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Effect of secondary and micronutrients blends on chemical properties in soil of soybean

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ABSTRACT

The present investigation entitled "EFFECT OF SECONDARY AND MICRONUTRIENTS BLENDS ON CHEMICAL PROPERTIES IN SOIL OF SOYBEAN" was carried out at All India Coordinated Research Project on Weed Management, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif season of 2025-26. The field experiment was laid out in randomized block design with ten treatments and four replications. The treatments were comprised T_1 - 100% NPK (30:60:30) kg ha⁻¹; T_2 - 100% NPKS (30:60:30:20) kg ha⁻¹; T_3 - 100% NPKS + SMB @ 15 kg ha⁻¹; T_4 - 100% NPKS + SMB @ 20 kg ha⁻¹; T_5 - 100% NPKS + SMB @ 25 kg ha⁻¹; T_6 - 100% NPKS + Micronutrients + Mg (equivalent to T_3); T_7 - 100% NPKS + Micronutrients + Mg (equivalent to T_4); T_8 - 100% NPKS + Micronutrients + Mg (equivalent to T_5); T_9 - 100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹ and T_{10} - 100% NPKS + Micronutrients + Mg (equivalent to T_9). The soil chemical properties viz. pH, electrical conductivity (EC), organic carbon (OC) and calcium carbonate (CaCO₃) were estimated after harvest of soybean. The application of secondary and micronutrient blends did not significantly impact soil pH, EC, OC and CaCO₃. Numerical differences were observed among the treatments but they were statistically non-significant. The results showed that the use of secondary and micronutrient blends in one cropping season did not result in significant changes in the basic chemical properties of the soil under the experimental conditions.

Keywords: Soybean, Secondary nutrients, Micronutrients, Soil chemical properties, Nutrient management

1. Introduction

Soybean (*Glycine max* L.) is an important oilseed and protein rich leguminous crop which heavily depends on an adequate and well-balanced supply of plant nutrients for optimum yield (Tiwari *et al.*, 2000) [1]. The main components of fertilizer management are nitrogen, phosphorus and potassium. But, the requirement of secondary nutrients and micronutrients has become important for optimum growth and yield of the crop. Sulfur, magnesium, zinc, iron, manganese, copper, boron and molybdenum are involved in various physiological and biochemical functions related to chlorophyll synthesis, photosynthesis, enzyme activation, protein synthesis, reproductive growth and nutrient metabolism (Thapa *et al.*, 2021) [2].

Sulfur is an important element for soybeans because it participates in the synthesis of sulfur containing amino acids and proteins. Adequate sulfur nutrition may thus promote both vegetative growth and seed formation. Magnesium is also important as a nutrient because of its role in the chlorophyll molecule and in photosynthesis. Micronutrients are substances that organisms require in small quantities but are still essential for a variety of enzymatic and physiological functions. Zinc, iron and manganese are vital for chlorophyll production, electron transport and enzyme activities, while boron and molybdenum are crucial for reproductive growth and biological nitrogen fixation.

Many researchers have reported the importance of balanced nutrient management in the cultivation of soybean. Improved growth and yield of soybean due to application of micronutrients was reported by Nagaraja *et al.* (2010) [3]. Kobraee *et al.* (2011) [4] reported the effect of micronutrients like zinc, iron and manganese on the growth of soybean. Similarly, Chaturvedi *et al.* (2012) [5] reported increase in dry matter yield through application of combined nutrients and observed progress in dry matter accumulation and different growth attributes with application of boron and molybdenum.

Another factor that could influence the chlorophyll content of soybeans is the intake of micronutrients. Kobraee *et al.* (2013) [6] reported that application of zinc, iron and manganese affected chlorophyll at reproductive stage of soybean. Buu *et al.* (2013) [7] also reported similar improvement in chlorophyll related characteristics.

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acters after application of micronutrients. Such responses are particularly important as increased chlorophyll content can improve photosynthetic efficiency and hence biomass production.

Nutrition of sulfur has been related to increase in yield of soybean. Devi *et al.* (2012) [8] reported that the application of sulfur and boron had a positive effect on soybean yield attributes and total productivity. Recently Patel *et al.* (2012) [9] reported positive effects of sulfur sources like Fertis on the yield and quality of soybeans. They suggested that significant higher seed and stover yield could be due to increased availability of sulfur.

Although the importance of some secondary and micronutrients is well known, the response of soybean to the simultaneous application of these nutrients with the prescribed NPK can be variable depending on the source, dosage, and mixture of the nutrient. Therefore, the present investigation was undertaken to evaluate the effect of secondary and micronutrients combinations on growth and yield of soybean. The experiment was designed to study the effects of different levels of SMB, micronutrients i.e. magnesium and combination of Fertis, sulphur-zinc complex and SMB.

2. Materials and methods

The experiment was conducted during the *Kharif* season of 2025–26 at the AICRP Weed Management, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, under the Department of Soil Science. The experimental crop was soybean variety PDKV Amba. During the experimental period, the weekly significant higher temperature ranged from 29.0 to 35.3 °C, while the lowest temperature ranged from 21.7 to 25.0 °C. Bright sunshine hours varied from 0.6 to 7.0 hours day⁻¹ and wind speed ranged from 1.7 to 13.7 km hr⁻¹. Morning relative humidity ranged from 75 to 93 per cent, whereas evening relative humidity varied from 48 to 80 per cent. Weekly evaporation ranged from 1.5 to 8.7 mm. The total rainfall received from the 25 to 39 SMW was 744 mm, with 42 rainy days. These climatic conditions prevailed during the crop growth period of soybean in *Kharif* 2025.

The experimental field was deep black clay soil vertisols in texture and moderately alkaline in reaction. The initial soil had a pH of 7.84, electrical conductivity of 0.24 dS m⁻¹, organic carbon of 5.26 g kg⁻¹, available nitrogen of 183 kg ha⁻¹, available phosphorus of 18.48 kg ha⁻¹ and available potassium of 379 kg ha⁻¹. The experiment consisted of 10 treatments replicated four times in a randomized block design. Soybean was sown by drilling method with a spacing of 45 × 05 cm and a seed rate of 65 kg ha⁻¹. The recommended fertilizer dose was 30:60:30:20 kg ha⁻¹ N:P₂O₅:K₂O:S.

Treatment details

T₁ 100% NPK (30:60:30 kg ha⁻¹)

T₂ 100% NPKS (30:60:30:20 kg ha⁻¹)

T₃ 100% NPKS + Secondary and Micronutrients Blend (SMB) @ 15 kg ha⁻¹

T₄ 100% NPKS + Secondary and Micronutrients Blend (SMB) @ 20 kg ha⁻¹

T₅ 100% NPKS + Secondary and Micronutrients Blend (SMB) @ 25 kg ha⁻¹

T₆ 100% NPKS + micronutrients + Mg (equivalent to T₃)

T₇ 100% NPKS + micronutrients + Mg (equivalent to T₄)

T₈ 100% NPKS + micronutrients + Mg (equivalent to T₅)

T₉ 100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹

T₁₀ 100% NPKS + micronutrients + Mg (equivalent to T₉)

2.1 Soil chemical analysis

Soil samples were analysed for the soil chemical analysis as soil pH, EC, OC, CaCO₃.

2.1.1 Soil pH

The soil pH was measured in a soil suspension (1:2.5 soil:water) using a glass electrode pH meter after allowing the soil to equilibrate with water for 30 minutes while occasionally stirring (Jackson, 1973) [10].

2.1.2 Electrical conductivity

The electrical conductivity was determined in a soil suspension (1:2.5 soil: water) after equilibrating the soil with water and keeping the sample undisturbed until the supernatant was obtained. The conductivity was measured using a conductivity meter (Jackson, 1973) [10].

2.1.3 Organic carbon (OC)

The organic carbon content of the was determined by the wet oxidation method (Walkley *et al.*, 1934) [11].

2.1.4 Calcium carbonate

Rapid titration method as described by Piper (1966) [12] was used to determine calcium carbonate content of soil

2.2 Observations and statistical analysis

Observations on growth parameters and yield were recorded at appropriate growth stages using standard experimental procedures. The data were analysed using analysis of variance appropriate for a randomised block design, as described by Gomez *et al.* (1984) [13]. The significance of treatment effects was tested using the *F*-test, and critical difference (CD) values at the 5% probability level (*P* = 0.05) were calculated for comparisons among treatment means wherever significant differences were observed.

3. Results and discussion

Table 1. Effect of Secondary and Micronutrients Blends on soil chemical properties (pH, EC, OC and CaCO₃) after harvest of soybean

Treatments		pH (1:2.5)	EC (dS m ⁻¹)	OC (g kg ⁻¹)	CaCO ₃ (%)
T1	100% NPK (30:60:30) Kg ha ⁻¹	7.79	0.24	5.26	6.95
T2	100% NPKS(30:60:30:20) Kg ha ⁻¹	7.76	0.24	5.27	6.90
T3	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 15 Kg ha ⁻¹	7.74	0.23	5.38	6.80
T4	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 20 Kg ha ⁻¹	7.71	0.22	5.49	6.70
T5	100% NPKS+ Secondary and Micronutrients Blend (SMB) @ 25 Kg ha ⁻¹	7.70	0.22	3.76	6.62
T6	100% NPKS + Micronutrients +Mg (equivalent to T ₃)	7.75	0.23	5.55	6.84

(continued on next page)

Treatments		pH (1:2.5)	EC (dS m ⁻¹)	OC (g kg ⁻¹)	CaCO ₃ (%)
T7	100% NPKS + Micronutrients + Mg (equivalent to T ₄)	7.73	0.22	5.45	6.75
T8	100% NPKS + Micronutrients + Mg (equivalent to T ₅)	7.69	0.22	5.50	6.68
T9	100% NPK + fertis @ 4.66 Kg ha ⁻¹ + SZC @ 12 Kg ha ⁻¹ + SMB @ 25 Kg ha ⁻¹	7.66	0.21	5.67	6.56
T10	100% NPKS + Micronutrients + Mg (equivalent to T ₉)	7.67	0.21	5.60	6.59
SE (m) ±		0.07	0.01	0.27	0.37
C.D. at 5%		NS	NS	NS	NS

The data pertaining to soil chemical properties, viz., pH, electrical conductivity (EC), organic carbon (OC) and calcium carbonate (CaCO₃), as influenced by different treatments after harvest of soybean, are presented in Table 1.

3.1 Soil pH

The soil pH values ranged from 7.66 to 7.79 and the variation among the treatments was statistically non-significant. The highest pH was recorded in T₁ (7.79), whereas the lowest value was observed in T₁₀ (7.66). The slight reduction in soil pH under sulfur-containing nutrient treatments may be attributed to the oxidation of sulfur and the consequent release of acidity. However, the magnitude of change was small and statistically non-significant, indicating that the treatments did not cause any appreciable alteration in soil reaction during the experimental period. Similar findings were reported by Dheri *et al.* (2021) [14] and Reis *et al.* (2021) [15].

3.2 Electrical conductivity (dS m⁻¹)

Electrical conductivity is an important parameter indicating the concentration of soluble salts in the soil and provides an indication of the soluble nutrient environment. The soil EC values ranged from 0.21 to 0.24 dS m⁻¹, with the variation among treatments being statistically non-significant. The highest EC was recorded in T₁ and T₂ (0.24 dS m⁻¹), whereas the lowest EC was recorded in T₉ and T₁₀ (0.21 dS m⁻¹).

A slight numerical decrease in soil EC was observed in T₉ and T₁₀, which may be associated with nutrient uptake by soybean and alterations in the concentration of soluble ions in the soil. Nevertheless, the magnitude of variation was small and statistically non-significant, suggesting that the application of secondary and micronutrients did not exert any appreciable influence on soil EC during the experimental period. Similar observations were reported by Dheri *et al.* (2021) [14] and Reis *et al.* (2021) [15].

3.3 Organic carbon (g kg⁻¹)

The soil organic carbon content ranged from 5.26 to 5.67 g kg⁻¹, and the variation among the treatments was statistically non-significant. The highest organic carbon content was recorded in T₉ (5.67 g kg⁻¹), while the lowest value was observed in T₁₀ (5.26 g kg⁻¹). However, the differences among the treatments were statistically non-significant, indicating that the application of the treatments did not cause any appreciable change in soil organic carbon during the experimental period. Similar findings were reported by Reis *et al.* (2021) [15].

3.4 Calcium carbonate (%)

The calcium carbonate content of the soil after harvest ranged from 6.56 to 6.95 per cent, and the variation among the treatments was statistically non-significant. The highest CaCO₃ content was recorded in T₁ (100% NPK), with a value of 6.95 per cent. The lowest CaCO₃ content was recorded in T₉ (6.56%), followed by T₁₀ (6.59%). The slight numerical reduction in CaCO₃ content under sulfur-containing treatments, particularly T₉ and T₁₀, may be attributed to sulfur

oxidation and its associated acidifying effect, which may facilitate the dissolution of calcium carbonate. However, the differences were statistically non-significant, indicating that the application of secondary and micronutrients during a single season was insufficient to bring about a significant change in soil CaCO₃ content. Therefore, the observed reduction should be considered only as a numerical trend.

Similar observations were reported by Abdelhamid *et al.* (2013) [16], who observed that sulfur application improved soil chemical properties by reducing CaCO₃ under saline calcareous conditions. Wang *et al.* (2022) [17] also reported that changes in soil carbonate content and associated chemical properties generally occur gradually and become more pronounced under long-term nutrient management.

4. Conclusion

The study indicated that application of secondary and micronutrient blends had no significant effect on soil pH, electrical conductivity, organic carbon and calcium carbonate after harvest of soybean. Soil pH was observed to be in the range of 7.66-7.79 with the highest value in T₁ (7.79) and the lowest value in T₉ (7.66). Electrical conductivity was between 0.21 and 0.24 dS m⁻¹, with maximum values in T₁ and T₂ (0.24 dS m⁻¹) and minimum values in T₉ and T₁₀ (0.21 dS m⁻¹). The organic carbon content ranged from 3.76 to 5.67 g kg⁻¹, the highest value was recorded in T₉ (5.67 g kg⁻¹) and the lowest value in T₅ (3.76 g kg⁻¹). The calcium carbonate content ranged from 6.56 to 6.95 per cent, with the highest value in T₁ (6.95%) and the lowest in T₉ (6.56%). However, the differences were not statistically significant, although there were numerical variations among the treatments. Thus, the application of secondary and micronutrient blends in one cropping season had non-significant effect on these soil chemical properties.

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