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Increasing Red Chili Plants (*Capsicum annuum* L) Growth Rate by Administering Photosynthetic Bacteria (PSB) Fertilizer and NPK Fertilizer

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ABSTRACT

Red chili is a significant horticultural crop in Indonesia. The goal is to determine how photosynthetic bacterial fertilizer (PSB) and NPK fertilizer impact the growth rates of plants. This research took place from March 2024 to June 2024. This study employed a quantitative research method, specifically using a factorial randomized block design (RAK) with an intensity factor (I) (0, 200, 300, and 400 ml/plant) and a fertilizer type factor (P) consisting of 2 factors. Specifically, there were 8 treatments with 3 replications each, resulting in a total of 24 experiments involving 120 plants. These treatments included doses of 0 and 10 grams per plant. We made observations when the red chili plants were between 1 and 7 weeks after planting (WAP), focusing on parameters such as plant height, number of leaves, and growth rate. Data was analyzed using analysis of variance (ANOVA) to identify significant differences, followed by a 5% level test (DMRT). According to the results of additional tests at 7 weeks after planting (WAP), it was found that the combination of photosynthetic bacterial fertilizer (PSB) and NPK fertilizer had a positive impact on plant height. The best results were observed in plants treated with 300 ml of PSB fertilizer and 10 g of NPK fertilizer per plant, with an average height of 57.80 cm and an average of 70.67 leaves per plant. The combination of fertilizers, with P1I2 treatment being the most effective, is capable of enhancing the growth and development of red chili plants.

Keywords: *Fertilization, Growth, NPK, Photosynthetic Bacteria (PSB), Red Chilies*

1. INTRODUCTION

Red chilies, also known as *Capsicum annum* L, are considered to be a highly significant horticultural product. This plant offers numerous benefits and has many uses for a variety of needs, such as household activities or other purposes. It can be used as an ingredient in traditional medicines, drinks, and food, and as a raw material for industrial purposes. This plant is rich in vitamins and nutrients such as fat, protein, carbohydrates, vitamin A, vitamin C, and vitamin B1 (Zahroh et al., 2018).

According to data from the Central Statistics Agency and the Directorate General of Horticulture, the production value of large chili in 2019 was 1,214,419 tons with a harvested area of 133,436 hectares and a productivity of 9.10 tons per hectare (Ministry of Agriculture, 2019). According to the Central Statistics Agency (BPS) of 2021, the production of chili plants increased from 1.21 million tons to 1.26 million tons from 2019 to 2020. The chili production is targeted to increase by 7%, around 1.35 million tons. The chili consumption demand in 2020 was 1.09 million tons and is projected to increase in 2021. The demand for red chilli from January to May 2021 reached 432,129 tons. The increasing demand for chili consumption in society requires an increase in chili production.

Factors affecting the production of red chili plants include the less fertile soil conditions resulting from continuous land use. Cultivation steps can be taken to achieve productive yields in such less fertile soil. One approach is to implement appropriate fertilization, which involves applying the right type, time, method, target, and dosage of fertilizer. Fertilizers are substances that support soil fertility because they contain one or more nutrients that replace the elements absorbed by plants. Red chili plants require relatively high amounts of nutrients N (nitrogen), P (phosphorus), and K (potassium). Therefore, to maximize yields, red chili plants must receive an optimal supply of nutrients (Purwanto 2020). The provision of nutrients to plants significantly influences their growth and development. The nutrients supplied to plants come in the form of fertilizers containing essential elements. Fertilizers can be organic, derived from living organisms, such as animal manure or plant residues, or inorganic, produced in industrial factories and containing high levels of macronutrients. In cultivation practices, inorganic fertilizers are commonly used. These fertilizers vary in type, including simple and multi-component formulations. Nutrients are provided through fertilization to enhance chili production (Mulya Deviyanti et al. 2023).

We know that NPK fertilizer consists of the elements nitrogen (N), phosphorus (P), and potassium (K). The NPK element is crucial for plants to carry out various growth processes. Plants that do not have enough N elements for growth, even if they have sufficient P and K elements, will not thrive, resulting in the leaves losing their green color and turning yellow. Plants will wilt and potentially die due to a significant deficiency in N. Conversely, without adequate phosphorus, the plant will not thrive, resulting in underdeveloped roots and hindered nutrient absorption. Providing NPK fertilizer during the vegetative phase of plant growth is highly beneficial due to its role in promoting plant growth (Abdillah and Laude 2023).

Nevertheless, the long-term use of chemical fertilizers will lead to a decrease in the availability of nutrients in the soil, ultimately resulting in reduced soil fertility. Consistently using chemical fertilizers, with higher amounts each year, can harm soil structure and upset the balance of soil nutrients. According to Razali and Fithria (2023), as well as Abdillah and Laude (2023), the soil's condition is deteriorating because of its low organic material content. Plants require organic material to support their growth. The organic material in the soil indirectly

affects the growth and development of plants. Soil containing a large amount of organic matter does not compact and harden easily. The availability of oxygen in the soil is the reason why this condition affects plant roots. Additionally, organic materials can assist in absorbing water and sunlight, ultimately enriching the soil. Perdana Putra and Abdul Basit (2023) state that organic fertilizer can improve the physical and chemical properties of agricultural soil, as well as enhance the efficiency of soil microorganisms.

Organic fertilizers are a type of fertilizer made from organic materials or living organisms. An example of an organic fertilizer is PSB (photosynthetic bacteria). Photosynthetic bacteria possess bioremediation capabilities as they utilize various organic materials as substrates, resulting in high growth rates. These bacteria are prokaryotes capable of photosynthesis and are widely distributed across various habitats such as land, lakes, rice fields, oceans, rivers, and active mud. Consequently, this type of fertilizer requires sunlight for its metabolism. In terms of plant growth and development, PSB offers numerous roles and important benefits, including fulfilling the nitrogen requirements of all plant types, adding hydrogen sulfide gas to soil structure through the decomposition of organic materials, accelerating plant growth, enriching amino acids, nucleic acids, physiological active compounds, and polysaccharides in the soil, enhancing plant quality and fertility, strengthening plant roots, protecting plants from various pests and diseases, and making plants more resilient and resistant to insects (Sudibya et al. 2022).

Photosynthetic bacteria, also known as PSB, are a type of autotrophic bacteria that can perform photosynthesis. PSB contain pigments known as bacteriophylls a or b, which are responsible for producing red, green, and purple pigments that capture solar energy essential for driving the process of photosynthesis. The advantages of PSB include nitrogen fixation in plants, promotion of plant growth, enhancement of plant root development, and improvement of plant resistance against pests and diseases. Due to their capability to conduct photosynthesis, photosynthetic bacteria are referred to as photoautotrophic bacteria, indicating their capacity to synthesize their own nutrients using sunlight energy through the process of photosynthesis. The pigment bacteriochlorophyll, found in the photosynthetic membrane, plays a crucial role in capturing sunlight for photosynthesis. These bacteria can thrive in aerobic conditions and carry out both photosynthesis and fermentation processes (Nugroho 2023).

PSB fertilizer is also known as MiTel fertilizer due to the fact that the term MiTel is derived from the combination of mycin (MSG), egg, and water, which are the primary components used in the production of PSB fertilizer. MSG, which contains potassium, plays a crucial role in the process of photosynthesis. Potassium deficiency in leaves can lead to a decrease in the absorption rate of carbon dioxide (CO2). Potassium is essential for the synthesis of proteins and carbohydrates, the hardening of seeds and woody plant parts, and enhancing resistance to diseases. Mycin also contains other elements like sodium (Na) and nitrogen. The nitrogen present in MSG promotes vegetative growth, protein synthesis, increased plant yield, and higher cellulose content. Additionally, the sodium (Na) content in MSG can accelerate growth and flowering, impact fertility, and reduce plant mortality rates. Another key ingredient in PSB fertilizer is eggs. Eggs are known for their protein content, which aids in the formation of amino acids. Plants with adequate amino acid levels produce pectin extract between cell walls, making them more robust and resistant to pest attacks. Moreover, amino acids can enhance soil microbial activity and facilitate nutrient

absorption by plant roots. Water, the final essential ingredient in PSB fertilizer production, serves as a medium for the growth and development of photosynthetic bacteria. The combination of mycin, eggs, and water results in the creation of liquid organic fertilizer, known as MiTel fertilizer, which offers numerous benefits for plant growth and development (Hana Lestari et al., 2022).

The purpose of this study is to investigate how the growth rate of red chili plants (Capsicum annuum L.) is affected by the use of photosynthetic bacteria (PSB) fertilizer. To investigate the impact of NPK fertilizer on the growth rate of red chili plants (Capsicum annuum L.). The aim of the study is to determine how the growth rate of red chili plants (Capsicum annuum L.) is affected by the combination of photosynthetic bacteria (PSB) fertilizer and NPK fertilizer.

2. MATERIAL AND METHODS

This research will be conducted from March 2023 to June 2024. The study will take place in the village of Aek Paing Bawah, Rantau Utara District, Labuhanbatu Regency. The tools used in this research include a hoe, a 1.5-liter plastic bottle, a spoon, a bowl, a bucket, a measuring tape, and writing instruments. The materials utilized in this study are red chili seeds (Capsicum annuum L.), photosynthetic bacteria (PSB) fertilizer, NPK fertilizer, water, monosodium glutamate (MSG), and soil. This research employs a Factorial Randomized Block Design (FRBD) with two factors: intensity (I) and type of fertilizer (P). There are eight treatment combinations and three replications, resulting in a total of 24 experimental units, with 120 plants in total. The factors and treatment combinations are as follows: Intensity factor: Control (without PSB), 200, 300, and 400 mL/plant; Type of fertilizer factor: Control (without NPK) and NPK 10 grams/plant.

Observations were made when the red chili plants (Capsicum Annuum L.) were 1, 2, 3, 4, 5, 6 and 7 weeks after planting. Several parameters observed in research on the effect of photosynthetic bacteria (PSB) fertilizer and NPK fertilizer on the growth rate of red chili plants (Capsicum Annuum L.) are as follows:

1. Height of the red chili plant

This observation uses the unit (Cm) for measuring plant height using a meter, measurements are made from the bottom of the soil or the lower stem of the red chili plant to the top of the stem or top of the red chili plant.

2. Number of leaves

This observation can be seen from the increase in the number of red chili leaves with leaf units (pieces) calculated on chili plants, namely leaves that have opened completely.

3. Growth rate of red chili plants

Plant growth rate is the speed of plant growth measured in a certain unit of time. Plant growth rate is greatly influenced by environmental factors such as temperature, humidity, light and plant nutrition. By knowing the growth rate of plants, we can find out how fast our plants grow and develop.

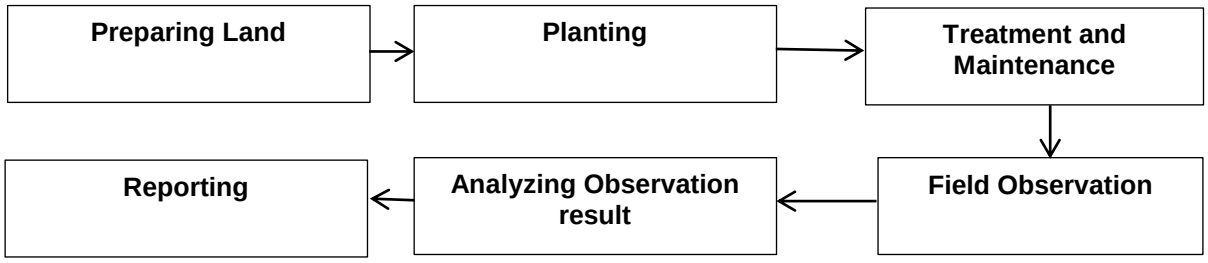


Figure 1. Research Flowchart

The data analysis used in this research was additive linear mode for a two-factor design with a randomized block design. Then the observation data was analyzed using variance (ANOVA) to measure the effect of treatment. Significantly different results, followed by Test (DMRT) at 5% level.

3. RESULT AND DISCUSSION

3.1 Plant Height

Plant height is an irreversible growth parameter that consistently increases with plant age and growth. It is also a vegetative growth parameter that is influenced by environmental factors within the plant, thus making it a crucial aspect of plant growth. This can be seen to assess the impact of the treatment, particularly the existence of a nutrient.

We use a meter to measure the height of plants, starting from the bottom of the soil or the lower stem of the red chili plant and ending at the top of the stem or top of the red chili plant. According to the analysis of variance, it is evident that the amount of PSB and NPK fertilizers directly affects the average height of chili plants as observed on a weekly basis. The analysis of variance results indicated a significant difference in the application of PSB and NPK fertilizers from 1 week after planting (MST) to 7 weeks after planting (MST). Therefore, a further DMRT (Duncan Multiple Range Test) was conducted at the 5% level (**Figure 2**).

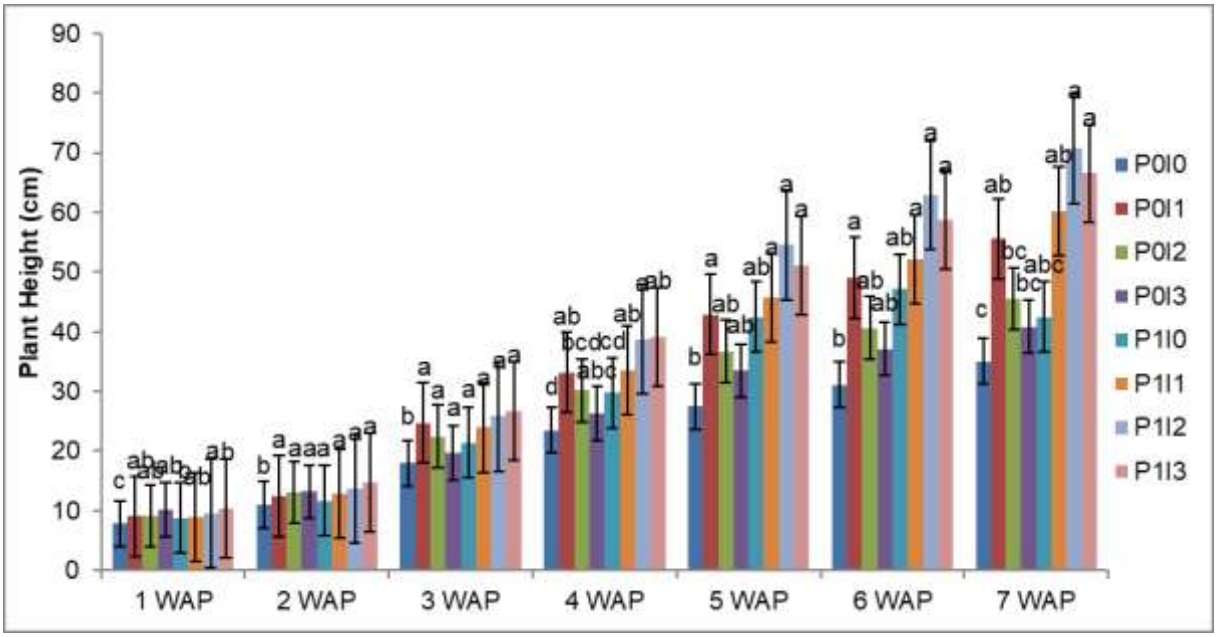


Figure 2. Average plant height (cm), MST (week after planting), P0 (control), P1 (NPK 10 g/plant), L0 (control), L1 (200 ml/plant), L2 (300 ml/plant), L3 (400 ml/plant)

From the results of further tests, it shows that at 7 WAP the highest plant height was in the PSB and NPK fertilizer treatment at a dose of 10 g/plant and 300 ml/plant with an average value of 57.80 cm, and the plants with the lowest plant height can be seen in P0I0 treatment is 38.27 cm. Based on table 1, the P1I3 treatment provides an average value for the number of plant leaves. This shows that the use of PSB 10 g/plant + NPK 300ml/plant has an influence on the number of plant leaves. The combination of fertilizers can increase plant growth and development.

The growth of plants is significantly influenced by the presence of elements such as N, P, and K. Nitrogen, which is a major component of amino acids and proteins, plays a crucial role in the formation of cell protoplasm and stimulates plant growth. This nutrient is especially important for stimulating vegetative growth, and when present in

sufficient quantities, it can lead to increased overall plant growth. Good. The nutrients in the planting media have a significant impact on plant fertility, including plant height. (Firdausia and Wahidah 2020).

3.2 Number of Leaves

The measurement of the number of leaves on the plants was conducted by counting the leaves for each treatment. Based on the analysis of variance, it was indicated that the doses of PSB and NPK fertilizers significantly affected the average number of chili plant leaves for each observation conducted weekly. The results of the analysis of variance demonstrated that the application of PSB and NPK fertilizers differed significantly from one week after planting (WAP) up to seven weeks after planting (WAP). Therefore, a further DMRT (Duncan Multiple Range Test) was performed at the 5% significance level (**Figure 3**).

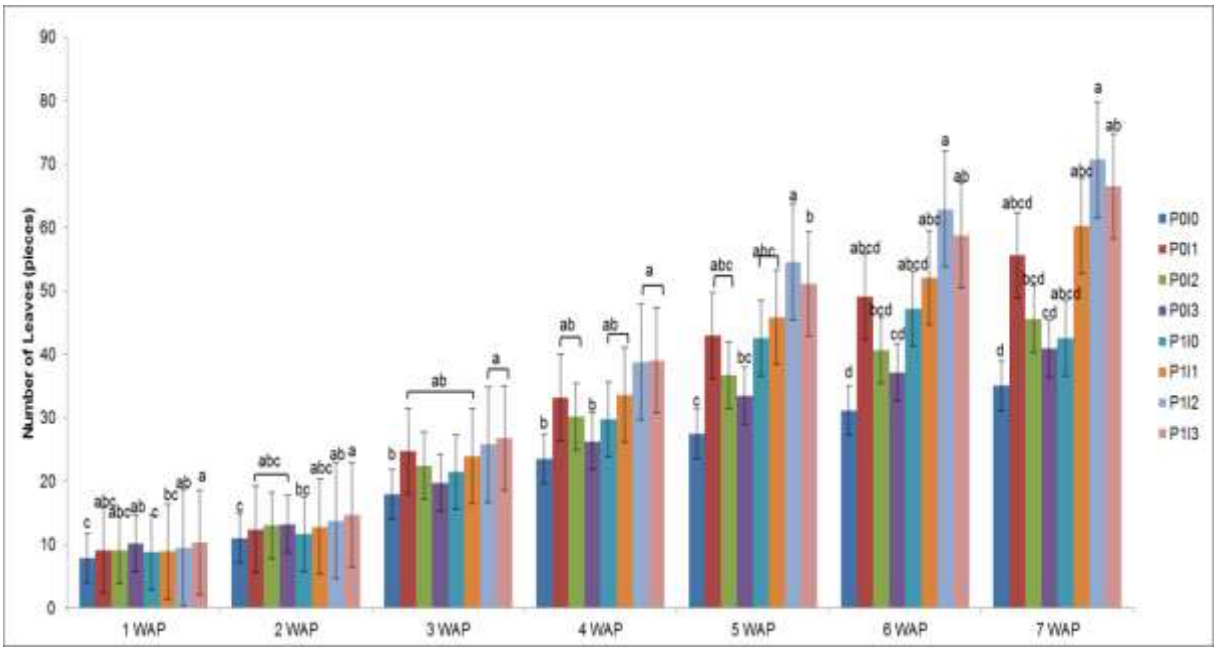


Figure 3. Average Number of Leaves (strands), WAP (Week After Planting), P0 (Control), P1 (NPK 10 g/plant), L0 (Control), L1 (200 ml/plant), L2 (300 ml/plant), L3 (400 ml/plant).

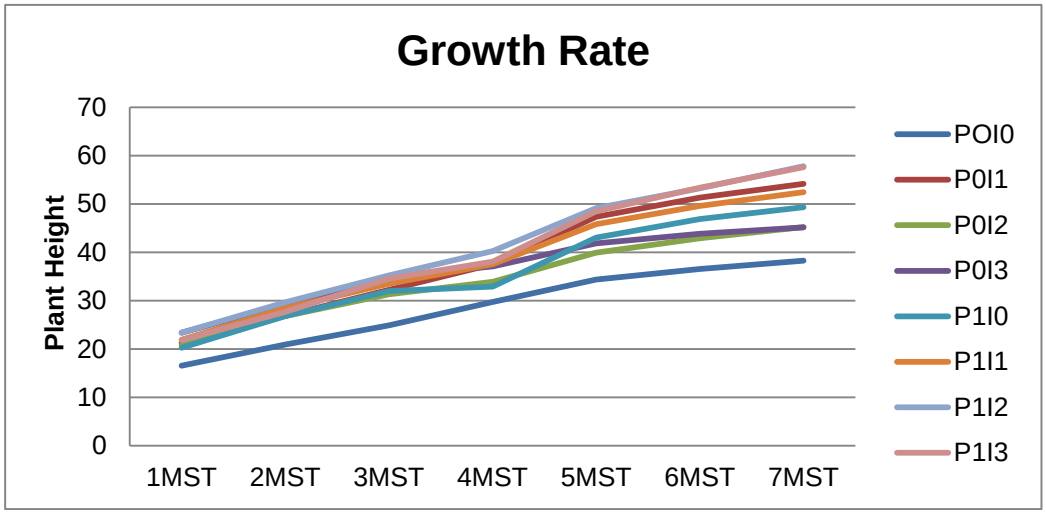
Based on the information presented in Table 2, it is evident that the treatment involving PSB and NPK fertilizer at a dosage of 10 g/plant and 300ml/plant respectively resulted in the highest average number of leaves at 7 WAP, with a value of 70.67. Conversely, the control treatment yielded the lowest average number of leaves at 35.07. The P1I3 treatment, as indicated in Table 2, also provided an average value for the number of plant leaves. This suggests that the combination of PSB and NPK fertilizers at the specified dosages has a significant impact on the number of plant leaves, ultimately leading to increased plant growth and development.

According to Maulana et al. (2023), the stimulation of new leaf growth in plants is closely linked to meeting their nutritional requirements, which can be achieved through the application of NPK fertilizer and the appropriate use of PSB. Furthermore, the increase in the number of leaves is associated with the growth in plant height and the number of branches.

3.3 Growth rate of red chili plants

Several factors influence the growth rate of chili plants, namely sunlight, rainfall, humidity, air temperature, wind and evaporation. Plant growth rate is useful for the results of the photosynthesis process, this will affect the weight of chili peppers at harvest. Plant growth rates are observed. at 1

WAP, 2 WAP, 3 WAP, 4 WAP, 5 WAP, 6 WAP and 7 WAP.



Graph 1. The effect of intensity and fertilizer on plant growth rate

From Graph 1 it can be seen that the growth rate of red chili plants when given PSB and NPK fertilizers has almost the same growth rate. In the P1I2 treatment with PSB and NPK fertilizers at a dose of 300 ml/plant and 10 grams/plant, namely the treatment that has the best plant growth rate and followed by the P1I3 treatment there is a slight difference compared to the P1I2 treatment, and in the P0I0 treatment or treatment without a dose the rate lowest growth.

4. CONCLUSION

Based on the research conducted in Aek Paing Bawah Village, Rantau Utara District, Labuhanbatu Regency, regarding the effect of Photosynthetic Bacteria (PSB) and NPK fertilizers on the growth rate of red chili plants (Capsicum annuum L), the conclusion is that:

The interaction between photosynthetic bacterial fertilizer (PSB) and NPK fertilizer significantly influenced plant height based on the results of additional tests conducted at 7 weeks after planting (WAP). The tallest plants were observed in the treatment group receiving PSB fertilizer and NPK fertilizer at rates of 300 ml/plant and 10 g/plant, respectively, with an average height of 57.80 cm. Notably, the P1I2 treatment exhibited the most favorable impact on plant height, indicating that this particular combination of fertilizers has the potential to enhance the growth and development of red chili plants.

The number of leaves in red chili plants was notably affected by the application of photosynthetic bacterial fertilizer (PSB) and NPK fertilizer, as evidenced by the results of subsequent tests. Among the various treatments, the P1I2 treatment demonstrated the most significant effect on plant height. This specific combination of fertilizers was found to promote leaf growth and development in red chili plants. At 7 weeks after planting (WAP), the highest number of leaves was observed in plants treated with PSB fertilizer and NPK fertilizer at a rate of 300 ml/plant and 10 g/plant, with an average count of 70.67 leaves.

The treatment combination involving PSB fertilizer at a rate of 300 ml/plant + NPK fertilizer at 10 g/plant (P1I2) yielded superior results compared to other treatment combinations in terms of the growth rate of red chili plants. This particular treatment regimen exhibited the most favorable growth rate for red chili plants, highlighting its efficacy in promoting the overall growth and development of the plants.

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