

Growth And Yield Responses Of Waxy Corn (*Zea Mays* L. Var. *Ceratina*) Treated With Arbuscular Mycorrhizal Fungi Biostimulant

Ipul Saputra Latif¹, Hayatiningsih Gubali², Mohamad Lihawa³

¹Alumnus of the Agrotechnology Study Program, Universitas Negeri Gorontalo, Indonesia

^{2–3}Lecturers of the Agrotechnology Study Program, Universitas Negeri Gorontalo, Indonesia

*Corresponding Author: hayatiningsihgubali@ung.ac.id

Abstract

Waxy corn (Zea mays L. var. ceratina) is one of the local genetic resources with potential as a food source; however, its productivity remains relatively low, necessitating efforts to improve plant growth through the use of arbuscular mycorrhizal fungi (AMF) as a biostimulant. This study aimed to determine the growth response of waxy corn plants treated with AMF and to identify the dosage that provided the best response. The research was conducted from October to December 2025 in Huangobotu Village, Dungingi District, Gorontalo City, using a non-factorial Randomized Complete Block Design (RCBD) with four treatments: D0 (without AMF), D1 (10 g AMF), D2 (20 g AMF), and D3 (30 g AMF), with three replications. The observed parameters included plant height, number of leaves, leaf area index, ear length with husks, ear length without husks, ear circumference with husks, ear circumference without husks, ear weight with husks, ear weight without husks, and number of rows per ear. The data were analyzed using analysis of variance (ANOVA), followed by the Least Significant Difference (LSD) test at the 5% significance level. The results showed that AMF application had no significant effect on most growth and yield parameters. However, AMF significantly affected the number of leaves at 2, 6, and 8 weeks after planting (WAP). Treatment D3 produced the highest number of leaves at 2 and 6 WAP, whereas D1 produced the highest number of leaves at 8 WAP.

Keywords: *Zea mays* L. var. *ceratina*, arbuscular mycorrhizal fungi (AMF), plant growth, number of leaves, biostimulant.

INTRODUCTION

Corn (*Zea mays* L.) is one of the strategic food commodities that plays an important role

in food security, industrial raw material supply, and livestock feed. In addition to widely cultivated hybrid varieties, Indonesia has diverse local corn germplasms with significant economic and cultural value, including waxy corn (*Zea mays* L. var. *ceratina*). Waxy corn is characterized by its soft and sticky kernels due to its high amylopectin content, making it an important local food resource and raw material for various processed products. Safrina et al. (2023) reported that waxy corn possesses distinctive morphological characteristics and has potential for development as a high-value local food commodity.

In Gorontalo Province, local waxy corn remains cultivated as one of the region's genetic resources. However, its productivity is still relatively low compared with its genetic potential. This condition is associated with several factors, including low soil fertility, limited nutrient availability, inefficient fertilizer application, and high dependence on inorganic fertilizers. Although continuous application of inorganic fertilizers can increase crop productivity in the short term, excessive and prolonged use may adversely affect soil physical, chemical, and biological properties. Tialo et al. (2022) reported that the cultivation of local waxy corn in Gorontalo is still largely dependent on inorganic fertilizers, highlighting the need for environmentally friendly and sustainable cultivation technologies.

The use of soil microorganism-based biostimulants, particularly Arbuscular Mycorrhizal Fungi (AMF), is one potential approach to improving nutrient-use efficiency. AMF form mutualistic symbiotic associations with plant roots and develop external hyphal networks that extend beyond the root depletion zone. This association can increase the effective root absorption area and improve the uptake of water and nutrients, particularly phosphorus, which has relatively low mobility in soil. AMF may also contribute to improved plant growth and tolerance to environmental stresses. Delaeter et al. (2024) reported that AMF can function as biostimulants by enhancing plant growth, nutrient uptake efficiency, and plant tolerance to various environmental conditions.

Several studies have demonstrated the potential of AMF to improve the growth and productivity of corn. Agbodjato et al. (2022) reported that AMF inoculation increased vegetative growth, nutrient uptake, and grain yield while reducing the requirement for mineral fertilizers. Farmawaty et al. (2025) found that AMF inoculum applied at doses of 15 and 20 g per polybag increased the relative growth rate of corn compared with the control. Ishaq et al. (2021) also reported that AMF increased root colonization, plant growth, and yield of corn grown in calcareous soil with low phosphorus availability. These findings indicate that the effectiveness of AMF can vary depending on plant genotype, inoculum dose, soil characteristics, and environmental conditions.



Despite the potential benefits of AMF in corn production, information regarding the response of local Gorontalo waxy corn to different AMF doses remains limited. Differences in genetic characteristics may influence the ability of plants to establish mycorrhizal associations and consequently affect their growth and yield responses. Therefore, evaluating the response of local Gorontalo waxy corn to different AMF doses is necessary to determine an appropriate application rate and provide a scientific basis for the development of efficient, environmentally friendly, and sustainable cultivation practices.

This study aimed to analyze the effect of different doses of AMF biostimulant on the growth and yield of local Gorontalo waxy corn (*Zea mays* L. var. *ceratina*) and to determine the dose that produced the best response. The findings are expected to contribute to the development of more efficient and sustainable waxy corn cultivation practices while supporting the conservation and utilization of local Gorontalo corn germplasm.

METHOD

This research was conducted from October to December 2025 in Huangobotu Village, Dungi District, Gorontalo City, Gorontalo Province, Indonesia. The experiment used a non-factorial Randomized Complete Block Design (RCBD) consisting of four AMF biostimulant treatments and three replications. The treatments were D0 (without AMF), D1 (10 g AMF polybag⁻¹), D2 (20 g AMF polybag⁻¹), and D3 (30 g AMF polybag⁻¹), resulting in 12 experimental units.

Local Gorontalo waxy corn seeds (*Zea mays* L. var. *ceratina*) and *Glomus intraradices* (MycoVir) inoculum were used in the experiment. The growing medium consisted of soil and farmyard manure mixed at a 1:1 ratio and placed in 40 × 40 cm polybags. Three healthy and uniform seeds were planted in each polybag at a depth of approximately 5 cm. AMF inoculum was applied directly to the planting hole at planting according to the treatment dose. Plant maintenance included daily watering, manual weed removal, and pest control when necessary. Harvesting was conducted at 60–70 days after planting when the ear silks had turned dark brown to black and the kernels had reached physiological maturity.

Plant height, number of leaves, and leaf area index (LAI) were observed at 2, 4, 6, and 8 weeks after planting (WAP). Yield parameters, including ear length, ear circumference, ear weight with and without husks, and number of kernel rows per ear, were measured at harvest. LAI was calculated as the ratio of leaf area to planting area, with leaf area estimated from leaf length × leaf width × 0.75.



The data were analyzed using analysis of variance (ANOVA). When significant differences were detected, treatment means were further compared using the Least Significant Difference (LSD) test at the 5% significance level.

RESULTS AND DISCUSSION

The application of AMF showed different responses among the observed growth parameters. Most parameters were not significantly affected, while the number of leaves showed a significant response at several observation times. The summarized growth data are presented in Table 1.

Table 1. Growth response of waxy corn to AMF application

Treatment	Plant Height (cm) 8 WAP	Number of Leaves (leaves) 2 WAP	LAI 8 WAP	6 WAP	8 WAP
D0 (0 g AMF)	165.00	4.67	6.67	9.00	10.33
D1 (10 g AMF)	177.00	2.67	6.33	11.67	14.67
D2 (20 g AMF)	159.00	3.67	7.67	11.67	12.67
D3 (30 g AMF)	178.00	5.33	6.33	12.33	14.00
Significance	ns	*	ns	*	*

Note: ns = not significant; * = significant at the 5% level; WAP = weeks after planting.

AMF application did not significantly affect plant height or leaf area index. At 8 WAP, plant height ranged from 159.00 to 178.00 cm, with D3 showing the highest value. A similar response was observed for LAI, indicating that AMF application did not consistently increase canopy development under the conditions of the experiment. This may be related to nutrient availability in the growing medium and the effectiveness of AMF colonization.

In contrast, the number of leaves was significantly affected at 2, 6, and 8 WAP. D3 produced the highest number of leaves at 2 and 6 WAP, while D1 recorded the highest value at 8 WAP. The response indicates that AMF contributed more clearly to vegetative development

than to plant height or leaf area. Increased nutrient acquisition, particularly phosphorus, through the external hyphal network of AMF may support leaf formation and vegetative growth. Lu et al. (2023) reported that AMF inoculation can improve phosphorus uptake and biomass production in maize. The variation among observation times may also be related to the development of root colonization and the compatibility between AMF and the host plant.

The effects of AMF on yield components were generally not significant. To avoid presenting repetitive tables, the main yield parameters are summarized in Table 2.

Table 2. Yield components of waxy corn treated with AMF

Treatment	Ear Length with Husk (cm)	Ear Length without Husk (cm)	Ear Circumference with Husk (cm)	Ear Circumference without Husk (cm)	Ear Weight with Husk (g)	Ear Weight without Husk (g)	Kernel Rows/Ear
D0	23.33	10.67	12.00	10.80	77.33	56.00	12.67
D1	24.33	14.00	14.00	11.43	110.67	95.67	13.33
D2	17.00	11.33	13.67	11.83	101.00	84.67	12.00
D3	20.67	13.67	15.17	13.50	133.00	101.33	11.33
Significance	ns	ns	ns	ns	ns	ns	ns

Note: ns = not significant at the 5% level.

None of the yield components were significantly affected by AMF application. Nevertheless, numerical differences were observed among treatments. D3 produced the highest ear circumference and ear weight, whereas D1 showed the highest ear length and number of kernel rows. The highest ear weight with and without husks was recorded in D3, at 133.00 and 101.33 g, respectively, although these differences were not statistically significant.

The limited response of yield components suggests that AMF application under the conditions of this study was more evident in vegetative growth than in yield formation. Yield development is influenced not only by nutrient uptake but also by genotype, environmental conditions, water availability, and assimilate distribution during ear formation. The response of maize to AMF may also depend on soil phosphorus availability and the level of root colonization. Agbodjato et al. (2022) reported that the effectiveness of AMF in maize can vary according to inoculum, growing conditions, and nutrient availability.



Overall, the application of AMF produced its clearest response in the number of leaves, particularly at 2, 6, and 8 WAP. The 30 g treatment generally showed a favorable vegetative response, while the effect on yield components remained statistically non-significant.

CONCLUSION

The application of arbuscular mycorrhizal fungi (AMF) did not significantly affect most growth and yield parameters of local Gorontalo waxy corn. A significant response was observed in the number of leaves at 2, 6, and 8 weeks after planting (WAP). The 30 g AMF treatment produced the highest number of leaves at 2 and 6 WAP, while the 10 g treatment produced the highest number at 8 WAP. The yield components, including ear length, ear circumference, ear weight, and number of kernel rows, were not significantly affected by AMF application. Overall, AMF application showed a more evident response in vegetative growth, particularly leaf development, than in yield components under the conditions of this study.

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