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Response of Actinomycetes Inoculation to the Growth Rate of Waxy Corn (*Zea mays* L. var. ceratina)

Adelia Salsabila Rahman[1], Novri Youla Kandowangko[1*], Wirnangsih Din Uno[1], Yuliana Retnowati[1], Devi Bunga Pagalla[1], Hayatiningsih Gubali[2], Muhammad Isra[3], Aisyah Ahmad[4]

[1]Department of Biology, Faculty of Mathematics and Natural Sciences, Gorontalo State University. Jl.Prof. Dr. B.J. Habibie, Tilongkabila, Bone Bolango Regency, Gorontalo Province, Indonesia.
[2]Department of Agrotechnology, Faculty of Agriculture, Gorontalo State University. Jl. Prof. Dr. BJ Habibie, Tilongkabila, Bone Bolango Regency, Gorontalo Province, Indonesia.
[3]Department of Food Technology, Faculty of Agriculture, Gorontalo State University. Jl. Prof. Dr. B.J. Habibie, Tilongkabila, Bone Bolango Regency, Gorontalo Province, Indonesia.
[4] Center for Agricultural Modernization Implementation, Agency for Agriculture and Modernization, Gorontalo Province. Jl. Moh Van Gobel No. 270, Iloheluma, Tilongkabila, Bone Bolango Regency, Gorontalo Province, Indonesia
[*] Corresponding author: novrikandowangko@ung.ac.id

ABSTRACT. Waxy corn (Zea mays var. ceratina) is an important food crop whose growth and productivity are strongly influenced by nutrient availability and soil microbial activity. The use of Actinomycetes as a biological biostimulant has gained attention due to its potential to enhance plant growth in an environmentally sustainable manner. This study aimed to evaluate the response of waxy corn growth rate to different doses of Actinomycetes inoculation. The experiment was conducted from July to December 2025 using a Randomized Block Design (RBD) consisting of three treatments: without Actinomycetes application (PA0), 5 g Actinomycetes (PA1), and 10 g Actinomycetes (PA2), with three replications for each treatment. Plant growth observations were performed at 14, 21, 28, 35, and 42 days after planting (DAP). Growth rate was determined based on the increase in plant dry biomass over each observation interval. The results showed that Actinomycetes inoculation affected the growth rate of waxy corn. The PA2 treatment consistently exhibited higher and more stable growth rates compared with PA0 and PA1 throughout the observation period. The enhanced growth performance was likely associated with the role of Actinomycetes in improving nutrient availability and stimulating vegetative development. In conclusion, the application of 10 g Actinomycetes demonstrated the greatest potential to increase the growth rate of waxy corn and may serve as an effective biological biostimulant for sustainable crop production.

Keywords : *Actinomycetes,* biostimulant, dry biomass, plant growth rate, waxy corn.

INTRODUCTION

Corn (*Zea mays* L.) is one of the strategic food commodities in Indonesia that plays an important role in supporting food security, providing industrial raw materials, and supplying animal feed. As the demand for corn continues to increase, efforts to improve crop productivity have become increasingly important. However, corn productivity still faces various constraints, one of which is the decline in soil quality and fertility due to the intensive and continuous use of inorganic fertilizers (Heryana et al., 2025). Long-term application of chemical fertilizers may reduce soil biological activity, disrupt the balance of beneficial microorganisms, and decrease the efficiency of nutrient utilization by plants. These conditions result in soil degradation and negatively affect plant growth and corn productivity (Masulili et al., 2024). In several agricultural regions, including Gorontalo, declining soil fertility remains one of the limiting factors in the development of sustainable corn cultivation.

Soil health is a major determinant of plant growth because soil functions as a medium for supplying water, nutrients, and habitats for various microorganisms involved in nutrient cycling. The deterioration of soil biological quality may interfere with the activity of beneficial microorganisms, thereby affecting root health and the ability of plants to absorb nutrients. Healthy and well-developed root systems have a greater capacity to absorb water and nutrients required for plant growth. Therefore, soil health and root health are closely interconnected components that determine the success of corn growth (Anwar, 2024).

The development of root systems is influenced not only by the physical and chemical properties of soil but also by the activity of rhizosphere microorganisms living around plant roots. Rhizosphere microorganisms are known to improve nutrient availability, enhance soil structure, and produce plant growth regulators that support root development. One of the most important plant growth regulators is Indole-3-Acetic Acid (IAA), an auxin hormone that stimulates cell elongation, lateral root formation, and root hair development. Increased numbers of lateral roots and root hairs expand the root absorption area, thereby improving the efficiency of water and nutrient uptake (Arifiani & Lisdiana, 2021).

One group of microorganisms with considerable potential as biological biostimulants is Actinomycetes, particularly those belonging to the genus Streptomyces. Actinomycetes are Gram-positive bacteria commonly found in the rhizosphere and are known to play important roles in maintaining soil health and promoting plant growth. These microorganisms contribute to soil fertility improvement through organic matter decomposition, nutrient mineralization, phosphate solubilization, and siderophore production, all of which increase nutrient availability to plants (Mitra et al., 2022). Therefore, Actinomycetes function not only as soil fertility enhancers but also as microorganisms capable of creating a rhizosphere environment conducive to root development.

The growth-promoting mechanisms of Actinomycetes occur through both direct and indirect pathways. Indirect mechanisms include phosphate solubilization, organic matter mineralization, siderophore production, and improvement of soil health, all of which contribute to enhanced nutrient availability. Direct mechanisms involve the production of phytohormones such as Indole-3-Acetic Acid (IAA), gibberellins, and cytokinins. IAA stimulates the formation of lateral roots and root hairs, gibberellins promote stem elongation and vegetative growth, while cytokinins regulate cell division and tissue development. The combined activities of these compounds enable plants to develop more extensive root systems, thereby enhancing water and nutrient uptake efficiency (Mehmood et al., 2024).

In addition to promoting plant growth, Actinomycetes also function as bioprotective agents that maintain root health through the production of antimicrobial compounds and secondary metabolites capable of suppressing soil-borne pathogens. Their presence in the rhizosphere creates a healthier microenvironment that supports root growth and improves nutrient uptake efficiency (Mohamad et al., 2025). Enhanced root development and nutrient absorption eventually increase plant biomass accumulation. Dry biomass is considered one of the primary indicators of plant growth rate because it reflects the net outcome of photosynthesis and nutrient utilization throughout the growth period.

Various studies have reported the ability of Actinomycetes to enhance the growth of cultivated plants through phytohormone production and increased nutrient availability. However, information regarding the effects of Actinomycetes application on waxy corn (*Zea mays* L. var. ceratina) remains limited, particularly concerning growth responses to different inoculum dosages. Moreover, studies investigating the utilization of local Actinomycetes isolates from Gorontalo as biological biostimulants in waxy corn cultivation are still scarce.

The isolate *Streptomyces albus* strain RzPK-05, originating from the Hulonthalangi karst ecosystem in Gorontalo, has been reported to possess the ability to produce IAA, solubilize phosphate, exhibit antagonistic activity against plant pathogens, and tolerate fungicides (Retnowati et al., 2024; Matalauni et al., 2025). These characteristics indicate its potential for development as a biological biostimulant to support plant growth. Therefore, this study was conducted to evaluate the effect of Actinomycetes inoculation on the vegetative growth of waxy corn under different application rates. The findings are expected to provide scientific information regarding the potential of local Actinomycetes as biological biostimulants and serve as a basis for developing more environmentally friendly corn cultivation technologies, reducing dependence on chemical fertilizers, and supporting sustainable agriculture in Gorontalo.

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MATERIALS AND METHODS

Research Location and Timeline

. The isolation, purification, propagation, and characterization of Actinomycetes were carried out at the Biology Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Negeri Gorontalo. The plant cultivation experiment was conducted in Huangobotu Village, Dungingi District, Gorontalo City. This study was conducted from July to December 2025

Materials and Equipment

The equipment used in this study included an autoclave, incubator, laminar airflow cabinet, Petri dishes, analytical balance, shovel, inoculating loop, Bunsen burner, heat-resistant plastic bags, oven, polybags, ruler, measuring cylinder, paper folders, scissors, and stationery.

The materials used consisted of waxy corn (Zea mays var. ceratina) seeds and the Actinomycetes isolate Streptomyces albus strain RzPK-05 originating from the Hulonthalangi karst ecosystem, Gorontalo. This isolate has been identified as capable of producing indole-3-acetic acid, solubilizing phosphate, exhibiting antagonistic activity against pathogens, and tolerating fungicides (Retnowati et al., 2024; Matalauni et al., 2025). Other materials included Starch Casein Agar (SCA), agar powder, 100% acetone, rice as a propagation medium, soil as a planting medium, distilled water, aluminum foil, and sterilization materials.

Research Procedures

Isolate Preparation and Propagation

The Actinomycetes isolate was purified on Starch Casein Agar medium and incubated at 28–30°C for 7–14 days until optimal colony growth was achieved. The isolate was then propagated on rice medium that had been washed, partially cooked, and sterilized at 121°C for 15 minutes. After cooling, the isolate was aseptically inoculated into the medium and incubated at 30°C for 10–14 days until uniform mycelial growth occurred (El Karkouri et al., 2019).

Preparation of Planting Materials and Soil Medium

The planting material used in this study was local Gorontalo waxy corn (Zea mays L. var. ceratina). Garden soil was used as the planting medium. Prior to treatment application, an initial analysis of soil chemical properties was conducted using composite soil samples. The samples were analyzed at the Agricultural Research and Modernization Center (BRMP) of Gorontalo. The analysis indicated that the soil had high phosphorus content, low potassium levels, slightly acidic pH, and low organic carbon content.

Experimental Design

The study employed a Randomized Block Design (RBD) with one treatment factor, namely the application of Actinomycetes-based microbial biostimulants. The treatments consisted of three levels:

PA0 = Control (without biostimulant),
PA1 = 5 g of Actinomycetes,
PA2 = 10 g of Actinomycetes.

Each treatment was replicated three times, and observations were conducted at 14, 21, 28, 35, and 42 days after planting (DAP), resulting in a total of 45 experimental units.

Determination of Plant Growth Rate

Observations were carried out at 14, 21, 28, 35, and 42 days after planting (DAP). The parameters observed included plant height, number of leaves, stem diameter, root length, and plant growth rate.

Plant growth is a process involving increases in size and biomass resulting from physiological activities such as cell division and enlargement. In plant growth analysis, dry biomass is considered the primary indicator because it is more stable and unaffected by tissue water content (Sopacua et al., 2021). Plant growth rate was determined based on the increase in plant dry biomass. Plants were harvested at each observation period, and the roots were cleaned of adhering soil. The roots, stems, and leaves were separated and cut into smaller pieces. The samples were oven-dried at 70°C for 48 hours until constant weight was achieved. The dried samples were then weighed to obtain total plant dry weight.

Dry biomass was obtained through oven-drying at approximately 70°C until a constant weight was reached. This method is a standard procedure in plant growth analysis because it provides accurate dry weight data to represent the accumulation of photosynthetic products (Baskara & Widyawati, 2022).

Plant growth rate was calculated using the following formula:

$$PGR = \frac{(W_2 - W_1)}{(T_2 - T_1)} \ (g\ m^{-2}\ day^{-1})$$ (Watson, 1952).

Data Analysis

The data obtained were analyzed using quantitative descriptive analysis.

RESULTS AND DISCUSSION

Figure 1. Growth of Waxy Corn Plants at Different Observation Intervals: (A) 14 DAP, (B) 21 DAP, (C) 28 DAP, and (D) 32 DAP.

Table 1. Plant Growth Rate of Waxy Corn at Different Observation Interval

Corn Plant Growth Rate Data (Grams Per Square Meter Per Day)				
PA0	-4.8099	71.61732	27.56586	31.25425
PA1	6.737853	47.29548	28.30354	-18.3061
PA2	39.12312	27.34185	32.82667	5.823773

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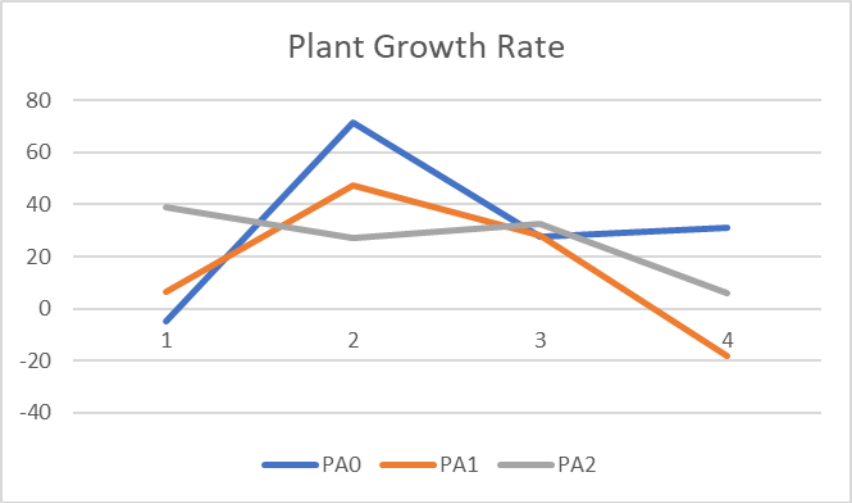

Figure 2. Root Plant Growth Rate

In addition to enhancing soil microbial activity, Actinomycetes are known to possess the ability to solubilize phosphate and potassium bound in the soil into forms that are more readily available to plants. Phosphorus plays an essential role in energy transfer, ATP formation, cell division, and the development of new tissues, whereas potassium is involved in enzyme activation and the regulation of cellular water balance. The availability of these nutrients is crucial for supporting vegetative growth and biomass production. Lamuka et al. (2025) reported that Actinomycetes isolates obtained from the corn rhizosphere exhibited phosphate-solubilizing abilities and have potential as biofertilizers. Similar findings were reported by Mahulette et al. (2023), who stated that rhizospheric Actinomycetes isolates could increase phosphorus availability through phosphate solubilization. Furthermore, Boubekri et al. (2021) demonstrated that Actinobacteria isolates possess both phosphate- and potassium-solubilizing capacities, thereby enhancing plant growth through improved nutrient availability in the rhizosphere.

Actinomycetes also promote plant growth through the production of phytohormones such as Indole-3-Acetic Acid (IAA), gibberellins, and cytokinins. These phytohormones stimulate lateral root formation, increase root surface area, and improve root system development, resulting in more efficient absorption of water and nutrients. According to Mehmood et al. (2024), plant growth-promoting Actinomycetes enhance vegetative growth through physiological and biochemical mechanisms that support root development and biomass accumulation.

In addition to producing phytohormones, Actinomycetes are capable of synthesizing siderophores, which increase the availability of iron (Fe) to plants. Iron is an essential element involved in chlorophyll biosynthesis and electron transport during photosynthesis. Mitra et al. (2022) explained that interactions between Actinobacteria and plants improve nutrient uptake efficiency, enhance soil health, and support sustainable plant growth. Similarly, Faddetta et al. (2023) reported that Actinobacteria produce various bioactive metabolites with considerable potential for development as environmentally friendly biofertilizers to support crop growth.

The increased dry biomass observed under the PA2 treatment indicates that Actinomycetes application was able to support plant physiological activities more effectively. Hala et al. (2023) reported that Actinomycetes inoculation in corn significantly influenced several vegetative growth parameters, including plant dry weight. The increase in dry biomass reflects greater accumulation of photosynthetic products, which serves as the basis for calculating plant growth rate.

Nevertheless, the plant growth rate observed in this study exhibited a fluctuating pattern. Variations in growth rate values among observation intervals, including low or even negative values in some treatments, indicate that plant growth did not proceed at a constant rate throughout the vegetative phase. During certain growth stages, photosynthates were predominantly allocated to the formation of new tissues, resulting in increased biomass accumulation. At other stages, however, a substantial proportion of photosynthates was utilized for metabolic processes and tissue maintenance, leading to lower biomass increments.

Low or negative growth rate values observed during specific intervals indicate that the increase in plant dry biomass during those periods was smaller than that of the preceding intervals. In addition to nutrient availability, plant growth rate is influenced by the plant's nutrient uptake capacity, physiological condition, and environmental factors during growth. Therefore, the variation in growth rates observed in this study likely resulted from interactions among Actinomycetes application, environmental conditions, and the physiological responses of plants throughout their growth period.

Based on the findings of this study, the PA2 treatment (10 g of Actinomycetes) consistently showed a tendency to produce better and more stable plant growth rates than the other treatments. These results indicate that Actinomycetes have the potential to support the vegetative growth of waxy corn through enhanced rhizosphere microbial activity, improved nutrient availability, phytohormone production, bioactive metabolite synthesis, and increased efficiency of biomass accumulation.

CONCLUSION

Based on the results of this study, Actinomycetes inoculation has the potential to improve the growth rate of waxy corn (Zea mays var. ceratina). The PA2 treatment (10 g of Actinomycetes) exhibited relatively higher and more stable plant growth rates than the control treatment (PA0) and PA1 (5 g of Actinomycetes). The enhancement in growth rate was presumably associated with the ability of Actinomycetes to improve nutrient availability, particularly phosphorus, and to support vegetative plant development, thereby increasing dry biomass accumulation. Although fluctuations in plant growth rate were observed across the different observation intervals, the application of 10 g of Actinomycetes produced the most favorable growth response and therefore has considerable potential for use as a biological biostimulant to promote the vegetative growth of waxy corn.

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REFERENCES

Anwar, S. (2024). Isolasi dan karakterisasi actinomycetes pada rhizosfer tanaman jagung. Chemviro: *Jurnal Kimia dan Ilmu Lingkungan*, 3(1), 45–52. https://doi.org/10.56071/chemviro.v3i1.119

Arifiani, D., & Lisdiana. (2021). Isolasi bakteri endofit penghasil IAA dari akar tanaman jagung (Zea mays L.). *LenteraBio,* 10(3), 285–291. https://doi.org/10.26740/lenterabio.v10n3.p285-291

Baskara, & Widyawati. (2022). Effect of planting media on plant growth. *Jurnal Teknik Pertanian Lampung*, 11(3), 354–364. https://doi.org/10.23960/jtep-l.v11i3.354-364

Boubekri, K., Soumare, A., Mardad, I., Lyamlouli, K., Hafidi, M., Ouhdouch, Y., & Kouisni, L. (2021). The screening of potassium- and phosphate-solubilizing Actinobacteria and the assessment of their ability to promote wheat growth parameters. *Microorganisms*, 9(3), 470. https://doi.org/10.3390/microorganisms9030470

El Karkouri, A., Ait Assou, S., & El Hassouni, M. (2019). Isolation and screening of actinomycetes producing antimicrobial substances from an extreme Moroccan biotope. Pan African *Medical Journal*, 33(1). https://www.ajol.info/index.php/pamj/article/view/237931

Faddetta, T., Polito, G., Abbate, L., Licciardello, G., Longa, C. M. O., Grasso, F. M., Catara, V., & Cacciola, S. O. (2023). Bioactive metabolite survey of Actinobacteria showing plant growth promoting traits to develop novel biofertilizers. *Metabolites*, 13(3), 374. https://doi.org/10.3390/metabo13030374

Hala, Y., Suryani, A. I., & Devi, O. C. (2023). Vegetative growth response of corn (Zea mays) to Actinomycetes, *Azospirillum, and Azotobacter. Bionature*, 24(1), 188–198. https://doi.org/10.35580/bionature.v24i1.44115

Heryana, H., Kusuma, R. A., & Prasetyo, B. (2025). Respon pertumbuhan tanaman jagung terhadap pemberian pupuk organik cair. *Agriprima: Journal of Applied Agricultural* Sciences, 9(1), 1–10. https://doi.org/10.25047/agriprima.v9i1.712

Kaharu, P. I., Tangapo, A. M., & Mambu, S. M. (2021). Dinamika populasi mikroba tanah dan respon pertumbuhan vegetatif tanaman jagung (*Zea mays* L.) terhadap aplikasi amelioran pupuk organik. *Jurnal Bios Logos*, 11(2), 102–108. https://doi.org/10.35799/jbl.11.2.2021.32896

Lamuka, A. P., Retnowati, Y., Katili, A. S., Kandowangko, N. Y., & Hasan, A. M. (2025). Phosphate solubilizing Actinomycetes in the rhizosphere of corn (Zea mays) in Gorontalo. *MIKHAYLA: Journal of Advanced Research*, 2(1), 1–10. https://doi.org/10.61579/mikhayla.v2i1.282

Masulili, A., Utami, S. N. H., & Kurniawan, A. (2024). Peningkatan kesuburan tanah dan pertumbuhan tanaman jagung pada lahan marginal. *Jurnal Agronomi Indonesia*, 10(1), 55–63. https://doi.org/10.30997/jag.v10i1.11852

Matalauni, C. L., Retnowati, Y., Katili, A. S., Hasan, A. M., & Kandowangko, N. Y. (2025). Isolation and characterization of Actinomycetes from plant rhizosphere in Gorontalo karst area. MIKHAYLA: *Journal of Advanced Research*, 2(1), 11–18. https://doi.org/10.61579/mikhayla.v2i1.286

Mehmood, A., Shahid, M., Khan, M. S., et al. (2024). Plant growth-promoting actinomycetes and their role in phytohormone-mediated growth enhancement. *Frontiers in Plant Science*, 15, 1343928. https://doi.org/10.3389/fpls.2024.1343928

Mitra, D., Mondal, R., Khoshru, B., et al. (2022). Actinobacteria-enhanced plant growth, nutrient acquisition, and crop protection: Advances in soil, plant, and microbial multifactorial interactions. *Pedosphere*, 32, 149–170. https://doi.org/10.1016/S1002-0160(21)60042-5

Mohamad, D., Retnowati, Y., Kandowangko, N. Y., Katili, A. S., & Uno, W. D. (2025). Kemampuan antagonistik actinomycetes dari rhizosfer tanaman jagung (Zea mays L.) di Gorontalo terhadap kapang patogen. *MIKHAYLA: Journal of Advanced Research*, 2(1), 35–45. https://doi.org/10.61579/mikhayla.v2i1.288

Retnowati, Y., Katili, A. S., Kandowangko, N. Y., & Pembengo, W. (2024). Molecular identification of rhizospheric Actinomycetes from karst ecosystems of Gorontalo, Indonesia, and its seed germination induction capability of Zea mays var. doti. *Biodiversitas*, 25(12), 4763–4771. https://doi.org/10.13057/biodiv/d251212

Sopacua, F., Wijayanto, N., & Wirnas, D. (2021). Growth analysis of plant biomass using dry weight method. *Biodiversitas Journal of Biological Diversity*, 22(10). https://doi.org/10.13057/biodiv/d221035

Watson, D. J. (1952). The physiological basis of variation in yield. *Advances in Agronomy*, 4, 101–145. https://doi.org/10.1016/S0065-2113(08)60307-7