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Effect of integrated nutrient management and methods of Biomix application on growth and yield in soybean (*Glycine max* L.)

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ABSTRACT

A field experiment was conducted during the kharif season of 2025–26 at the Experimental Farm of the Agronomy Section, College of Agriculture, Latur, Maharashtra, to evaluate the response of soybean (*Glycine max* L.) to integrated nutrient management and different methods of Biomix application. The experiment was laid out in a Randomized Block Design (RBD) with seven treatments and three replications. The treatments were T_1 : RDF (30:60:30 kg N:P₂O₅:K₂O ha⁻¹), T_2 : RDF + FYM @ 5 t ha⁻¹, T_3 : T_2 + seed treatment with Biomix @ 8 ml kg⁻¹ seed, T_4 : T_2 + soil application of Biomix @ 10 kg ha⁻¹, T_5 : T_2 + foliar spray of Biomix @ 1% at 30 and 60 days after sowing (DAS), T_6 : T_2 + foliar spray of Biomix @ 2% at 30 and 60 DAS and T_7 : control. Among the treatments, T_4 (RDF + FYM @ 5 t ha⁻¹ + soil application of Biomix @ 10 kg ha⁻¹) recorded the highest plant height (67.87 cm), number of functional leaves plant⁻¹ (29.33), leaf area plant⁻¹ (6.32 dm²), number of branches plant⁻¹ (10.20) and dry matter accumulation plant⁻¹ (34.85 g). Among the yield attributes and yield highest number of pods plant⁻¹ (63.50), pod yield plant⁻¹ (30.33 g), seed yield plant⁻¹ (16.94 g), seed yield (3083 kg ha⁻¹) and biological yield (8015 kg ha⁻¹) were recorded with the application of T_4 (RDF + FYM @ 5 t ha⁻¹ + soil application of Biomix @ 10 kg ha⁻¹) which was closely followed by the application of T_6 (RDF + FYM @ 5 t ha⁻¹ + foliar spray of Biomix @ 2% at 30 and 60 DAS).

Keywords: Biomix, FYM, Integrated nutrient management, Soybean, Soil application, Growth and yield

1. Introduction

Soybean (*Glycine max* L.) is an important oilseed and protein-rich crop and its productivity is strongly influenced by balanced nutrient management. Commonly known as the “Golden Bean” or “Wonder Crop,” Soybean seeds contain 43.2% protein, 19.5% fat, 20.9% carbohydrate and a good amount of other nutrients like calcium, phosphorus, iron and vitamins (Gopalan *et al.*, 1971) [1]. Soybean is an excellent source of major nutrients including vitamin A, B, C and D, rich in unsaturated fatty acid and minerals like Ca and P that can meet up different nutritional need (Rahman, 1982) [2]. Integrated use of inorganic fertilizers with organic manures such as farmyard manure (FYM) can improve nutrient availability, crop growth, productivity and yield while contributing to better soil health. Singh *et al.* (2004) [3] reported that the combined application of recommended NPK with FYM and biofertilizers improved yield attributes, seed yield and quality of soybean compared with recommended NPK alone. Beneficial microorganisms can complement mineral fertilizers by enhancing nutrient availability and promoting plant growth. Singh *et al.* (2007) [4] observed improved growth, nodulation, seed yield and nutrient uptake of soybean with the use of bio-inoculants and FYM. Similarly, Rana *et al.* (2014) [5] reported that integrated use of organic manures and recommended fertilizer levels improved seed yield, yield attributes and nutrient uptake in soybean. Biomix is a useful mixture of biological agents, which is a low-cost input technology that contributed to pollution free atmosphere. It is prepared by the Department of Plant Pathology, VNMKV Parbhani, from 14 beneficial fungi and bacteria with functions such as nitrogen fixation, phosphorus solubilization, plant growth promotion and biological protection, may therefore have potential as a component of integrated nutrient management in soybean. However, the effectiveness of microbial inputs may vary with the method of application. Therefore, evaluation of suitable Biomix application methods in combination with organic and inorganic nutrient sources is necessary for improving soybean productivity under local agro-climatic conditions of the Marathwada region. Hence, the present investigation was undertaken to study the response of soybean to integrated nutrient management and different methods of Biomix application with respect to growth, yield attributes and productivity.

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2. Materials and methods

A field experiment was conducted during the *kharif* season of 2025–26 at the Experimental Farm of the Agronomy Section, College of Agriculture, Latur, Maharashtra, India. The experimental location falls under the semi-arid tropical climatic region of Maharashtra. The experimental soil was clayey in texture and moderately alkaline in reaction, with a soil pH of 7.55. The soil was low in available nitrogen, medium in available phosphorus and high in available potassium. The initial available nutrient status of the experimental soil was 125.90 kg N ha⁻¹, 8.46 kg P ha⁻¹ and 1150.60 kg K ha⁻¹. The experiment was laid out in a Randomized Block Design (RBD) with three replications. Seven treatments were evaluated to study the effect of integrated nutrient management and different methods of Biomix application. The treatments consisted of different combinations of recommended dose of fertilizer (RDF), farmyard manure (FYM) and methods of Biomix application. The treatment combinations were: T₁: RDF (30:60:30 N:P₂O₅:K₂O kg ha⁻¹); T₂: RDF + FYM @ 5 t ha⁻¹; T₃: T₂ + Biomix seed treatment @ 8 ml kg⁻¹ seed; T₄: T₂ + Biomix soil application @ 10 kg ha⁻¹; T₅: T₂ + Biomix foliar spray @ 1% at 30 and 60 DAS; T₆: T₂ + Biomix foliar spray @ 2% at 30 and 60 DAS; and T₇: control. The gross plot size was 5.4 m × 4.5 m and the net plot size was 4.20 m × 3.90 m. Biomix is an eco-friendly mixture of biological agents and microbial consortium developed by the Department of Plant Pathology, VNMKV Parbhani, from various beneficial fungi and bacteria. This is a combination of fourteen different type of microorganism (*Trichoderma asperellum*, *Aspergillus niger*, *Pseudomonas striata*, *Neumoria reyi*, *Gluconacetobactor*, *Bacillus subtilis*, PPFM (Pink pigmented facultative methylophs), *Trichoderma harzianum*, *Pseudomonas fluorescens*, *Beauveria bassiana*, *Metarhizium anisopliae*, *Paecilomyces lilacinus*, *Verticillium lecanii*, *Azospirillum brasilense*) in which Nitrogen fixers, Phosphorus solubilizers and PGPR found to enhance the growth of cereals, oilseeds and legumes better and save about 20-25% inorganic fertilizers such as nitrogenous and phosphorus in case of Soybean, rice, cotton, chilli, groundnut and pulses. Soybean variety MAUS-158 was used for the experiment. Sowing was carried out by dibbling on 18 July 2025 at a spacing of 45 cm × 5 cm, using a seed rate of 65 kg ha⁻¹. The recommended dose of fertilizer, 30:60:30 kg N:P₂O₅: K₂O ha⁻¹ was applied according to the respective treatment. FYM was in-

corporated as specified in the treatment schedule. Biomix was applied through seed treatment, soil application or foliar spray according to the respective treatments. All other recommended agronomic practices, including weed management and plant protection measures were followed uniformly for all treatments. Five representative plants were selected from each net plot for recording observations. Plant height was measured from the base of the plant to the growing tip and expressed in centimeters. The number of functional leaves was counted on the selected plants. Leaf area was determined from representative plant samples and expressed as dm² plant⁻¹. The number of branches plant⁻¹ was recorded at 75 DAS. For determination of dry matter accumulation, plant samples were collected at the specified growth stages and dried in a hot-air oven until constant weight was achieved. The dry matter was expressed as g plant⁻¹. At harvest, yield attributes such as number of pods plant⁻¹, pod yield plant⁻¹ and seed yield plant⁻¹ were recorded. Seed and biological yields were expressed in kg ha⁻¹. The experimental data were subjected to statistical analysis appropriate for a Randomized Block Design. Analysis of variance was performed following the procedure described by Panse *et al.* (1967) [6]. The critical difference (CD) at the 5% level of significance was used for comparing treatment means wherever the treatment effect was significant.

3. Results and discussion

3.1 Growth attributes

The data presented in table 1 indicated that application of integrated nutrient management significantly influenced the growth of soybean. Among the different treatments, T₄ (RDF + FYM @ 5 t ha⁻¹ + soil application of Biomix @ 10 kg ha⁻¹) recorded the highest values for all the major growth attributes. As presented in table 1, treatment T₄ recorded the highest plant height (67.87 cm), number of functional leaves plant⁻¹ (29.33), leaf area plant⁻¹ (6.32 dm²), number of branches plant⁻¹ (10.20) and dry matter accumulation plant⁻¹ (34.85 g). The performance of T₄ was followed by T₆ (RDF + FYM @ 5 t ha⁻¹ + foliar spray of Biomix @ 2% at 30 and 60 DAS). The superior growth under RDF + FYM @ 5 t ha⁻¹ + soil application of Biomix @ 10 kg ha⁻¹ (T₄) may be attributed to the combined effect of inorganic fertilizers, FYM and soil-applied Biomix.

Table 1. Mean of growth attributes and growth of soybean as influenced by various treatments.

Treatment	Plant height AH (cm)	Functional leaves plant ⁻¹ (60 DAS)	Leaf area plant ⁻¹ (dm ²) (60 DAS)	Branches plant ⁻¹ (75 DAS)	Dry matter plant ⁻¹ (g)
T ₁ :RDF	55.33	18.17	4.49	8.17	24.01
T ₂ :RDF + FYM @ 5 t ha ⁻¹	57.16	20.17	4.63	8.67	26.34
T ₃ :T ₂ + Biomix seed treatment @ 8 ml kg ⁻¹	62.83	27.83	5.16	8.90	29.96
T ₄ :T ₂ + Biomix soil application @ 10 kg ha ⁻¹	67.87	29.33	6.32	10.20	34.85
T ₅ :T ₂ + Biomix foliar spray @ 1% at 30 and 60 DAS	60.50	26.07	5.47	9.63	30.93
T ₆ :T ₂ + Biomix foliar spray @ 2% at 30 and 60 DAS	64.81	27.17	5.69	9.80	32.76
T ₇ : Control	50.07	14.90	4.16	7.43	21.75
SEm ±	2.52	1.18	0.27	0.39	1.25
CD @ 5%	7.63	3.57	0.82	1.18	3.80

* AH= At harvest, DAS = days after sowing

The application of RDF supplied readily available nutrients required for vegetative growth, whereas FYM improved the soil environment and provided organic matter and nutrients. Soil application of Biomix may have enhanced microbial activity in the rhizosphere and facilitated nutrient availability and uptake. Improved nutrient availability

during the vegetative phase could have promoted cell division, cell elongation, leaf development and dry matter accumulation.

The present findings are in agreement with earlier reports indicating beneficial effects of integrated nutrient management and biological inputs on crop growth Awasarmal *et al.*, 2013 [7], Morya *et al.*, 2018 [8], Kaur *et al.*, 2023 [9].

3.2 Yield attributes

The data presented in table 2 indicate that Integrated nutrient management and different methods of Biomix application significantly influenced the yield attributes of soybean. The highest number of pods plant⁻¹ (63.50), pod yield plant⁻¹ (30.33 g) and seed yield plant⁻¹ (16.94 g) were recorded under RDF + FYM @ 5 t ha⁻¹ + soil application of Biomix @ 10 kg ha⁻¹ (T₄) which was at par with T₆, which received RDF + FYM @ 5 t ha⁻¹ along with foliar application of Biomix @ 2% at 30 and 60 DAS. The enhanced yield attributes under integrated nutrient management may be associated with improved vegetative growth, greater leaf area and higher dry matter production. Better nutrient availability and uptake during the reproductive phase may have contributed to improved pod formation and seed development. The treatment (T₇) recorded the lowest number of pods plant⁻¹, pod yield plant⁻¹ and seed yield plant⁻¹. The improved yield attributes under the integrated treatment were consistent with the superior growth performance observed under T₄. Similar beneficial effects of integrated nutrient management on soybean growth and productiv-

ity have been reported by Awasarmal *et al.* (2013) [7] and Morya *et al.* (2018) [8].

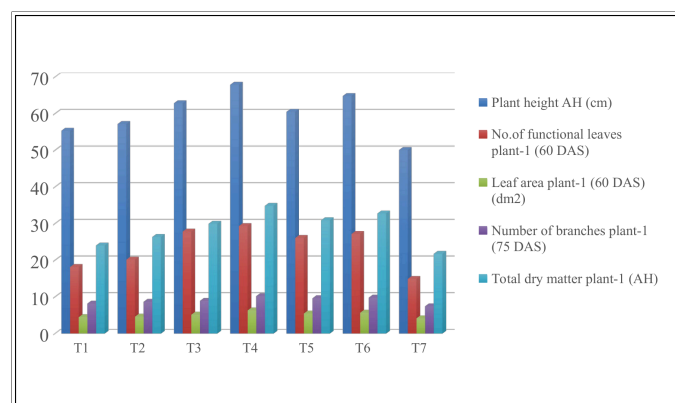


Figure 1. Mean of growth attributes of soybean as affected by various treatments

Table 2. Mean of yield attributes and yield of soybean as influenced by various treatments.

Treatment	Pods plant ⁻¹	Pod yield plant ⁻¹ (g)	Seed yield plant ⁻¹ (g)	Seed yield (kg ha ⁻¹)	Biological yield (kg ha ⁻¹)
T ₁ :RDF	44.67	22.90	10.14	2264	6516
T ₂ :RDF + FYM @ 5 t ha ⁻¹	49.87	24.83	12.80	2529	6988
T ₃ :T ₂ + Biomix seed treatment @ 8 ml kg ⁻¹	52.87	25.53	13.13	2545	7025
T ₄ :T ₂ + Biomix soil application @ 10 kg ha ⁻¹	63.50	30.33	16.94	3083	8015
T ₅ :T ₂ + Biomix foliar spray @ 1% at 30 and 60 DAS	55.77	26.00	14.85	2629	7191
T ₆ :T ₂ + Biomix foliar spray @ 2% at 30 and 60 DAS	58.80	28.80	15.90	2887	7705
T ₇ : Control	40.33	21.67	9.49	1610	5066
SEm ±	2.30	1.17	0.61	139	293
CD @5%	6.98	3.55	1.85	420	887

3.3 Seed and biological yield

The data presented in Table 2 indicate that a marked variation in seed and biological yield was observed among the treatments. The highest seed yield (3083 kg ha⁻¹) and biological yield (8015 kg ha⁻¹) were obtained with T₄, comprising RDF + FYM @ 5 t ha⁻¹ + soil application of Biomix @ 10 kg ha⁻¹. Treatment T₆, consisting of RDF + FYM @ 5 t ha⁻¹ + foliar spray of Biomix @ 2% at 30 and 60 DAS, recorded the next highest seed yield (2887 kg ha⁻¹) and biological yield (7705 kg ha⁻¹). The higher seed yield obtained under RDF + FYM @ 5 t ha⁻¹ + soil application of Biomix @ 10 kg ha⁻¹ (T₄) may be attributed to the cumulative effect of improved plant growth and yield attributes. Soil application of Biomix in conjunction with FYM and RDF may have provided a favourable rhizosphere environment and enhanced nutrient availability during crop growth. Greater plant height, leaf area, branching and dry matter production under T₄ ultimately resulted in more pods and greater seed production. The results indicate that the method of Biomix application influenced its effectiveness, with soil application performing better than seed treatment and foliar application under the conditions of the present experiment. However, the response of microbial formulations can be influenced by soil properties, environmental conditions, formulation quality and crop management practices. Therefore, further multi-location studies would be useful for validating the response. Similar responses were reported by Awasarmal *et al.* (2013) [7], Chakraborty *et al.* (2016) [10], Suryavanshi *et al.* (2024) [11].

4. Conclusion

The field experiment demonstrated that integrated application of inorganic fertilizer, FYM and Biomix had a positive influence on soybean growth and productivity. Among the treatments application of RDF + FYM @ 5 t ha⁻¹ + soil application of Biomix @ 10 kg ha⁻¹ (T₄) recorded the highest growth attributes, viz., plant height, functional leaves plant⁻¹, leaf area plant⁻¹, branches plant⁻¹, dry matter accumulation plant and yield attributes, viz., number of pods plant⁻¹, pod yield plant⁻¹, seed yield plant⁻¹, seed yield and biological yield, which was found to be the most effective treatment for improving soybean growth and yield.

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