem, carried out at the end of the study, namely after harvest is complete.

ISSN 3031-0571

Plant Age at Flowering (HST)

Plant age at flowering is determined when there is at least one flower that blooms and is calculated from the first flower blooming.

Plant Age at Harvest (HST)

Plant age at harvest is determined in days from planting to the first harvest.

Number of Pods per Plant (fruit)

The number of pods per plant was determined by counting the number of all pods produced by plants from the first harvest to the fourth harvest of each plant, then calculated the average per plant.

Fresh Pod Weight per Plant (g)

The weight of fresh pods per plant was determined by calculating the average weight of chickpea pods from the first harvest to the fourth harvest of each plant.

Results and Discussion

Pest Attack Intensity

The results of variance analysis on the intensity of pest attack of upright chickpea plants showed that the effect of PGPR application was significantly different. The average number of branches of bean plants can be seen in Table 1.

Table 1. Effect of Plant Growth Promoting Rhizobacteria on the Intensity of Pest Attacks of Upright Chickpea Plants 4,5,6,7,8 MST That Have Been Transformed Arschin

PGPR concentrations (mL L^{-1})	Pest Attack Intensity				
	4 MST	5 MST	6 MST	7 MST	8 MST
p0 (0)	23,12^{a}	22,19^{a}	21,00^{a}	28,05^{a}	33,61^{a}
p1 (10)	17,44^{b}	17,35^{b}	16,70^{bc}	20,06^{b}	22,18^{b}
p2 (20)	15,14^{c}	14,83^{c}	14,03^{c}	14,17^{b}	16,20^{c}
p3 (30)	18,19^{b}	19,00^{b}	17,09^{b}	20,51^{b}	22,57^{b}
p4 (40)	18,23^{b}	19,43^{b}	17,21^{b}	20,90^{b}	24,31^{b}
p5 (50)	18,71^{b}	19,66^{b}	17,45^{b}	20,97^{b}	24,61^{b}

Observations of the intensity of pest attacks on bean plants showed a very significant effect at the age of 4, 5, 6, 7 and 8 weeks after planting. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 decreased the curve. This shows that giving PGPR concentrations of 0, 10, 20 mL L-1 causes a decrease in the intensity of pest attacks on chickpeas in accordance with the addition of PGPR concentrations. The increase in PGPR concentrations of 30, 40 and 50 mL L-1 caused an increase in the curve. The lowest average intensity of pest attack starting from 4, 5, 6, 7 and 8 mst was shown by p2 (20 mL L-1), namely: 15.14%, 14.83%, 14.03%, 14.17% and 16.20%, while the highest intensity of pest attack was shown by the control (0 mL L-1), namely: 23.12%, 22.19%, 21.00%, 28.05% and 33.61%.

This is because PGPR is able to spur the growth of root physiology and can reduce disease or damage by pests. In addition, PGPR also increases the availability of other nutrients such as phosphate, sulfur, iron and copper. PGPR can also produce plant hormones, increase beneficial bacteria and fungi and control pests and diseases in bean plants.

The dose treatment of Plant Growth Promoting Rhizobacteria (PGPR) had a very significant effect on the intensity of pest attacks on upright chickpea plants. This indicates that the PGPR can reduce the intensity of pest attacks on upright chickpea plants.

PGPR are beneficial bacteria that aggressively occupy (colonize) the rhizosphere (root zone). The activity of rhizobacteria is beneficial to plants both directly and indirectly. The direct effect of PGPR is based on its ability to provide and facilitate the uptake of various nutrients in the soil as well as to synthesize and alter the concentration of plant-promoting phytohormones. The indirect effect of PGPR is related to its ability to suppress pathogen activity by producing compounds or metabolites such as antibiotics.

ISSN 3031-0571

Pod Attack Intensity

The results of variance analysis on the intensity of pod attack of upright chickpea plants showed the effect of PGPR application was significantly different. The average number of branches of bean plants can be seen in Table 2.

Table 2. The Effect of Plant Growth Promoting Rhizobacteria on the Intensity of Attack of Upright Chickpea Plant Pods Harvest 1, 2, 3 and 4

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p0 (0)	0,43	0,28	0,44	0,50	0,37	1,65	0,44[a]
p1 (10)	0,16	0,18	0,21	0,19	0,38	1,11	0,22[b]
p2 (20)	0,11	0,11	0,06	0,10	0,15	0,53	0,08[c]
p3 (30)	0,21	0,29	0,43	0,29	0,24	1,46	0,23[b]
p4 (40)	0,19	0,32	0,26	0,38	0,39	1,54	0,25[b]
p5 (50)	0,34	0,41	0,25	0,31	0,33	1,65	0,26[b]

Observations of the intensity of attack on chickpea pods showed a significantly different effect. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 decreased the curve. This shows that giving PGPR concentrations of 0, 10, 20 mL L-1 causes a decrease in the intensity of attacks on chickpea pods in accordance with the addition of PGPR concentrations. Increasing PGPR concentrations of 30, 40 and 50 mL L-1 caused an increase in the curve. The average intensity of attack on the pods was the lowest in treatment p2 (20 mL L-1), which was 0.8%, while the highest number of branches was shown by the control (0 mL L-1), which was 0.44%.

The intensity of the attack on the pods of the plants that have been observed shows that the PGPR treatment makes the intensity of the attack lower than the plants without using PGPR (control). This is caused by the ability of PGPR to act as a biofertilizer, which helps provide nutrients needed by plants. One of them is by dissolving the P element bound in the soil. Element P has an effect on cell division, flowering, fertilization and plant immunity to certain diseases, therefore the use of PGPR will further accelerate the dissolution of element P, so that plant resistance to pest attacks is better maintained and can also increase pod and seed production in upright chickpea plants.

Table 3. Types of Pests and Symptoms of Infestation

Types of Insects	**Status**	**Treatment**					
		T0	**T1**	**T2**	**T3**	**T4**	**T5**
Larva *Orgyia leucostigma*	Pest		✓				
Black Looper (*Hyposidra talaca*)	Pest		✓	✓	✓	✓	✓
Leaf Roller (*Lamprosema indicare*)	Pest	✓	✓	✓	✓	✓	✓
Mealybug (*Paracoccus marginatus*)	Pest	✓				✓	
Pod Borer (*Maruca vitrata*)	Pest	✓	✓	✓	✓	✓	✓
Polyphagous Predator (*Rhinocoris fuscipes)*	Pest			✓	✓		
Mantis (*Mantodae*)	Predator	✓				✓	
Riptortus linearis (*Riptortus linearis*)	Predator	✓					
Bullet Ant (*Paraponera clavata)*	Predator		✓	✓			
Wasp Moth (*Hamata huebneri*)	Pollinator				✓		

ISSN 3031-0571

The most common pests found in the field are caterpillars (*Hyposidra talaca*) and caterpillars (*Lamprosema indicare*), as well as other pests that attack bean plants such as Orgyia leucostigma larvae, mealybugs (*Paracoccus marginatus*), pod borers (*Maruca vitrata*).

a. Black Looper (*Hyposidra talac*a)

Black looper (*Hyposidra talaca*) or caterpillar kilan, morphologically this caterpillar is very distinctive, because the way the caterpillar walks on tiptoe, the caterpillar is like the motion of the human hand when measuring by inch by inch, namely by means of the tip of the back body pulled to the front so that the body is curved, then the front body moves forward. Caterpillars move like that because caterpillars do not have legs in the middle of their body. If there is a disturbance, the caterpillar will straighten its body (supine position). The following is the classification of the caterpillar that attacks the leaves on bean plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Lepidoptera, Family: Geometridae, Genus: Hyposidra, Species: *Hyposidra talaca*. Caterpillars in their reproduction belong to the Holometabola insect group, which is a group of insects that experience four stages of development, namely eggs, larvae, pupae (cocoons), and imago.

Caterpillars (larvae) attack young leaves at the edges of the leaves by eating them, so that the edges of the leaves are torn, in severe attacks causing perforated leaves and bare plant shoots, so that only leaf bones remain. When the young leaves are exhausted, this pest will increase the attack to the old leaves below. Attacks generally occur at night until early morning. Caterpillars begin to actively damage bean plants from the time they hatch from eggs until they become pupae.

The high percentage of caterpillar attacks on bean plants is thought to occur due to the high rainfall factor, soil moisture becomes quite high and is favored by caterpillar larvae to breed. Based on observations in the field, it is known that the availability of young leaves as a source of food is quite abundant, making the caterpillar population increase, fluctuations in the caterpillar population are in line with changes in the intensity of the formation of young leaf shoots. If there are many shoots formed, the caterpillar population will increase. However, if there are few shoots formed, the caterpillar population will also be small.

Caterpillars have several natural enemies, including pathogens that attack caterpillars in the larval phase. There are also parasitoid flies from the Sarcophagidae family that attack the caterpillars in the pupa phase. Too much rainfall can cause high mortality in the larval vase. Larvae trapped by rainwater are unable to escape and die. In the pupal phase, soil moisture conditions that are too wet or too dry can also increase caterpillar mortality.

b. **Leaf Roller (*Lamprosema indicare*)**

Caterpillar (Lamprosema indicare) is a greenish larva, the head is light yellow and shiny, on the prothorax there is a pair of black spots, the type of mouth biting chewing. The following is the classification of the caterpillar found on chickpea plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Lepidoptera, Family: Pyralidae, Genus: Lamprosema, Species: *Lamprosema indicata.*

Leaf roller caterpillar pests attacked chickpea plants at the age of 35 HST. The attack began to spread evenly throughout the bean plants at the age of 50 HST. Observations showed that these caterpillars attacked the plants by rolling the leaves by gluing one leaf to another from the inner side with the adhesive substance it produces. Inside the leaf roll, the caterpillar eats the leaves of the plant until finally only the leaf bones are left. When the scroll is unrolled, blackish caterpillars or droppings are found. The larvae attack the second or third leaf from the shoot, in severe infestations the larvae also attack the shoot, then the leaf is pulled until it joins another leaf roll.

c. Orgyia leucostigma larvae

Orgyia leucostigma larvae are potential pests and not major pests, but they can become major pests if the ecosystem is disturbed and changed. Climate change characterized by a prolonged rainy season is the main factor causing caterpillar explosions.

The caterpillars found are brightly colored, the hair growing on the head is black and longer than the hair growing on other parts, the head is bright red and there is a white or yellow stripe on each side of the dorsal midline with a black stripe along the middle of the back. Bright red defense glands are visible from the rear end of the back. There are four white toothbrush-like tufts protruding from the back, and a gray-brown hair pencil at the back end, the larva is 1-1.5 inches long. The hairs all over the caterpillar's body cause an itchy reaction when in contact with the skin [39]. This caterpillar is the larva of one of the species of the Lymantridae (moth) family. The following is the classification of caterpillars found on chickpea plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Lepidoptera, Family: Erebidae, Genus: Orgyia, Species: *Orgyia leucostigma.*

ISSN 3031-0571

This caterpillar attacks T1R4 plants at the age of 3 weeks until harvest. Observations showed that this pest attacked the plants by eating the leaves of T1R4 bean plants and leaving only the leaf bones. The attack of this caterpillar on T1R4 plants was quite severe, making the plants slow to flower and have few fruits.

d. Mealybug (*Paracoccus marginatus*)

White fleas (*Paracoccus marginatus*) are a type of flea whose entire body is covered with a white waxy coating. The body is oval in shape with white hair-like appendages of short size. This pest consists of males and females and has several developmental phases, namely: egg, preadult (nymph), and imago phases. Paracoccus marginatus eggs are round, greenish-yellow in color and covered by a cotton-like mass and will hatch within 10 days. Here are the mealybugs found on chickpea plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Homoptera, Family: Pseudococcidae, Genus: Paracoccus, Species: *Paracoccus marginatus.*

Mealybug pests are usually clustered up to tens of thousands. They damage by sucking the liquid. All parts of the plant can be attacked from fruit to shoots. Observations show that this pest attacks plants on the shoots, causing the leaves to become stunted and wrinkled as if burned.

e. Pod borer (*Maruca vitrata*)

Pod borer (*Maruca vitrata*) is an important pest in bean plants that attacks flowers and pods. Eggs are laid on flowers, leaves and pods in clusters. One group of eggs consists of 2-4 eggs with a slightly flattened oval shape and yellowish white color with a length of up to 18 mm. The head is brown to black in color and each segment consists of dark spots along the body located on the back. The larval stage lasts for 10-15 days. The pupa forms in the soil or inside the pods. The brown body of the pupa is approximately 13.5 mm long and the pupa stage lasts 7-10 days. The following pod borers are found on chickpea plants: Kingdom: Animalia, Phylum: Arthopoda, Class: Insecta, Order: Lepidoptera, Family: Pyralidae, Genus: Maruca, Species: *Maruca vitrata* Fab.

This pest attacks the plant at the time of flowering and the symptoms and characteristics caused by the attack of this pest appear in the flowers and pods of plants that are damaged and then fall. One larva can damage 4-6 flowers per plant during its lifetime. Germination on the pods causes the seed pods on the bean plants to be damaged, the skin on the bean pods becomes perforated and from the holes come out wet gerek powder mixed with brown larvae feces.

Plant Height (cm)

The results of variance analysis of upright chickpea plant height showed the effect of PGPR application was significantly different. The average number of branches of bean plants can be seen in Table 4.

Table 4. Effect of Plant Growth Promoting Rhizobacteria on Upright Chickpea Plant Height 2, 4, 6, and 8 mst (cm)

PGPR concentrations ($mL\ L^{-1}$)	Plant Height			
	2 MST	4 MST	6 MST	8 MST
p0 (0)	12,3^{d}	25,9^{c}	35^{c}	45,2^{c}
p1 (10)	15,3^{b}	31,6^{b}	44^{b}	52,9^{b}
p2 (20)	16,8^{a}	37,5^{a}	53^{a}	61,1^{a}
p3 (30)	14,8^{bc}	30,^{b}	42,6^{b}	51,3^{b}
p4 (40)	14,5^{bc}	30,4^{b}	42,2^{b}	50,6^{b}
p5 (50)	14,2^{c}	30,2^{b}	41,2^{b}	50,1^{b}

The observation of the height of chickpea plants gives a very significantly different effect. This shows that the application of PGPR concentrations of 0, 10, 20 mL L-1 causes an increase in the height of chickpea plants in accordance with the addition of PGPR concentrations. The increase in PGPR concentrations of 30, 40 and 50 mL L-1 causes a decrease. The highest average plant height starting from 2, 4, 6 and 6 weeks after planting was found in treatment p2 (20 mL L-1), namely, 16.8; 37.5; 53; and 61.1 cm, and the lowest plant height was found in the control (without PGPR), namely, 12.8; 25.9; 35; and 45.2 cm.

ISSN 3031-0571

The treatment of Plant Growth Promoting Rhizobacteria (PGPR) dose had a very significant effect on the height of upright chickpea plants at the age of 2, 4, 6, and 8 weeks after planting. This shows that the provision of PGPR can increase the height of upright chickpea plants, with the provision of PGPR nutrients in the soil can increase and can be absorbed by plants optimally. PGPR can improve the quality of plant growth through the production of growth hormones, the ability to fix nitrogen to increase the supply of soil nitrogen, the producer of osmolytes as an osmoprotectant in drought stress conditions and the producer of certain compounds that can kill pathogens in plants.

PGPR can produce IAA, Cytokinin and Gibberellin, because IAA is an active form of auxin hormones found in plants that play a role in improving crop quality and yield, can increase cell development, stimulate growth, and increase enzyme activity. Auxin and Gibberellin are both found in embryos and apical epical meristems and function for cell elongation so that it is thought that these two hormones have an influence on plant height. However, because the response to hormones is usually not so dependent on the absolute amount of the hormone, but depends on its relative concentration compared to other hormones, it is suspected that this phenomenon is the influence so that even though the dose of PGPR is increased to a certain extent there is an increase in influence but not significantly different.

During the experiment, environmental conditions such as rainfall and high humidity will affect plant growth. The effect of PGPR on control with treatments (10; 30; 40; and 50 mL L-1) was not significantly different on plant height, presumably because plants could not absorb nutrients optimally. This is caused by high rainfall so that the soil in the planting media becomes dense which results in plant roots not being able to absorb nutrients optimally. Rainfall during the vergetative phase, namely April to June 2023 averaged 133; 271; and 159 mm per month, including quite high rainfall (100-300 mm per month) [27].

Number of Branches per Plant (branches)

The results of variance analysis of the number of branches on upright chickpea plants showed the effect of PGPR application was significantly different. The average number of branches of chickpea plants can be seen in Table 5.

Table 5. Effect of Plant Growth Promoting Rhizobacteria on the Number of Plant Branches

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p_0 (0)	6	4	4	5	4	23	4,2^c
p_1 (10)	5	5	8	4	6	28	6^b
p_2 (20)	5	6	7	4	5	27	6,4^b
p_3 (30)	7	7	8	8	8	38	8^a
p_4 (40)	5	4	6	5	6	26	5,8^b
p_5 (50)	4	7	4	5	4	24	5,6^b

Observations of the number of branches of chickpea plants gave a significantly different effect. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 30 mL L-1 increased the curve. This shows that giving PGPR concentrations of 0, 10, 20 and 30 mL L-1 causes the highest number of branches in accordance with the addition of PGPR concentrations. An increase in PGPR concentration of 40 and 50 mL L-1 causes a decrease in the curve.

The results of variance analysis of the effect of PGPR application with different concentrations showed significantly different on the number of branches on upright chickpea plants. Comparison test using BNT at 5% level showed that the treatment of 5% BNT test results showed that among the five PGPR treatments (10; 20; 40; and 50 mL L-1) were not significantly different, but all four were significantly different from p0 (0 mL L-1) and p3 (30 mL L-1). Between p0 (0 mL L-1) and p3 (30 mL L-1) were significantly different. The average number of branches is most shown by p3 (30 mL L-1), which is 8 branches, while the least number of branches is shown by the control (0 mL L-1), which is 4.2 branches.

The number of branches of bean plants with PGPR treatment is more than the number of branches on plants that are not treated with PGPR (control). This is because nitrogen (N) nutrients in plants treated with PGPR are thought to be more available in sufficient quantities compared to bean plants that are not treated with PGPR (control). Nitrogen contained in PGPR is very beneficial for growth, namely (1) making plants fresher green and containing many green leaf grains that play a role in the photosynthesis process, (2) accelerating plant growth (height, branches, etc.), (3) increasing protein content in plants.

In addition, rooting bacteria can help plant roots absorb nitrogen better than plants that are not treated with PGPR. Plant Growth Promoting Rhizobacteria contains a group of beneficial bacteria that are around plant roots, able to increase free nitrogen which helps in plant growth.

Plant Age at Flowering (HST)

The results of variance showed that the effect of PGPR concentration was significantly different on plant age at flowering. The average age of bean plants can be seen in Table 6.

Table 6. Effect of *Plant Growth Promoting Rhizobacteria* on Plant Age at Flowering (HST)

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p_0 (0)	41	41	42	40	41	205	$42,2^{a}$
p_1 (10)	38	37	38	41	40	194	$37,8^{c}$
p_2 (20)	36	36	37	36	38	183	$36,2^{d}$
p_3 (30)	38	41	38	40	39	196	38^{bc}
p_4 (40)	40	40	39	39	41	199	$39,6^{bc}$
p_5 (50)	40	41	40	41	40	202	$39,2^{b}$

The observation of the age of flowering plants gives a very different effect. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 increased the curve. This shows that giving PGPR concentrations of 0, 10, and 20 mL L-1 causes the age of flowering plants to be faster in accordance with the addition of PGPR concentrations. An increase in PGPR concentration of 40 and 50 mL L-1 causes a decrease in the curve.

Based on Table 6. shows that PGPR treatment p2 (20 mL L-1) is the treatment that appears the fastest flowers compared to other treatments, namely, 36.2 hst and the slowest is found in the control (without PGPR), namely, 42.2 hst. Vegetative growth that affects the age of flowering in plants is not only influenced by a treatment alone but also influenced by the environment in which it lives. In addition to environmental and genetic factors, soil factors, availability of light, water and nutrients also play a role in triggering the flowering process. The availability of nutrients for bean plants will affect the growth of the vegetative phase, where plants will accelerate their generative phase.

Plant Growth Promoting Rhizobacteria (PGPR) is useful as a growth regulator (biostimulant) that can produce the hormone gibberellin. Gibberellins are able to stimulate flower growth and strengthen stem conditions in bean plants. In addition, in the flowering phase, gibberellin plays a role in preventing flower shedding.

PGPR can prevent the flowering process in plants because of the presence of rooting bacteria that help plants absorb and meet nutrient needs [31] Rooting bacteria contained in PGPR function to dissolve and increase the availability of phosphorus (P) in the soil which can later be absorbed by plants through the roots. The element P functions as a component of cell membranes, seed formation, reduces fruit loss, stimulates root growth, especially the roots of young plants, accelerates and strengthens the growth of young plants into mature plants while accelerating flowering.

The flowering age is the slowest in the dick treatment (without PGPR) because there is no PGPR given compared to other plant treatments that are absorbed by plant roots, causing the flowering age to be late. P-deficient soils while ultisol soils are very poor in P. The consequences of P deficiency in utilization include physical, chemical and biological properties that are less supportive of soil growth. The pH value, which is usually acidic, and the nutrient content, especially P, which is low due to P diksation are obstacles to plant growth.

Plant Age at Harvest (HST)

The results of variance analysis showed that the application of PGPR was significantly different on the age of upright chickpea plants at harvest. The average harvest age of bean plants can be seen in Table 7.

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Table 7. Effect of *Plant Growth Promoting Rhizobacteria* on Plant Age at Harvest (HST)

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p0 (0)	68	67	68	67	68	338	68[a]
p1 (10)	64	64	65	64	65	322	65[c]
p2 (20)	64	65	64	64	65	322	63,4[d]
p3 (30)	65	65	66	68	65	329	66[bc]
p4 (40)	67	65	67	67	65	331	66,4[b]
p5 (50)	68	67	65	68	65	333	66,8[b]

The observation of the age of harvest plants gives a very different effect. Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 increased the curve. This shows that giving PGPR concentrations of 0, 10, and 20 mL L-1 causes the age of flowering plants to be faster in accordance with the addition of PGPR concentrations. An increase in PGPR concentration of 40 and 50 mL L-1 causes a decrease in the curve.

Based on (Figure 6) shows that PGPR treatment p2 (20 mL L-1) is the treatment with the fastest age compared to other treatments, namely, 63.4 hst, while the age of plants at harvest is the slowest shown by p0 (0 mL L-1), which is 68 hst. This is because the provision of PGPR with a concentration of p2 (20 mL L-1) in increasing the age of harvest because the bacteria in PGPR stimulate the formation of hormones so that plants are more fertile.

The benefit of PGPR is as a biostimulant (growth regulator) that is useful for the process of growth and fertilization in plants. Gibberellin produced by PGPR is not only useful for flowering in plants, but also helps accelerate the formation of fruit ovules.

In addition to containing gibberellins, PGPR contains phosphorus (P) nutrients that play a role in the pod maturation process. Phosphorus (P) is useful for improving flowering, fruit formation and maturation, seed formation, and accelerating harvest age. In addition to phosphorus (P) from PGPR, phosphorus from the soil is dissolved by Rhizobium contained in PGPR because Plant Growth Promoting Rhizobacteria also produce Rhizobium bacteria that breed in plant roots. Rhizobium bacteria can help dissolve P so that P absorption becomes better.

Number of Pods per Plant (fruit)

The results of variance analysis showed that the application of PGPR was significantly different on the number of pods of upright chickpea plants per plant. The average harvest age of bean plants can be seen in Table 8.

Table 8. Effect of Plant Growth Promoting Rhizobacteria Number of Pods per Plant (fruit)

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p0 (0)	28	29	24	24	30	135	25,5[c]
p1 (10)	32	34	29	27	26	148	31,2[b]
p2 (20)	38	37	33	39	33	180	36[a]
p3 (30)	28	28	25	28	29	138	30[b]
p4 (40)	32	28	31	26	31	148	29,6[b]
p5 (50)	29	32	36	32	33	162	29,4[b]

The observation of the number of pods per plant gave a significantly different effect. The application of PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 experienced an increase in the curve. This shows that giving PGPR concentrations of 0, 10, and 20 mL L-1 causes the number of pods per plant to increase faster in accordance with the addition of PGPR concentrations. Increasing PGPR concentrations of 40 and 50 mL L-1 caused a decrease in the curve.

Based on Table 8, it shows that PGPR treatment p2 (20 mL L-1) is the treatment with the highest number of pods compared to other treatments, namely 36 pods, while the least number of pods is shown by p0 (0 mL L-1), namely 25.6 pods.

ISSN 3031-0571

This is due to the presence of gibberellins in the PGPR solution that can help ripen the fruit [38]. Therefore, upright chickpea plants given PGPR averaged more number of pods such as p2 (20 mL L-1), which is (36 pieces), followed by p1 (10 mL L-1), which is (31.2 pieces), p3 (30 mL L-1), which is (30 pieces), p4 (40 mL L-1), which is (29.6 pieces), and p5 (50 mL L-1), which is (29.4 pieces), while the least plant pods in the treatment p0 (0 mL L-1), which is 25.5 pieces.

Besides gibberellins, PGPR also contains phosphorus. Phosphorus is an essential nutrient that plays a role in pod formation. In addition to containing nutrients that can be absorbed by plants, PGPR also contains P-solubilizing bacteria. Pseodomonas sp. and Bacillus sp. bacteria contained in PGPR are useful for absorbing P elements available in the soil to meet the nutrient needs of plants.

High rainfall can cause disease, reduce crop quality and yield components. This is in accordance with the weather conditions at the time of the study. The high rainfall caused some bean pods to rot, so they could not be harvested,

Pod Weight per Plant (g)

The results of variance analysis showed that the application of PGPR was significantly different on the weight of upright chickpea pods per plant. The average harvest age of chickpea plants can be seen in Table 9.

Table 9. Effect of Plant Growth Promoting Rhizobacteria on the Number of Pod Weights per Plant (g)

PGPR concentrations (mL L^{-1})	Repeat					Total	Average
	1	2	3	4	5		
p0 (0)	14	13	16	18	17	78	17^{c}
p1 (10)	29	18	27	20	14	108	$27{,}2^{b}$
p2 (20)	37	29	35	43	24	168	$33{,}6^{a}$
p3 (30)	20	29	28	24	17	118	$26{,}4^{b}$
p4 (40)	29	23	20	26	27	125	26^{b}
p5 (50)	23	27	29	27	30	136	$25{,}2^{b}$

Giving PGPR with a concentration of 0 mL L-1 up to a concentration of 20 mL L-1 increased the curve. This shows that the application of PGPR concentrations of 0, 10, 20 mL L-1 causes an increase in the weight of fresh pods of chickpeas in accordance with the increase in PGPR concentration. Increasing PGPR concentrations of 30, 40 and 50 mL L-1 causes a decrease in the curve. The highest average weight of chickpea pods in treatment p2 (20 mL L-1), which is 33.6 g, while the lowest weight of chickpea pods in treatment p0 (0 mL L-1), which is: 17 g.

Plant Growth Promoting Rhizobacteria contains phosphorus needed by plants during the process of pod and seed formation. In addition to getting phosphorus from PGPR, plants can absorb phosphorus in the soil, because PGPR contains bacteria Pseudomons sp. and Bacillus sp. which play a role in helping plants meet their phosphorus needs. Nutrients from soil and cow dung fertilizer can be dissolved by these bacteria so that plants given PGPR provide better fresh pod weight compared to the control.

Pseudomons sp. and Bacillus sp. bacteria present in PGPR help plants absorb phosphorus by converting these nutrients into soluble and available nutrients for plants. During the pod filling process, the role of nutrients, especially phosphorus, is needed to stimulate fruit and seed formation in plants, the largest period of phosphorus use by plants occurs since pod formation until about 10 days before seeds begin to develop.

Phosphorus is a necessary nutrient in plants, functioning to accelerate the harvest period, stimulate flower growth, and increase flowers into seeds and fruits [44]. Pods that are not perfectly filled are caused by phosphorus deficiency. Lack of phosphorus nutrient causes the pods to form incompletely [45].

CONCLUSION

Based on the results of research on the effect of Plant Growth Promoting Rhizobacteria for bean plant resistance to pests, it can be concluded as follows:

1. The results showed that the application of Plant Growth Promoting Rhizobacteria (PGPR) was able to control pests in upright chickpea plants.

ISSN 3031-0571

2. The results showed that the best results were at a concentration of 20 mL PGPR L-1 with the lowest pest attack intensity (16.20%), pod attack intensity (0.08%), number of branches (6.4 branches), plant age at flowering (36.2 HST), plant age at harvest (63.4 HST), number of plant pods (36 pieces) and pod weight per plant (33.6 g).

ACKNOWLEDGMENTS

Thank you to Mr. Rosfiansyah, S.P., M.Si., Ph.D. as the first examiner and Dr. Ir. Muhammad Akhyar Roeslan, M.P. as the second examiner who has given direction and input.

REFERENCES

A. Dwi Prasetyo and S. Joko Santoso. 2021. "KAJIAN PESTISIDA NABATI TERHADAP HAMA ULAT PENGGULUNG DAUN (Lamprosema indicata) PADA TANAMAN KACANG TANAH (Arachishypogaea L.)," Jurnal Inovasi Pertanian, vol. 23, no. 2, p.

C. Poniman, T. Sunardi, and H. Pujiwati. 2020. "SERANGAN HAMA PENGGEREK POLONG PADA ENAM VARIETAS KEDELAI DAN PENGARUHNYA TERHADAP HASIL," Jurnal Ilmu-Ilmu Pertanian Indonesia, vol. 22, no. 1, pp. 38–44,doi: 10.31186/jipi.22.1.38-44.

D. Persemaian, H. Nurul Hidayah, A. Irawan, dan Illa Anggraini, B. 2017. Penelitian dan Pengembangan Lingkungan Hidup dan Kehutanan Manado Jl Tugu Adipura Raya Kel Kima Atas Kec Mapanget Kota Manado Telp, and P. Litbang Hutan Jl Raya Gunung Batu No, "Serangan Ulat Jengkal (Hyposidra talaca Wlk.) Pada Bibit Pakoba (Syzygium luzonense (Merr.).

E. Ritonga and D. Mardawilis. 2018. "POLA TANAM TANAMAN PANGAN DAN SAYURAN DI KABUPATEN KAMPAR PROVINSI RIAU."

M. L. A. Hosang, J. C. Alouw, and D. F. Djufry. 2017. "Ulat Bulu Orgyia sp. (Lepidoptera: Erebidae), Hama Potensial pada Tanaman Kelapa Sawit Hairy Caterpillar, Orgyia sp. (Lepidoptera: Erebidae), Potential Pest on Oil Palm,".

Muh Yusuf Idris. 2022. "PENGARUH PEMBERIAN BERBAGAI KONSENTRASI PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR) PADA AKLIMATISASI ANGGREK Dendrobium sp," Journal TABARO, vol. 6, no. 1.

N. Pramayudi dan Hartati Oktarina. 2018. "BIOLOGI HAMA KUTU PUTIH PEPAYA (Paracoccus marginatus) PADA TANAMAN PEPAYA The Biological Study of Papaya Mealybug (Paracoccus marginatus) on Papaya," Prodi Agroteknologi Fakultas Pertanian Universitas Syiah Kuala Darussalam Banda Aceh.

N. , S. H. , C. I. , dan T. A. Rosdah Thalib1*). 2019. "Spesies Ulat Bulu dan Tanaman Inangnya yang Ditemukan di Daerah Sumatera Selatan," pp. 1–17.

P. Nur Azizah and N. Arfarita. 2021. "APLIKASI LAPANG PUPUK HAYATI VP3 DIBANDINGKAN DENGAN EMPAT MACAM PUPUK HAYATI YANG BEREDAR DI PASARAN TERHADAP PRODUKSI TANAMAN KEDELAI (Glycine max L.),".

S. M. S. Evi Oktaviani. 2018. "PENGARUH PEMBERIAN Plant Growth Promoting Rhizobacteria (PGPR) TERHADAP PERTUMBUHAN DAN HASIL TANAMAN KAILAN (Brassica oleraceae var. Acephala) SISTEM VERTIKULTUR," pp. 1–23.

St. Subaedah, N. Netty, and A. Ralle. 2021. "Respons Hasil beberapa Varietas Kedelai terhadap Aplikasi Pupuk Fosfat," Agrotechnology Research Journal, vol. 5, no. 1, p. 12, doi: 10.20961/agrotechresj.v5i1.39650

T. D. Schowalter. 2018. "Biology and Management of the Whitemarked Tussock Moth (Lepidoptera: Erebidae)," J Integr Pest Manag, vol. 9, no. 1, doi: 10.1093/jipm/pmy016.