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Affect of PGPR Concentration (Plant Growth Promoting Rhizobacteria) on Growth and Yield of Some Sorghum Varieties in Dry Land

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ABSTRACT: This study aims to determine the effect of PGPR concentration and sorghum variety on the growth and yield of sorghum plants. The experimental design used in this study was a randomised block design with a factorial experiment. This experimental design consisted of two factors, namely PGPR concentration (K0 without PGPR, K1 with 20 ml/l PGPR per plant, K2 with 40 ml/l PGPR per plant, and K3 with 60 ml/l PGPR per plant) and sorghum variety (V1 is the Soper 9 variety, V2 is the SR2401 variety, and V3 is the SR2404 variety). Based on the analysis of the research results, it was found that PGPR concentration and sorghum variety significantly influenced several sorghum growth parameters, including the number of leaves, leaf area, and stem diameter, but did not significantly differ in plant height. For sorghum yield parameters, concentration and variety significantly influenced 1000-seed weight, root length, panicle length, seeds per panicle, wet weight, and Brix content. The interaction between PGPR concentration and sorghum variety significantly influenced seeds per panicle. A PGPR concentration of 60 ml/l yielded higher results compared to other concentrations, and the SR2404 variety had a significant effect on all observed parameters. It is hoped that this study can serve as a reference and guideline for farmers and the general public in determining the variety and PGPR concentration to be used in sorghum cultivation on dry land.

Keywords: Sorghum (Sorghum bicolor L.), PGPR (Plant Growth-Promoting Rhizobacteria), Sorghum Varieties

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INTRODUCTION

The development of sorghum cultivation in West Nusa Tenggara (NTB) has a high prospect given the extensive availability of dry land, particularly in Lombok Utara Regency (KLU), which spans 38,000 hectares (Hermanto et al., 2013). The main challenge is the low annual rainfall (<3 months/year) which limits agricultural productivity (BPS KLU, 2017). Cultivating sorghum is a strategic solution to enhance agricultural output on marginal lands, supported by a series of research conducted in the area.

In Lombok Utara Regency, the productivity of sorghum on dry land is still limited, ranging from 1.5 to 3 tons per hectare, despite various research efforts not yet achieving optimal results (Apliza et al., 2020). This is far below the international average productivity of 6 to 9 tons per hectare (McGuire, 2015). The primary factor hindering the optimal use of dry land is the poor physical, chemical, and biological properties of the soil (Ngawit et al., 2020).

Strategi to enhance productivity in dry land can be achieved through the application of NPK fertilizer combined with biofertilizers such as PGPR (Plant Growth Promoting Rhizobacteria). These rhizosphere bacteria play a dual role as biostimulants, enhancing nutrient uptake efficiency and plant hormone production, while also acting as bioprotectants that increase plant resistance to abiotic stresses (drought, salinity, temperature fluctuations) due to climate change (Asri Ningrum et al., 2017; Hasan et al., 2024).

The selection of sorghum varieties is a critical aspect of cultivation given the wide range of their characteristics, including productivity, harvest maturity, and seed quality. Variety selection should consider the intended use: (1) high-quality seed varieties for human consumption, (2) varieties with high stover for animal feed, (3) high-yielding varieties with optimal input, or (4) sweet-stalk varieties for bioethanol production (Tabri & Zubachtirodin, 2014).

Therefore, this research aims to determine the effect of PGPR on the growth and yield of several sorghum varieties in dry land, as well as to provide recommendations for farmers in the sustainable management of dry land.

THEORETICAL REVIEW

The Potential of Sorghum as a Drought-Tolerant Crop

Sorghum (Sorghum bicolor L.) is a cereal crop that is adaptable to marginal land conditions and drought, making it a solution for sustainable agriculture in arid regions such as West Nusa Tenggara (Andriani & Isnaini, 2013). In addition to being a food source, sorghum is also used as livestock feed and raw material for the bioethanol industry (Azrani et al., 2016; Stamenković et al., 2020).

Productivity Challenges of Sorghum in Dry Lands

Sorghum productivity in North Lombok remains low (1.5–3 tons/ha) compared to national/international potential (6–9 tons/ha) due to nutrient-poor soil conditions, low water retention, and weak soil microbial activity (Apliza et al., 2020; Ngawit et al., 2020).

The Role of PGPR in Enhancing Sorghum Growth

Plant Growth-Promoting Rhizobacteria (PGPR) are rhizosphere bacteria that enhance plant growth through: Production of growth hormones (IAA, gibberellin) Phosphate solubilization and nitrogen fixation Enhanced resistance to abiotic stress (drought, salinity) (Hasan et al., 2024; Wulandari et al., 2021).

Effectiveness of PGPR on Agronomic Parameters

PGPR has been shown to increase plant height, leaf area, root length, and seed yield in sorghum, corn, and other crops (Hidalgo et al., 2024; Shivashakarappa et al., 2022). For example, research by Rohmaniati & Sarjan (2023) demonstrated increased productivity of cotton and corn in dryland areas of Lombok with PGPR application.

The Effect of Varieties on Cultivation Yields

Sorghum varieties such as SR2404 have high brix levels, making them suitable for bioethanol (Tabri & Zubachtirodin, 2014). Research by Andayani (2021) proves that varieties have a significant effect on seed weight, panicle length, and number of seeds per panicle.

Interaction between PGPR and Varieties for Optimal Yields

The combination of PGPR (60 ml/l) and the SR2404 variety produced the highest number of grains (4,530.5 grains/ear) (Ikhwan et al., 2016). The effectiveness of PGPR depends on rhizosphere adaptation and variety genetics (Safrida et al., 2019).

Impact of PGPR on Brix Levels and Nutrient Uptake

PGPR enhances plant metabolism, including stem sugar content (°Brix) (Hawari et al., 2021). Bacteria such as Bacillus and Pseudomonas aid in nitrogen and phosphorus uptake, while Serratia spp. fix nitrogen and synthesize IAA (Setiawati et al., 2014; Susilo et al., 2021).

METHODOLOGY

This research was conducted in Akar-Akar Village, Bayan Subdistrict, Lombok Utara Regency, from January to April 2025. The method used was a factorial Randomized Block Design (RBD), consisting of two main factors: (1) PGPR concentration (K0: without PGPR; K1: 20 ml/l per plant; K2: 40 ml/l per plant; K3: 60 ml/l per plant) and (2) sorghum varieties (V1: Soper 9; V2: SR2401; V3: SR2404).

The two factors combined resulted in 12 different treatment combinations. Each combination was replicated three times, resulting in a total of 36 experimental units. Research materials included PGPR, sorghum seeds from three varieties (SR2401, SR2404, and Soper 9), and NPK Pelangi fertilizer. The equipment used included hoes, spades, hand sprayers, spading forks, plastic sheets, rulers, digital scales, measuring tapes, buckets, brix measuring instruments, copes, and various writing supplies.

Experiment implementation included: (1) preparation of the experimental plot, (2) planting and fertilization, (3) determination of plant samples, and (4) maintenance until harvest.

Observations included growth parameters (plant height, stem diameter, number and leaf area, root length, fresh and dry seedling weight, chlorophyll content) and harvest results (pod length, number and weight of seeds per panicle, 1000 seed weight). Data analysis used a 5% ANOVA followed by DMRT if significant differences were shown.

RESULTS AND DISCUSSION

Based on the results of the analysis of variance (Table 1), the concentration of PGPR did not show a significant effect on plant height, stem diameter, and dry branch weight parameters. However, the concentration factor of PGPR did have a significant different effect on growth and other yield parameters. On the other hand, variety had a significant effect on all observed parameters, including plant height, stem diameter, leaf characteristics (number and leaf area), root length, fresh branch weight, and harvest components (sorghum ear length, 1000 grain weight, seed weight per ear, number of seeds per year).

Table 1. Summary of the analysis of variance (ANOVA) results for all sorghum observation parameters

Observation Parameters	Single Factor		Interaction
	K	V	KV
Height of tree 56 HST	NS	S	NS
Diameter of stem 56 HST	NS	S	NS
Number of leaves 56 HST	S	S	NS
Leaf Wide	S	S	NS
Chlorophyll content a	S	NS	NS
Chlorophyll content b	NS	S	NS
Root length	S	S	NS
Wet seedling weight	S	S	NS
Dry seedling weight	NS	NS	NS
Length of panicle	S	S	NS
Weight of 1000 seeds	S	S	NS
Weight of seeds per panicle	S	S	NS
Number of seeds per panicle	S	S	S
Brix concentration	S	S	NS

Plant Growth Parameter

Based on the results of the analysis of variance (Table 2), it shows that for the plant height, stem diameter, and leaf area parameters, variety 1 produced a significant different effect compared to variety 3, but not significantly different from variety 2. For the number of leaves and root length parameters, variety 1 was significantly different from varieties 2 and 3, but varieties 2 and 3 were not significantly different from each other. For the chlorophyll b parameter, variety 2 was significantly different from variety 3, but not significantly different from variety 1. For all observation parameters, the response of variety 3 was higher than that of varieties 1 and 2, as can be seen from the highest average results. PGPR provided the optimal effect on variety 3, thus improving plant growth more than the other varieties.

Table 2. Average plant height, stem diameter, number of leaves, leaf area, and root length of sorghum due to the effect of sorghum varieties at 56 HST age

PLK	Plant Height	Stem Diameter	Number of Leaves	Leaf wide	Root Length	Chlorophyll b
V1	89.80 a	20.64 a	10.8 a	503,50 a	29,27 a	0,42 ab
V2	99,88 ab	21.98 ab	12.95 b	517.32 ab	35.23 b	0.43 b
V3	113.78 b	23.54 b	13.17 b	546,73 c	36,675 b	0,34 a

Note: Numbers followed by the same letter in the same column indicate no significant difference according to the DMRT test at 5% level.

Based on the DMRT test, the highest PGPR concentration (60 ml/l) had a significant effect on increasing leaf area compared to other concentrations, but was not significantly different from the 20 ml/l and 40 ml/l treatments in terms of the number of leaves and root length. For chlorophyll a content, the dose of 60 ml/l showed a significant difference from the control (0 ml/l) and 20 ml/l, but was not significantly different from 40 ml/l. Overall, the 60 ml/l treatment produced the highest average values for all growth parameters compared to the control, indicating that increasing the PGPR dose is directly proportional to plant growth. This is due to the ability of PGPR microorganisms to provide nutrients optimally, where the higher the concentration provided, the better the nutrient availability for the plant, thus promoting more optimal growth (Rohmaniati & Sarjan, 2023). Consistent with the statement byWulandari et al., (2021), a positive correlation was observed between the increase in PGPR dose and the acceleration of plant growth. The mechanism of action of PGPR includes the production of plant hormones, vitamin compounds, and organic acids that act as growth stimulants, simultaneously increasing the efficiency of nutrient uptake by plants (Rahni, 2012). Rhizobacteria in PGPR function as plant growth promoters (Husein et al., 2022).

Table 3. Average number of leaves at 56 HST, Leaf area, Root length and Chlorophyll a due to the effect of PGPR concentration

PLK	Leaf Quantity 56 HST	Leaf Wide (cm^2)	Root Length (cm)	Chlorophy ll a
Ko (0 ml/l)	8.74 a	401.94 a	31,66 a	0.67 a
K1 (20 ml/l)	9.2 ab	504.02 b	33,28 ab	0.78 ab
K2 (40 ml/l)	9.42 ab	561.28 c	34,13 ab	0,86 bc
K3 (60ml/l)	9,6 b	622,83 d	35,82 b	0,99 c

Note: Numbers followed by the same letter in the same column indicate no significant difference according to the DMRT test at 5% level.

Sorghum Yield Parameter

Table 3 analysis shows that sorghum varieties have a significant effect on wet grain weight, panicle length, grain weight per panicle, 1000 grain weight, and number of grains per panicle. At the brix level, varieties 1 and 2 are not significantly different, but both are significantly different from variety 3.

Table 4. Average Wet seedling Weight, Dry seedling Weight, panicle Length, panicle Grain Weight, 1000 Grain Weight, Number of Grains per panicle due to the Effect of sorghum varieties

PLK	Wet seedling (g)	Panicle Length (cm)	B. Number of seeds per panicle	B. 1000 seeds	Total number of seeds per panicle	Brix Concentration
V1	770,1556 a	14,84 a	72,63 a	44.5 a	800.36 a	17 a
V2	919,0711 b	18,26 b	80,33 b	47,64 b	1149,66 b	17,5 a
V3	1009,444 c	21.55 c	89.5 c	49.08 c	1469.62 c	19,75 b

Note: Numbers followed by the same letter in the same column indicate no significant difference according to the DMRT test at 5% level.

The test results indicate that sorghum varieties have a significant effect on all observed parameters. Variety SR2404 (variety 3) produces the highest average value for each parameter. In addition, the weight of 1000 grains is not only used to estimate seed requirements per hectare, but also serves as an indicator of the quality of a genotype's grain production (Andayani, 2021). The analysis results show a significant difference in the 1000 grain weight observation. The variety that can provide more seeds is Variety 3, i.e., SR2404. While the variety with the least ability to provide seeds is Variety Soper 9.

Analysis shows a significant difference in malai length among sorghum varieties, even when grown under the same field conditions. Variety SR2404 (Variety 3) showed the highest panice length, whereas Soper 9 only reached 14.84 cm lower than its described length of 18.61 cm. This disparity is suspected to be caused by: (1) soil nutrient deficiency, and (2) the inefficacy of PGPR application in affecting panicle growth.

Analysis shows a significant effect of variety on seed weight per malai, with SR2404 producing the highest weight. This variation is caused by genetic differences in the allocation of dry matter to plant organs (stem, leaves, seeds) rather than environmental effects (Andayani, 2021).

Based on the research results, the average Brix level of SR2404 is 19.75, which indicates that this variety can be used as a raw material for bioethanol. Sarath et al. (2008) explain that sweet sorghum is a potential raw material for bioethanol production because it contains fermentable carbohydrates (FC) in the stalk ranging from 15-25%. Additionally, sweet sorghum produces a large amount of biomass and has multiple functions, making it a primary candidate for biofuel crops (Stamenković et al., 2020).

Table 5 Average Wet seedling Weight, Dry seedling Weight, seedling Length, Seed Weight per seedling, 1000 Seed Weight, Number of Seeds per seedling Due to the Influence of PGPR Concentration

PLK	Wet seedling (g)	Panicle Length (cm)	B. Number of seeds per panicle	B. 1000 seeds	Total number of seeds per panicle	Brix Concentration	Root Length (cm)
K0 (0 ml/l)	375.69 a	16.63 a	66.82 a	42.77 a	549.59 a	17.11 a	31,66 a
K1 (20 ml/l)	473,47 b	17,88 ab	69.77 a	47.67 b	673.57 b	17.44 ab	33,28 ab
K2 (40 ml/l)	514,44 b	18,41 b	86,28 b	48,29 bc	761,20 b	18,66 bc	34,13 ab
K3 (60 ml/l)	660,39 c	19,96 c	100.41 c	49.57 c	1435.29 c	19.11 c	35,82 b

Note: Numbers followed by the same letter in the same column indicate no significant difference according to the DMRT test at 5% level.

The weight of the seeds produced on variety Soper 9 in this study is 72.63g per plant, which converts to 3.87 tons/ha when converted to hectares. This result is still not optimal when compared to the potential yield description of 10.17 tons/ha. Many factors contribute to this, including soil quality (lacking nutrients, inappropriate pH), insufficient fertilizer dosage, and poor plant management.

The effect of PGPR concentration on average yield can be seen in Table 3. For the wet harvest yield and number of seeds per plant, the treatment K0 (concentration 0ml/l) is significantly different from the treatments K1 (concentration 20ml/l), K2 (concentration 40ml/l), and K3 (concentration 60ml/l). However, K1 is not significantly different from K2. At a concentration of 60ml/l, the wet harvest yield and number of seeds per plant achieve the highest results, indicating that PGPR has the maximum effect at this concentration. The bacterial content in PGPR plays an optimal role in seed formation and wet harvest yield.

The actual length of panicle K0 differs significantly from K2 and K3 but is not significantly different from K1. This means that at concentrations of 0 ml/L and 20 ml/L, the same effect is observed. The concentration of 60 ml/L shows the highest effect on panicle length, which is 19.96 cm. This indicates that the Rizobacteria contained in PGPR has an optimal effect, as per the research conducted. Hidalgo (2024) showed that the bacteria Bacillus megaterium and Pseudomonas japonica, when treated on sorghum varieties, significantly increased the panicle length (malai length) along with other variables such as plant height and plant diameter, with a bacterial concentration of about 10^7 CFU/g soil. This is in line with the research conducted by Shivashakarappa et al., (2022) on similar cereal crops (foxtail millet), where PGPR inoculation significantly enhanced growth and yield, including panice length, through improved nutrient uptake and hormone activity.

The analysis shows that the seed weight per plant at K0 (0 ml/L) is not significantly different from K1 (20 ml/L), but is significantly different from K2 (40 ml/L) and K3 (60 ml/L). The conversion results indicate an increase in productivity with increasing PGPR concentration: 3.56 tons/ha (K0), 3.72 tons/ha (K1), 4.6 tons/ha (K2), and 5.35 tons/ha (K3). The optimal concentration of 60 ml/L is suspected to have positive effects through the mechanisms: (1) provision of P for the generative phase by rhizobacteria, (2) production of phytohormones (IAA and gibberellin) by Pseudomonas sp., and (3) enhancement of nutrient uptake efficiency by Rhizobium, which accelerates flowering (Sitawati et al., 2022). Similar results were reported for corn, where the use of Bacillus spp. and Pseudomonas spp. had positive effects: increasing growth and green biomass and seed production (Khuzzaimatul et al., 2023). According to Setiawati et al. (2014), some rhizosphere bacteria have the ability to enhance the availability of nutrients for plants. The genus Bacillus and Pseudomonas are known to have phosphatase activity, while Serratia spp. has multiple functions as a phosphate solvent, nitrogen fixer, and synthesis of auxin hormone IAA (indole-3-acetic acid). Phosphorus, an essential element for plant growth, is generally bound in soil compounds that are poorly available. The role of phosphate-solubilizing bacteria in the root zone becomes crucial in converting bound phosphorus into a form available for plant uptake. (Siregar et al., 2016). As decomposers, phosphate- solubilizing bacteria enhance soil fertility through the secretion of low-molecular-weight organic acids that solubilize phosphorus. Their metabolic activities are supported by the availability of simple carbon compounds from root exudates and plant residues (Susilo et al., 2021).

Analysis shows a positive correlation between the increase in PGPR concentration and yield, where a concentration of 60 ml/L produced the highest seed weight. This mechanism is believed to occur through: (1) increased availability of phosphorus (P) through microbial dissolution, and (2) stimulation of growth hormone production by PGPR bacteria (Marom et al., 2017). In soybean PGPR studies, higher PGPR concentration was found to increase the wet pod yield more significantly because PGPR helps with nutrient uptake (Marom et al., 2017). According to Anesta et al. (2016), the application of PGPR significantly increased the 1000-grain weight of rice paddy compared to plants without PGPR treatment.

Research results show that at a concentration of 60 ml/l, the root length is the longest at 35.82 cm, compared to others. There is no significant difference between the 60 ml/l concentration and the 20 ml/l and 40 ml/l concentrations, but there is a significant difference with no PGPR. The research conducted by Sitawati and Hendiriau, (2018) showed thattheincrease in results due to the application of PGPR is mainly caused by the bacterial activity in producing phytohormones, particularly IAA (indole acetic acid). This hormone stimulates root hair growth, thus enhancing the capacity to absorb water and dissolved nutrients from the soil.

The PGPR concentration of 60 ml/L produced the highest brix level (19.11°Bx), indicating an optimal effect on sugar accumulation. This increase in brix was influenced by the application of NPK (potassium) and Agrosil (silicate) through the mechanisms: (1) inhibition of enzymes (invertase, peroxidase, polyphenol oxidase, phosphatase, and ATPase), and (2) enhancement of energy supply for sugar synthesis through reduced phosphatase activity.(Hawari et al., 2021).This is in line with the findings of Apliza et al., (2020), who concluded that the addition of silicon fertilizer can significantly increase sorghum yield and brix content.

Table 6. Number of tiller seeds due to the interaction of PGPR concentration and sorghum varieties

Treatment	Number of grains panicle (g)
K0V1	1154 a
K0V2	1569.83 b
K0V3	2222.5 b
K1V1	1572.33 c
K1V2	2048.5 d
K1V3	2441,33 e
K2V1	2029,83 f
K2V2	2198,16 g
K2V3	2622,83 h
K3V1	2447,16 i
K3V2	4530,5 j

Note: Numbers followed by the same letter in the same column indicate no significant difference according to the DMRT test at 5% level.

The DMRT 5% analysis (Table 4) revealed a significant interaction between PGPR concentration and variety regarding the number of seeds per hill, with the optimal combination of SR2404 variety and PGPR 60 ml/L producing 4530.5 seeds per hill. It is suspected that PGPR enhances nutrient availability, while the genetic superiority of SR2404 contributes more significantly than other varieties. According to Ikhwan et al. (2016), the effectiveness of endosymbiotic bacteria depends on their adaptation in the host rhizosphere environment. The nitrogen-fixing and phosphorus-solubilizing bacteria in PGPR are suspected to increase the availability of essential nutrients for grain filling, resulting in higher seed weight compared to the control. According to Safrida et al. (2019), plant height growth is determined by both external factors (such as temperature, light, air, and nutrient availability) and internal factors (including genetics, morphology, storage capacity of food reserves, and resistance to stress).

The results of this study show that the application of PGPR increases nutrient availability, while the genetic superiority of the SR2404 variety makes a more dominant contribution. According to Ikhwan et al. (2016), the effectiveness of endophytic bacteria depends on their ability to adapt to the host rhizosphere environment. Nitrogen-fixing and phosphorus- solubilizing bacteria in PGPR are suspected to enhance essential nutrient availability for seed filling.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results and discussion above, it can be concluded that the highest PGPR concentration (60 ml/l) significantly affects the wet harvest weight, panicle length, seed weight per panicle, 1000 seed weight, number of seeds per panicle, and brix content. The SR2404 variety produces the highest average yield in each parameter. The interaction between concentration and variety is observed in the number of seeds per panicle.

The implications of this research can be suggested to farmers or the general public that when cultivating sorghum in dry land, adding PGPR with a concentration of 60 ml/l during cultivation should be done. And using variety SR2404 to achieve the highest yield.

FURTHER STUDY

Future research could explore the synergistic interaction between PGPR and other soil microbes, such as arbuscular mycorrhizal fungi, to enhance nutrient uptake efficiency in dryland farming systems. In addition, metabolomic and molecular studies on superior sorghum varieties like SR2404 could uncover the genetic mechanisms underlying increased productivity and sugar content (brix) resulting from PGPR application. Further studies should also be conducted across multiple locations and growing seasons to assess the stability and consistency of varietal responses to PGPR treatments. Moreover, spatial data-driven agronomic modeling can be employed to design precision biofertilization strategies tailored to specific varietal requirements and local soil conditions.

REFERENCES

Andayani, R. D. (2021). Uji adaptasi sorgum berdaya hasil tinggi di wilayah Kediri. *14*(1), 6. https://doi.org/9.

Andriani, A., & Isnaini, M. (2013). Morfologi dan Fase Pertumbuhan Sorgum. *Sorgum : Inovasi Teknologi Dan Pengembangan*, 47–68.

Apliza, D., Ma'shum, M., Suwardji, S., & Wargadalam, V. J. (2020). The Effect of Silicate Fertilizer and Manure Fertilizer on the Growth, Brix Content, and Yield of Sorghum (Sorghum bicolor (L.) Moench). *Jurnal Penelitian Pendidikan IPA*, *6*(1), 16–24. https://doi.org/10.29303/jppipa.v6i1.229

Asri Ningrum, W., Puji Wicaksono dan Setyono Yudo Tyasmoro Jurusan Budidaya Pertanian, K., & Pertanian, F. (2017). Pengaruh Plant Growth Promoting Rhizobacteria (Pgpr) Danpupuk Kandang Kelinci Terhadap Pertumbuhan Dan Produksitanaman Jagung Manis (Zea mays saccharata). *Jurnal Produksi Tanaman*, *5*(3), 433–440.

Azrani, M., Pabendon, M. B., Aqil, M., Suarni, Arvan, R. Y., Zainudin, B., & Andayani, N. N. (2016). *Advanced Cultivation Technology for Limassol-Free Sorghum* (Vol. 19, Issue 5).

Hasan, A., Tabassum, B., Hashim, M., & Khan, N. (2024). Role of Plant Growth Promoting Rhizobacteria (PGPR) as a Plant Growth Enhancer for Sustainable Agriculture: A Review. *Bacteria*, *3*(2), 59–75. https://doi.org/10.3390/bacteria3020005

Hawari, H., Suwardji, S., & Idris, H. (2021). The Role of Biochar and the Combination of Inorganic Fertilizers and Biological Fertilizers in Increasing Yield and Brix Levels of Sorghum (Sorghum bicolor (L.) Moench) in Dry Land. *Jurnal Penelitian Pendidikan IPA*, *7*(3), 437. https://doi.org/10.29303/jppipa.v7i3.729

Hendiriau, S. and S. M. (2018). The Effect of PGPR (Plant Growth Promoting Rhizobcteria) Dose and Flower Pruning on the Growth and Number of Flower Buds of Salvia (Salvia Splendens). *Produksi Tanaman*, *6*(5), 716–22.

Hidalgo-de León, A., Sáenz-Mata, J., Véliz-Deras, F. G., Flores-Salas, J. M., Carrillo-Moreno, D. I., Arellano-Rodríguez, F., & Núñez-Colima, J. A. (2024). Rhizobacteria inoculation and its effect on the productive parameters of sorghum. *Agro Productividad*, *16*(12), 35–40. https://doi.org/10.32854/agrop.v16i12.2765

Husein, M., Umami, N., Pertiwiningrum, A., & … (2022). The role of arbuscular mycorrhizal fungi density and diversity on the growth and biomass of corn and sorghum forage in trapping culture. *Tropical Animal …*. http://myscholar.umk.edu.my/handle/123456789/3156

Khuzzaimatul, Laili, Umarie, I., & Suroso, B. (2023). The Effect of Concentration and Application Time of Plant Growth Promoting Rhizobacteria (PGPR) on the Production Result of Eggplant (Solanum melongena L.). *Callus: Journal of Agrotechnology Science*, *1*(1), 1–8. https://doi.org/10.47134/callus.v1i1.1856

Marom, N., Rizal, F., & Bintoro, M. (2017). Effectiveness Test of Application Time and Concentration of PGPR (Plant Growth Promoting Rhizobacteria) on Peanut (Arachis hypogaea L.) Production and Seed Quality. *Agriprima : Journal of Applied Agricultural Sciences*, *1*(2), 174–184. https://doi.org/10.25047/agriprima.v1i2.43

Ngawit, I. K., Ernawati, N. M. L., & Farida, N. (2020). Optimalisasi Penerapan Sistem Usahatani Ekologis Terpadu Di Desa Akar-Akar Kabupaten Lombok Utara Increased Productivity of Dry Land Farmers Through Optimized Application of Integrated Ecological Farming Systems in Akar-akar Village, North Lombok. *Jurnal Abdi Insani Universitas Mataram*, *7*(2), 211–224.

Rahni, N. M. (2012). Eggplant (Zea mays). Jurnal Agribisnis Dan Pengembangan Wilayah, 3*(16), 27–35.*

Rohmaniati, & Sarjan, S. (2023). The Effect of Adding Soil Amendments and PGPR (Plant Growth Promoting Rhizobacteria) on the Growth and Yield of Cotton Plants Intercropped with Corn Plants in Dry Land of North Lombok Regency, Indonesia.

Safrida, S., Ariska, N., & Yusrizal, Y. (2019). Respon Beberapa Varietas Padi Lokal (Oryza Sativa L.) Terhadap Amelioran Abu Janjang Sawit Pada Lahan Gambut. Jurnal Agrotek Lestari, 5(1), 28–38. https://doi.org/10.35308/jal.v5i1.1964

Shivashakarappa, K., Gunnaiah, R., Ajjappala, B. S., Kadi, A., & Vuppula, A. (2022). Effect of Plant Growth Promoting Rhizobacteria on the Growth and Yield of Foxtail Millet (Setaria italica L. Beauv). *International Journal of Plant & Soil Science*, *May*, 1737–1744. https://doi.org/10.9734/ijpss/2022/v34i222477

Siregar, N., Irmansyah, T., & Mariati. (2016). Pertumbuhan dan Produksi Sorgum Manis. Jurnal Agroekoteknologi, 4(3), 2188–2195.

Sitawati, Sintawati, M. B., & Fajriani, S. (2022). Effectiveness of Plant Growth Promotion Rhizobacteria (PGPR) and NPK Fertilizer on the Growth and Flowering of Aster Ericoides (Symphyotrichum ericoides). *Jurnal Hortikultura Indonesia*, *13*(2), 64–71. https://doi.org/10.29244/jhi.13.2.64-71

Stamenković, O. S., Siliveru, K., Veljković, V. B., & ... (2020). Production of biofuels from sorghum. *… and Sustainable Energy …*. https://www.sciencedirect.com/science/article/pii/S1364032120300654

Susilo, E., Pujiwati, H., & Husna, M. (2021). Pertumbuhan Dan Hasil Sorgum Pada Pemberian Beberapa Dosis Pupuk Npk Majemuk Di Lahan Pesisir. Jurnal Ilmu-Ilmu Pertanian Indonesia, 23(1), 15–22. https://doi.org/10.31186/jipi.23.1.15-22

Tabri, F., & Zubachtirodin. (2014). Cultivation of Sorghum. *Balai Penelitian Tanaman Serealia*, 1–13.

Wulandari, S., Syam, N., & Suriyanti, S. (2021). The Effect of Pgpr (Plant Growth Promoting Rhizobacteria) Concentration and KCl Fertilizer on Growth and Production in Tomato Plants (Solanum lycopersicum L.). AGrotekMAS Jurnal Indonesia: Jurnal Ilmu Peranian, 2*(3), 76–85. https://doi.org/10.33096/agrotekmas.v2i3.216*