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GROWTH AND YIELD PERFORMANCE OF BLACK RICE (ORYZA SATIVA) APPLIED WITH DIFFERENT LEVELS OF BIOSSA-AGRI ENZYME AND FERMENTED PLANT JUICE (FPJ)

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ABSTRACT

This study evaluated the growth and yield performance of black rice (Oryza sativa) as influenced by different levels of Biossa-Agri Enzyme and Fermented Plant Juice (FPJ) applied as foliar biostimulants. A factorial experiment arranged in a Randomized Complete Block Design (RCBD) with three replications was conducted in Barangay Jose Rizal, Makilala, North Cotabato from March 26 to July 23, 2025. Factor A consisted of Biossa-Agri Enzyme at 3 mL/L (A1), 6 mL/L (A2), and 9 mL/L (A3) of water, while Factor B consisted of Fermented Plant Juice at 0.5 mL/L (B1), 1.0 mL/L (B2), and 1.5 mL/L (B3) of water. Growth parameters — plant height and number of tillers measured at 21, 30, and 60 days after transplanting (DAT) — and yield parameters — panicle length, number of grains per panicle, grain weight, and grain yield per hectare — were recorded. Cost and return on investment (ROI) were also computed. Results showed that treatment A3B3 (9 mL/L Biossa-Agri Enzyme + 1.5 mL/L FPJ) consistently produced the tallest plants (120.03 cm at 60 DAT), the most tillers (14.80 at 60 DAT), the heaviest grain weight (549 g), the highest yield per hectare (5.49 mt/ha), and the highest ROI (43.16%). Significant interaction effects between Factors A and B were observed in plant height at 21 DAT, tiller count at all observation periods, and grain weight. The combined application of Biossa-Agri Enzyme at 9 mL/L and FPJ at 1.5 mL/L is recommended for optimizing the growth, yield, and profitability of black rice production under organic biostimulant management.

KEYWORDS: Black rice; Biossa-Agri Enzyme; Fermented Plant Juice; biostimulants; grain yield; foliar application; Oryza sativa; organic farming

INTRODUCTION

Black rice (Oryza sativa), sometimes referred to as forbidden rice, is a highly valued functional food recognized for its rich anthocyanin content, dietary fiber, antioxidants, and health-promoting properties including cardioprotective, anti-inflammatory, and anti-cancer effects (Chen et al., 2022). Despite its nutritional and economic potential, black rice cultivation in the Philippines remains relatively limited in scale, primarily due to high seed costs and the labor-intensive nature of its organic production (Villanueva et al., 2024).

Biostimulants have emerged as a promising class of agricultural inputs capable of enhancing crop growth, improving soil health, and supporting sustainable production without increasing dependence on synthetic chemicals. Biossa-Agri Enzyme, an enzyme-based biostimulant, improves nutrient availability and soil fertility by accelerating organic matter decomposition and releasing essential minerals such as nitrogen, phosphorus, and potassium in plant-accessible forms (Calvo et al., 2014; Rouphael & Colla, 2020). Fermented Plant Juice (FPJ), an organic biostimulant produced through the fermentation of young plant materials with molasses, provides plant hormones, beneficial microorganisms, minerals, vitamins, and enzymes that promote shoot and root growth, improve nutrient absorption, and enhance soil microbial activity (Song et al., 2019; Widiastuti et al., 2021).

Despite the potential benefits of Biossa-Agri Enzyme and FPJ, there is insufficient empirical evidence on their specific effects on black rice, particularly regarding the appropriate concentrations and their combined interactive effects on crop growth and yield. Most existing studies have focused on conventional rice varieties or other crops, leaving a significant research gap in this area. This study therefore aimed to determine the performance of black rice applied with different levels of Biossa-Agri Enzyme and FPJ, identify the optimal treatment combination, and evaluate the cost and return on investment of production under these biostimulant programs.

MATERIALS AND METHODS

Research Design and Treatments

The study employed a factorial experiment arranged in a Randomized Complete Block Design (RCBD) with three replications. The total experimental area was 54.0 m² (13.5 m × 4.0 m). Factor A consisted of three levels of Biossa-Agri Enzyme: A1 – 3 mL/L, A2 – 6 mL/L, and A3 – 9 mL/L of water. Factor B consisted of three levels of Fermented Plant Juice: B1 – 0.5 mL/L, B2 – 1.0 mL/L, and B3 – 1.5 mL/L of water, resulting in nine treatment combinations (A1B1 to A3B3).

Study Location and Period

The experiment was conducted from March 26 to July 23, 2025, in Barangay Jose Rizal, Makilala, North Cotabato (6.9736° N, 125.0249° E; elevation ~120 m above sea level).

Cultural Management

Soil samples were collected prior to land preparation and submitted to a Regional Soils Laboratory for analysis. Land was prepared through double plowing and harrowing. Black rice seeds (10 kg) were soaked for 24 hours and incubated for 36 hours before sowing in a wet seedbed. Seedlings were transplanted at 18 days after sowing at a spacing of 20 cm × 20 cm, with one seedling per hill. Biossa-Agri Enzyme and Fermented Plant Juice were applied as foliar sprays according to treatment specifications, beginning at 14 days after transplanting (DAT) at two-week intervals until 15 days before harvest. Weed management was done by hand weeding; pests and diseases were managed using biological control agents (Trichogramma japonicum and Metarhizium anisopliae). Manual harvesting was performed at 120 days after planting.

FPJ Preparation

FPJ was prepared using swamp cabbage (1 kg) and young banana trunk (1 kg) cut into 2-inch pieces, mixed with 2 liters of molasses. The mixture was sealed in a pail and fermented in a warm, dark location for 7 days, after which the liquid was extracted by straining through cheesecloth.

DATA COLLECTION

Plant height (cm) and number of tillers were measured from 10 randomly selected plants per treatment at 21, 30, and 60 DAT. Number of productive and unproductive tillers were counted one week before harvest. Panicle length (cm) was measured at harvest; number of grains per panicle and grain weight (g) were determined per treatment combination. Grain yield (mt/ha) was computed using harvested grain weight per plot extrapolated to hectare. Cost and return on investment were computed based on variable production costs and gross income per treatment.

Statistical Analysis

Data were analyzed using the Statistical Tool for Agricultural Research (STAR). Analysis of Variance (ANOVA) was applied at 5% and 1% significance levels. Least Significant Difference (LSD) tests were used to compare treatment means when significant differences were detected.

RESULTS AND DISCUSSION

Plant Height (cm)

Treatment A3B3 consistently produced the tallest black rice plants across all observation periods: 39.77 cm at 21 DAT, 72.89 cm at 30 DAT, and 120.03 cm at 60 DAT (Tables 1a, 2a, 3a). The lowest plant height at all periods was recorded in A1B1. ANOVA results indicated that both Factor A and Factor B, as well as their interaction, significantly affected plant height at 21 DAT (Table 1b). At 30 DAT, only Factor B was significant; at 60 DAT, both factors were significant individually but their interaction was not. These findings are consistent with Kushwaha (2016) and Ei et al. (2024), who reported that foliar application of biostimulants significantly enhances plant height and vegetative growth in rice. The heightened growth response at higher biostimulant levels reflects improved nutrient availability and physiological activity attributable to enzymatic catalysis and bioactive compounds in FPJ (Calvo et al., 2014; Song et al., 2019).

Table 1. Mean Plant Height (cm) of Black Rice at 21, 30, and 60 DAT.

Treatment	21 DAT (cm)	30 DAT (cm)	60 DAT (cm)
A1B1	36.60	63.87	107.52
A1B2	36.85	65.13	109.43
A1B3	37.08	66.18	110.03
A2B1	37.32	64.77	108.18
A2B2	37.22	65.13	109.63
A2B3	37.41	64.63	111.85
A3B1	37.30	64.41	111.70
A3B2	37.68	67.73	113.93
A3B3	39.77*	72.89*	120.03*
Grand Mean	37.47	66.08	111.37

*Highest value per observation period

Number of Tillers

Treatment A3B3 recorded the highest tiller count at all DAT: 7.83 at 21 DAT, 9.87 at 30 DAT, and 14.80 at 60 DAT (Tables 4a, 5a, 6a). The lowest counts were recorded in A1B1. ANOVA results confirmed significant main effects and significant interaction effects of Factors A and B on tiller number at all three observation periods. These results are supported by Rueda-Puente et al. (2025) and Elekhtyar and Al-Huqail (2023), who reported that higher dosages of biostimulants and foliar fertilizers significantly increased tiller production in rice. The synergistic interaction between Biossa-Agri Enzyme and FPJ likely enhanced nutrient availability and root activity, promoting greater axillary bud development and tiller initiation.

Table 2. Mean Number of Tillers of Black Rice at 21, 30, and 60 DAT.

Treatment	21 DAT	30 DAT	60 DAT
A1B1	6.86	8.57	12.73
A1B2	6.87	8.73	13.10
A1B3	7.07	8.80	13.33
A2B1	7.00	8.70	13.50
A2B2	7.00	8.73	13.60
A2B3	7.00	8.90	13.73
A3B1	7.13	9.17	13.90
A3B2	7.13	9.27	14.17
A3B3	7.83*	9.87*	14.80*
Grand Mean	7.19	8.97	13.65

*Highest value per observation period

Productive and Unproductive Tillers

Treatment A3B2 produced the highest number of productive tillers (12.33), followed by A3B3 (12.27). A1B1 had the lowest (11.23). ANOVA showed that Factor A significantly affected productive tiller count while Factor B and the AxB interaction were not significant. In contrast, both Factors A and B significantly reduced unproductive tillers; A3B3 recorded the lowest unproductive tiller count (0.97), while A1B1 had the highest (2.07). These results are consistent with Tuiwong et al. (2024) and Islam et al. (2024), who reported that foliar nutrient application increases effective tiller formation while reducing unproductive shoots by improving overall plant nutritional status.

Panicle Length and Number of Grains per Panicle

No significant treatment effects were observed for panicle length or number of grains per panicle. The grand mean for panicle length was 23.72 cm and for grains per panicle was 139.56. Blocking significantly affected panicle length, suggesting that environmental variation across the experimental plots influenced this parameter, consistent with Ibrahim and Abdullahi (2023). The absence of significant treatment effects on grain count is consistent with Mahmoodi et al. (2020) and Zhang et al. (2024), who reported that individual foliar fertilizer treatments did not significantly affect the number of grains per panicle under similar application regimes.

Grain Weight and Yield per Hectare

Treatment A3B3 produced the highest grain weight (549 g) and yield per hectare (5.49 mt/ha), while A1B3 recorded the lowest weight (423 g) and A1B1 the lowest yield (4.32 mt/ha). ANOVA revealed highly significant main effects and a highly significant interaction effect ($p = 0.008$) for grain weight, while yield per hectare showed significant main effects but no significant interaction. These findings align with Tuiwong et al. (2024) and Arif et al. (2012), who demonstrated that combined foliar nutrient application improves grain weight and yield components. The lack of significant interaction for yield per hectare is consistent with Khanal and Islam (2023) and Elsayed and Elfky (2024), who observed that certain foliar treatment combinations produced statistically comparable grain yields.

Table 3. Mean Grain Weight (g) and Yield per Hectare (mt/ha) of Black Rice.

Treatment	Grain Weight (g)	Yield (mt/ha)	ROI (%)
A1B1	432	4.32	30.29
A1B2	440	4.40	30.81
A1B3	423	4.23	27.74
A2B1	442	4.42	30.07
A2B2	504	5.04	38.49
A2B3	476	4.76	34.78
A3B1	529	5.29	41.10
A3B2	542	5.42	42.44
A3B3	549*	5.49*	43.16*
Grand Mean	482	4.82	35.43

*Highest value

Cost and Return on Investment

The highest ROI (43.16%) was achieved by A3B3 (gross income: ₱110,000; net income: ₱47,480 against total expenses of ₱62,520), followed by A3B2 (42.44%) and A3B1 (41.10%). The lowest ROI was recorded for A1B3 (27.74%). These findings demonstrate that the economic profitability of black rice production is maximized at the highest combined levels of Biossa-Agri Enzyme and FPJ. This is consistent with Sica et al. (2020) and Rathod et al. (2020), who reported that biostimulant application in black rice improved plant growth, yield, and return on investment, with gross margin increases exceeding 30% in high-dose programs. The premium market value of black rice (PhilRice, 2022) further enhances the profitability advantage of optimized biostimulant protocols.

CONCLUSION

The combined application of Biossa-Agri Enzyme at 9 mL/L of water and Fermented Plant Juice at 1.5 mL/L of water (A3B3) produced the best results in terms of plant height, tiller production, grain weight, grain yield per hectare (5.49 mt/ha), and return on investment (43.16%) in black rice cultivation. Significant interaction effects between the two biostimulants were observed in plant height at 21 DAT, tiller number at all observation periods, and grain weight. In contrast, panicle length and number of grains per panicle were not significantly affected by any treatment combination. These results support the use of A3B3 as the optimal biostimulant treatment combination for black rice production in Barangay Jose Rizal, Makilala, North Cotabato. The application of higher levels of both Biossa-Agri Enzyme and FPJ is recommended for farmers seeking to improve black rice productivity and profitability within an organic or reduced-chemical input production framework.

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