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EFFECT OF SECONDARY AND MICRONUTRIENTS BLENDS ON GROWTH AND YIELD BY SOYBEAN (*Glycine max* L.)

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ABSTRACT

The present investigation 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 T₁ - 100% NPK (30:60:30) kg ha⁻¹; T₂ - 100% NPKS (30:60:30:20) kg ha⁻¹; T₃ - 100% NPKS + SMB @ 15 kg ha⁻¹; T₄ - 100% NPKS + SMB @ 20 kg ha⁻¹; T₅ - 100% NPKS + 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 and T₁₀ - 100% NPKS + Micronutrients + Mg (equivalent to T₉). Application of 100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹ was significant at par with 100% NPKS + Micronutrients + Mg (equivalent to T₉). The lowest days to first flowering and days to 50% of flowering was observed also with T₉ (100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹). These findings conclude that soil application of 100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹ increased the growth and yield under the conditions of this experiment.

Key words: growth, yield, SMB, secondary, Micronutrients

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 and Karmakar, 2000). 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

Sushil *et al.*, 2021)

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 and Mohankumar (2010). Kobraee *et al.*, (2011) reported the effect of micronutrients like zinc, iron and manganese on the growth of soybean. Similarly, Chaturvedi *et al.* (2012) reported increase in dry matter yield thru 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) reported that application of zinc, iron and manganese affected chlorophyll at reproductive stage of soybean. Buu *et al.*, (2013) also reported similar improvement in chlorophyll related characters 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) reported that the application of sulfur and boron had a positive effect on soybean yield attributes and total productivity. Recently Patel *et al.*, (2012) 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.

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 (vertisol) 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)

Observations recorded and Method Adopted

Plant height (cm):

The plant height at 30, 60 and 90 DAS was measured from the base to the terminal leaf of tagged five plants which were selected randomly in each net plot, the mean values were expressed in cm.

Chlorophyll (SPAD values):

A Minolta chlorophyll meter (Model SPAD 502, Minolta Co., Japan) was used to measure SPAD values. Observations were recorded at the third leaf from the

top (Centre position avoiding the midrib). Measurements were taken between 9:00-11:00 AM to minimize diurnal variation. The same leaf and their position, growth stage was maintained for all treatments. Measurements were taken from five tagged plants at 30 and 60 DAS and the mean value was calculated.

Leaf area plant⁻¹ (cm²):

Leaf area was determined at 30 and 60 days after sowing (DAS). Five representative plants were randomly selected from each experimental plot at each observation stage. The leaves from the sampled plants were collected and their total leaf area was measured in laboratory using a leaf area meter.

Dry matter accumulation plant⁻¹ (g):

Five plants from each treatment plot were carefully uprooted and washed to remove any adhered soil. The samples were then shade-dried for 2-3 days before being oven-dried at 65°C until a constant dry weight was achieved. The final dry weight of the samples was recorded and expressed in grams per plant. Dry matter accumulation was recorded at 30, 60 and 90 DAS.

Days to first flowering and 50% of flowering (DAS):

The days to first flowering and 50% of flowering were recorded from date of sowing to the appearance of the first flower and flowering in approximately 50% of the plants, respectively, in each plot across all treatments and replications.

Grain and straw yield (kg ha⁻¹):

The harvested produce from each plot was separately bundled, sun dried and weighed using a spring balance to record biological yield. After threshing and cleaning, grain yield was recorded from each net plot, while straw yield was calculated by subtracting grain yield from the corresponding biological yield of the respective plot.

$$\text{Grain (or) Straw yield (kg ha}^{-1}\text{)} = \frac{\text{Grain (or) Straw yield per plot kg}}{\text{Net plot area (m}^2\text{)}} \times 10,000$$

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 and Gomez (1984). 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.

Results and Discussion

Plant height

The data pertaining to plant height as influenced by different treatments at various growth stages are presented in Table 1

The non-significant plant height at 30 DAS ranged from 28.65 to 32.20 cm. The higher plant height was recorded in T₁₀ (100% NPKS + micro nutrients + Mg similar to T₉) with 32.20 cm. The lowest plant height was found in T₁ (100% NPK) with 28.65 cm.

The effect of the nutrient applications was more pronounced in 60 and 90 DAS. At 60 DAS of plant height was significant higher in T₉ (68.16cm) statistically at par with T₁₀ (67.90cm) whereas lowest height was found in T₁ (65.27cm). At 90 DAS significant higher plant height was observed in T₉ (70.22 cm) statistically at par with T₁₀ (69.77 cm) and lowest plant height was observed in T₁ (67.63 cm).

The increased plant height in T₉ and T₁₀ may be due to the balanced distribution of primary, secondary and micronutrients which probably promoted cell division, cell

Table 1: Effect of Secondary and Micronutrients Blends on Plant height of soybean (cm).

Treatments		Plant height (cm)		
		30 DAS	60 DAS	90 DAS
T ₁	100% NPK (30:60:30) Kg ha ⁻¹	28.65	65.27	67.63
T ₂	100% NPKS (30:60:30:20) Kg ha ⁻¹	29.83	65.45	67.84
T ₃	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 15 Kg ha ⁻¹	28.74	65.86	68.48
T ₄	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 20 Kg ha ⁻¹	29.05	66.27	68.82
T ₅	100% NPKS+ Secondary and Micronutrients Blend (SMB) @ 25 Kg ha ⁻¹	29.60	66.60	69.22
T ₆	100% NPKS + Micronutrients +Mg (equivalent to T ₃)	30.21	65.65	68.29
T ₇	100% NPKS + Micronutrients + Mg (equivalent to T ₄)	30.89	66.08	68.55
T ₈	100% NPKS + Micronutrients + Mg (equivalent to T ₅)	31.18	66.48	69.04
T ₉	100% NPK + fertis @ 4.66 Kg ha ⁻¹ + SZC @ 12.0 Kg ha ⁻¹ + SMB @ 25 Kg ha ⁻¹	31.51	68.16	70.22
T ₁₀	100% NPKS + Micronutrients + Mg (equivalent to T ₉)	32.20	67.90	69.77
SE (m) ±		0.37	0.30	0.26
C.D. at 5%		NS	0.89	0.76

elongation, chlorophyll synthesis and photosynthetic processes. The combination of sulfur, magnesium and micro-nutrients may have provided a favorable nutritional environment during the vigorous vegetative phase. Similar improvement in soybean growth by use of micro nutrients was also reported by Nagaraja and Mohankumar (2010) and Kobraee *et al.*, (2011).

Dry matter accumulation

The data pertaining to dry matter accumulation as influenced by different treatments at various growth stages are presented in Table 2.

Dry matter accumulation is non-significant effect at 30 DAS ranged from 6.20 to 8.53 g plant⁻¹. Significant higher was observed in T₁₀ (100% NPKS + micronutrients + Mg equivalent to T₉) (8.53 g plant⁻¹). The lowest value was found in T₁ which was 6.20 g plant⁻¹.

At 60 and 90 DAS there was a clear response of dry matter accumulation to enrichment with nutrients. At 60 DAS significant higher dry matter accumulation was observed in treatment T₉ (100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB at 25 kg ha⁻¹) with

Table 2: Effect of Secondary and Micronutrients Blends on Dry matter of soybean (g plant⁻¹).

Treatments		Dry matter (g plant ⁻¹)		
		30 DAS	60 DAS	90 DAS
T ₁	100% NPK (30:60:30) Kg ha ⁻¹	6.20	19.50	22.78
T ₂	100% NPKS (30:60:30:20) Kg ha ⁻¹	7.02	20.05	23.18
T ₃	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 15 Kg ha ⁻¹	6.44	20.60	24.25
T ₄	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 20 Kg ha ⁻¹	6.61	22.03	24.85
T ₅	100% NPKS+ Secondary and Micronutrients Blend (SMB) @ 25 Kg ha ⁻¹	6.87	22.86	25.52
T ₆	100% NPKS + Micronutrients +Mg (equivalent to T ₃)	7.33	20.39	23.54
T ₇	100% NPKS + Micronutrients + Mg (equivalent to T ₄)	7.51	21.81	24.69
T ₈	100% NPKS + Micronutrients + Mg (equivalent to T ₅)	7.79	22.47	25.04
T ₉	100% NPK + fertis @ 4.66 Kg ha ⁻¹ + SZC @ 12.0 Kg ha ⁻¹ + SMB @ 25 Kg ha ⁻¹	8.12	23.87	26.00
T ₁₀	100% NPKS + Micronutrients + Mg (equivalent to T ₉)	8.53	23.48	25.77
	SE (m) ±	0.31	0.23	0.18
	C.D. at 5%	NS	0.67	0.45

Table 3: Effect of Secondary and Micronutrients Blends on Chlorophyll (SPAD Values) of soybean.

Treatments		Chlorophyll (SPAD Values)	
		30DAS	60DAS
T ₁	100% NPK (30:60:30) Kg ha ⁻¹	35.20	44.71
T ₂	100% NPKS (30:60:30:20) Kg ha ⁻¹	36.52	44.77
T ₃	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 15 Kg ha ⁻¹	35.66	45.35
T ₄	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 20 Kg ha ⁻¹	36.03	45.95
T ₅	100% NPKS+ Secondary and Micronutrients Blend (SMB) @ 25 Kg ha ⁻¹	36.37	46.31
T ₆	100% NPKS + Micronutrients +Mg (equivalent to T ₃)	36.87	45.10
T ₇	100% NPKS + Micronutrients + Mg (equivalent to T ₄)	37.04	45.83
T ₈	100% NPKS + Micronutrients + Mg (equivalent to T ₅)	37.38	46.14
T ₉	100% NPK + fertis @ 4.66 Kg ha ⁻¹ + SZC @ 12.0 Kg ha ⁻¹ + SMB @ 25 Kg ha ⁻¹	37.78	47.24
T ₁₀	100% NPKS + Micronutrients + Mg (equivalent to T ₉)	38.27	46.52
	SE (m) ±	0.43	0.31
	C.D. at 5%	NS	0.92

23.87 g plant⁻¹ statistically at par with T₁₀ 23.48 g plant⁻¹ while T₁ showed lowest value of 19.50 g plant⁻¹. At 90 DAS significant higher dry matter accumulation was 26 g plant⁻¹ in T₉ and statistically at par with 25.77 g plant⁻¹ in T₁₀ at 90 DAS. The lowest was 22.78 g plant⁻¹ in T₁.

The significant higher dry matter accumulation under nutrient-enriched treatments may be attributed to the balanced supply of NPK along with sulfur, magnesium and micronutrients, which promoted nutrient uptake, chlorophyll formation, photosynthetic activity and assimilate production. Improved root growth and physiological activity may have further contributed to greater biomass accumulation during the active growth stages. Similar findings were reported by Chaturvedi *et al.*, (2012), reported that appropriate sulfur nutrition enhanced dry matter accumulation in soybean.

Chlorophyll (SPAD values)

The data pertaining to Chlorophyll (SPAD Values) as influenced by different treatments at various growth stages are presented in Table 3.

The non-significant SPAD values varied from 35.20

Table 4: Effect of Secondary and Micronutrients Blends on Leaf area ($\text{cm}^2 \text{plant}^{-1}$) of soybean.

Treatments		Leaf area ($\text{cm}^2 \text{plant}^{-1}$)	
		30DAS	60DAS
T ₁	100% NPK (30:60:30) Kg ha ⁻¹	296.4	728.8
T ₂	100% NPKS (30:60:30:20) Kg ha ⁻¹	306.6	730.5
T ₃	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 15 Kg ha ⁻¹	298.8	733.3
T ₄	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 20 Kg ha ⁻¹	300.8	738.3
T ₅	100% NPKS+ Secondary and Micronutrients Blend (SMB) @ 25 Kg ha ⁻¹	302.9	741.6
T ₆	100% NPKS + Micronutrients +Mg (equivalent to T ₃)	308.6	732.8
T ₇	100% NPKS + Micronutrients + Mg (equivalent to T ₄)	311.2	736.9
T ₈	100% NPKS + Micronutrients + Mg (equivalent to T ₅)	313.4	740.5
T ₉	100% NPK + fertis @ 4.66 Kg ha ⁻¹ + SZC @ 12.0 Kg ha ⁻¹ + SMB @ 25 Kg ha ⁻¹	315.1	743.7
T ₁₀	100% NPKS + Micronutrients + Mg (equivalent to T ₉)	317.0	742.8
	SE (m) ±	0.35	0.36
	C.D. at 5%	NS	1.06

to 38.27 at 30 DAS. The higher SPAD value was obtained in T₁₀ (100% NPKS Z+ micronutrients plus Mg equivalent to T₉) with 38.27, while T₁ showed the lowest value of 35.20. In this first phase of growth there were no statistically significant differences between treatments.

At 60 DAS significant higher SPAD value was recorded in T₉ (100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹) (47.24) statistically at par with T₁₀ (46.52) while T₁ recorded lowest (44.71).

The significant higher SPAD values in T₉ and T₁₀ might be due to the balanced distribution of nutrients needed for chlorophyll synthesis and photosynthetic activities. Magnesium is an important component of chlorophyll and iron, manganese, zinc and copper are involved in chlorophyll synthesis, electron transport and enzymatic processes. The present findings are in line with Kobrae *et al.*, (2015) who reported that zinc, iron and manganese fertilization influenced the chlorophyll of soybean. Improvements in chlorophyll related traits after application of micronutrients were also reported by Buu *et al.*, (2013).

Table 5: Effect of Secondary and Micronutrients Blends on flowering of soybean.

Treatments		Flowering (DAS)	
		First flowering	50 % flowering
T ₁	100% NPK (30:60:30) Kg ha ⁻¹	42.50	49.00
T ₂	100% NPKS (30:60:30:20) Kg ha ⁻¹	42.00	48.25
T ₃	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 15 Kg ha ⁻¹	40.25	48.50
T ₄	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 20 Kg ha ⁻¹	38.75	46.75
T ₅	100% NPKS+ Secondary and Micronutrients Blend (SMB) @ 25 Kg ha ⁻¹	36.75	44.25
T ₆	100% NPKS + Micronutrients +Mg (equivalent to T ₃)	40.50	48.00
T ₇	100% NPKS + Micronutrients + Mg (equivalent to T ₄)	39.75	47.50
T ₈	100% NPKS + Micronutrients + Mg (equivalent to T ₅)	37.50	46.25
T ₉	100% NPK + fertis @ 4.66 Kg ha ⁻¹ + SZC @ 12.0 Kg ha ⁻¹ + SMB @ 25 Kg ha ⁻¹	32.25	40.55
T ₁₀	100% NPKS + Micronutrients + Mg (equivalent to T ₉)	35.50	42.55
	SE (m) ±	0.59	0.58
	C.D. at 5%	1.36	1.37

Leaf area

The data presented in Table 4 reported that the leaf area of soybean was non significant affected at 30 DAS. The treatments showed a effect at 60 DAS. The leaf area at 30 DAS varied from 296.4 to 317.0 $\text{cm}^2 \text{plant}^{-1}$. The higher leaf area was obtained under T₁₀ (317.0 $\text{cm}^2 \text{plant}^{-1}$). While the lowest leaf area was observed under T₁ (296.4 $\text{cm}^2 \text{plant}^{-1}$).

The application of secondary and micronutrient blends had significant influence on leaf area of soybean at 60 DAS. The leaf area significant higher of 743.7 $\text{cm}^2 \text{plant}^{-1}$ was recorded under T₉ [100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12 kg ha⁻¹ + SMB @ 25 kg ha⁻¹] which was statistically at par with T₁₀ (100% NPKS + Micronutrients + Mg (equivalent to T₉)) is (742.8 $\text{cm}^2 \text{plant}^{-1}$). The lower leaf area of 728.8 $\text{cm}^2 \text{plant}^{-1}$ was recorded under T₁ (100% NPK).

Similarly, findings were corroborated by Singh *et al.* (2016), Pal *et al.*, (2019) and Ajannavar *et al.*, (2021), they reported that improved chlorophyll content with different combinations of secondary and micronutrients with RDF and other nutrient sources.

Table 6: Effect of Secondary and Micronutrients Blends on Seed and Stover yield of soybean (q ha⁻¹).

Treatments		Seed yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)
T ₁	100% NPK (30:60:30) Kg ha ⁻¹	22.78	30.48
T ₂	100% NPKS (30:60:30:20) Kg ha ⁻¹	23.21	30.65
T ₃	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 15 Kg ha ⁻¹	23.41	31.39
T ₄	100% NPKS + Secondary and Micronutrients Blend (SMB) @ 20 Kg ha ⁻¹	23.66	31.81
T ₅	100% NPKS+ Secondary and Micronutrients Blend (SMB) @ 25 Kg ha ⁻¹	23.84	32.03
T ₆	100% NPKS + Micronutrients +Mg (equivalent to T ₃)	23.32	31.20
T ₇	100% NPKS + Micronutrients + Mg (equivalent to T ₄)	23.51	31.62
T ₈	100% NPKS + Micronutrients + Mg (equivalent to T ₅)	23.77	31.98
T ₉	100% NPK + fertis @ 4.66 Kg ha ⁻¹ + SZC @ 12.0 Kg ha ⁻¹ + SMB @ 25 Kg ha ⁻¹	24.38	32.90
T ₁₀	100% NPKS + Micronutrients + Mg (equivalent to T ₉)	24.22	32.52
SE (m) ±		0.10	0.24
C.D. at 5%		0.30	0.71

Flowering

The data pertaining to flowering as influenced by different treatments at various growth stages are presented in Table 5

The results showed that flowering between 32.25 and 42.50 DAS. The first flowering was observed in T₉ (100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹) 32.25 DAS whereas T₁ recorded the most delayed initial a flowering (42.50 DAS).

Similarly, Days to 50 percent flowering ranged from 40.55 to 49.00 DAS (DAS). T₉ recorded earliest 50 percent flowering at 40.55 DAS whereas late 50 percent flowering observed in T₁.

The early flowering of T₉ and T₁₀ was attributed to better availability of nutrients and more efficient physiological processes due to integrated provision of primary, secondary and trace nutrients. Sulfur, boron and zinc are important for reproductive development and may have had a role in the earlier transition from vegetative to reproductive growth. Devi *et al.*, (2012) found that sulfur and boron application had positive effects on

soybean yield and Vaseghi *et al.*, (2013) found that boron nutrition had positive effects on reproductive success of soybean.

Seed and Stover yield

The data pertaining to seed and stover yield of soybean as influenced by different treatments are presented in Table 6.

Seed yield:

The seed yield significant higher was recorded as 24.38 q ha⁻¹ in T₉ (100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹) which was statistically on par with T₁₀ (100% NPKS + micronutrients + Mg equivalent to T₉) with 24.22 q ha⁻¹, while the lowest value was recorded in T₁ 22.78 q ha⁻¹.

The increased seed yield in T₉ and T₁₀ is due to the balanced supply of primary, secondary and micronutrients which resulted in better vegetative growth, chlorophyll function, flowering and translocation of assimilates to the maturing seeds. Sulfur participates in the synthesis of proteins and in enzymatic activity. Micronutrients, such as zinc, iron, manganese, boron, copper and molybdenum, participate in several metabolic and reproductive activities stated positive effects of sulfur sources such as Fertis on soybean yield and Chaturvedi *et al.*, (2012) reported improvements in soybean yield parameters following application of micronutrients.

Stover yield:

The stover yield significant higher was obtained in T₉ (100% NPK + Fertis 4.66 kg ha⁻¹ + SZC 25 kg ha⁻¹ + SMB 25 kg ha⁻¹) with 32.90 q ha⁻¹ statistically at par with T₁₀ (100% NPKS + micronutrients + Mg is equivalent to T₉) 32.52 q ha⁻¹ whereas lowest stover yield was recorded by T₁ (30.48 q ha⁻¹).

The increased stover yield in T₉ and T₁₀ might be associated with better vegetative development, chlorophyll activity and dry matter accumulation as a consequence of optimum nutrient supply. The present data are in

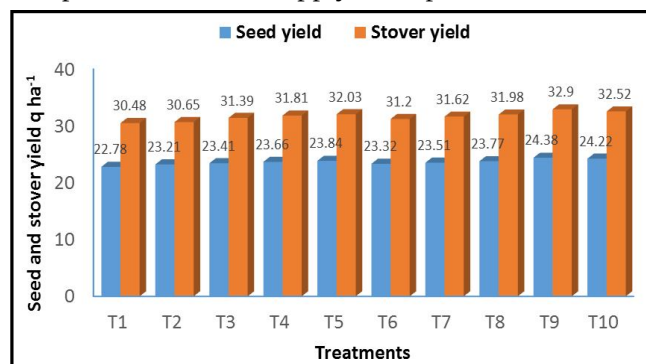


Fig. 1: Soybean Yield Response to Effect of Secondary and Micronutrient Blends of soybean.

agreement with the results of Dheri *et al.*, (2021) who reported positive soybean yield response to S application. Patel *et al.*, (2023) reported the improvements in soybean seed and stover production by using efficient sulfur sources.

Conclusion

The study demonstrated that the application of 100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹ produced significant higher growth and yield response in soybean. This treatment recorded a seed yield of 24.38 q ha⁻¹ and a stover yield of 32.90 q ha⁻¹. Its performance was significant comparable with application of 100% NPKS + Micronutrients + Mg (equivalent to T₉), which produced 24.22 q ha⁻¹ seed yield and 32.52 q ha⁻¹ stover yield. The treatment 100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹ is significant higher plant height, chlorophyll (SPAD value), leaf area plant⁻¹ and dry matter accumulation plant⁻¹. Earliness to days to first flowering and 50% flowering were also noticed with application of 100% NPK + Fertis @ 4.66 kg ha⁻¹ + SZC @ 12.0 kg ha⁻¹ + SMB @ 25 kg ha⁻¹.

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