Open Science and Technology
Volume 5, Issue 1, 10-17.
E-ISSN :2776-1681
https://opscitech.com/journal
DOI: 10.33292/ost.vol5no1.2025.135

Effect of Potassium and Plant Growth Promoting Rhizobacteria on Mung bean Yield

Sumiarjo Kiswondo[1]*

[1]Department of Agrotechnology, Faculty of Agriculture, Moch Sroedji University, Jember, Indonesia

*Corresponding author's email: sum14rjok@gmail.com

Article Info

Article history:

Received: 26 January 2025
Revised: 5 February 2025
Accepted: 7 February 2025
Published: 30 May 2025

Keywords:

Potassium (KNO_3),
Plant Growth Promoting Rhizobacteria,
Mung Bean Plants.

Abstract

Background: Mung beans (*Vigna radiata* L.) are a family of legumes and have great potential to be developed because they are one of the food crops widely consumed by the Indonesian people, market demand continues to increase both domestically and for export. However, according to the Directorate General of Food Crops (2022), in the 2021 annual report, in East Java mung bean production has decreased since 2017 - 2021. Potassium (KNO_3) is a useful nutrient to meet plant needs, as well as increase yields and resistance to pests and diseases of mung bean plants. PGPR (Plant Growth Promoting Rhizobacteria) are biological agents around plant roots (rhizosphere) and play an important role in increasing plant growth and development, have a positive effect both directly and indirectly, mobilize the absorption of nutrients by plants and play a role in the fixation of free nitrogen into ammonia that can be absorbed by plants.

Aims: The purpose of the study was to determine the effect of potassium and PGPR and the interaction of the two treatments on the yield of mung bean plants (*Vigna radiata* L).

Methods: The research method used a factorial Randomized Block Design (RBD), consisting of two treatment factors and 3 (three) replications. The first factor was Potassium (K), consisting of 3 treatment levels, namely K1: 50 kg KNO_3 per hectare, K2: 100 kg KNO_3 per hectare, K3: 150 kg KNO_3 per hectare. The second factor was PGPR fertilizer (P), consisting of 3 treatment levels, namely P1: 6 ml PGPR per liter of water, P2: 12 ml PGPR per liter of water, and P3: 18 ml PGPR per liter of water. The variables observed were plant height, stem diameter, number of pods, pod weight and dry seed weight.

Result: The results of the study showed that there was an interaction between the treatment of potassium 150 kg KNO_3 per hectare with PGPR 12 ml/L (K3P2) on the growth and yield of mung bean plants, the height of plants at 45 HST was 39.36 cm, the diameter of the stem at 45 HST was 8.16 mm, the number of pods was 22.33 pieces, the weight of the pods was 91.85 grams, and the weight of the seeds was 65.68 grams. The single factor of potassium treatment of 150 kg KNO_3 per hectare (K3) and PGPR 12 ml/L (P2) gave the best effect on the growth of plant height, stem diameter and the results of the number of pods, pod weight and seed weight of mung bean plants.

To cite this article: Kiswondo, S. (2025). Effect of potassium and plant growth promoting rhizobacteria on mung bean yield. *Open Science and Technology*, *5*(1), 10-17.

1. Introduction

Mung beans (*Vigna radiata* L.) are a family of legumes and have great potential to be developed because mung beans are one of the food crops widely consumed by the Indonesian people. The demand for mung beans is quite high and tends to increase from year to year, while the increase in the rate of area of plants is still below of corn and soybeans. The nutritional content of mung beans includes 62.90 grams of carbohydrates, 20.00 grams of protein, 1.20 grams of fat, also contains 157.00 SI of Vitamin A, 10.64 grams of Vitamin B, 6.00 grams of Vitamin C and minerals Ca, P, Fe and contains 345 grams of calories (Rusmana, 2017). Mung beans are the third most widely cultivated legume crop after soybeans and peanuts. Mung beans are one of the strategic commodities because market demand has not decreased and continues to increase, both domestically and for export. However, the high demand for mung beans is not balanced by the availability and production of mung beans (Wang et al., 2022). According to the (Directorate General of Food Crops, 2022) in the 2021 annual report, in East Java, mung bean production has decreased since 2017 - 2021, namely 52,403 tons of dry weight (2017), 40,780 tons of dry weight (2018), 26,464 tons of dry weight (2019), 28,382 tons of dry weight (2020) and 34,841 tons of dry weight (2021). In line with the report on the area of mung bean harvest since 2017 - 2021, namely 45,325 Ha (2017), 32,110 Ha (2018), 38,690 Ha (2019), 37,956 Ha (2020) and 32,339 Ha (2021). Potassium is a nutrient that is useful for meeting the nutrient needs of plants and improving the soil. The benefits of potassium are that it can increase plant resistance to pests and diseases, and increase crop yields. Potassium fertilizer as a source of nutrients for mung bean plants together with phosphorus to help growth, protein formation, root formation, accelerate fruit or seed maturity and strengthen plants. Lack of potassium leaves will turn yellow and will affect the photosynthesis process so that mung bean production will decrease. Based on the results of the study, the results of this study indicate that the provision of KCl fertilizer can increase the growth and yield of mung bean plants, namely the number of pods of 15.52 fruits and a seed weight of 9.72 grams per plant (Wang *et al.*, 2022).

The application of potassium fertilizer can be given especially when entering the flowering period, because it helps increase the activity of seed or fruit formation in plants Based on the results of the study by Wang et al. (2022), potassium can increase the growth and yield of mung bean plants. According to Syahira et al. (2019), PGPR (*Plant Growth Promoting Rhizobacteria*) is a biological agent found around plant roots (rhizosphere) and is classified as a microbe that plays an important role in increasing plant growth and development, has a positive effect on plants both directly and indirectly, mobilizes the absorption of nutrients by plants, plays a role in the fixation of free nitrogen into ammonia which can be absorbed by plants because it contains Rhizobium sp. bacteria. While indirectly, the role of PGPR is to produce antibiotic compounds that can reduce the activity of pathogens that are detrimental to plants. Based on the results of Syahira *et al.* (2019), there was an interaction between the treatment of PGPR concentration of 15 ml/liter and the composition of the soil planting media 75%: 25% compost (P3M1) which gave the best effect on the variables of plant height, dry weight of the crown, total dry weight and weight of 100 seeds in mung bean plants. Based on the study above, there is interest from researchers to conduct further research related to the use of Potassium and PGPR combined in mung bean plants. The aim of the study was to determine the effect of potassium and PGPR and the interaction of the two treatments on the yield of mung bean (*Vigna radiata* L) plants.

2. Materials and Methods

2.1 Experimental Site Description

The research was conducted from May to July 2024 in Mangaran Village, Jenggawah District, Jember Regency, with an altitude of ± 110 meters above sea level, an average temperature of 25º-32º. The materials in the study were Vima-1 variety mung bean seeds, Pak Tani white KNO_3 fertilizer, Plant Growth Promoting Rhizobacteria (PGPR) (PokTan Mandiri Kamal Arjasa Jember), manure, soil, polybags. The tools in this study were hoes, sickles, scales, meters, digital calipers, buckets, plastic ropes, cameras, trays, and labels.

The design used in the study used a Factorial Randomized Block Design (RAK), consisting of two treatment factors and 3 (three) repetitions. The treatment factors are:

Potassium factor (KNO_3 fertilizer) (K), consists of 3 treatment levels, namely:

K1: 50 kg KNO_3 per hectare equivalent to 300 mg per plant

K2: 100 kg KNO_3 per hectare equivalent to 600 mg per plant

K3: 150 kg KNO_3 per hectare equivalent to 900 mg per plant

PGPR factor (P), consists of 3 treatment levels, namely:
P1: 6 ml/l water
P2: 12 ml/l water
P3: 18 ml/l water

There are 9 (nine) treatment combinations with 3 (three) replications, so there are 27 experimental units. The combination of treatments between Potassium (K) and PGPR (P) is presented in the following table:

Potassium or Kalium (K)	PGPR (P)		
	P1	P2	P3
K1	K1P1	K1P2	K1P3
K2	K2P1	K2P2	K2P3
K3	K3P1	K3P2	K3P3

Data analysis using F Test (analysis of variance) with 5% and 1% levels. If the F test results of each treatment factor are significantly different, then it is continued with Duncan's α 5% test analysis (Duncan's Multiple Range Test). Duncan's further test is carried out to determine the effect of each treatment level

2.2 Stages of Research Implementation

Sowing: Mung bean seeds are planted 0.5 cm from the surface of the seedling tray media and the humidity is maintained, carried out for 7 HSS (Days after sowing). *Preparation of Planting Media:* Prepared 30x30 cm polybags as many as 108 polybags (estimated soil weight 17 kg per polybag), then filled with planting media of manure and soil in a ratio of 2:1 Planting. When the seedlings have 2-3 leaves or 7 HSS, transplanting is carried out, planting with a spacing of 40 x 15 cm, each polybag is planted with 1 seedling. Planting is done in the afternoon at 15.00 WIB, because the weather is not too hot so it can prevent wilting in plants. Replanting is done if there are unhealthy seedlings with spare seedlings. The population of mung bean plants is 4 plants per experimental plot.Watering. Implementation is carried out in the morning or evening, evenly distributed over the entire surface of the plant media, approximately 220 - 440 ml, adjusted to weather conditions.

Fertilization: Application of SP-36 base fertilizer 100 kg / ha is carried out 5 HST (day after planting) by burying it around the plant stem at a distance of 5 cm. *Treatment Application:* Application of Potassium (white KNO_3 fertilizer) is done twice with a time interval of 2 weeks once at the age of 15 and 30 HST, by pouring it around the stems of the mung bean plants according to the treatment, namely K1 50 kg KNO_3 per hectare equivalent to 300 mg per plant, K2 100 kg KNO_3 per hectare equivalent to 600 mg per plant, K3 150 kg KNO_3 per hectare equivalent to 900 mg per plant. While PGPR is done three times with a time interval of 2 weeks once at the age of 15, 30, and 45 HST by pouring it around the stems of the mung bean plants according to the concentration of P1 6 ml/l of water, P2 12 ml/l of water, and P3 18 ml/l of water. *Pest and Disease Control:* Control of pest and disease attacks, then control is carried out every week. Initially, it was done manually, but if the pest and disease attacks increased and had exceeded the threshold, then it was done chemically using a type of pesticide with the active ingredient chlorpyrifos.*Weed Control*: Weeding is done manually, carried out when the plants are 2 MST old. Weeding aims to control weeds that grow in the mung bean planting area. *Harvesting:* Harvesting is carried out in stages after the plants are 60 days old with the criteria that many leaves have turned yellow and the pods are black.

2.3 Observation Variables

Plant Height (cm): Measurements begin when the plants are 15, 30, and 45 HST old with a ruler. *Stem Diameter (mm)*: Measurement of the diameter of the main stem using a vernier caliper at a height of 5 cm from the ground surface, carried out at the ages of 15 HST, 30 HST, and 45 HST. *Number of Pods (fruit):* Calculation of the number of finished pods on all plants together during the harvest phase. *Pod Weight (grams)*: The weight of the fruit is weighed after the fruit is harvested with the criteria that the fruit is black.

Dry Seed Weight (grams Seed): weight is weighed after the pods are dried first and peeled from the fruit skin.

3. Results dan Discussion

The results of the analysis of variance (F Test) at 5% and 1% levels of the effect of treatment on the observation variables are listed in the following table. Furthermore, the observation variables that have a significant effect are tested using the Duncan test analysis at 5% level.

Table 1. Summary of variance analysis of the effect of treatment on observation variables.

Observation Variable	Treatment		
	Potassium (K)	*PGPR (P)*	*Interaction K x P*
Plant height 15 HST	**	**	**
Plant height 30 HST	**	**	**
Plant height 45 HST	**	**	**
Stem diameter 15 HST	**	**	**
Stem diameter 30 HST	**	**	**
Stem diameter 45 HST	*	**	**
Number of Pods	**	**	**
Pod Weight	**	**	**
Seed Weight	**	**	**

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

Plant Height

Plant height is positively correlated with stem diameter. The growth of mung beans is interpreted in plant height as one form that mung bean plants are able to absorb nutrients in the soil. Based on table 2, the results of further tests of the interaction of Potassium and PGPR treatments are presented which provide a very significant difference in plant height. Table 2. Duncan α 0.05 test results for the effect of interaction between Potassium and PGPR treatments on plant height observations

Tabel 2. Hasil uji Duncan α 0,05 untuk pengaruh interaksi antara perlakuan Kalium dan PGPR pada pengamatan tinggi tanaman

Treatment	**Plant height (cm)**					
	15 HST		**30 HST**		**45 HST**	
P1K1	10.74	a	20.43	a	32.74	a
P1K2	11.38	b	20.97	bc	33.57	ab
P1K3	11.18	ab	20.80	b	33.40	a
P2K1	11.99	c	21.15	cd	34.92	c
P2K2	12.21	cd	21.39	c	35.46	cd
P2K3	13.72	e	22.93	f	39.36	e
P3K1	11.84	bc	21.05	c	34.33	b
P3K2	12.60	d	21.77	e	36.76	d
P3K3	12.29	cd	21.53	de	36.23	d

Description: : The same letter notation in the same column indicates no significant difference in the Duncan test at a significance level of α 5%; HST = days after planting

Based on the table above, it shows that the interaction of P2K3 treatment (PGPR dose 12 ml/l and Potassium 150 kg/ha) on mung beans aged 15-45 HST experienced an increase in plant height for each observation of 13.72 cm, 22.93 cm and 39.36 cm. Compared to the P1K1 treatment (PGPR dose 6 ml/l and Potassium 50 kg/ha) gave the lowest average value for ages 15-45 HST of 10.74 cm, 20.43 cm and 32.74 cm. This is suspected that the nutrients provided are sufficient for the growth period of mung beans. The PGPR dose of 12 ml/l and Potassium 150 kg/ha was able to produce a plant height at age 45 HST of 39.36

cm, although below the description of the Vima-1 variety of mung beans, which is 53 cm. Furthermore, it is suspected that the height of the plant is influenced by environmental factors and water availability during the growth phase. Potassium is believed to help plants accelerate plant growth and development, strengthen plants, and prevent flower and fruit loss. This is in line with Hastuti *et al.* (2018) that potassium can stimulate plant growth and root development, prevent flower and fruit loss, improve the quality and quality of plant yields, and accelerate the flowering and fruiting process of plants. According to Sagay *et al.* (2020), plants really need high nitrogen elements for the growth process, if plants lack N it causes stunted plants. The results of Syahira *et al.* (2019) showed that PGPR treatment was able to have a positive effect on plant height, weight of 100 seeds, and number of mung bean pods.

Stem Diameter

Stem diameter is a plant size measured at the base of the plant using a caliper. Based on the results of the 5% F test analysis of variance, it showed that there was an interaction between Potassium and PGPR treatments which had a significant effect on stem diameter at the age of 15-45 HST. Table 3 is the result of further testing of the average stem diameter value.

Table 3. Results of the Duncan α 0.05 test for the effect of interaction between Potassium and PGPR treatments on observations of plant stem diameter.

Treatment	Plant stem diameter (mm)		
	15 HST	30 HST	45 HST
P1K1	4.31 a	6.13 a	7.13 a
P1K2	4.39 b	6.36 bc	7.47 b
P1K3	4.37 b	6.28 b	7.18 ab
P2K1	4.48 cd	6.48 cd	7.57 bc
P2K2	4.52 d	6.54 d	7.67 bc
P2K3	4.67 f	7.18 f	8.16 d
P3K1	4.45 c	6.43 c	7.52 bc
P3K2	4.59 e	6.69 e	7.79 c
P3K3	4.55 de	6.62 de	7.68 bc

Description: The same letter notation in the same column indicates no significant difference in the Duncan test at a significant level of α 5%; HST = days after planting.

Table 3 above shows the interaction of Potassium and PGPR treatments on stem diameter 15-45 HST. The interaction of treatments with the highest average value is P2K3 (Potassium 150 kg/ha and PGPR 12 ml/l) compared to other treatments. Based on the table above, it shows that the interaction of P2K3 treatment (PGPR dose 12 ml/l and Potassium 150 kg/ha) on mung beans aged 15-45 HST experienced an increase in plant stem diameter of 4.67 mm, 7.18 mm and 8.16 mm. Compared to the P1K1 treatment (PGPR dose 6 ml/l and Potassium 50 kg/ha) gave the lowest average value at the age of 15-45 HST of 4.31 mm, 6.13 cm and 7.13 cm. This is suspected that the nutrients provided are sufficient for the growth period of mung beans. The dose of PGPR 12 ml/l and Potassium 150 kg/ha can produce a stem diameter of 45 HST plants of 8.16 mm. The addition of KNO_3 fertilizer can increase the availability of nutrients in the soil. One of the nutrients that plays an important role in the vegetative phase of mung bean plants is nitrogen and potassium. The results of research by Hussain et al. (2016), that Potassium fertilizer plays an important role in the process of cell metabolism through the absorption of nutrients from the soil which are distributed to plant tissue. In addition, the N element in NO_3^- plays a role in regulating plant growth in the vegetative phase. The elements N and K have functions in plant metabolism and growth, K plays a role during the generative phase because in the vegetative phase K is not absorbed much by plants. The need for nutrients during generative is needed to increase in conditions that are sufficient to support vegetative and generative growth. PGPR can optimize the absorption and utilization of N elements needed in the vegetative phase (Handayani, 2024). The use of N affects the synthesis of carbohydrates in plant cells. Potassium also acts as a plant stem strengthener so that the plant is sturdy. Meanwhile, PGPR can bind free N2 in the air which is converted into N for plants for root growth so that K absorption can be maximized to support photosynthesis. Based on Syahira et al. (2024), it shows that PGPR 15 ml/L has a positive effect on plant height, plant stem diameter, dry weight, seeds, and seed weight. Giving PGPR can increase plant growth because there is Bacillus sp. which can stimulate plant growth and development in the vegetative phase.

Number of Pods

Observation of the number of filled pods per plot was carried out by counting all the pods that were full or filled in each mung bean sample and was carried out at the end of the harvest period. Based on the analysis of variance table 4, it shows that there is an interaction and a very significant effect of the application of Potassium and PGPR on the number of mung bean pods 60 HST. The treatment of Potassium 150 kg/ha and PGPR 12 ml/l) (P2K3) produced the highest average number of pods. The treatment also produced an average number of pods higher by 22.33 fruits than other treatments.

Table 4. Duncan's α 0.05 test results for the effect of interaction between PGPR treatment and KNO3 fertilizer on observations of the number of pods, pod weight and seed weight per plant aged 60 HST.

Treatment	Number of pods (fruit)	Pod weight (grams)	Seed weight (grams)
P1K1	12.48 a	58.00 a	39.14 a
P1K2	14.82 b	65.98 b	48.94 bc
P1K3	14.56 b	61.40 ab	46.74 b
P2K1	16.73 c	74.77 cd	54.65 d
P2K2	15.60 bc	72.39 c	51.93 cd
P2K3	22.33 e	91.85 f	65.68 f
P3K1	15.63 bc	69.53 bc	49.82 c
P3K2	19.83 d	85.63 e	58.97 e
P3K3	18.28 cd	79.46 d	55.43 d

Description: The same letter notation in the same column indicates no significant difference in the Duncan test at a significance level of α 5%; HST = days after planting.

In line with Haidlir (2019), stating that unmet N and K needs can result in a lack of nutrient supply for plants in increasing plant growth and seed filling during the generative phase. K needs increase with increasing plant yields, because the function of K is related to photosynthesis (Haidlir, 2019). Furthermore, according to Azril (2022), potassium is very influential in the vegetative phase of plants, so the availability of potassium is very important for plant growth and development so that it will also affect the high and low plant yields. Potassium also plays a role in the process of photosynthesis and respiration, plays a role in the formation of starch, enzyme activators, stomata opening, physiological processes in plants, metabolic processes in cells, affects the absorption of other elements, increases resistance to drought and disease and improves the root system, forms stronger stems, and affects plant yields. According to Mustafa (2022), PGPR is a bacteria that can colonize plant roots so that they are able to absorb elements that can increase plant growth and production. According to Yuni *et al.* (2019), bacteria in PGPR can also dissolve P and K fertilizers so that the absorption of P and K nutrients is maximized. KNO_3 fertilizer given to plants shows a very significant difference.

Pod Weight

Based on the analysis of variance, it shows that there is an interaction between the behavior of PGPR and KNO3 fertilizer and is significantly different from the weight of mung bean pods with a dose of 150 kg/ha Potassium and 12 ml/l PGPR (P2K3) has a larger pod weight and is significantly different from other treatments, namely 91.85 grams. It is suspected that Potassium and PGPR can provide macro and micro nutrients in the soil so that absorption by plants is maximized. According to Aminah *et al.* (2023), K plays a role in metabolism, improving soil fertility, carbohydrate translocation, forming and dividing cell tissue to strengthen stems and greatly influencing plant yields both in quantity and quality. According to Ardianti & Maghfoer (2023) in Yuni *et al.* (2019) that, bacteria in PGPR can also dissolve P and K fertilizers so that the absorption of P and K nutrients is maximized. KNO_3 fertilizer given to plants shows a very significant difference.

Seed Weight

Based on the analysis of variance, it shows that there is an interaction between the behavior of PGPR and KNO_3 fertilizer and has a significant effect on the weight of mung bean pods with a dose of 150 kg/ha Potassium and 12 ml/l PGPR (P2K3) having a larger seed weight and significantly different from other treatments, namely 39.36 grams. This is suspected that mung bean plants can absorb K nutrients given to plants optimally by roots infected by rhizobacteria and can be translocated evenly so that the nutrients for filling mung bean seeds are met. As a result of the availability of nutrients, it can fulfill the photosynthesis process so that the photosynthate produced is also more to be translocated to the formation of pods (Hastuti *et al.,* 2018). PGPR and KNO3 fertilizers also have N and K nutrients needed by plants for the growth process because they function in cell division, flower, fruit and seed formation, accelerating ripening, strengthening stems and root development. In seed formation and filling, seed weight is influenced by the parent plant and N and K nutrients. KNO3 is a type of chemical fertilizer with Potassium and Nitrogen content in it. Adequate supply of K elements for plants can increase plant growth and production, because K and P play a role in the formation of nucleic acids, energy transfer, and stimulation of enzyme activity. (Haidlir, 2019). The N nutrient element in PGPR directly affects mung bean plants in the vegetative phase, if the growth of the vegetative phase is good, then generative growth is also good because the K element is a nutrient supplier that will affect production results. This study used mung beans of the Vima-1 variety. Based on the crop results, the interaction of P2K3 (Potassium dose 150 kg/ha and PGPR 12 ml/l) gave the highest average value for seed weight per plot of 65.68 grams or an estimated equivalent of 1.64 - 1.85 tons/ha.

5. Conclusion

There was an interaction and treatment of 150 kg of Potassium per hectare and 12 ml/l PGPR (K3P2) was the best combination of treatments on mung bean yields with plant height at 15 HST of 13.72 cm, 30 HST of 22.93 cm, and 45 HST of 39.36 cm; stem diameter at 15 HST of 4.67 mm, 30 HST of 7.18 mm and 45 HST of 8.16 mm; number of pods of 22.33 pieces, pod weight of 91.85 grams, and dry seed weight of 65.68 grams.

6. References

Ardianti, M., & Maghfoer, M. D. (2023). Pengaruh Dosis Pupuk Kandang dan Konsentrasi Plant Growth Promoting Rhizobacteria (PGPR) Terhadap Pertumbuhan dan Hasil Tanaman Kedelai (Glycine max L.). Produksi Tanaman, 011(04), 265–272. https://doi.org/10.21776/ub.protan.2023.011.04.07

Directorate General of Food Crops. (2022). Food Crops, Horticulture, and Smallholders Estate Crops Subsector.

Haidlir, K. A. (2019). Pengaruh Pemberian Sumber Pupuk Kalium dan Dosis Pupuk Fosfor terhadap Pertumbuhan dan Hasil Tanaman Kacang Hijau (Vigna radiata L.) Effect of Potassium Fertilizer Source and Dosage of Phosphorus Fertilizer on the Growth and Yield of Mung Bean (*Vigna radiata* L.). *Jurnal Produksi Tanaman*, 7(5), 874–880.

Hastuti, D. P., Supriyono, S., & Hartati, S. (2018). Pertumbuhan dan Hasil Kacang Hijau (Vigna radiata, L.) pada Beberapa Dosis Pupuk Organik dan Kerapatan Tanam. *Caraka Tani: Journal of Sustainable Agriculture*, 33(2), 89. https://doi.org/10.20961/carakatani.v33i2.20412

Hussain, F., Buriro, M., Nizamani, M. R., Ahmed, S., Rehman, S. U., Ahmed, N., Huma, Z. (2016). Growth and yield response of mung bean to different level of potassium. *International Journal of Agricultural and Environmental Research*, 2(1): 67-76.

Mustafa, P. A., Paulus, J. M., & Polii, M. G. (2023). Respons Pertumbuhan Dan Hasil Tanaman Kedelai Pada Konsentrasi Plant Growth Promoting Rhizobacteria (PGPR) Dari Akar Bambu (Bambusa sp.). *AGRI-SOSIOEKONOMI*, 19(1), 579 –. https://doi.org/10.35791/agrsosek.v19i1.46755

Aminah, Saida, Nuraeni, Numba, S., Syam, N., Palad, M. S. (2023). Respon Pertumbuhan dan Produksi Kacang Hijau terhadap pemberian pupuk organik cair herbafarm dan pupuk npk. Jurnal Pertanian Berkelanjutan, 11(2), 103-114.

Rusmana. (2017). PERTUMBUHAN DAN HASIL KACANG HIJAU (Vigna radiata L. Wilczeck) YANG DIPUPUK N DENGAN DOSIS BERBEDA DAN PENYIANGAN

Sagay, K. S., Siahaan, P., & Mambu, S. (2020). Respon Pertumbuhan Vegetatif Sawi Hijau (Brassica rapa l. Var. Tosakan) Akibat Pemberian PGPR (Plant Growth Promoting Rhizobacteria) yang Dikombinasikan dengan Pupuk Kompos dan NPK. JURNAL BIOS LOGOS, 10(2), 79–85. https://doi.org/10.35799/jbl.11.2.2020.29017

Syahira, W., Pamujiasih, T., & Rachmawatie, S. J. (2022). Pengaruh Plant Growth Promoting Rhizobacteria (PGPR) terhadap Pertumbuhan dan Hasil Tanaman Kacang hijau (Vigna radiata L.). *Daun: Jurnal Ilmiah Pertanian Dan Kehutanan*, 9(1), 60–66. https://doi.org/10.33084/daun.v9i1.3411.

Wang, L., Wang, S., Luo, G., Zhang, J., Chen, Y., Chen, H., & Cheng, X. (2022). Evaluation of the Production Potential of Mung Bean Cultivar "Zhonglv 5." Agronomy, 12(3). https://doi.org/10.3390/agronomy12030707

Yuni, S., Ramlah, A., & Guritno, D. B. (2019). Pengaruh Konsentrasi PGPR (Plant Growth Promoting Rhizobacteria) terhadap Pertumbuhan dan Hasil Tiga Tanaman Kedelai (Glycine max L.). Jurnal Produksi Tanaman, 7(9), 1732–1741.