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Research Article

Vegetative Growth and Potential of Turi (*Sesbania grandiflora*) as Forage under PGPR Application on Ultisol Soil

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ABSTRACT

Turi (*Sesbania grandiflora*) is a high-protein forage legume with significant potential to support ruminant nutrition in tropical regions. This study aimed to evaluate the effect of Plant Growth-Promoting Rhizobacteria (PGPR; Rhizomax) on the vegetative growth of turi as an indicator of forage productivity in ultisol soil. The experiment was conducted using a Completely Randomized Design with five treatments and five replicates: P0 (without PGPR), P1 (100 ml/plant), P2 (200 ml/plant), P3 (300 ml/plant), and P4 (400 ml/plant). The measured variables included plant height, stem diameter, and number of leaf stalks. Data were analyzed using analysis of variance (ANOVA), followed by Duncan's Multiple Range Test when appropriate. The results showed that different doses of PGPR had no significant effect ($P>0.05$) on any of the observed parameters during the early vegetative phase. This indicates that PGPR application did not enhance the early growth performance or potential forage biomass production of turi under the conditions of this study. The lack of response is likely associated with the early growth stage, where external nutrient supplementation is not critical for plant development. These findings suggest that the effectiveness of PGPR on Turi as a forage crop may require longer observation periods or integration with additional nutrient sources to be fully realized.

Keywords: forage, livestock feed, rhizomax, ruminant, vegetative growth

INTRODUCTION

The availability of high-quality forage remains a major constraint in tropical livestock production systems, particularly for ruminants that depend heavily on a continuous supply of nutritious feed. In many regions, the limited availability of protein-rich forage leads to suboptimal animal performance and an increased reliance on costly commercial concentrates. Therefore, the exploration and optimization of locally available forage resources are essential for supporting sustainable livestock production.

Turi (*Sesbania grandiflora*) is a leguminous tree widely recognized for its high crude protein content and rapid growth, making it a promising alternative forage source for ruminants. Every part of the turi (*Sesbania grandiflora*) can be utilized. Turi is classified as a legume and is a high-quality forage and multifunctional plant, also known as a medicinal plant (Bhalke et al., 2012). Sutikno (2002) stated that almost all parts of the turi plant can be used as livestock feeds. Turi contains 31.29% crude protein, 7.57% crude fat, 27.88% crude fiber, 7.34% ash, and 28.02% nitrogen-free extract (BETN) (Aryani et al., 2018). The crude fiber content in red turi flowers is 2.11-2.85% and in white turi is 1.82-2.55% (Setiawan et al., 2018).

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The cultivation of turi plants is recommended to be carried out conventionally using seeds. The use of cuttings in other legumes is also often used as an alternative, depending on availability. When taking cuttings from turi, it is important to consider the appropriate cutting age to ensure that the cut plants can grow well. This is done to overcome the low regrowth of the turi plants (John and Mannetje, 1992).

Turi plants are classified as leguminous trees, with a crude protein content that is better than that of other leguminous trees, such as lamtoro (Siregar, 1994). Turi is also one of the legumes that can form root nodules, which can be utilized as biofertilizer. Nodules are abnormal tissue parts of plant roots that are formed as a result of the interaction between plant roots and rhizobium bacteria, functioning to support nitrogen fixation from the atmosphere or as an inoculant material (Suryantini, 2015). Inoculation with the appropriate Rhizobium strain is one way to increase nitrogen fixation, as these bacteria can provide nutrients to plants if they symbiotically interact with the roots of legume plants by forming nodules on the roots (Sari and Prayudyaningsih, 2015).

The high residue resulting from the use of chemical fertilizers can be overcome by using Turi plants. Given the many benefits of the turi plant, its cultivation needs to be increased so that it can be used as a solution to emerging problems in a way that is easy, safe, and cost-efficient. Ultisol soil has great potential for cultivating turi, with an area of approximately 45.8 million hectares or 25% of the total land area (Septiaji et al., 2024). Although suitable for the expansion of cultivated land, proper management is required because this soil has high acidity, Al saturation, low nutrient and organic matter content, and is prone to erosion (Aufa et al., 2020).

To maintain fertility and sustainably increase productivity, the use of biofertilizers that are adequate in terms of quantity, quality, and continuity is important (Ginting et al., 2020). PGPR, as a biofertilizer, is expected to be a solution for Ultisol soils, and its utilization is also environmentally friendly.

Plant growth-promoting rhizobacteria (PGPR) are a group of microorganisms that function as biostimulants with the ability to produce growth hormones, such as IAA, cytokinins, and gibberellins, that support seed germination and plant development. The effectiveness of PGPR is not limited to growth enhancement but also contributes to root nodule formation (Rifka et al., 2019). The presence of nodules or root nodules greatly affects plant growth because rhizobium is present in nodules. The effect of PGPR addition can be seen in plant height, stem diameter, and number of leaf stalks. Based on the explanation of the problem, the author is interested in conducting research on the effect of PGPR dosage on turi growth.

MATERIAL AND METHODS

Research Materials

The materials used in this study included red turi seeds (*Sesbania grandiflora*) purchased from the Shopee Marketplace from Ninu Farm. Ultisol soil was collected from the University of Andalas campus. Water for other purposes was obtained from the greenhouses. The PGPR biofertilizer brand Rhizomax (Bacillus polymyxa, Rhizobium sp., and Pseudomonas fluorescens) was also obtained from an online store.

Research Tools

The tools used in this research included 10 kg capacity polybags, 20 × 20 cm plastic (mica) containers, soldering tools, sprayers, scales, plastic measuring cups, bottles, label paper,

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stationery, rulers or measuring tapes, graph paper, razor blades, sieves, and a mobile phone camera.

Research Method

This research was conducted using an experimental method with a Completely Randomized Design (CRD), which involved five treatments and five replications. The following treatments were applied:

P0: Without PGPR application
P1: PGPR application of 100 ml per plant
P2: PGPR application of 200 ml per plant
P3: PGPR application of 300 ml per plant
P4: PGPR application of 400 ml per plant

Observed Variable

Vegetative growth parameters, such as plant height, stem diameter, and leaf development, are closely associated with forage biomass yield and feed availability for livestock.

1. Plant height. This can be done by measuring the part of the plant above the growing medium up to the highest part of the leaves. Observations were made weekly, starting from 4 weeks after planting (WAP) until 9 WAP. Plant height was measured once a week.
2. Stem diameter
3. Number of leaf stalks. It can be obtained by counting the number of leaf stalks on each plant in the polybag. Observations were conducted from 4 to 7 weeks after planting.

Procedures of Research

The implementation of this research included the stages of preparing planting media, selecting seeds, soaking seeds, sowing turi seeds, planting red turi seedlings, using PGPR (Rhizomax), maintenance, observation, and data collection from observations.

1. Preparation of growing media

The growing medium used in this study was Ultisol soil obtained from Edu Farm, Faculty of Animal Husbandry, Andalas University. Soil samples were collected at a depth of 15-30 cm from the surface. Subsequently, the soil was dried and aired while being separated from twigs, leaves, stones, and other unnecessary materials. This process was continued by sieving the soil to ensure a uniform particle size and texture, thereby facilitating homogenization. Facial cotton pads placed in a round plastic container with a capacity of 200 ml, 10 cm in diameter, and 5 cm in height were used as seedling media. Cotton was then moistened with water. The reason for using cotton as seedling media is that cotton can maintain moisture, allowing plants to grow faster than soil (Nurifah and Fajarfika, 2020). For the main growing medium, 10 kg of Ultisol soil was placed in a polybag with a capacity of 10 kg.

2. Selection of turi seeds

Red turi seeds require an initial selection process to evaluate their quality. This selection is carried out to choose superior seeds by separating healthy seeds from those that are damaged or infected with disease. After determining the seeds for planting, the next step is to soak the seeds before the sowing process is conducted.

3. Soaking turi seeds

Red turi seeds are soaked in hot water at 60°C for 15 min and then soaked in regular water for 24 h. This soaking of turi seeds aims to break seed dormancy due to the hard seed coat of the turi (Mewangi et al., 2019). After the soaking process was complete, the seeds were removed using a strainer and washed again with clean water. Next, the seeds are drained and left to dry in open air. Only then is the germination of turi seeds carried out.

4. Germination of turi seeds

Red turi seeds are sown in 20 × 20 cm mica plastic containers that have been prepared beforehand. Before use, the containers were perforated at the bottom and top using a soldering tool to ensure smooth water circulation. Next, the sowing medium, consisting of 1 kg of Ultisol soil and 1 kg of sand, was placed into the container and homogenized. Subsequently, sowing holes were made with a depth of 0.9–1.2 cm, with 30 holes per container. The seeds were planted in these holes and then lightly covered with soil without pressing too tightly. The planted seeds were watered using a sprayer. The sowing containers were covered with transparent plastic with 2–5 small holes as a greenhouse cover; this cover was removed once the sprouts appeared or the seeds germinated. The germination process continued until the plants were 2 weeks old, after which the seedlings were transferred to polybags.

5. Planting turi seedlings

A day before planting, the polybag was filled with a planting medium consisting of 10 kg of ultisol soil. Planting was performed by first creating a planting hole in the polybag. The seedling was taken along with the soil around its roots, then placed into the hole in an upright position, followed by adding soil around it to stabilize it. The polybags were placed in a shaded location.

6. Use of PGPR (rhizomax)

PGPR was applied by dissolving 50 g of Rhizomax in 10 liters of distilled water (aquadest), according to the packaging instructions. The solution was poured around the root area of the plants according to the specified dosage. PGPR watering is performed on plants that are two weeks old after sowing and when they are newly transplanted into polybags.

7. Maintenance

Plant maintenance in this study included watering twice a day and weeding around the plants, using 1 liter of water per polybag.

RESULTS AND DISCUSSION

The Effect of Rhizomax Use on Turi Plant Height

The results of the effect of different Rhizomax doses on turi growth in Ultisol are presented in Table 1. The variance analysis results showed that the addition of Rhizomax had no significant effect ($P>0.05$) on the height of the turi plants. The height of red turi plants in this study was 18.07, 23.22 on week 5, and 30.33 cm on weeks 4, 5, and 6, respectively.

Treatment with biofertilizer had no significant effect on plant height during the early growth phase. Plant height is the indicator that responds most quickly to the applied treatment; however, sometimes the results obtained vary for each plant. According to Vessey (2003), the effects of PGPR can vary among growth parameters, with significant effects more often found in biomass

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than in plant height. Gholami et al. (2009) showed that PGPR inoculation significantly increased plant height. These differences in results indicate that the effectiveness of PGPR is influenced by many factors, such as the type of host plant, bacterial strain, and environmental conditions.

Table 1. The effect of Rhizomax use on the height of Turi plants (cm)

Dose (ml)	4 weeks	5 weeks	6 weeks
0	18.50	23.33	32.07
100	19.71	25.61	34.21
200	18.57	22.89	30.36
300	16.00	21.50	28.11
400	17.60	22.79	26.93
Average	18.07	23.22	30.33

Treatment with biofertilizer had no significant effect on plant height during the early growth phase (Junaedi et al., 2010). According to Vessey (2003), the effects of PGPR can vary among growth parameters, with significant effects more often found in biomass than in plant height. Gholami et al. (2009) showed that PGPR inoculation significantly increased plant height. These differences in results indicate that the effectiveness of PGPR is influenced by many factors, such as the type of host plant, bacterial strain, and environmental conditions.

The Effect of Rhizomax Use on the Stem Diameter of Turi Plants

The results of the study on the growth of taro on ultisol soil with the use of Rhizomax at different doses on the stem diameter of taro plants are presented in Table 2.

Table 2. The effect of Rhizomax use on the diameter of Turi plants (cm)

Dose (ml)	4 weeeks	5 weeks	6 weeks
0	0.30	0.39	0.51
100	0.34	0.44	0.54
200	0.31	0.43	0.51
300	0.30	0.37	0.49
400	0.33	0.41	0.47
Average	0.32	0.40	0.50

Measuring the stem diameter from the treatments given is necessary to see the indication; an increase in stem diameter shows good growth. The increase in stem diameter can be caused by the additional nutrients provided and can also be due to the availability of nutrients in the soil. The analysis of variance results showed that the addition of Rhizomax had no significant effect ($P>0.05$) on the diameter of the turi plants. The stem diameter of red turi plants in this study was 0.32 cm in week 4, 0.40 cm in week 5, and 0.50 cm in week 6, respectively.

The results obtained did not show a significant response to stem diameter; this was not caused by a lack of water and nutrients, but because the turi was still in the early vegetative growth phase, and its nutrient requirements were still limited. Other factors can also be caused by the slow response of the stem to treatment. Some studies have shown that biofertilizers can increase the

stem diameter of plants, but the results vary depending on the type of plant and environmental conditions (Syavitri et al., 2019).

The Effect of Rhizomax Usage on the Number of Leaf Stalks of Turi Plants

The results of the effect of different Rhizomax doses on the number of taro plant stems grown in ultisol soil are presented in Table 3.

Table 3. The effect of Rhizomax use on the number of leaf stalks of Turi plants (cm)

Dose (ml)	4 weeks	5 weeks	6 weeks
0	8.29	9.71	13.29
100	8.00	10.57	13.86
200	8.29	9.29	12.57
300	6.57	8.57	11.71
400	6.43	8.14	11.29
Average	7.52	9.26	12.54

The results of the variance analysis showed that the addition of different Rhizomax doses had a different but not significant effect ($P<0.05$) on the number of leaf stalks. This result is not much different from that observed in soybean plants with the provision of concentration and time interval of bioactive application (Afrina and Frisella, 2023). The study results showed that the number of leaf stalks formed in this study averaged 7.52 in the 4th week, 9.26 in the 5th week, and 14.54 leaf stalks in the 6th week.

These results indicate that the addition of Rhizomax did not increase the number of leaf stalks formed with increased doses of Rhizomax. In PGPR, that is, inside Rhizomax, there are microorganisms such as Rhizobium sp., Bacillus polymyxa, and Pseudomonas fluorescens, which can produce phytohormones (auxin, cytokinin, and gibberellin) and fix nitrogen. However, these microorganisms also require nutrients during metabolism, which can stimulate cell division in the formation of leaf stalks and other variables. Nevertheless, in this study, it has not yet been observed morphologically; it is suspected that the availability of nutrients to meet the needs of the microorganisms is limited, resulting in low activity.

The results of this study suggest that there is a need to add nutrients, such as organic fertilizers, and to use inorganic fertilizers as a reference or comparison. This is also supported by the research results of Sari (2018), who showed that the application of PGPR combined with the addition of cow manure fertilizer had a significant interaction on the number of branches and leaves of sweet corn plants at 14 days after planting. Cytokinin hormones, which function in cell division in plants, can stimulate the division of cells that will divide and develop into branches, shoots, and leaves, thereby increasing the number of branches on the plant (Tekei et al., 2001).

CONCLUSION

The application of PGPR (Rhizomax) at doses of 100–400 ml/plant did not significantly affect the plant height, stem diameter, or number of leaf stalks of turi (Sesbania grandiflora) during the early vegetative phase. This indicates that PGPR application has not yet contributed to improving early forage biomass potential under ultisol conditions, likely because of the limited nutrient demand at this growth stage. These findings suggest that the effectiveness of PGPR in supporting

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turi as a forage resource for ruminants may require longer growth periods or integration with additional nutrients. Further research should focus on biomass yield, nutritive value (crude protein), and digestibility to better evaluate the role of this species in livestock feeding systems.

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