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ASSESSMENT OF RICE VARIETIES FOR SEMI-DRY CULTIVATION IN THE SOUTHERN AGRO-CLIMATIC ZONE OF TAMIL NADU

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ABSTRACT
Rice production under semi-dry, rainfed conditions is frequently affected by limited and variable soil moisture. An on-farm field experiment was conducted in Piranthamangalam village, Ilayangudi block, Sivaganga district, Tamil Nadu, during the rabi seasons of 2022–2023 and 2023–2024 to compare the performance of five rice variety and nutrient-management treatments under semi-dry cultivation. The experiment comprised five treatments and five replications in a randomized block design: BPT 5204 under farmers' practice (T1); CO 55 with Azophos and ZSB14 (T2); RNR 15048 with Azophos and ZSB14 (T3); CO 51 with Azophos and ZSB14 (T4); and Jothi with Azophos and ZSB14 (T5). Growth, maturity, grain-yield and economic parameters were recorded. Treatment T2 recorded the highest plant height (112.7 cm), number of tillers per plant (32) and grain yield (58.3 q ha−1), representing an 18.5% increase over the farmers' practice (49.2 q ha−1). Treatment T4 recorded the shortest time to maturity (110 days). The highest reported net return (Rs. 59,488 ha−1) and benefit–cost ratio (2.78) were also recorded for T2. Under the conditions of this on-farm evaluation, the CO 55-based treatment recorded the highest grain yield and reported economic return. These findings indicate the potential of this treatment for semi-dry rice cultivation in the study area; validation across additional locations and seasons is required.

KEYWORDS: Oryza sativa; semi-dry cultivation; rice varieties; grain yield; bioinoculants; Tamil Nadu

INTRODUCTION
Rice (Oryza sativa L.) is a major staple food crop in India and an important source of livelihood for farming households (Dar *et al.,* 2020). In Sivaganga district, Tamil Nadu, rice is commonly cultivated under rainfed, direct-sown semi-dry conditions. Such production systems are vulnerable to irregular rainfall and soil-moisture deficits, which can reduce crop establishment, growth and grain yield.

Farmers in the region commonly cultivate varieties including BPT 5204, NLR 34449 and JGL 1798. The continued use of a limited range of varieties may constrain farmers' ability to manage variable moisture conditions. A participatory rural appraisal conducted with farming households in Piranthamangalam village, Ilayangudi block, identified the perceived constraints to rice production. These included the limited availability of varieties considered suitable for moisture-stress conditions (60%), inadequate knowledge of integrated crop management practices (20%), limited awareness of soil-test-based fertilizer application (10%) and low awareness of foliar and critical micronutrient management (10%).

On-farm evaluation of suitable varieties and associated nutrient-management practices can help identify options for improving productivity in semi-dry rice systems. Therefore, the present study compared the growth, maturity, grain yield and economic performance of four rice varieties grown with bioinoculants against the farmers' practice using BPT 5204 in Piranthamangalam village, Sivaganga district.

MATERIALS AND METHODS
Study site and experimental period
The on-farm field experiment was conducted by ICAR–Krishi Vigyan Kendra, Kundrakudi, in farmers' fields at Piranthamangalam village, Ilayangudi block, Sivaganga district, Tamil Nadu. The experiment was carried out during the rabi seasons of 2022–2023 and 2023–2024. The soil at the experimental site was described as clay loam, with low nitrogen, medium phosphorus and high potassium status.

Experimental design and treatments
The experiment was laid out in a randomized block design with five treatments and five replications. The treatments were: T1, BPT 5204 under farmers' practice; T2, CO 55 + Azophos + ZSB14; T3, RNR 15048 + Azophos + ZSB14; T4, CO 51 + Azophos + ZSB14; and T5, Jothi + Azophos + ZSB14. Five plants were randomly selected and tagged in the net plot of each treatment for recording growth and yield attributes.

Growth and yield observations

Plant height was measured at physiological maturity from the ground level to the tip of the longest panicle using a graduated measuring scale. Tillers arising from the base of each tagged hill were counted at the maximum tillering stage and at harvest; the number of productive tillers was recorded at harvest. For thousand-grain weight, 1,000 mature grains were randomly sampled from each treatment plot and weighed using an electronic balance after ensuring uniform moisture content. Days to maturity were calculated from sowing to the stage at which approximately 75% of the panicles in a treatment plot had turned golden yellow. For grain yield, plants from the net plot area were harvested, threshed, winnowed and dried to approximately 14% moisture content; yield was expressed in quintals per hectare (q ha−1).

Economic analysis

Gross returns, cost of cultivation, net returns and benefit–cost (B:C) ratio were assessed for each treatment. The values reported in the original experimental dataset are presented in Table 2.

Statistical analysis

The data were subjected to statistical analysis following the procedures described by Gomez and Gomez (1984). Standard error of the difference (SEd) and the critical difference (CD) at the 5% probability level are presented in Table 1.

RESULTS

Growth and yield attributes

The treatment means for plant height, tiller number, thousand-grain weight, days to maturity and grain yield are presented in Table 1. T2 recorded the greatest plant height (112.7 cm) and the highest number of tillers per plant (32). T5 recorded the lowest plant height (98.5 cm) and tiller number (22). The highest thousand-grain weight was recorded in T5 (21.5 g), while the lowest was recorded in T3 (18.7 g).

T4 reached maturity in the shortest period (110 days), followed by T2 (118 days), T5 (120 days), T3 (126 days) and T1 (129 days). The highest grain yield was recorded in T2 (58.3 q ha−1), followed by T4 (53.5 q ha−1), T3 (51.6 q ha−1), T1 (49.2 q ha−1) and T5 (44.8 q ha−1). The yield recorded in T2 was 18.5% higher than that in T1.

Table 1. Growth and yield attributes of rice under the five treatments

Treatment	Variety and management	Plant height (cm)	Tillers per plant	1000-grain weight (g)	Days to maturity	Grain yield (q ha−1)
T1	BPT 5204 (farmers' practice)	102.3	24	19.0	129	49.2
T2	CO 55 + Azophos + ZSB14	112.7	32	18.9	118	58.3
T3	RNR 15048 + Azophos + ZSB14	109.5	27	18.7	126	51.6
T4	CO 51 + Azophos + ZSB14	105.0	29	19.2	110	53.5
T5	Jothi + Azophos + ZSB14	98.5	22	21.5	120	44.8
	SEd	1.42	0.72	0.17	0.81	1.15
	CD (P = 0.05)	4.25	2.16	0.52	2.43	3.45

Economic performance

The economic indicators reported for the five treatments are summarized in Table 2. T2 recorded the highest gross returns (Rs. 93,280 ha−1), net returns (Rs. 59,488 ha−1) and B:C ratio (2.78). T4 recorded gross returns of Rs. 85,600 ha−1, net returns of Rs. 52,400 ha−1 and a B:C ratio of 2.58. The lowest gross return was reported for T5 (Rs. 71,680 ha−1).

Table 2. Economic performance of the five rice treatments

Treatment	Gross returns (Rs. ha−1)	Cost of cultivation (Rs. ha−1)	Net returns (Rs. ha−1)	B:C ratio
T1	74,880	36,230	32,650	1.90
T2	93,280	33,792	59,488	2.78

T3	82,560	33,657	48,903	2.45
T4	85,600	33,200	52,400	2.58
T5	71,680	34,100	37,580	2.10

DISCUSSION

The on-farm results showed differences among the evaluated variety and management combinations under the semi-dry conditions of the study site. The CO 55-based treatment (T2) recorded the highest grain yield (58.3 q ha−1), which was 18.5% greater than the yield under farmers' practice (T1). The yield advantage of T2 over T4, the next-highest treatment, was 4.8 q ha−1, exceeding the reported CD of 3.45 q ha−1. This indicates a statistically significant difference between these two treatment means at the stated 5% level.

T2 also recorded the highest plant height and tiller number. Based on the reported CD values, its plant height was significantly greater than that of T1 and T5, but the difference from T3 (3.2 cm) was smaller than the CD (4.25 cm). For tiller number, T2 exceeded the other treatment means by more than the reported CD. These growth attributes may have contributed to the higher grain yield observed in T2; however, the experiment did not report measurements of root development, nutrient uptake or plant physiological responses, and therefore the mechanisms underlying the treatment differences cannot be established from the available data.

The shortest crop duration was recorded in T4 (110 days), which was 19 days shorter than T1 and 8 days shorter than T2. A shorter duration may be advantageous where terminal moisture stress occurs late in the season. However, the study did not provide rainfall distribution, soil-moisture measurements or year-wise treatment results. The ability of T4 to escape terminal drought should therefore be interpreted as a potential advantage based on its shorter maturity period rather than as a directly demonstrated drought-avoidance response.

The highest reported net return and B:C ratio were recorded in T2, suggesting that this treatment may offer an economically promising option for the study area. Nevertheless, the economic values in Table 2 require verification because the reported net return and B:C ratio for T1 do not reconcile with its gross return and cost of cultivation. In addition, the present experiment compared variety and bioinoculant combinations; it did not include separate treatments for each variety without bioinoculants. Consequently, the independent effects of variety and bioinoculant application cannot be distinguished.

The findings are consistent with the broader interest in evaluating rice production practices that can sustain productivity under water-limited conditions (Dar et al., 2020). Research has also examined the role of microbial inoculation in rice responses to drought stress (Singh *et al.,* 2020). However, the present field experiment did not measure antioxidant activity, defense-related gene expression or other molecular traits. Such mechanisms should not be inferred directly from the agronomic observations reported here.

CONCLUSION

Under the on-farm conditions evaluated in Piranthamangalam village, the treatment comprising CO 55 + Azophos + ZSB14 (T2) recorded the highest grain yield (58.3 q ha−1), an 18.5% yield increase over farmers' practice, and the highest reported net return and B:C ratio. CO 51-based treatment (T4) recorded the shortest time to maturity (110 days) and may be considered where a shorter-duration crop is required. These results support further multi-location and multi-season evaluation of the treatments before wider recommendations are made for semi-dry rice cultivation in the southern agro-climatic zone of Tamil Nadu.

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