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Yield, quality and nutrient uptake of soybean as influenced by water soluble fertilizer, micro-nutrient and plant growth regulators

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Abstract

Yield, quality and nutrient uptake of soybean as influenced by foliar sprays of water soluble fertilizers, plant growth regulators and micronutrients was assessed by conducting the field experiment during *kharif*, 2012 at PGI Research Farm. The experiment was laid out in randomized block design with three replications. The treatment consist of foliar sprays of 19:19:19 N, P₂O₅ and K₂O (0.5%), ZnSO₄ (0.5%), H₃BO₃ (0.5%) and NAA (50 µg mL⁻¹) alone and incombination with each other. Recommended dose of fertilizer (50:75:0 kg ha⁻¹ N and P₂O₅ + 5 t ha⁻¹ FYM) was applied to all the treatments.

Foliar sprays of 19:19:19 (0.5%) + ZnSO₄ (0.5%) + H₃BO₃ (0.5%) at 30 and 40 DAS was recorded higher grain and straw yield (22.70 and 21.00 q ha⁻¹). It was at par with 19:19:19 (0.5%) + ZnSO₄ (0.5%), 19:19:19 (0.5%) + H₃BO₃ (0.5%) and ZnSO₄ (0.5%) + H₃BO₃ (0.5%) + NAA (50 µg mL⁻¹) at 30 and 40 DAS for grain yield (22.00, 21.75, 22.30 and 21.50 q ha⁻¹, respectively).

Total uptake of macro and micronutrients, protein and oil content was higher in soybean by foliar sprays of 19:19:19 (0.5%) + H₃BO₃ (0.5%) + ZnSO₄ (0.5%) at 30 and 40 DAS.

Keywords: Yield, nutrient uptake, zinc, boron and NAA

1. Introduction

Soybean is one of the important oil seed grown in the temperate and tropical climate. The crop being pulse and oil seed plays three dimensional role as pulse, oilseed and legume. In Maharashtra, it was grown on 3.07 million ha area with production of 4.30 million tonnes and productivity 1076 kg ha⁻¹ (Anonymous, 2012) [1]. The soils of Maharashtra are deficient in zinc, low in nitrogen and medium in phosphorus and potassium (Patil, 2001) [4]. However, soil application of high analysis fertilizers are costly affairs to the farmers. To overcome this constrains, the present investigation was planned to fulfill the nutrient requirement of soybean through foliar application for harvesting potential yield and reduced the cost of fertilizer.

Material and Methods

The field experiment on effect of foliar sprays of water soluble fertilizers, growth regulator and micronutrients on growth, yield and quality of soybean cv. JS-335 sowing on 21.07.2012 was conducted at Post Graduate Institute, MPKV, Rahuri during *Kharif* season 2012. The treatments consist of foliar sprays of T₁ – foliar sprays of 19:19:19 (0.5%) at 30 and 40 DAS, T₂ – foliar sprays of ZnSO₄ (0.5%) at 30 and 40 DAS, T₃ – foliar sprays of NAA (50 ppm) at 30 and 40 DAS, T₄ – foliar spray of H₃BO₃ (0.5%) at 30 and 40 DAS, T₅ – foliar sprays of 19:19:19 (0.5%) + ZnSO₄ (0.5%) at 30 and 40 DAS, T₆ – foliar sprays of 19:19:19 (0.5%) + H₃BO₃ (0.5%) at 30 and 40 DAS, T₇ – foliar sprays of 19:19:19 (0.5%) + NAA (0.5%) at 30 and 40 DAS, T₈ – foliar sprays of 19:19:19 (0.5%) + H₃BO₃ (0.5%) + ZnSO₄ (0.5%) at 30 and 40 DAS, T₉ – foliar sprays of ZnSO₄ (0.5%) + H₃BO₃ (0.5%) + NAA (50 ppm) at 30 and 40 DAS and T₁₀ - only GRDF (50:75:00 kg ha⁻¹ N, P₂O₅ and K₂O). These treatments were replicated thrice in randomized block design. All the sprays was given at 30 and 40 DAS. The experimental soil was clayey with medium in soil available nitrogen, phosphorus and high in potassium. The DTPA-Zn and hot water soluble boron was deficient in soil (0.452 and 0.430 µg g⁻¹). The initial and harvest soil samples were analysed for soil available nutrients and plant samples for their nutrient concentration at harvest. The standard analytical methods Alkaline KMnO₄, 0.5 M NaHCO₃, NNNH₄OAc, atomic absorption spectrophotometer, 0.01 M CaCl₂, N analyzer, Vanadomolybdate-yellow colour method in nitric acid system, flame photometer, atomic absorption spectrophotometer and Azomethine-H colorimetric method were followed for estimation of nutrients from soil and plants.

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Results

Yield

The grain, straw, biological yield and harvest index of soybean was significantly influenced by spray treatments of water soluble fertilizers micronutrients and plant growth regulators (Table 1). The spraying of 19:19:19 (0.5%) + ZnSO₄ (0.5%), 19:19:19 (0.5%) + NAA (50 ppm) and 19:19:19 (0.5%) + H₃BO₃ (0.5%) + ZnSO₄ (0.5%) at 30 and 40 DAS were statistically at par with each other for grain yield of soybean (22.0, 22.3 and 22.7 q ha⁻¹, respectively). This might be because of spraying of 19:19:19, ZnSO₄ and H₃PO₄ provides balance nutrition to soybean, zinc act as reducing agent in plant metabolic activities as well as co-enzyme. The boron accelerated the protein synthesis and translocation of sugar from source to sink by formation of sugar borate. Similarly, boron improves the pollen viability which may reflected in higher grain yield of soybean. These results are conformity with Dixit and Elamathi (2007) [3] and Tate (2010) [5].

The highest straw yield was noticed in treatment 19:19:19 (0.5%) + H₃BO₃ (0.5%) + ZnSO₄ (0.5%) at 30 and 40 DAS (21.0 q ha⁻¹). Similar trend was observed biological yield and harvest index.

Quality

The protein and oil content of soybean was not significantly influenced by foliar application of 19:19:19, boric acid and zinc sulphate. However, numerically it was higher in 19:19:19 (0.5%) + H₃BO₃ (0.5%) + ZnSO₄ (0.5%) spray to soybean at 30 and 40 DAS (38.54 and 19.14%). Similar trend was observed for protein and oil yield. Similar observations were also reported by Dhakane (2005) [2] and Vahedi (2012) [6].

Nutrient uptake

Total uptake of nitrogen, phosphorus, potassium, zinc and boron were significantly influenced by foliar application (Table 1). The highest uptake of nitrogen, phosphorus and potassium was observed in 19:19:19 (0.5%) + H₃BO₃ (0.5%) + ZnSO₄ (0.5%) at 30 and 40 DAS (188.50, 27.06 and 145.46 kg ha⁻¹, respectively). Similar treatment recorded the highest zinc and boron uptake (70.13 and 60.18 g ha⁻¹). This might be because of boron sprays improves the protein synthesis, photosynthesis by translocating the photosynthate from source to sink. It was reflected in enhancing the growth and nutrient uptake.

Table 1: Effect of foliar sprays of water soluble fertilizers, micronutrients and plant growth regulators on yield and nutrient uptake of soybean

Treatment	Yield (q ha ⁻¹)			Harvest index	Nutrient uptake (kg ha ⁻¹)			Micronutrient uptake (kg ha ⁻¹)	
	Grain	Straw	Biological		N	P	K	Zn	B
T ₁ : 19:19:19 (0.5%) at 30 and 40 DAS	21.00	20.10	41.10	51.09	160.05	21.74	134.93	65.18	55.78
T ₂ : ZnSO ₄ (0.5%) at 30 and 40 DAS	20.30	19.70	40.00	50.75	151.09	19.37	131.52	63.29	53.67
T ₃ : NAA (50 ppm) at 30 and 40 DAS	20.70	19.90	40.60	50.98	153.70	20.46	133.24	64.58	54.54
T ₄ : H ₃ BO ₃ (0.5%) at 30 and 40 DAS	19.80	19.40	39.20	50.51	147.39	17.68	129.49	62.27	52.27
T ₅ : 19:19:19 (0.5%) + ZnSO ₄ (0.5%) at 30 and 40 DAS	22.00	20.50	42.50	51.74	169.35	24.46	141.36	68.38	58.38
T ₆ : 19:19:19 (0.5%) + H ₃ BO ₃ (0.5%) at 30 and 40 DAS	21.75	20.40	42.15	51.60	166.89	24.11	138.84	67.24	57.42
T ₇ : 19:19:19 (0.5%) + NAA (50 ppm) at 30 and 40 DAS	22.30	20.70	43.00	51.85	171.90	26.14	143.46	69.17	59.57
T ₈ : 19:19:19 (0.5%) + H ₃ BO ₃ (0.5%) + ZnSO ₄ (0.5%) at 30 and 40 DAS	22.70	21.00	43.70	51.94	188.50	27.06	145.46	70.13	60.18
T ₉ : ZnSO ₄ (0.5%) + H ₃ BO ₃ (0.5%) + NAA (50 ppm) at 30 and 40 DAS	21.50	20.30	41.80	51.43	163.90	23.12	136.57	66.76	56.26
T ₁₀ : Only GRDF	18.73	19.10	38.10	49.86	133.68	15.03	128.32	61.74	51.72
S.Em ±	0.27	0.08	0.22	0.31	4.21	2.56	0.01	1.24	1.34
CD at 5%	0.80	0.24	0.66	0.94	12.54	7.63	0.03	3.70	4.02

Note: GRDF was uniformly applied from T₁ to T₁₀ treatments

Table 2: Effect of foliar sprays of water soluble fertilizers, micronutrients and plant growth regulators on protein and oil content of soybean

Treatment	Protein content (%)	Oil content (%)
T ₁ : 19:19:19 (0.5%) at 30 and 40 DAS	35.71	18.40
T ₂ : ZnSO ₄ (0.5%) at 30 and 40 DAS	35.44	18.10
T ₃ : NAA (50 ppm) at 30 and 40 DAS	35.56	18.20
T ₄ : H ₃ BO ₃ (0.5%) at 30 and 40 DAS	35.41	18.00
T ₅ : 19:19:19 (0.5%) + ZnSO ₄ (0.5%) at 30 and 40 DAS	37.37	18.77
T ₆ : 19:19:19 (0.5%) + H ₃ BO ₃ (0.5%) at 30 and 40 DAS	37.11	18.63
T ₇ : 19:19:19 (0.5%) + NAA (50 ppm) at 30 and 40 DAS	37.47	18.87
T ₈ : 19:19:19 (0.5%) + H ₃ BO ₃ (0.5%) + ZnSO ₄ (0.5%) at 30 and 40 DAS	38.54	19.14
T ₉ : ZnSO ₄ (0.5%) + H ₃ BO ₃ (0.5%) + NAA (50 ppm) at 30 and 40 DAS	36.01	18.50
T ₁₀ : Only GRDF	34.69	17.87
S.Em ±	0.77	0.27
CD at 5%	N.S.	N.S.

Note: GRDF was uniformly applied from T₁ to T₁₀ treatments

Table 3: Gross monetary returns, cost of cultivation, net monetary returns and benefit: cost ratio of soybean as influenced by different treatments

Treatment	Gross monetary returns	Cost of cultivation	Net monetary returns	B:C ratio
T ₁ : 19:19:19 (0.5%) at 30 and 40 DAS	67020.20	35020.25	32000.45	1.91
T ₂ : ZnSO ₄ (0.5%) at 30 and 40 DAS	64840.60	34720.30	30120.40	1.87
T ₃ : NAA (50 ppm) at 30 and 40 DAS	66080.45	34790.40	31290.70	1.90
T ₄ : H ₃ BO ₃ (0.5%) at 30 and 40 DAS	63280.20	34480.70	28800.65	1.84
T ₅ : 19:19:19 (0.5%) + ZnSO ₄ (0.5%) at 30 and 40 DAS	70100.30	35470.75	34630.30	1.98
T ₆ : 19:19:19 (0.5%) + H ₃ BO ₃ (0.5%) at 30 and 40 DAS	69330.30	35230.65	34100.75	1.97
T ₇ : 19:19:19 (0.5%) + NAA (50 ppm) at 30 and 40 DAS	71040.20	35540.25	35500.50	2.00
T ₈ : 19:19:19 (0.5%) + H ₃ BO ₃ (0.5%) + ZnSO ₄ (0.5%) at 30 and 40 DAS	72300.30	35680.45	36620.70	2.03
T ₉ : ZnSO ₄ (0.5%) + H ₃ BO ₃ (0.5%) + NAA (50 ppm) at 30 and 40 DAS	68560.60	35450.60	33110.60	1.93
T ₁₀ : Only GRDF	60020.35	34270.65	25750.40	1.75
S.Em ±	806.11	-	806.11	0.22
CD at 5%	2394.17	-	2394.17	0.68

Note: GRDF was uniformly applied from T₁ to T₁₀ treatments

Conclusion

The spray application of 19:19:19 + H₃BO₃ + ZnSO₄ of 0.5% each at 30 and 40 DAS to soybean was beneficial for increasing the grain yield and nutrient uptake. Gross monetary returns, net monetary returns and B:C ratio were found to be highest with GRDF + foliar application of 19:19:19 NPK 0.5% + H₃BO₃ 0.5% + ZnSO₄ 0.5% which was Rs. 72300.25 ha⁻¹, Rs. 36620.68 and 2.03, respectively and the cost of cultivation was Rs. 35680.45 ha⁻¹.

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