IIAJ INTERNATIONAL INTEGRATED AGRICULTURAL JOURNAL
Volume 01 Number 01
May 2025
p-ISSN: 0000-0000
e-ISSN: 0000-0000

Growth and yield response of Edamame soybean plants (*Glycine max* L.) to application of straw mulch and PGPR (*Plant Growth Promoting Rhizobacteria*)

Khusnil Karomah[1], Rr. Liliek Dwi Soelaksini[1], Christa Dyah Utami[1], Tirto Wahyu Widodo[1]

[1] *Food Crop Production Technology, Department of Agricultural Technology, State Polytechnic of Jember, Indonesia*

Correspondence should be addressed to:
Khusnil Karomah
khusnilkaromah@gmail.com

Abstract:
Soil microorganism activity is inhibited during the dry season, especially in dry land. Mulching is one of the efforts to maintain soil moisture and microorganism activity. This study aims to examine the growth response plant edamame against the use of mulch straw and application PGPR (*Plant Growth Promoting Rhizobacteria*). Conducted from July to September 2024 in Kaliurang Village, Jember with an altitude of 146 meters above sea level. This experiment was designed using factorial RAK consisting of two factors and three replications. Factor First that is concentration PGPR Which consists of from 0 ml/l (control), 12.5 ml/l and 25 ml/l, while the second factor is the thickness of straw mulch consisting of 2.5 cm, 4.5 cm, And 6.5 cm. Results study This show existence interaction from PGPR And mulch straw on treatment mulch 6.5 cm + 12.5 ml/l with tall 17.30 cm 24 HST. In the treatment (4.5 cm + PGPR 12.5 ml/l) it influenced the height plant age 32 HST (23.00 cm), amount pod per sample 20.13 pod and biomass dry18.53 g, whereas amount branch per sample on treatment (0 ml/l + 6.5 cm) 1.93 branches. However, the weight of pods per sample and the weight of pods per plot did not happen interaction. Heavy pod per sample on concentration 25 ml/l (55.02 g), at a mulch thickness of 4.5 cm (54.31 g). Pod weight per plot 1255.89 g (25 ml/l) and 1253.22 (4.5 cm). Use mulch straw allegedly capable guard humidity soil so that the microorganisms in PGPR are able to grow well and activity microorganisms in a way can directly influence growth and edamame crop yields.

Keywords:
PGPR, straw mulch, Edamame

Article info:
Submitted:
25-06-2025
Revised:
30-06-2025
Accepted:
30-06-2025

INTRODUCTION

Edamame is a type of soybean that originates from Japan and has been cultivated in Indonesia, as well as can be consumed in its pod, still young or colored green (Sudiarti, 2017). It includes the plant subsector of plant food types of secondary crops, nuts (Adellia, 2022). Soybeans are beneficial for health because they contain good nutrients. This is why the demand for edamame is high compared to other types of soybeans.

Indonesia has good potential to develop edamame plants. One of them is by fulfilling the demand for edamame exports to other countries, such as Japan, which needs to supply edamame around 100,000 tons per year, while the United States needs as much as 7,000 tons per year. Currently, Indonesia is only able to meet 3% of the Japanese market needs, while the remaining 97% is supplied by Taiwan and China (Nurman, 2013). The productivity of edamame plants in Indonesia averages between 10 and 12 tons/ha, while the productivity of edamame plants in Japan

Volume 01 Number 01
May 2025
p-ISSN: 0000-0000
e-ISSN: 0000-0000

is around 19.7 tons/ha, in China, 18 tons/ha, and in the United States, around 16.3 tons/ha (Firmansyah, 2014). Based on the productivity data above, Indonesia is classified as low in producing edamame plant production compared to other countries.

Use mulch straw on condition land dry, especially in season drought, is one alternative in maintaining humidity in the soil, so that the growth and activity of microorganisms can be optimal. The addition of PGPR plays an important role as a biofertilizer because it can accelerate nutrient absorption, as a biostimulant that can stimulate phytohormone production, and as a bioprotectant because it can prevent the emergence of pathogens (Shofiah and Tyasmoro, 2018). Information related to the use of germ mulch and PGPR on edamame plants is not yet available. Lots of information, so I need to study the effect of the treatment I tested on edamame plants.

METHOD

The research was conducted from July to September 2024 in Kaliurang Village, Sumbersari District, Jember Regency, East Java, at an altitude of 146 meters above sea level (masl) with an average temperature of 23°C - 32°C. The research location is at coordinates 8°09'29.2"S 113°44'21.0" E. Average rainfall in July reaches 0-176 mm and in September, around 1-232 mm (BMKG Jember, 2024).

The research design used was a factorial randomized block design. RAKF, which consists of 3 levels of dose giving PGPR, namely 0 ml/l (control), 12.5 ml/l, and 25 ml/l, and 3 levels of straw mulch thickness, namely 2.5 cm, 4.5 cm, and 6.5 cm. Each treatment was repeated 3 times, resulting in 9 combinations and 27 treatment plots. Edamame seeds were planted with a distance of 20 x 35 cm in a plot measuring 2 x 1 meter, by making holes with each planting hole filled with 2 seeds. PGPR application was carried out 3 times, namely at the age of 10, 20, and 30 days after planting (DAP) by spraying all parts of the plant. While the application of straw mulch was only done once at the time of planting, it was left until harvest. Plant maintenance was carried out intensively, including replanting, weeding, watering, fertilizing, and controlling pests and diseases. Fertilization was given 2 times at the age of 10 days after planting using KCL (100 kg/ha), Urea (150 kg/ha), and NPK (100 kg/ha). The second fertilization was carried out at 21 days after planting using urea (150 kg/ha) and NPK (100 kg/ha).

Observations were made on growth and yield variables including the percentage of normal sprout growth at 7 HST, plant height at 14, 24, and 32 HST, number of pods per sample, pod weight per sample, pod weight per plot, dry biomass weight per sample, and number of branches per sample at harvest time. All observation results were analyzed using analysis of variance (ANOVA). If there is an effect in the treatment, further testing is carried out with the Duncan Multiple Range Test (DMRT) at a level of 5% if the treatment shows a significant difference and a level of 1% if the treatment shows a very significant difference.

RESULT

Based on the results of the research that has been done, there are seven observation variables which include the percentage of normal growing sprouts, plant height, number of pods per sample, pod weight per sample, pod weight per plot, dry biomass weight per sample, and number of branches per sample. The observation data obtained were analyzed using analysis of variance and then notated for each observation variable that was observed. The results of the recapitulation of the analysis of variance are presented in the form of a table below.

Volume 01 Number 01
May 2025
p-ISSN: 0000-0000
e-ISSN: 0000-0000

Table 1. Recapitulation of results analysis of variance on all variables of observation

No	Variables Observation	F Count		
		PGPR (P)	Mulch straw (M)	Interaction (PxM)
1.	Presentation Sprout Normal Growth	1.06 ns	3.09 ns	1.14 ns
2.	Tall Plant	55.5 ns	7.92 *	6.69 *
3.	Amount Pod Per Sample	1.08 ns	2.17 ns	4.08 *
4.	Heavy Pod Per Sample	6.61 **	5.96 *	2.89 ns
5.	Heavy Pod Per Plot	4.92 *	4.28 *	1.00 ns
6.	Dry Biomass Weight Per Sample	2.68 ns	2.89 ns	3.74 *
7.	Amount Branch Per Sample	0.30 ns	2.56 ns	3.64 *

Information: Notation shows results different No real (ns), different real (*), and different very real (**)

Percentage of Normal Growing Sprouts

After the analysis was carried out using ANOVA on the thickness of straw mulch, various concentrations of PGPR, and the interaction of both, did not have a significant effect on the percentage of normal growing seedlings. This occurs because seed germination is a process that activates embryonic axis growth in seeds, which then form seedlings. In order for seeds to germinate well, good conditions are also needed in the seeds themselves and their environment. The time of germination and the emergence of cotyledons on the soil surface mainly depend on the planting depth, seed quality, temperature, and soil humidity. Soil lumps and planting conditions that are too deep (> 3 cm) can inhibit germination and the emergence of cotyledons (Sari, 2020).

Plant Height

Based on data, which was obtained from observation of high plant stowage 14, HST does not provide significant results on plant height. This is due to the provision of PGPR, which is still given at age 10, HST, so that the absorption of PGPR in plants still has no effect on plant growth. This is in accordance with the statement of Sitompul et al (2022), who suspect that the application time of PGPR at the age of 15 and 30 HST soybean plants already has more perfect roots compared to the application time treatment of 10 and 20 HST. However, at the ages of 24 and 32 HST, it gave a significantly different effect, which can be seen in the table below.

Table 2. Height plant Edamame Age 24 HST

Concentration PGPR (ml/l)	Thickness Mulch Jermy (cm)		
	2.5	4.5	6.5
0 (Control)	14.90 B b	16.27 AB b	17.03 A a
12.5	16.03 B a	16.43 AB a	17.30 A a
25	16.43 A a	17.03 A a	15.57 B b

Description: Numbers followed by the same capital letter in the same row and numbers followed by the same lower-case letter in the same column show no significant difference in the 5% DMRT.

Based on the average plant height in each replication, it can be seen in the table. 4.2 to show on treatment thickness mulch 6.5 cm + 12.5 ml/l, and 25 ml/l + 2.5 cm has an effect on plant height with results of 17.30 cm and 16.43 cm. The use of 6.5 cm mulch also has a good effect on plant height, even though PGR is not given, with a result of 17.03 cm. This happens because, according to Setyawan et al. (2015), PGPR contains phytohormones and is able to mobilize nutrients that can trigger plant growth, including plant height. PGPR is able to optimize the absorption and utilization of the element N, which is needed in the vegetative phase.

Volume 01 Number 01
May 2025
p-ISSN: 0000-0000
e-ISSN: 0000-0000

Table 3. Height plant Edamame age 32 HST

Concentration PGPR (ml/l)	Thickness Mulch Jermy (cm)		
	2.5	4.5	6.5
0 (Control)	18.60 B b	19.43 AB b	21.80 A a
12.5	19.43 B a	23.00 A a	21.95 AB a
25	20.50 A a	21.27 A ab	19.30 B b

Information: The number that followed the letter big one is the same on the same line, and the number that is followed by the letters small is the same in the column, which shows different. No real DMRT 5%.

Based on Table 3, a mulch thickness of 12.5 ml/l + 4.5 cm and 2.5 cm + PGPR 25 ml/l gave a better effect than the others, with results of 23.00 cm and 20.50 cm. When giving PGPR 0 ml/l with a mulch thickness of 6.5 give influence Which Good from Which other with results 21.80 cm. According to Nurgraha (2023), the mechanism of PGPR as a plant growth stimulant is related to its role Which complex as well as influence from condition physique, chemistry, And biology in the rhizosphere environment. The presence of microorganisms, such as rhizobacteria, in the soil plays an important role in increasing plant growth. These rhizobacteria contribute by helping plants absorb nutrients from the soil.

Number of Edamame Branches Per Sample

Table 4. Number of branches of Edamame per sample

Concentration PGPR (ml/l)	Thickness Mulch Jermy (cm)		
	2.5	4.5	6.5
0 (Control)	1.13 AB ab	1.00 B b	1.93 A a
12.5	0.80 B b	1.87 A a	0.93 AB b
25	1.13 B a	1.33 AB b	1.47 A b

Information: The number that follows the letter big one is the same on the line. Which is the same as the number that is followed by the letter's small. Which is the same as the column. Which shows different No real. DMRT 5%.

Based on the results of Table 4, the PGPR treatment (0 ml/l) with a mulch thickness of 6.5 cm has a good effect on the number of branches, with a result of 1.93 branches. While in the treatment of 12.5 ml/l with a mulch thickness of 6.5 cm, the number of branches is 1.93. mulch 4.5 cm give influence Which significant to amount branches with an average of 1.87 branches. Branches are one part of the plant that grows next to the main stem. Branches that grow are not necessarily able to produce fruit or pod, besides That pod Which grow from branch generally different in quality from the pods that grow on the main stem.

Heavy Edamame Pods Per Sample on PGPR Concentration

Table 5. Heavy Edamame pods per sample on PGPR concentration

Concentration PGPR (ml/l)	Heavy Pod Per Sample (g)
0 (Control)	45.18 b
12.5	48.62 ab
25	55.02 a

Information: Number followed by a notation letter, which shows a different No real in the DMRT test, p=5%

Based on data, which is obtained from Table 5, shows that treatments with PGPR at 25 ml/l and 12.5 ml/l give more influence than the control, with an average pod weight produced of 55.02 g

Volume 01 Number 01
May 2025
p-ISSN: 0000-0000
e-ISSN: 0000-0000

and 48.62 g. Meanwhile, the control treatment had a lower effect with an average of heavy pod around 45.18 g. Although the treatment PGPR 12.5 ml/l is not different from the control, the concentration is 25 ml/l. According to Ramadhan et al (2016), the increase in pod weight is due to the sufficiency of both macro and micronutrients needed by the plant. In this way, the photosynthesis process can run smoothly when the plant enters the generative phase in the formation and filling of pods, where the flow of photosynthate is almost completely running. To the formation of flowers, pods, and seeds of the soybean (Efriady, 2020).

Heavy Edamame Pods Per Sample on Thickness Mulch Straw

Table 6. Heavy Edamame Pods Per Sample on Thickness Mulch Straw

Thickness Mulch Straw (cm)	Heavy Pod Per Sample (g)
2.5	44.82 b
4.5	54.31 a
6.5	49.69 ab

Information: Number followed by a notation letter, which shows a different No real in the DMRT test, p=5%

Based on the data obtained in Table 6, the treatment of giving mulch straw on thicknesses of 4.5 cm and 6.5 cm shows an influence, which is better than the thickness of 2.5 cm, with an average pod weight per sample of 54.31 g and 49.69 g. Whereas results on perlskusn mulch straw with thicknesses of 6.5 and 2.5 were not significantly different from the average result of 44.82 g in the 2.5 cm treatment. The use of mulch straw is Also Wrong. One material is used on the surface of the land, which has the function of pressing out water through evaporation and can suppress weed growth. Straw mulch can help maintain the land, so it is not easily eroded by water. Straw mulch is also a type of organic material that is easily decomposed and does not contain chemicals that have an impact on the soil used (Darmawan et al., 2014).

Heavy Edamame Pods Per Plot on PGPR Concentration

Table 7. Heavy Edamame Pods Per Plot on PGPR Concentration

Concentration PGPR (ml/l)	Heavy Pod Per Sample (g)
0 (Control)	1054.44 b
12.5	1117.56 b
25	1255.89 a

Information: Number followed by a notation letter, which shows a different No real in the DMRT test, p=5%

Table 4.7 shows that the PGPR treatment with a concentration of 25 ml/l gave a better effect than the others, with an average pod weight of 1255.89 g. While the 12.5 ml/l treatment obtained 1117.56 g. The control gave a lower effect with an average result of 1054.44 g. This can occur because the concentration given is deep enough to fulfill the need for happiness in the plant edamame. PGPR here also has a role as a bio-stimulant that can increase nutrient absorption and improve plant quality. In accordance with the opinion of Ningrum (2017), who stated that in the PGPR, there are bacteria that can help the absorption of phosphorus and potassium nutrients, which have the function of helping the formation and development of fruit, and the weight of the fruit, which is determined by the amount of content absorbed by the plant.

Volume 01 Number 01
May 2025
p-ISSN: 0000-0000
e-ISSN: 0000-0000

Heavy Edamame Pods Per Plot on Thickness Mulch Straw

Table 8. Heavy Edamame Pods Per Plot on Thickness Mulch Straw

Thickness Mulch Straw (cm)	Heavy Pod Per Sample (g)
2.5	1094.89 b
4.5	1253.22 a
6.5	1079.78 b

Information: Number followed by a notation letter, which shows a different No real in the DMRT test, p=5%

Table 8 shows that the straw mulch treatment with a thickness of 4.5 cm has a greater influence, which is good for heavy pods per plot, with an average yield of 1253.22 g. While in the 2.5 cm and 2.5 cm treatments, 6.5 is no significant difference in influence. The average results at a thickness of 2.5 cm are 1094.89 g and 6.5 cm, with only 1079.78 g. The decrease in yield when using 6.5 cm straw mulch is due to the condition of the mulch being too thick, causing lower air aeration, the respiration process is hampered, and the energy produced is reduced. This is in accordance with the statement of Naikofi and Neonbeni (2016) that mulch with a thickness of more than 2 cm can result in poor aeration in the soil and can result in high soil moisture.

Amount Pod Edamame Per Sample

Table 9. Amount Pod Edamame Per Sample

Concentration PGPR (ml/l)	Thickness Mulch Jermy (cm)		
	2.5	4.5	6.5
0 (Control)	16.33 A ab	12.47 B b	16.33 A a
12.5	16.40 B a	20.13 A a	14.13 B b
25	14.13 B b	19.87 A a	14.40 B ab

Information: The number that follows the letter big one is the same on the same line, and the number that is followed by the letter small is the same in the column, which shows different. No real DMRT 5%.

Based on results from Table 4.7 on treatment (12.5 ml/l + 4.5 cm) and (25 ml/l + 4.5 cm), it is evident that one influences more than the others, with the average number of pods per plant being 20.13 pods and 19.89 pods. This is thought to be due to the plant roots having formed perfectly so that, in absorption, the nutrients become optimal, and the bacterial content in PGPR can loosen the soil (Arofah, 2022). The interaction between PGPR and straw mulch is very good because both are able to provide sufficient and complementary nutrients for plants, and their use is environmentally friendly.

Biomass Dry Edamame Plant

Table 10. Biomass Dry Edamame Plant

Concentration PGPR (ml/l)	Thickness Mulch Jermy (cm)		
	2.5	4.5	6.5
0 (Control)	14.53 A a	12.20 B b	15.13 A a
12.5	13.53 B ab	18.53 A a	14.40 AB b
25	14.00 B a	18.13 A a	16.07 AB a

Information: The number that follows the letter big one is the same on the same line, and the number that is followed by the letter small is the same in the column, which shows different. No real DMRT 5%.

Volume 01 Number 01
May 2025
p-ISSN: 0000-0000
e-ISSN: 0000-0000

On results, Table 8 shows that on treatment 12.5 ml/l + 4.5 and 25 ml/l + 4.5 cm gave a better effect than the others, with the dry biomass weight produced in both treatments of around 18.53 g and 18.13 g. Dry biomass weight is the result of the overall growth of plant organs. Dry biomass weight also shows the ability of plants to absorb nutrients in the media used for the process of plant growth and development. According to Sumarsono (2002), the accumulation of dry matter reflects the ability of plants to bind solar energy through the mechanism of photosynthesis, as well as interactions between other environmental factors. The process of photosynthesis produces energy for the formation of carbohydrates, which act as compounds that form the body of the plant (dry plant waste).

DISCUSSION

The results showed that the application of straw mulch and PGPR had a significant effect on the growth of edamame plants in the vegetative phase of edamame plants. The interaction of the two treatments was obtained from a mulch thickness of 4.5 cm, while the concentration of PGPR was given at 12.5 ml/l. While increasing the results of edamame pod weight, it was obtained at a PGPR concentration of 25 ml/l, and the most effective use of mulch was at a thickness of 4.5 cm. The novelty of this study is the use of organic materials to support edamame soybean production by considering environmental sustainability. These results provide a good contribution to the cultivation of edamame soybeans, especially in increasing production results and the sustainability of the environmental ecosystem. However, this study is limited to one location. So that further research is expected in selecting locations and using other organic materials to further determine the effects of PGPR and straw mulch.

CONCLUSION

Based on the results of the research that has been conducted, the following conclusions were obtained: Happen interaction between treatment PGPR And mulch straw against tall plants (23 cm), number of pods (20.13) pods, and dry biomass (18.53 g) obtained in the PGPR treatment of 12.5 ml/l + 4.5 cm, while 0 ml/l + 6.5 cm had a significantly different effect on the number of branches (1.93) branches. Administration of PGPR at a concentration of 25 ml/l had a significantly different effect on heavy pod per sample (55.02 g) and heavy pod per plot (1225.89 g). The use of straw mulch with a thickness of 4.5 cm had a significantly different effect on the weight of pods per sample (54.31 g) and the weight of pods per plot (1253.22 g).

REFERENCES

Adellia, VD (2022). TA: *Cultivation of Edamame (Glycine max (* L *). Merril) Intercropped with Sweet Corn Aged 2 and 4 Weeks After Planting*. Retrieved from UPT. Perpustakaan Repository: http://repository.polinela.ac.id/2406/

Arofah, YES. (2022). “Application of Biostimulant PGPR (*Plant Growth Promoting Rhizobacteria*) and Cow Manure on Edamame Soybean Plant Production (*Glycine max* (L) Merrill)”. Thesis of Jember State Polytechnic.

Meteorology, Climatology, and Geophysics Agency (BMKG), 2024. *Climate Analysis for July-September 2024, Jember Regency. https://staklim- jatim.bmkg.go.id/index.php/ analis -iklim/ analis-bulanan/ analis- Distribusi-hujan/ analis- Distribusi-curah-hujan/555561292- analis-bulanan- rainfall-distribution-in-july-2024-in-east-java-province* . [October 2024].

Volume 01 Number 01
May 2025
p-ISSN: 0000-0000
e-ISSN: 0000-0000

Darmawan, IGP, & Nyana, IDN. (2014). The effect of using plastic mulch on the yield of cayenne pepper (*Capsicum frutescens* L.) plants outside the season in Kerta Village. *Jurnal Agroekoteknologi 3*(3), 148–157. https://ojs.unud.ac.id/index.php/JAT/article/download/9609/7119 .

Efriady D. (2020). *Growth and Yield of Edamame Soybeans (Glycine max (* L. *) on various distance plant*. Thesis Faculty of Agriculture Universitas Andalas.

Firmansyah & Dhuha. (2014). Jember Soybeans Penetrate the International Market. Data Center, Cabinet Secretariat of the Republic of Indonesia.

Naikofi, KIS, & Neonbeni, EY (2016). Effect of Enriched Rice Husk Biochar Hara And Thickness Mulch towards Growth And Results Land Lettuce (Lactuca sativa L.). *Journal of Dryland Conservation Agriculture, 1*(04), 116–117. https://doi.org/10.32938/sc.v1i04.71

Ningrum, WA, Karuniawan PW, & Setyono YT. (2017). The Effect of Plant Growth Promoting Rhizobacteria (PGPR) and Rabbit Manure on the Growth and Production of Sweet Corn (*Zea mays* Saccharata). *Journal of Crop Production, 5*(3), 433–440.

Nugraha E., Noertjahyani, & Parlinah, L. (2023). *Effect of Pgpr (Plant Growth Promoting Rhizobacteria) Concentration on the Growth and Yield of Water Spinach (Ipomoea Reptans Poir) Bika Variety*. DOI: http://dx.doi.org/10.35138/orchidagro.v3.i1.513

Nurman, AH. (2013). Differences in Quality and Growth of Ryoko Variety Edamame Seeds Produced at Different Altitudes in Lampung. *Journal of Applied Agricultural Research.*

Ramadhan M., F. Silvina, & Arminia. (2016). Giving Fertilizer Pen And Water Volume on the Growth and Yield of Edamame Soybeans (*Glycine max* (L) Merril). *Jurnal Faperta UNRI, 3*(1).

Sari M, F., Saputra H., & Dulbari. (2020). Germination of Cultivated Edamame Seeds in Plains Low. In proceedings *Seminar National Indonesian Horticultural Association (PERHORTI) 2020* (Editors Deden D,M., and Nirmala, F, D.) Malang: Indonesian Horticultural Association (PERHORTI). Pages 341-346.

Setyawan, F., Santoso, M., & Sudiarso, S. (2015). The Effect of Rhizobium Inoculum Application and Organic Fertilizer on the Growth and Production of Peanut Plants Land *(Arachis hypogaea* L.) *Journal Production Plant, 3*(8), 97- 705.

Shofiah, DK, & Tyasmoro, SY. (2018). Application of PGPR (Plant Growth Promoting Rhizobacteria) and Goat Manure on the Growth and Yield of Shallots (*Allium ascalonicum* L.) Manjung Variety. *Journal of Plant Production*.

Sitompul FH, & Mary A. (2022). Influence Time Application PGPR (Plant Growth Promoting Rhizobacteria) and Types of Manure on the Growth and Yield of Black Soybean Plants (*Glycine max* L.). *Research Journal Agroocean, 9*(1)

Sudiarti, D. (2017). Effectiveness of Biofertilizer on the Growth of Edamame Soybean Plants (*Glycin max*). *Jurnal Sain Health, 1*(2), 97-106.

Sumarsono. (2002). Quantitative Analysis of Soybean Plant Growth. Department of Animal Nutrition and Feed. Faculty of Animal Husbandry, Diponegoro University. Semarang.