E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(9): 356-358
Received: 05-07-2025
Accepted: 07-08-2025

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Effect of liquid biofertilizer consortia and micronutrient on yield and economics of *kharif* soybean (*Glycine max* L.)

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DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i9e.3776

Abstract
An experiment was conducted to study the effect of liquid biofertilizer consortia and micronutrient on yield and economics of *kharif* soybean (*Glycine max* L.) at Post Graduate Research Farm, Agronomy Section, College of Agriculture, Dhule during *kharif* 2024. The experiment consisted of 10 treatments laid out in a randomized block design with three replication, which includes 100% RDF (50;75;45, N, P2O5 and K2O kg ha-1), 75% RDF, seed treatment with Rhizobium + PSB @ 25 g each kg-1 seed, seed treatment with liquid bio fertilizer consortia @ 25 ml kg-1 seed, two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS. Results revealed that use of 100% RDF + seed treatment with liquid bio fertilizer consortia @25 ml kg-1 seed + two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS recorded highest yield parameter *viz*., number of pods per plant (53.80), number of grains per plant (3.00 g), weight of grain per plant (26.09 g), test weight (18.28 g), grain yield (26.00 qt ha-1), straw yield (37.00 qt ha-1) along with highest net monetary return (₹ ha-1), gross monetary return (₹ ha-1) and highest B:C ratio (2.28) of soybean than other biofertilizer and micro nutrient treatments.

Keywords: Soybean, consortia, liquid biofertilizer, Phule micronutrient GR-II yield and economics

Introduction
Soybean (*Glycine max* L.,) often referred to as "nature's gold," is a crucial crop with immense economic, agricultural, and industrial importance worldwide. *Glycine max* L. is among the most cost effective and nutrient rich crops, with high protein (36 - 40%) and oil (20%) content (Raghav *et al.*, 2019) [11]. The yield of soybean is a generally low because it is less cared crop and mostly grown under rainfed condition without biofertilizers. The application of biofertilizer into the soil leads to increase soil fertility and crop productivity (Yadav and Sarkar, 2019) [12]. Liquid biofertilizer reduces the use of chemical fertilizer by 15-40%. They have long shelf life, easy to produce and apply (Kumar *et al.*, 2017) [6]. Biofertilizer consortia improve soil organic matter and microbial diversity, as noted by (Mishra *et al.*, 2021) [9]. Adequate supply of these nutrients not only enhances crop productivity but also improves seed quality, ensuring higher protein and oil content in soybean grains (Fageria *et al.*, 2011) [5].

Materials and Methods
A field experiment was conducted to study the effect of liquid biofertilizer consortia and micronutrient on yield and economics of *kharif* soybean (*Glycine max* L.) at Agronomy Research Farm, College of Agriculture, Dhule, during *kharif* season 2024. The treatments consist of Absolute control (T1), 100% RDF (50;75;45, N, P2O5 and K2O kg ha-1) (T2), 100% RDF + (seed treatment with Rhizobium + PSB @ 25 g each kg-1 seed) (T3), 75% RDF + (seed treatment with Rhizobium + PSB @ 25 g each kg-1 seed) (T4), 100% RDF + seed treatment with liquid bio fertilizer consortia @ 25 ml kg-1 seed (T5), 75% RDF + seed treatment with liquid bio fertilizer consortia @ 25 ml kg-1 seed (T6), 100% RDF + seed treatment with Rhizobium + PSB @ 25 g each kg-1 seed +Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS. (T7), 75% RDF + seed treatment with Rhizobium + PSB @ 25 g each kg-1 seed + Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS

(T8), 100% RDF + Seed treatment with liquid bio fertilizer consortia @ 25 ml kg-1 seed + Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS (T9) and 75% RDF
+ seed treatment with liquid bio fertilizer consortia @25 ml kg-1 seed + Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS (T10). FYM 10 ton ha-1 was applied common for all treatment except T1. Liquid Biofertilizer consortia consists of *Rhizobium* + PSB+ PMB. The seed of soybean variety 'Phule Sangam' was sown on July 29, 2024 at spacing of 45 x 5 cm2.

Results and Discussion

Yield attributes and yield

The yield-contributing traits, such as the number of pods per plant, pod weight, number of grains per pod, grain weight per plant and test weight (g), were significantly enhanced under the treatment of 100% recommended dose of fertilizer (RDF) combined with seed treatment using liquid biofertilizer consortia at a rate of 25 ml kg-1 seed, along with two foliar sprays of Phule Micronutrient GR-II at 1% at 30 and 45 days after sowing (DAS) (T9) than rest of the treatments. The grain and straw yield of soybean (qt ha-1) was found to be significantly higher (26.00 and 37.00 qt ha-1, respectively). The lowest grain and straw yield are under absolute control (T1). The superior performance of treatment T9 compared to other treatments can be attributed to its comprehensive nutrient management approach. This strategy combines the benefits of a full dose of recommended fertilizers (RDF), liquid bio fertilizers and micronutrient foliar applications. The RDF provides an adequate supply of primary nutrients (N, P, K), while the liquid bio fertilizer enhances soil microbial activity, promoting nutrient solubilization and uptake. Additionally, the foliar application of Phule Micronutrient GR II addresses micronutrient deficiencies of iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), molybdenum (Mo) and Boron (B) during Key growth stages, ensuring rapid absorption through the foliage. Such a combination improves physiological parameters like leaf area index and crop growth rate, ultimately resulting in higher grain yield compared to treatments lacking one or more of these components. Similar result was reported by Mandale *et al.*, (2020) [7], Bhosale *et al*., (2024) [2], Chandapure, *et.al.*, (2024) [3], Meher *et al.*, (2024) [8] and Pawar *et al*., (2024) [10].

Economics

The data recorded in Table 2 showed that among different bio fertilizer and micronutrient treatments, the cost of cultivation, gross and net monetary returns were found to be maximum (₹ 60365, ₹ 137400 and ₹ 77035 ha-1, respectively) in 100% RDF + seed treatment with liquid bio fertilizer consortia @25 ml kg-1 seed + two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 and 45 DAS (T9) and it was found to be at par with the application of 75% RDF + Seed treatment with liquid bio fertilizer consortia @25 ml kg-1 seed + two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 and 45 DAS (T10) (₹ 58801, ₹ 129380 and ₹ 70579 ha-1). The benefit- cost ratio was considerably maximum (2.28) in 100% RDF + seed treatment with liquid bio fertilizer consortia @ 25 ml kg-1 seed + two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 and 45 DAS (T9) than other treatments under study followed by (T10) (2.20) and (T5) (2.20) was found to be an economically better treatment. Similar results were also stated by Avachar, *et.al.*, (2024) [1], Bhosale *et al.*, (2024) [2], Chandapure, *et.al.*, (2024) [3], Durgude, *et.al.*, (2024) [4], Meher *et al.*, (2024) [8] and Pawar *et al*., (2024) [10].

Table 1: Yield attributes of soybean as influenced by different treatment

Treatment Details		Number of pods plant-1	Number of grain plant-1 (g)	Weight of grain plant-1 (g)	Test Weight (g)	Grain yield (qt ha-1)	Straw yield (qt ha-1)
T1	Absolute control (No fertilizer, No liquid bio fertilizer consortia, No Micronutrient)	22.25	2.03	11.80	16.50	10.59	17.26
T2	100% RDF (50;75;45, N, P2O5 and K2O Kg ha-1)	37.13	2.32	16.40	17.00	20.00	29.10
T3	100% RDF + (Seed treatment with Rhizobium + PSB @ 25 g each Kg-1 seed)	42.80	2.50	18.80	17.03	21.34	30.56
T4	75% RDF + (Seed treatment with Rhizobium + PSB @ 25 g each Kg-1 seed)	32.66	2.20	14.10	16.67	17.41	25.40
T5	100% RDF + Seed treatment with liquid bio fertilizer consortia @ 25 ml Kg-1 seed	49.10	2.85	23.40	17.21	23.45	32.50
T6	75% RDF + Seed treatment with liquid bio fertilizer consortia @ 25 ml Kg-1 seed	36.57	2.32	16.50	16.78	19.80	27.03
T7	100% RDF + Seed treatment with Rhizobium + PSB @ 25 g each Kg-1 seed +Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS.	49.00	2.85	23.58	17.50	24.10	33.00
T8	75% RDF + Seed treatment with Rhizobium + PSB @ 25 g each Kg-1 seed + Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS	45.57	2.67	21.10	17.16	22.00	30.15
T9	100% RDF + Seed treatment with liquid bio fertilizer consortia @ 25 ml Kg-1 seed + Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS	53.80	3.00	26.09	18.28	26.00	37.00
T10	75% RDF + Seed treatment with liquid bio fertilizer consortia @25 ml Kg-1 seed + Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS	49.62	2.89	23.70	18.20	24.50	34.40
SE (m.) ±		1.07	0.05	0.71	0.52	0.40	0.55
C. D. @ 5%		3.19	0.14	2.11	NS	1.17	1.64
General mean		41.95	2.56	19.54	17.23	10.59	17.26

Table 2: Economics of soybean as influenced by different treatment

Treatment Details		Total cost of cultivation (₹ ha-1)	Gross returns (₹ ha-1)	Net returns (₹ ha)	B:C Ratio
T1	Absolute control (No fertilizer, No liquid bio fertilizer consortia, No Micronutrient)	44159	56402	12243	1.28
T2	100% RDF (50;75;45, N, P2O5 and K2O Kg ha-1)	55501	105820	50319	1.90
T3	100% RDF + (Seed treatment with Rhizobium + PSB @ 25 g each Kg-1 seed)	56009	112812	56803	2.01
T4	75% RDF + (Seed treatment with Rhizobium + PSB @ 25 g each Kg-1 seed)	54241	92130	37889	1.70
T5	100% RDF + Seed treatment with liquid bio fertilizer consortia @ 25 ml Kg-1 seed	56220	123750	67530	2.20
T6	75% RDF + Seed treatment with liquid bio fertilizer consortia @ 25 ml Kg-1 seed	54481	104406	49925	1.92
T7	100% RDF + Seed treatment with Rhizobium + PSB @ 25 g each Kg-1 seed +Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS.	60084	127100	67016	2.12
T8	75% RDF + Seed treatment with Rhizobium + PSB @ 25 g each Kg-1 seed + Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS	58500	116030	57530	1.98
T9	100% RDF + Seed treatment with liquid bio fertilizer consortia @25 ml Kg-1 seed + Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS	60365	137400	77035	2.28
T10	75% RDF + Seed treatment with liquid bio fertilizer consortia @25 ml Kg-1 seed + Two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 DAS and 45 DAS	58801	129380	70579	2.20
SE (m.) ±		55836	110523	27343.4	1.95
C. D. @ 5%		-	-	-	-
General mean		-	-	-	-

Conclusion

Based on the results it could be concluded that among different biofertilizer and micronutrient treatments application of 100% RDF along with seed treatment with liquid bio fertilizer consortia @ 25 ml Kg-1 seed and two foliar sprays of Phule Micronutrient GR-II @ 1% at 30 and 45 DAS most effective in higher yield and profitability of soybean crop as compared to other treatments.

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