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Impact of integrated nutrient management on growth attributes of soybean (*Glycine max* L.)

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Abstract

A field trial was conducted during *kharif* season, 2025-26 at the Experimental Farm, Department of Agronomy, College of Agriculture, Latur (Maharashtra), “Impact of Integrated Nutrient Management on Growth Attributes of Soybean (*Glycine max* L.)” The experiment was laid out in a Randomized Block Design (RBD) with seven treatments and three replications to study the effect of integrated nutrient management practices on growth attributes of soybean. The treatments consisted of the recommended dose of fertilizers (RDF) supplemented with farmyard manure (FYM), neem cake powder and multi-micronutrient Grade-I, either individually or in combination. The results revealed that the application of RDF + FYM @ 5 t ha⁻¹ + neem cake powder @ 3 q ha⁻¹ + multi-micronutrient Grade-I @ 25 kg ha⁻¹ (T₇) recorded superior growth and yield attributes of soybean compared to the other treatments. The integrated application of organic manure, neem cake powder and multi-micronutrients along with the recommended dose of fertilizers enhanced plant growth and yield performance. Treatment RDF + FYM @ 5t/ha⁻¹ + Neem cake powder @ 3qt/ha⁻¹ + Multi micronutrient Grade-I @ 25kg/ha⁻¹(T₇) was followed by RDF + FYM @ 5 t ha⁻¹ + multi-micronutrient Grade-I @ 25 kg ha⁻¹(T₅) and RDF + neem cake powder @ 3 q ha⁻¹ + multi-micronutrient Grade-I @ 25 kg ha⁻¹ (T₆).

Keywords: Integrated nutrient management, soybean, growth attributes, farmyard manure, multi-micronutrients

Introduction

Soybean (*Glycine max* L.) is an economically significant annual leguminous crop cultivated globally for its dual role as a pulse and an oilseed crop. Commonly known as the “Golden Bean,” it holds immense importance as a food legume owing to its high protein content (approximately 40%) and oil content (around 20%), making it a vital source of nutrition for both humans and livestock. Taxonomically, soybean belongs to the family *Fabaceae* (Leguminosae), tribe *Phaseoleae*, which comprises several agronomically important legumes. The genus *Glycine* was first described by Linnaeus in the initial edition of *Genera Plantarum* and has since been classified into two subgenera *Glycine* and *Soja* based on morphological characteristics and molecular phylogenetic studies.

Integrated Nutrient Management (INM) is an eco-sustainable strategy that integrates organic manures, inorganic fertilizers, biofertilizers, and micronutrients in a balanced and complementary manner to maintain soil fertility and enhance crop productivity. In soybean cultivation, INM plays a crucial role in improving soil health, nutrient availability, and yield sustainability. Although soybean fixes atmospheric nitrogen through symbiotic association with *Rhizobium japonicum*, the crop still requires balanced nutrient supplementation to meet its high nutrient demand. The combined use of organic and inorganic sources improves nutrient use efficiency and reduces nutrient losses through leaching, volatilization, and fixation.

The incorporation of organic amendments such as farmyard manure (FYM) and neem cake enhances soil organic carbon, microbial activity, and cation exchange capacity, improving the physical and biological properties of soil (Mundhe *et al.*, 2023) [6]. FYM at 5 t ha⁻¹ with the recommended dose of fertilizers (RDF) has been found to increase the availability and uptake of N, P, and K, leading to higher yields. Neem cake also acts as a nitrification inhibitor and provides

secondary benefits such as pest suppression. The inclusion of multi-micronutrient mixtures (Zn, Fe, Mn, B, Cu) helps to correct hidden deficiencies, enhance photosynthetic activity, and improve seed quality parameters (Gupta *et al.*, 2024) [3]. Biofertilizers such as *Rhizobium* and phosphate solubilizing bacteria (PSB) further promote biological nitrogen fixation and phosphorus mobilization, improving overall soil fertility (Sahu *et al.*, 2006) [10].

INM practices have also been shown to improve soybean productivity, protein and oil content, and economic returns while reducing dependence on costly chemical fertilizers. Long-term studies have demonstrated that the combined application of FYM and fertilizers enhances soil microbial populations and enzymatic activities, thereby sustaining soil fertility and yield stability (Yadav *et al.*, 2021) [12]. Moreover, INM reduces environmental pollution, improves soil carbon sequestration, and contributes to climate-resilient and sustainable agriculture (Panda *et al.*, 2020). Thus, INM not only ensures higher and stable yields of soybean but also maintains the ecological balance, soil fertility, and economic viability of farming systems under diverse agro-ecological condition.

Materials and Method

An experiment was conducted during *kharif* season, 2025-2026 at the Experimental Farm of Agronomy, College of Agriculture, Latur, Geographically Latur district of Maharashtra state is located at 18°05' to 18° 75' North latitude and 77° 25' to 77° 36' East latitude with the total geographical area is 7.37 million ha. Latur area comes under semi-arid and tropical region of the Maharashtra. The average annual rainfall of the Latur district is 795.3 mm. The mean maximum temperature during crop growth period was 26.54 °C while the mean minimum temperature was 17.18°C. The mean humidity during morning was 1017.9 %. The soil of experimental plot was clayey in texture, low in available nitrogen (112.9 kg ha⁻¹), medium in available phosphorus (7.46 kg ha⁻¹) and high in available potassium (1145.6 kg ha⁻¹). The soil was moderately alkaline in reaction having pH 7.4. The experimental field was laid out in a Randomized Block Design (RBD) with seven treatments replicated three times. The treatments were T1: Control T2:100 % RDF T3:100% RDF + FYM @ 5t/ha⁻¹ T4:RDF + Neem cake powder @3qt/ha⁻¹ T5: RDF + FYM@ 5t/ha⁻¹+multimicronutrient grade- I @ 25kg/ha⁻¹ T6: RDF + Neem cake powder @3qt/ha⁻¹ + multi micronutrient grade- I @25 kg /ha⁻¹ T7: RDF + FYM @5t/ha⁻¹+ Neem cake powder @3qt/ha⁻¹+ multi micronutrient Grade-I @25kg/ha⁻¹. Sowing was done by dibbling with seed rate of 65 kg/ha⁻¹. Soybean variety MAUS 158 was sown with recommended fertilizer dose of 30:60:30 NPK kg/ha⁻¹. Gross plot was of size 5.4 m x 4.5 m and net plot of 4.5 m x 3.9 m. Soil application of nitrogen and phosphorous was applied through urea and SSP respectively at the time of sowing and FYM was applied at 15 days before sowing. The recommended cultural practices and plant protection measures were taken. Five plants were randomly selected and tagged from each net plot to record biometric observations at various growth stages. These same plants were later harvested individually for post-harvest analysis. The data collected from various observations were organized into tables and analyzed using analysis of variance (Panse and Sukhatme, 1967) [8].

Result And Discussion

Growth attributes

Plant height(cm)

The application of RDF + FYM @ 5 t ha⁻¹ + Neem cake powder

@ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₇) recorded significantly superior plant height at all the growth stages. However, it remained statistically at par with RDF + FYM @ 5 t ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₅) and RDF + Neem cake powder @ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₆). The superiority of RDF + FYM @ 5 t ha⁻¹ + Neem cake powder @ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₇) may be due to the synergistic effect of organic and inorganic nutrient sources. FYM and neem cake improved nutrient availability and soil microbial activity, while micronutrients supported key physiological processes. This balanced nutrient supply enhanced root growth, nutrient uptake and cell elongation, resulting in greater plant height. The present findings are in close agreement with those reported by Kumawat *et al.* (2019) [4], Patil *et al.* (2021) [9].

Number of branches plant⁻¹

The data revealed that the number of branches plant⁻¹ was significantly influenced by different integrated nutrient management treatments at all the growth stages viz., 30, 45, 60, 75 DAS and at harvest. The treatment RDF + FYM @ 5 t ha⁻¹ + Neem cake powder @ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₇) recorded the highest number of branches plant⁻¹ at all the growth stages. However, it remained statistically at par with RDF + FYM @ 5 t ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₅) and RDF + Neem cake powder @ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₆). As FYM and neem cake improved nutrient availability and soil microbial activity, this resulted in better root growth, nutrient uptake and vegetative development, ultimately promoting greater branch formation.

No. of functional leaves plant⁻¹

The application of RDF + FYM @ 5 t ha⁻¹ + Neem cake powder @ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₇) recorded the highest number of functional leaves plant⁻¹ at all the growth stages, which was remained statistically at par with RDF + FYM @ 5 t ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₅) at 45, 60 and 75 DAS. The increase in the number of functional leaves under integrated nutrient management treatments may be attributed to the balanced and sustained supply of nutrients through RDF, FYM, neem cake and multi micronutrients, which promoted vigorous vegetative growth, enhanced chlorophyll synthesis and delayed leaf senescence. The present findings are in close agreement with those reported by Verma *et al.* (2023) [11], Gupta *et al.* (2024) [3], and Biswas *et al.* (2025) [2], who also reported a significantly higher number of functional leaves in soybean under integrated nutrient management practices.

Leaf area plant⁻¹ (dm²)

The data concluded that leaf area plant⁻¹ was significantly influenced by different integrated nutrient management treatments at all the growth stages viz., 30, 45, 60 and 75 DAS. The treatment RDF + FYM @ 5 t ha⁻¹ + Neem cake powder @ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₇) recorded the highest leaf area plant⁻¹ at all the growth stages, which was found statistically at par with RDF + FYM @ 5 t ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₅) and RDF + Neem cake powder @ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₆). The higher leaf area observed under integrated nutrient management treatments may be attributed to the balanced supply of macro- and micronutrients coupled with the beneficial effects of FYM and neem cake on soil fertility, nutrient availability and microbial activity. The present findings are in agreement with

those reported by Mundhe *et al.* (2023) [6], Gupta *et al.* (2024) [3], and Biswas *et al.* (2025) [2], who also reported that integrated nutrient management significantly increased leaf area in soybean due to improved nutrient availability and better crop growth.

Functional root nodules plant⁻¹

The treatment RDF + FYM @ 5 t ha⁻¹ + Neem cake powder @ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₇) recorded the highest mean number of functional root nodules plant⁻¹ at all the growth stages which was at par with RDF + FYM @ 5 t ha⁻¹

+ Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₅). At 45 DAS, T₇ was also at par with RDF + Neem cake powder @ 3 qt ha⁻¹ + Multi micronutrient Grade-I @ 25 kg ha⁻¹ (T₆) and RDF + Neem cake powder @ 3 qt ha⁻¹ (T₄), while at 60 DAS it remained at par with T₆. The present findings are in conformity with those reported by Meena *et al.* (2018) [5], Biswas *et al.* (2025) [2], and Amanullah *et al.* (2025) [1], who also reported that integrated nutrient management significantly increased the number of functional root nodules in soybean by improving soil fertility, microbial activity and biological nitrogen fixation.

Table 1: Mean of growth attributes of Soybean as influenced by various treatments

Treatments	Plant height -1 (cm)	No. of branches plant ⁻¹	No. of functional leaves plant ⁻¹	Leaf area plant ⁻¹	Functional rood nodules plant ⁻¹
T1 - Control	31.10	4.40	14.90	3.27	28.67
T2 - RDF	33.50	5.53	15.77	3.41	30.67
T3 - 100 % RDF + FYM @5t/ha ⁻¹	36.20	6.17	17.20	4.68	38.33
T4 - RDF + Neem cake powder @3 qt/ha ⁻¹	37.80	6.37	18.63	4.67	38.00
T5 - RDF + FYM @ 5t/ha ⁻¹ + Multi micronutrient grade-I @ 25 kg/ha ⁻¹	42.32	6.60	22.03	5.70	40.33
T6 - RDF + Neem cake powder @ 3qt/ha ⁻¹ + Multi micronutrient grade-I @ 25kg/ha ⁻¹	41.96	6.40	18.93	5.60	36.67
T7 - RDF + FYM @5t/ha ⁻¹ + Neem cake powder @ 3qt/ha ⁻¹ + Multi micronutrient grade-I @25kg/ha ⁻¹	45.20	7.17	23.13	5.77	43.67
SE ±	1.26	0.29	0.89	0.28	1.82
CD @ 5%	3.78	0.87	2.66	0.84	5.46
Grand Mean	38.30	6.09	18.66	4.73	36.62

Conclusion

Based on the above results, it can be concluded that the application of RDF + FYM @ 5 t ha⁻¹ + neem cake powder @ 3 q ha⁻¹ + multi-micronutrient Grade-I @ 25 kg ha⁻¹ (T₇) enhancing the growth and yield attributes, resulting in higher seed yield of soybean. This treatment was closely followed by RDF + neem cake powder @ 3 q ha⁻¹ + multi-micronutrient Grade-I @ 25 kg ha⁻¹ (T₆).

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