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Effect of micronutrient grades on growth, yield and economics of soybean (*Glycine max* L.)

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Abstract

In order to study the effect of micronutrient grades on growth, yield and economics of soybean, a field experiment was performed at Experimental Farm, Agronomy Section, College of Agriculture, Latur on clayey soil during *kharif* season of 2022-2023. The experiment was laid out in Randomized Block Design with seven treatments replicated thrice. The treatments were T₁: Absolute control, T₂: RDF (30:60:30 NPK kg ha⁻¹), T₃: RDF + FYM @ 5 t ha⁻¹, T₄: RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹, T₅: RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (Foliar spray at 20 DAS), T₆: RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.5% (Foliar spray at 40 DAS), T₇: RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (Foliar spray at 20 & 40 DAS). The result revealed that the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS) recorded significantly highest plant height, number of branches plant⁻¹ and number of leaves plant⁻¹, followed by the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS) and RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.5% (foliar spray at 40 DAS). Whereas other growth, yield attributes, yield and economics viz., leaf area plant⁻¹ (dm²), dry matter accumulation plant⁻¹, number of pod plant⁻¹, number of seeds plant⁻¹, weight of pod plant⁻¹, weight of seeds plant⁻¹, seed yield, GMR and NMR were significantly highest with the application of application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS), which was at par with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS). Highest harvest index and B:C ratio was obtained with the application of application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS).

Keywords: Soybean, nutrient management, micronutrients, growth, yield, economics, quality

Introduction

Golden bean Soybean (*Glycine max* L.) is a leguminous crop, member of Fabaceae family and Faboideae subfamily. Soybean has compelling importance in the human and livestock nutrition. It consists of about 40% quality proteins, 20% cholesterol free oil and 23% carbohydrates. About 85% unsaturated fatty acids including 55% polyunsaturated fatty acids (PUFA). It has high caloric value releasing 446 calories from 100 gm of edible soybean. Considering its nutritional contribution, it is also known as a 'Wonder Crop', 'Miracle Crop' and 'Golden Bean'. The assumed nitrogen fixed by soybean is approximately 50- 450 kg ha⁻¹. So, it is also called as 'Gold of soil'. Maharashtra and Madhya Pradesh dominate the production of soybean in India, which contribute about 89% of the total India's Production. (Anonymous, 2022) [2]. During year 2020-2021, area sown in Maharashtra was 4.36 million ha with production of 6.20 million ton and productivity of 1423 kg ha⁻¹ (Anonymous, 2020) [1]. Nutrients interaction is the core of balanced nutrition. Along with macronutrients like nitrogen, phosphorus and potassium, some micronutrients are believed to be necessary for increasing growth & seed yield of soybean. Among various plant nutrients, micronutrients play an important decisive role in improving the productivity of crop. There is better awareness and adoption among the farmers for the use of macronutrients compared to micronutrients. As a result, it has become the great need of time to suggest most effectual and economical source of application of micronutrients to meet the hidden hunger of crop like soybean. Therefore, keeping these facts in view, attempts are made to be acquainted with the field experiment entitled "Effect of micronutrient grades on growth, yield and economics of soybean (*Glycine max* L.)".

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Materials and Methods

The field experiment was carried out at Experimental Farm, Agronomy Section, College of Agriculture, Latur during *kharif* season of 2022-2023. The experimental area is located between 18°05' to 18° 75' North latitude and between 76° 25' to 77° 36' East latitude. The experimental field was levelled and well drained. The soil of experimental plot was clayey in texture low in available nitrogen (126.8 kg ha⁻¹), medium in available phosphorous (18.31 kg ha⁻¹), high in available potassium (497.85 kg ha⁻¹) and alkaline in reaction having pH 7.8. The temperature data revealed that thermal condition of crop environment during crop life were within physiological cardinal limits. During crop period, mean maximum and minimum temperatures of 30.13 °C and 17.52 °C were recorded. The total precipitation received during crop period was 949 mm with 43 rainy days.

The experiment was laid out in Randomized Block Design. The seven treatments were replicated thrice. The treatments were T₁: Absolute control, T₂: RDF (30:60:30 NPK kg ha⁻¹), T₃: RDF + FYM @ 5 t ha⁻¹, T₄: RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹, T₅: RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (Foliar spray at 20 DAS), T₆: RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.5% (Foliar spray at 40 DAS), T₇: RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (Foliar spray at 20 & 40 DAS). The gross and net plot size of each experimental plot was 5.4 m x 4.5 m and 4.5 m x 3.9 m respectively. Sowing was done by dibbling method on 5th July 2022 at the spacing of 45 cm x 05 cm with seed rate of 65 kg ha⁻¹. The recommended dose of fertilizer of 30:60:30 NPK kg ha⁻¹ was applied. The micronutrient grade-I complex contains Zn- 5%, Fe- 2%, Mn- 1%, B- 1%, Cu- 0.5% and micronutrient grade-II complex contains Zn- 3%, Fe- 2.5%, Mn- 0.1%, B- 0.5%, Cu- 1%, Mo- 0.1%. The whole dose of NPK was applied as a

basal dose. The crop was harvested on 19th October 2022. The data recorded were statistically analyzed by using technique of analysis of variance (Panse and Sukhatme, 1967) [8].

Results and Discussion

Growth attributes

The various growth parameters of soybean *viz.*, plant height, number of branches plant⁻¹, number of leaves plant⁻¹, leaf area plant⁻¹ (dm²), dry matter accumulation plant⁻¹ and number of pod plant⁻¹ were significantly influenced due to different treatments (Table 1). The application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS) recorded significantly higher plant height (cm), number of branches plant⁻¹ and number of leaves plant⁻¹ which was at par with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS) and RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.5% (foliar spray at 40 DAS) and found significantly superior over rest of the treatments. Leaf area plant⁻¹ (dm²), dry matter accumulation plant⁻¹ (g) and number of pod plant⁻¹ were highest with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS) which was at par with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS) (T₅) and found significantly superior over rest of the treatments. The increase in growth parameters might be due to balanced application of nutrients through RDF, micronutrient grades and FYM which enhanced the plant height, number of branches and leaf area *i.e.*, overall growth and development of crop and resulted into higher mean number of pods plant⁻¹ of crop. Results are in conformity with the findings of Shinde *et al.* (2015) [9] and Bhosale and Pacharne (2017) [5].

Table 1: Effect of different treatments on growth attributing characters of soybean

Treatments	Plant height at harvest (cm)	No. of branches plant ⁻¹	No. of leaves of plant ⁻¹	Leaf area plant ⁻¹ (dm ²)	Dry matter plant ⁻¹ (g)	No. of pods plant ⁻¹
T ₁ : Absolute Control	53.60	8.00	36.43	10.46	19.04	38.05
T ₂ : RDF (30:60:30 NPK kg ha ⁻¹)	58.94	8.83	40.50	11.53	21.34	39.89
T ₃ : RDF + FYM @ 5 t ha ⁻¹	60.85	9.07	42.60	12.01	23.76	40.92
T ₄ : RDF + FYM @ 5 t ha ⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha ⁻¹	63.72	9.33	44.77	12.71	27.29	42.70
T ₅ : RDF + FYM @ 5 t ha ⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha ⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS)	68.94	10.87	50.17	14.05	34.31	47.88
T ₆ : RDF + FYM @ 5 t ha ⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha ⁻¹ + Micronutrient Grade-2 complex @ 0.5% (foliar spray at 40 DAS)	66.93	10.17	46.80	13.49	30.09	43.20
T ₇ : RDF + FYM @ 5 t ha ⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha ⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS)	73.18	11.10	51.47	15.04	36.90	49.01
S.E. (m) ±	2.32	0.54	1.81	0.36	0.88	1.91
C.D. at 5%	6.96	1.60	5.33	1.11	2.67	5.62
General Mean	63.74	9.76	44.68	12.76	27.53	43.14

Yield attributes and yield

The various yield attributes and yield of soybean *viz.*, number of seeds plant⁻¹, weight of pod plant⁻¹ (g), weight of seeds plant⁻¹ (g) and seed yield (kg ha⁻¹) were influenced significantly due to different treatments (Table 2). The highest values of number of seeds plant⁻¹, weight of pod plant⁻¹ (g),

weight of seeds plant⁻¹ (g) and seed yield (kg ha⁻¹) were obtained with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS) which was at par with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ +

Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS) and found significantly superior over rest of the treatments. This might be due to sufficient amount micronutrient application along with RDF and FYM supported the plant growth and yield attributing characters resulting in higher seed yield and yield contributing characters of soybean. Present finding was in line with results obtained by Huger and Kurdikeri (2000) [6], Awlad *et al.* (2003) [3],

Bhosale and Pacharne (2017) [5] and Kumari *et al.* (2017) [7]. The maximum harvest index (41.80%) was obtained with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS) This might be due to higher seed yield in proportionate to biological yield. Present finding was in line with results obtained by Kumari *et al.* (2017) [7] and Bhosale and Pacharne (2017) [5].

Table 2: Effect of different treatments on yield attributing characters, yield and economics of soybean

Treatments	No. of seeds plant ⁻¹	Pod yield plant ⁻¹ (g)	Seed yield plant ⁻¹ (g)	Seed Yield (Kg ha ⁻¹)	Harvest index (%)	GMR (₹)	NMR (₹)	B:C ratio
T ₁ : Absolute Control	102.89	24.87	11.74	1571	32.14	62068	48137	2.10
T ₂ : RDF (30:60:30 NPK kg ha ⁻¹)	108.52	26.44	12.67	2048	35.19	80889	51628	2.18
T ₃ : RDF + FYM @ 5 t ha ⁻¹	113.23	28.68	13.44	2420	36.86	95603	53442	2.27
T ₄ : RDF + FYM @ 5 t ha ⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha ⁻¹	120.37	29.47	14.19	2625	38.31	103689	69063	2.35
T ₅ : RDF + FYM @ 5 t ha ⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha ⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS)	141.87	37.84	17.39	3116	41.60	123076	77765	2.70
T ₆ : RDF + FYM @ 5 t ha ⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha ⁻¹ + Micronutrient Grade-2 complex @ 0.5% (foliar spray at 40 DAS)	127.04	32.41	15.80	2899	40.60	114541	57228	2.47
T ₇ : RDF + FYM @ 5 t ha ⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha ⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS)	151.69	38.95	18.62	3255	41.80	128591	80980	2.72
S.E. (m) ±	5.52	1.45	0.52	119	-	3914	3914	-
C.D. at 5%	16.29	4.38	2.13	352	-	11906	11906	-
General Mean	123.66	30.95	14.84	2562	38.07	101208	59427	2.40

Economics

Gross monetary returns and net monetary returns of soybean were influenced significantly due to different treatments (Table 2). The maximum gross monetary returns and net monetary returns were recorded with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS), which was at par with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS) and found significantly superior over rest of the treatments. The application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS) recorded highest B:C ratio, followed by the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS). The results of the present investigation are in accordance with the findings of Bahure *et al.* (2016) [4], Bhosale and Pacharne (2017) [5] and Kumari *et al.* (2017) [7].

Conclusion

The results of the experiment revealed that the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS) (T₇) was proved to be effective for obtaining higher growth attributes, yield attributes and yield of soybean, closely followed by RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 DAS) (T₅). The highest economic returns *viz.*, mean gross return and net return and B:C ratio were found with the application of RDF + FYM @ 5 t ha⁻¹ + Micronutrient Grade-1 complex @ 25 kg ha⁻¹ + Micronutrient Grade-2 complex @ 0.25% (foliar spray at 20 and 40 DAS).

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