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ASSESSING THE ROLE OF LIQUID BIOFERTILIZERS IN ENHANCING RICE YIELD AND FARM ECONOMICS IN SURYAPET DISTRICT, TELANGANA, INDIA

Arigela Kiran[1], D. Naresh[2], D. Adarsh[3], Ch. Naresh[4], T. Madhuri[5] and G. Santhosh[6]
[1]Scientist, Soil Science, Krishi Vigyan Kendra-Gaddipally, Suryapet District, 508201, Telangana, India.
[2]Scientist, Agronomy Krishi Vigyan Kendra-Gaddipally, Suryapet District, 508201, Telangana, India.
[3]Scientist, Plant Protection, Krishi Vigyan Kendra-Gaddipally, Suryapet District, 508201, Telangana, India.
[4]Scientist, Horticulture, Krishi Vigyan Kendra-Gaddipally, Suryapet District, 508201, Telangana, India.
[5]Scientist, Sericulture, Krishi Vigyan Kendra-Gaddipally, Suryapet District, 508201, Telangana, India
[6]Y.P-2, Krishi Vigyan Kendra-Gaddipally, Suryapet District, 508201, Telangana, India.
*Corresponding author E- mail: kiranarigela16@gmail.com.
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ABSTRACT

A field-based study was conducted during the kharif seasons of 2022–23 and 2023–24 across selected villages in Suryapet district of Telangana to evaluate the impact of liquid biofertilizer application on growth, yield, and economic returns of rice cultivation. The experimental design involved as the basal application of a liquid biofertilizer mixture - Azospirillum (500 ml/ha) + PSB (500 ml/ha) and KMB (500 ml/ha) in combination with 75% of the Recommended Dose of Fertilizers (RDF) in demonstration (demo) plots, compared to control plots where 100% RDF was applied without biofertilizers. Five progressive farmers from different mandals were selected to implement and monitor the trials in their own paddy fields using a participatory approach. Observations revealed that the demo plots recorded significantly higher values for key growth parameters such as plant height, leaf area per hill, leaf area index, days to 50% flowering, days to maturity, and dry matter accumulation at harvest, as compared to the control plots. In terms of yield attributes, the demo plots showed improvements in total tillers per hill, productive tillers per hill, panicle length, panicle weight, total and filled grains per panicle, test weight, and seed yield per hectare. A reduction in the number of unfilled spikelets per panicle was also observed in the biofertilizer-treated plots. Economically, the demo plots performed high in terms of gross returns, net returns, and benefit-cost (B:C) ratio compared to control plot and highlighting the potential of integrated nutrient management using biofertilizers to enhance rice productivity and profitability. The study confirms that partial substitution of chemical fertilizers with liquid biofertilizers through basal application not only supports sustainable rice production but also reduces input costs, improves soil health, and enhances overall economic efficiency under real-world farming conditions.
***Keywords*: Rice, Liquid Biofertilizers, Azospirillum, PSB, KMB, Basal Application, Yield Attributes, RDF, Farm Economics.

Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop globally, serving as the primary source of sustenance for nearly one-third of the world's population. Over two billion people in Asia rely on rice and its derivatives for 60–70% of their daily caloric intake. With rising demand, modern rice cultivation has become increasingly dependent on synthetic fertilizers. While these inputs can initially boost productivity, their overuse has led to detrimental impacts on soil health, ecological balance, and human well-being. Issues such as soil degradation, declining nutrient use efficiency, increased input costs, and environmental pollution underscore the need for sustainable alternatives. The growing concerns over food security, rising fertilizer prices, and the degradation of agro-ecosystems have spurred renewed interest in non-chemical nutrient sources, including farmyard manure, composts, green manures, and biofertilizers. As awareness about soil health and crop quality increases, farmers are turning to organic and eco-friendly cultivation practices (Sharma, 2008). Among these, biofertilizers products containing living beneficial microorganisms play a vital role by enhancing nutrient availability to plants and promoting soil fertility in a sustainable manner.

Biofertilizers consist of specific strains of bacteria, fungi, or cyanobacteria capable of biological nitrogen fixation, phosphate solubilization, potassium mobilization, and decomposition of organic residues. These microbes colonize the rhizosphere or plant tissues and enhance nutrient uptake by producing phytohormones, siderophores, and organic acids, while also suppressing plant pathogens. Arbuscular mycorrhizal fungi (AMF), phosphate-solubilizing bacteria (PSB), potassium-solubilizing bacteria (KSB), Rhizobium, Azospirillum, and Azotobacter are among the often employed strains (Tamilkodi and Victoria, 2018).

Traditionally, biofertilizers have been applied in carrier-based formulations, which often suffer from short shelf life (typically 4–6 months), sensitivity to high temperatures and ultraviolet (UV) radiation, and declining microbial viability over time. Colony-forming units (CFUs) in such formulations can drop from 10 CFU/mL initially to as low as 10 CFU/mL within four months, significantly reducing their effectiveness (Ansari *et al*., 2015; Verma *et al*., 2018).

In contrast, liquid biofertilizers - a more recent innovation offer several advantages: extended shelf life (up to 12–24 months), higher microbial load, tolerance to environmental stress, and better field performance. These formulations have demonstrated promising results in various crops by enhancing nutrient use efficiency, crop yield, and reducing dependency on chemical inputs.

In rice-based systems, the application of liquid biofertilizers has shown potential not only for improving growth and yield attributes but also for enhancing soil organic carbon, microbial biomass, and overall soil health. This aligns well with the global agenda of promoting sustainable agricultural practices. Hence, the present on-farm study was conducted across selected villages in the Suryapet district of Telangana to evaluate the efficacy of liquid biofertilizer application on rice growth, yield performance, and economic viability compared to conventional fertilizer practices.

Materials and Methods

The field experiment was conducted during the Kharif seasons of 2022–23 and 2023–24 at the Krishi Vigyan Kendra (KVK), Gaddipally, situated in Garidepally Mandal, Suryapet district, Telangana State, India. The experimental site is geographically located at 17°11' N latitude and 79°30' E longitude, falling under the tropical climatic zone. The region experiences hot summers, moderate to high rainfall during the monsoon, and mild winters, typical of a tropical monsoon climate.

Composite soil samples were taken from the top 0–15 cm depth throughout the study site prior to the experiment starting. These samples were analyzed for their physico-chemical and biological properties, including soil pH, electrical conductivity, organic carbon, available N, P, K, and microbial population, using standard protocols prescribed by the ICAR and Soil Testing Laboratory procedures.

Experimental Design and Treatments

The study was laid out in a comparative On-Farm Trial format involving two treatments with multiple replications across selected farmer fields. The treatment details are as follows:

Demonstration Plot (T_1)

Application of liquid biofertilizer consortium Azospirillum (500 ml/ha) + Phosphorus solubilizing Bacteria (500 ml/ha) + PSB (500 ml/ha) and KMB (500 ml/ha) in combination with 75% of the Recommended Dose of Fertilizers (RDF) in demonstration (demo) plots.

Control Plot(T_2)

Application of 100% RDF alone without any biofertilizer.

Method of Biofertilizer Application

For soil application, a liquid biofertilizer consortium (N-fixing, P-solubilizing, and K-mobilizing bacteria) was prepared by mixing 500 ml per hectare of the culture with 25 liters of water, and uniformly blending it with 500 kg of well-decomposed powdered farmyard manure (FYM). This mixture was incubated overnight under shade to allow microbial enrichment and stabilization, as recommended by Trimurtulu and Rao (2014).

During transplanting, this enriched FYM was applied directly to the furrows at the root zone of rice seedlings at a rate of 1 kg per hill. The use of partially reduced chemical fertilizers (75% RDF) in conjunction with biofertilizers aimed to promote synergistic effects on nutrient availability and plant uptake.

Crop Management and Observations

The rice variety commonly cultivated in the region was used across all plots. Standard agronomic practices, including timely irrigation, pest and disease management, and weed control, were uniformly followed across both demo and control plots to ensure fair comparison.

Observations were recorded on:

- **Growth parameters:** plant height, number of tillers, leaf area index, dry matter accumulation
- **Phenological stages:** days to 50% flowering and maturity
- **Yield attributes:** panicle length, panicle weight, number of grains per panicle (filled/unfilled), test weight
- **Economic returns:** gross returns, net returns, and benefit-cost ratio (B:C)

Data collected from five selected farmers' fields across different mandals were analyzed descriptively to assess the effect of treatments under real farming conditions.

Results and Discussion

Soil pH and EC

The pH of soils slightly decreased from initial to harvest stages in both treatments, which may be attributed to enhanced microbial activity and organic acid production, especially in the demonstration plots (T_1). A marginal rise in EC was noted in both treatments, more so in T_2, likely due to higher mineral residue from 100% RDF application.

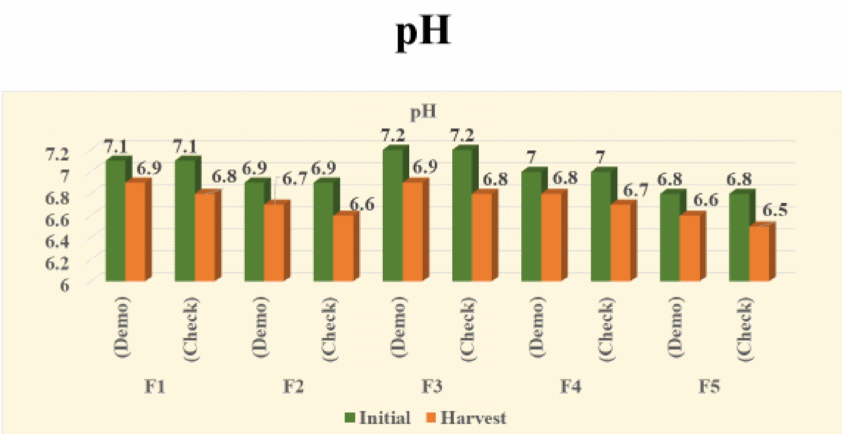

Fig. 1: Soil pH

Organic Carbon Content

The T_1 plots recorded a notable increase in organic carbon (up to 0.61%), compared to the control plots (T_2), which showed an increase only up to 0.54%. This highlights the contribution of biofertilizers in improving soil organic matter, microbial biomass, and residue decomposition.

Available Nitrogen

In demonstration plots, the increase in available nitrogen from initial to harvest ranged between 35–45 kg/ha. This improvement is attributed to nitrogen-fixing capabilities of *Azospirillum*, which effectively supplemented nitrogen even at 75% RDF. In contrast, T_2 plots recorded comparatively lower N availability.

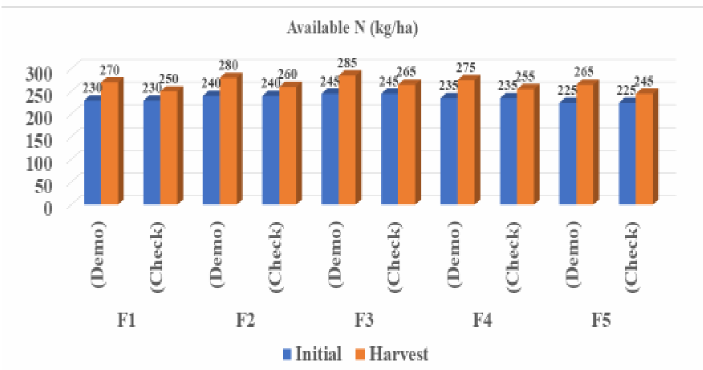

Fig. 2: Available Nitrogen

Available Phosphorus

T_1 plots exhibited improved phosphorus availability (up to 28 kg/ha), while T_2 plots remained lower (max 24 kg/ha). This increase is directly linked to the phosphate-solubilizing ability of *Phosphobacterium*, which enhances P uptake by plants.

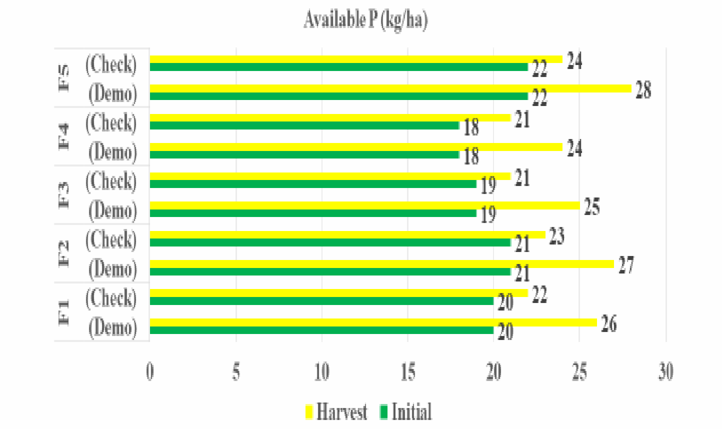

Fig. 3 : Available Phosphorus

Available Potassium

A consistent increase in K levels was observed in T_1 plots (up to 345 kg/ha). The *Potassium Mobilizing Bacteria (KMB)* contributed to better K availability from soil reserves, which was otherwise lower in T_2 plots (up to 325 kg/ha).

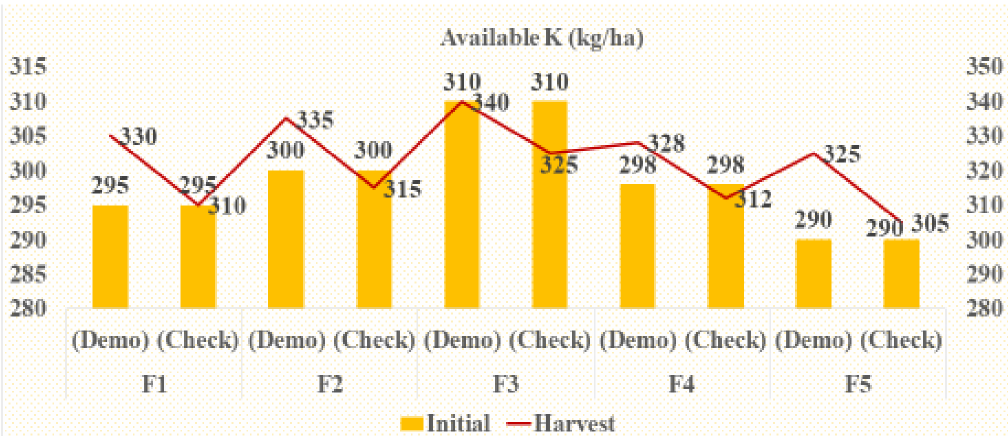

Fig. 4 : Available Potassium

Table 1 : Soil Chemical Properties of Six Farmers' Fields at Initial and Harvest Stage under Different Treatments

Name of the Farmer	Address	Treatment	Stage	pH	EC (dS/m)	Organic Carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
A. Sudhakar (F1)	Husanbad (V) Mothey (M) Suryapet (D)	T_1 (Demo)	Initial	7.1	0.38	0.46	230	20	295
			Harvest	6.9	0.42	0.58	270	26	330
		T_2 (Check)	Initial	7.1	0.38	0.46	230	20	295
			Harvest	6.8	0.46	0.50	250	22	310
B. Shankar (F2)	Gorentla (V), Maddirala (M), Suryapet (D)	T_1 (Demo)	Initial	6.9	0.35	0.48	240	21	300
			Harvest	6.7	0.40	0.59	280	27	335
		T_2 (Check)	Initial	6.9	0.35	0.48	240	21	300
			Harvest	6.6	0.47	0.52	260	23	315
A .Kotaiah (F3)	Dupahad (V), Penpahad (M),	T_1(Demo)	Initial	7.2	0.42	0.52	245	19	310
			Harvest	6.9	0.46	0.61	285	25	340

	Suryapet (D)	T_2(Check)	Initial	7.2	0.42	0.52	245	19	310
			Harvest	6.8	0.50	0.54	265	21	325
K. Venkateshwarlu (F4)	Ganpavaram (V), Kodad (M), Suryapet (D)	T_1(Demo)	Initial	7.0	0.36	0.47	235	18	298
			Harvest	6.8	0.41	0.57	275	24	328
		T_2(Check)	Initial	7.0	0.36	0.47	235	18	298
			Harvest	6.7	0.48	0.50	255	21	312
T. Ravinder Reddy (F5)	Kamalanagar (V), Neruducherla(M), Suryapet (D)	T_1(Demo)	Initial	6.8	0.33	0.45	225	22	290
			Harvest	6.6	0.39	0.56	265	28	325
		T_2(Check)	Initial	6.8	0.33	0.45	225	22	290
			Harvest	6.5	0.44	0.48	245	24	305

Plant Height (cm)

The data indicates that rice plants grown in the demonstration plots, which received liquid biofertilizers in combination with 75% RDF, exhibited significantly greater plant height at all observed growth stages compared to those in the control plots that received 100% RDF alone. The increased plant height in the biofertilizer-treated plots can be attributed to the enhanced nutrient uptake, particularly of nitrogen (N) and phosphorus (P), facilitated by the microbial activity of the inoculated biofertilizers. The Azospirillum species, a nitrogen-fixing bacterium, played a crucial role in fixing atmospheric nitrogen and making it available to the crop, thereby supporting robust vegetative growth. Simultaneously, phosphate-solubilizing bacteria (PSB) converted insoluble phosphorus into plant-available forms, which further promoted root development and nutrient uptake efficiency. Together, these microbial functions likely contributed to improved cell division, elongation, and leaf expansion, resulting in increased plant height. The findings are consistent with previous research by Upadhaya *et al*. (2022), Rani *et al*. (2019), Rathore and Gautam (2003), Choudhary and Gautam (2007), and Latake *et al*. (2009), all of whom reported that the application of biofertilizers significantly improved vegetative parameters, particularly plant height, due to better nitrogen availability and root proliferation. These results further reinforce the role of biofertilizers as a viable component of integrated nutrient management, capable of enhancing early crop vigor and improving overall plant architecture in a sustainable manner.

Days to 50% flowering

The effect of liquid biofertilizer treatments on days to 50% flowering was statistically non-significant**.** However, a numerical trend was observed wherein plants in the demonstration plots (treated with biofertilizers and 75% RDF) reached 50% flowering earlier compared to those in the control plots (100% RDF without biofertilizers). The earlier initiation of flowering in the demo plots may be attributed to the improved physiological efficiency and balanced nutrient availability, particularly of nitrogen and phosphorus, supplied through Azospirillum and phosphate-solubilizing bacteria (PSB).

Efficient nutrient uptake at early growth stages could have accelerated the plant's metabolic activity and phenological development, thereby advancing the flowering process. These findings are consistent with those of Upadhaya *et al*. (2022), Damame *et al*. (2013), and Divya *et al*. (2017), who also found that the use of biofertilizers caused crops like rice and millets to flower earlier. This was probably because the microbes stimulated nutrient dynamics and hormonal balance more

Days to maturity

Similarly, the data show that days to physiological maturity were also statistically non-significant among treatments. Nonetheless, a numerical reduction in days to maturity was observed in the demo plots compared to the control, suggesting a trend toward earlier crop maturity with the application of biofertilizers.

This advancement in maturity may be attributed to the synergistic effect of microbial inoculants, where:

- Azospirillum contributed to nitrogen fixation,
- PSB enhanced phosphorus solubilization, and
- Improved potassium availability was made possible by potassium-mobilizing bacteria (KMB).

These combined effects may have led to enhanced plant metabolism, accelerated reproductive development, and efficient translocation of photosynthates, thereby promoting earlier crop completion. Similar trends have been reported in cereal crops such as foxtail millet and pearl millet by Upadhaya *et al.* (2022) and Damame *et al.* (2013), where biofertilizer applications shortened the crop duration by improving physiological functions. These findings support the potential of liquid biofertilizers not only to improve crop growth but also to optimize crop maturity, which is particularly beneficial for efficient crop rotation and timely harvest in rainfed and irrigated farming systems.

Dry matter accumulation (g/plant):

The impact of varying liquid biofertilizer treatments on dry matter accumulation is clearly evident. Across all growth stages, the demonstration (demo) plot consistently yielded significantly greater dry weight compared to the control. Conversely, the plot under absolute control (no treatment) recorded the lowest dry matter accumulation at every stage. These results likely stem from enhanced soil fertility and microbial activity induced by biofertilizer application an effect well-documented in agronomic literature.

For instance, Kumari *et al.* (2024) observed that integrating liquid biofertilizer with vermicompost elevated dry matter accumulation in field pea at 30, 60, 90 days after sowing (DAS), as well as at harvest Similarly, Upadhyay *et al.* (2012) reported that cabbage plants receiving organic manures plus biofertilizers showed increased dry matter partitioning and head mass . In wheat, the concurrent use of full recommended fertilizer dose with Azotobacter and phosphate-solubilizing bacteria significantly improved biological yield, including dry biomass. Yadav and colleagues (2024) further reinforced this trend, demonstrating that combined inoculation with Rhizobium, PSB, and KMB maximized dry matter accumulation and overall yield in black gram.

Mechanistically, biofertilizers enhance nutrient uptake through nitrogen fixation, phosphorus solubilization, and production of growth-promoting substances, collectively stimulating vegetative growth and accelerating biomass development. This aligns with findings in mung bean and sorghum, where microbial consortia boosted root proliferation and shoot dry matter accumulation at critical phenological stages

Table 2 : Agronomic performance of Rice as influenced by liquid Biofertilizer showing Plant height, Leaf area per hill, Leaf area index, Days to 50% flowering, Days to maturity and Dry matter production per plant at harvest stages in demo plot of farmer's field

Name of the Farmer	Address	Plant height (cm)	Leaf area per hill (cm^2 $hill^{-1}$)	Leaf Area index	Days to 50% flowering	Days to maturity	Dry matter production per plant (g)
A. Sudhakar	Husanbad (V) Mothey (M) Suryapet (D)	108.91	482.41	2.357	86.8	126.15	71.51
B. Shankar	Gorentla (V), Maddirala (M), Suryapet (D)	107.89	481.51	2.376	84.9	127.18	72.89
A. Kotaiah	Dupahad (V), Penpahad (M), Suryapet (D)	109.98	483.53	2.418	87.7	128.17	73.42
K. Venkateshwarlu	Ganpavaram (V), Kodad (M), Suryapet (D)	108.52	480.81	2.398	85.9	125.11	72.54
T. Ravinder Reddy	Kamalanagar (V), Neruducherla(M), Suryapet (D)	106.98	471.59	2.310	83.1	124.25	70.21
(Demo plot)		**108.5**	**480.0**	**2.4**	**85.7**	**126.2**	**72.1**

Table 3: Agronomic performance of Rice as influenced by liquid Biofertilizer showing Plant height, Leaf area per hill, Leaf area index, Days to 50% flowering, Days to maturity and Dry matter production per plant at harvest stages in Control plot of farmer's field

Name of the Farmer	Address	Plant height (cm)	Leaf area per hill (cm^2 $hill^{-1}$)	Leaf Area index	Days to 50% flowering	Days to maturity	Dry matter production per plant (g)
A. Sudhakar	Husanbad (V) Mothey (M) Suryapet (D)	100.87	426.92	2.122	89.3	124.67	56.06
B. Shankar	Gorentla (V), Maddirala (M), Suryapet (D)	99.45	424.98	2.115	82.5	123.21	55.08

A. A. Kotaiah	Dupahad (V), Penpahad (M), Suryapet (D)	97.67	423.86	2.101	81.7	122.98	52.11
K. Venkateshwarlu	Ganpavaram (V), Kodad (M), Suryapet (D)	98.78	425.78	2.113	85.6	123.58	54.98
T. Ravinder Reddy	Kamalanagar (V), Neruducherla(M), Suryapet (D)	99.95	424.25	2.117	85.2	123.84	53.78
(Control plot)		**99.34**	**425.16**	**2.11**	**84.86**	**123.66**	**54.40**

No. of productive tillers plant

The number of productive tillers per plant was significantly influenced by the application of liquid biofertilizers. Throughout all growth stages, the demo plot exhibited the highest number of productive tillers, while the control plot consistently recorded the lowest. This superior performance in the demo plot can be attributed to the basal application of biofertilizer combined with 75□% of the recommended fertilizer dose (RDF), which likely enhanced soil nutrient availability and microbial activity. These findings are consistent with the work of Ngui *et al.* (2023), who reported a 28% increase in productive tillers per plant when combining Bacillus-based biofertilizer with inorganic NPK fertilization. Additionally, similar trends have been observed by Upadhaya *et al.* (2022) and Latake *et al.* (2009), supporting the positive impact of biofertilizers on tiller production.

Length of panicle (cm) and Panicle weight (g)

The Data illustrates that panicle length and panicle weight were significantly influenced by liquid biofertilizer treatments. Throughout the growth cycle, the demo plot consistently exhibited greater panicle length compared to the control plot. This improvement likely results from a balanced basal application combining NPK, farmyard manure (FYM), and a liquid biofertilizer, all of which enhanced nutrient availability and microbial activity.

These findings align with earlier studies. For instance, Sinha and Mishra (2013) reported increased panicle length and grain weight in rice treated with Brassica alba extract combined with nitrogen fertilizer. A recent field experiment in Nepal also demonstrated that combining organic amendments such as mustard cake or FYM with biofertilizers and NPK significantly enhanced panicle characteristics including length and weight over control. Furthermore, trials involving fermented organic matter and FYM showed notable increases in panicle length, weight, and grain number in rice under rice–wheat systems. These studies reinforce our results and support the observations of Monisha *et al.* (2019), Husain *et al.* (2017), Latake *et al.* (2009), and Divya *et al.* (2017).

No. of seeds panicle

It shows that the number of seeds per panicle was significantly influenced by different liquid biofertilizer treatments. The demo plot recorded the highest seed count per panicle, while the control consistently had the lowest. These results align closely with the findings of Upadhaya *et al.* (2022), who documented a substantial increase in grain number per panicle under liquid biofertilizer regimes.

1000 seed weight (g)

It indicates no statistically significant effect of biofertilizer treatments on 1000-seed weight, the demo plot showed the highest test weight, in contrast to the control plot, which had the lowest. This pattern of minor yet consistent increases mirrors the observations by Upadhaya *et al.* (2022), who reported similar trends with liquid biofertilizer applications.

Grain Yield

When compared to the traditional 100% RDF treatment without biofertilizers, the findings showed unequivocally that the use of liquid biofertilizers in combination with 75% of the necessary dose of fertilizers (RDF) improved rice grain production. The mean grain yield recorded in the demonstration plots was 62.8 quintals per hectare (q ha^{-1}), while the control plots recorded a mean yield of 48.98 q ha^{-1}, resulting in a 28.21% increase in yield in the biofertilizer-treated plots. The inoculation with Azospirillum, a well-known nitrogen-fixing bacterium, likely enhanced atmospheric nitrogen fixation and its subsequent availability to the rice crop. Similarly, the application of phosphate-solubilizing bacteria (PSB) facilitated the transformation of insoluble forms of phosphorus into plant-available forms, thereby supporting better root development, tillering, and overall plant vigor.

These results are in agreement with earlier findings by Banayo *et al.* (2012), who reported that the integration of biofertilizers with reduced chemical fertilizer inputs led to improved crop yields and better soil nutrient status compared to the application of chemical fertilizers alone. Moreover, the observed improvement in yield under liquid biofertilizer application reflects the synergistic interaction between microbial inoculants and available soil nutrients, which can enhance nutrient-use efficiency, sustain productivity, and contribute to environmentally sound farming practices.

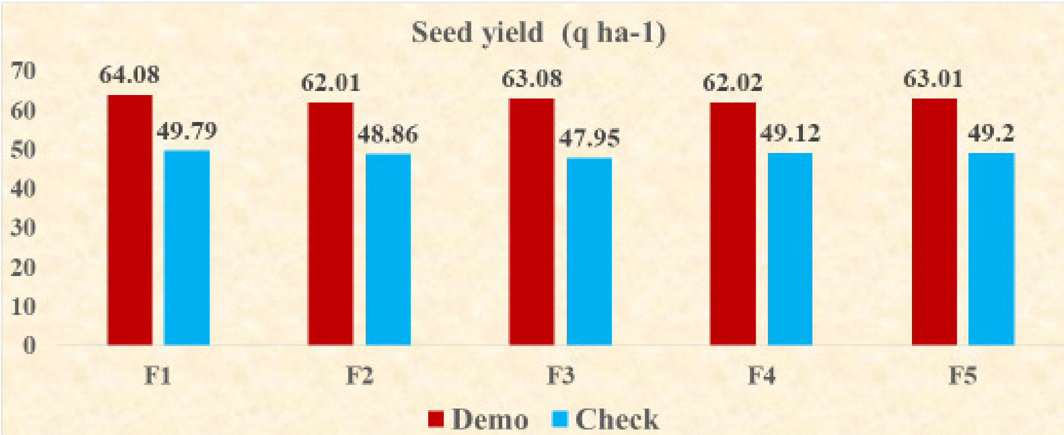

Fig. 05: Seed yield

Table 4: Agronomic performance of Rice as influenced by liquid Biofertilizer showing Total No. of tillers/hill, No. of Productive tillers/hill, Panicle length, panicle weight, Total number of seeds/panicle, No. of filled/unfilled spikelets per panicle, seed yield and Test weight at harvest stages in demo plot of farmer's field

Name of the Farmer	Address	Total number of tillers per hill	Number of productive tillers per hill	Panicle length (cm)	Panicle weight (g)	Total number of seeds per panicle	Number of filled seeds per panicle	Number of unfilled spikelets per panicle	Seed yield per plot ($q\ ha^{-1}$)	Test weight (g)
Sudhakar (F1)	Husanbad (V) Mothey (M) Suryapet (D)	23.27	20.7	25.0	3.20	151.5	140.2	11.4	64.08	23.00
B. Shankar (F2)	Gorentla (V), Maddirala (M), Suryapet (D)	21.10	19.1	24.1	2.91	150.9	139.1	10.2	62.01	22.2
A. Kotaiah (F3)	Dupahad (V), Penpahad (M), Suryapet (D)	22.10	18.8	23.5	3.10	149.7	138.4	9.9	63.08	21.8
K. Venkateshwarlu (F4)	Ganpavaram (V), Kodad (M), Suryapet (D)	23.10	19.2	24.6	3.15	150.1	137.9	10.8	62.02	22.9
T. Ravinder Reddy (F5)	Kamalanagar (V), Neruducherla(M), Suryapet (D)	20.98	20.9	24.9	3.05	148.8	140.1	9.2	63.01	22.5
(Demo plot)		**22.11**	**19.74**	**24.42**	**3.08**	**150.20**	**139.14**	**10.30**	**62.84**	**22.48**

Table 5: Agronomic performance of Rice as influenced by liquid Biofertilizer showing Total No. of tillers/hill, No. of Productive tillers/hill, Panicle length, panicle weight, Total number of seeds/panicle, No. of filled/unfilled spikelets per panicle, seed yield and Test weight at harvest stages in Control plot of farmer's field

Name of the Farmer	Address	Total number of tillers per hill	Number of productive tillers per hill	Panicle length (cm)	Panicle weight (g)	Total number of seeds per panicle	Number of filled seeds per panicle	Number of unfilled spikelets per panicle	Seed yield per plot (q ha^{-1})	Test weight (g)
C. Sudhakar (F1)	Husanbad (V) Mothey (M) Suryapet (D)	20.32	18.3	21.8	2.82	125.0	112.5	12.5	49.79	19.97
D. Shankar (F2)	Gorentla (V), Maddirala (M), Suryapet (D)	20.10	17.9	21.2	2.50	124.5	110.9	9.6	48.86	18.87
B. Kotaiah (F3)	Dupahad (V), Penpahad (M), Suryapet (D)	19.68	18.1	19.5	2.41	123.9	110.2	9.2	47.95	19.21
K. Venkateshwarlu (F4)	Ganpavaram (V), Kodad (M), Suryapet (D)	18.98	17.5	20.4	2.65	124.2	111.8	10.5	49.12	17.98
T. Ravinder Reddy (F5)	Kamalanagar (V), Neruducherla(M), Suryapet (D)	19.56	17.2	18.9	2.25	123.7	110.1	8.5	49.20	19.25
(Control plot)		**19.73**	**17.80**	**20.36**	**2.53**	**124.26**	**111.10**	**10.6**	**48.98**	**19.06**

Economics:

Table 6: Economics

Particulars	Demo plot			Control plot		
	2022-23	**2023-24**	**Pooled Mean**	**2022-23**	**2023-24**	**Pooled Mean**
Yield (q/ha)	61.2	63.5	**62.3**	58.3	60.7	**59.5**
Percent increase in yield over control	4.97	4.61	**4.79**			
Cost of Cultivation	51,500	53200	**52350**	56800	57200	**57000**
Gross Returns	1,24,848	138620	**131734**	118932	132508	**125720**
Net Returns	73348	85420	**79384**	62132	75308	**68720**
B:C Ratio	2.42	2.60	**2.51**	2.09	2.31	**2.2**

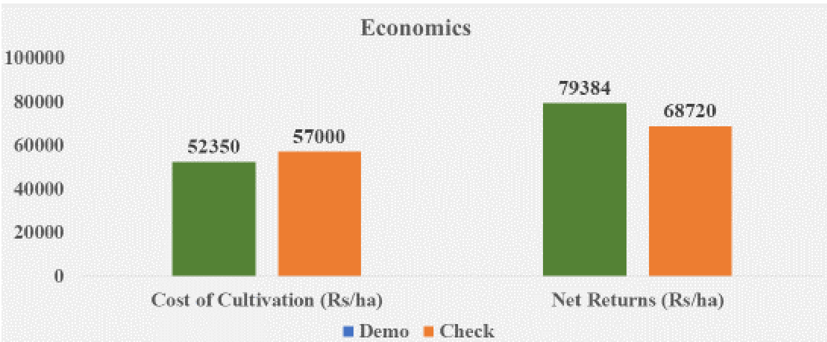

Fig. 6: Economics

Gross returns and benefit-cost (B:C) ratio were substantially higher in the demonstration plots (T_1) compared to the control plot (T_2) (Table.3). The demonstration plot, which received 75% of the recommended dose of fertilizers (RDF) along with a liquid biofertilizer consortium, recorded higher mean gross returns of Rs. 1,31,734 per hectare and net returns of Rs. 79,384 per hectare, with a B:C ratio of 2.51. In contrast, the control plot, which received 100% RDF without biofertilizers, recorded mean gross returns of Rs. 1,25,720 per hectare and net returns of Rs. 68,720 per hectare, with a B:C ratio of 2.20. The enhanced gross and net returns, as well as the higher B:C ratio observed in the demonstration plot, can be attributed to improved crop yield, likely driven by better nutrient uptake and soil biological activity facilitated by the liquid biofertilizers. The use of Azospirillum, Phosphobacterium, and Potassium-Mobilizing Bacteria not only reduced the dependence on chemical fertilizers but also contributed to improved plant growth and yield parameters. These findings are in line with previous research by [Insert reference, e.g., Upadhaya *et al*., 2022], which reported that integrated nutrient management with liquid biofertilizers significantly enhances economic returns in rice cultivation. The results emphasize the economic viability and sustainability of adopting biofertilizer-based nutrient management strategies in rice-growing regions like Suryapet district of Telangana.

Conclusion

The present on-farm study conducted in Suryapet district, Telangana, clearly demonstrated the positive impact of integrating liquid biofertilizers with a reduced dose of chemical fertilizers on rice productivity and farm profitability. The application of a liquid biofertilizer consortium comprising Azospirillum*,* Phosphorus Solubulizing Bacteria, and Potassium-Mobilizing Bacteria and KMB along with 75% of the recommended dose of fertilizers (T_1), resulted in improved soil health parameters, enhanced nutrient availability, and higher rice yield compared to the conventional practice of applying 100% RDF alone in (T_2). Furthermore, the demonstration plots recorded significantly higher gross and net returns with an improved benefit-cost ratio, indicating the economic viability of the biofertilizer-based nutrient management strategy. The findings highlight that the combined use of liquid biofertilizers and reduced chemical inputs offers a sustainable, eco-friendly, and cost-effective approach to rice cultivation in the region. Adoption of such integrated nutrient management practices can contribute towards improving farmer income while preserving long-term soil fertility and environmental health.

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