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Effect of foliar application of potassium, boron and zinc on quality and seed yield in soybean

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Abstract

A field experiment was conducted at Agricultural College Farm, Bapatla during *Kharif* 2013 to study the effect of foliar application of potassium, boron and zinc on quality p and seed yield in soybean. The experiment was laid out in clay loam soil in a Randomized Block Design with eight treatments and three replications. Treatments consisted of T₁- Foliar applications of potassium nitrate @ 2 per cent at 30 and 60 DAS, T₂- Foliar application of boric acid @ 50 ppm, T₃- Foliar application of zinc sulphate @ 1 per cent, T₄- Foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm, T₅- Foliar application of potassium nitrate @ 2 per cent + zinc sulphate @ 1 per cent at, T₆- Foliar application of boric acid @ 50 ppm + zinc sulphate @ 1 per cent, T₇- Foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent, T₈- Control (Water spray). The results revealed that foliar application of potassium nitrate @ 2 % + boric acid @ 50 ppm + zinc sulphate @ 1 % (T₇) at 30 and 60 DAS was found to be superior in increasing the quality parameters like SCMR (29.12% over control), total chlorophyll content (20.60% over control), protein (12.82% over control), oil content (26.24% over control) and yield (28.59% over control) followed by potassium nitrate @ 2 % + boric acid @ 50 ppm at 30 and 60 DAS (T₄), boric acid @ 50 ppm + zinc sulphate @ 1 % at 30 and 60 DAS (T₆) and potassium nitrate @ 2 % + zinc sulphate @ 1 % at 30 and 60 DAS (T₅).

Keywords: Nutrition, Seed quality, SCMR (SPAD reading), Soybean

Introduction

In Andhra Pradesh, soybean was grown in an area of 2.84 lakh ha with a production of 3.48 lakh metric tons and productivity of 1225 kg ha⁻¹ (The Soybean Processors Association of India, 2013). Foliar application of micronutrients was more beneficial than soil application, since application rates are lesser as compared to soil application and same results could be obtained easily and the crop responds to nutrient application immediately (Zayed *et al.*, 2011) [18]. Foliar application of potassium nitrate @ 2 % significantly increased the proline content and crude protein content in mungbean (Thalooth *et al.*, 2006) [14]. Parvaneh Rahdari *et al.* (2013) [9] showed that chlorophyll a, chlorophyll b, carotenoids and protein contents of soybean were increased with supply of zinc @ 200 µM. High oil percentage and protein percentage were obtained in canola with soil and foliar application of zinc @ 40 kg ha⁻¹ along with iron @ 25 kg ha⁻¹ (Ahmad and Garib, 2010) [1]. Less research was done on effect of foliar application of potassium, boron and zinc on quality parameters. Keeping this in view, the work on effect of foliar application of potassium, boron and zinc on quality parameters and seed yield in soybean was taken up.

Materials and methods

A field experiment was conducted at college farm, Agricultural College, Bapatla during *Kharif* 2013. The experiment was laid out in clay loam soil in a Randomized Block Design with eight treatments and three replications. Treatments consisted of T₁- Foliar applications of potassium nitrate @ 2 per cent at 30 and 60 DAS, T₂- Foliar application of boric acid @ 50 ppm, T₃- Foliar application of zinc sulphate @ 1 per cent, T₄- Foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm, T₅- Foliar application of potassium nitrate @ 2 per cent + zinc sulphate @ 1 per cent, T₆- Foliar application of boric acid @ 50 ppm + zinc sulphate @ 1 per cent, T₇- Foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent, T₈- Control (Water spray). The plot size was 4m x 3m with a spacing of 30 cm x 10 cm. The total chlorophyll content was measured with SPAD chlorophyll meter reading (SCMR) following the method of Turner and Jund (1991) [16] from 30 to 90 DAS.

Estimation of chlorophyll content in leaves was done by DMSO method as described by Hiscox and Stam (1979) [3]. The oil content and protein content were estimated by using soxhlet method as described by Sadasivam and Manickam (1992) [11] and Lowry's method (1951) [5] respectively. Seed yield and yield components were recorded at harvest.

Results and discussion

The SPAD chlorophyll meter reading (SCMR) and total chlorophyll content was gradually increased from 30 DAS to 60 DAS in all the treatments and thereafter it declined (Table 1). The decline in SCMR and total chlorophyll content after 60 DAS might be due to the onset of senescence which resulted in chlorophyll degradation. Significant differences among treatments were noticed from 45 DAS due to the effect of foliar application from 30 DAS. Maximum SCMR and total chlorophyll values were recorded in treatment T₇ at 60 DAS. Among the treatments, the treatment containing potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS (T₇) recorded higher SCMR (51.67) and total chlorophyll content (1.99 mg g⁻¹) which was 29.17 per cent higher over control (40.0) and 20.6 per cent higher over control (1.65 mg g⁻¹) respectively. Higher SCMR and total chlorophyll content in T₇ treatment might be due to the role of boron in chlorophyll synthesis and the role of zinc in inducing auxin synthesis which delays the processes such as senescence and abscission (Sakal, 1991) [12]. Similar results were reported by Parvaneh Rahdari *et al.* (2013) [9] in soybean.

The treatments T₄ (47.17 and 1.88 mg g⁻¹), T₆ per cent (46.70 and 1.85 mg g⁻¹), T₅ (45.17 and 1.82 mg g⁻¹), T₂ (45.00 and 1.79 mg g⁻¹) were on par with each other regarding SCMR and total chlorophyll content respectively.

The data regarding total protein and oil content of seeds are presented in table 1. Significant differences among treatments were observed for total protein and oil content of seeds. Foliar spray of nutrients significantly enhanced the total protein and oil content over control. The treatment of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS (T₇) increased the total protein content by 12.82 per cent over control and oil content by 26.24 per

cent over control followed by potassium nitrate @ 2 per cent + boric acid @ 50 ppm which were on par. High protein and oil content in T₇ might be due to the role of boron in synthesis of protein and in translocation of assimilates and role of potassium in improving the quality parameters, by sulphur supplied through zinc sulphate in enhancing the oil content (Nandini Devi *et al.*, 2012 and Sarkar and Malik, 2001) [8, 13]. Foliar sprays of nutrients increased the seed yield significantly over control (Table 1). Significant differences were observed among different treatments with regard to seed yield in soybean. Among all the treatments, foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS (T₇) recorded significant increase in seed yield (2996.23 kg ha⁻¹) which was 28.59 per cent higher over control (2330.00 kg ha⁻¹). The T₇ treatment was followed by potassium nitrate @ 2 per cent + boric acid @ 50 ppm (2817.27 kg ha⁻¹) and boric acid @ 50 ppm + zinc sulphate @ 1 per cent (2723.00 kg ha⁻¹). Remaining treatments also recorded significantly higher seed yield over control and were on par with each other.

Greater seed yield recorded in T₇ might be due to the significant effect of nutrient sprays enhancing number of pods per plant and the role of boron in enhancing drymatter and efficiency of translocation of assimilates to developing sink leading to increased pods and higher seed yield (Pradeed and Elamathi, 2007) [10]. Potassium might have improved pod filling and phytomass production due to increased photosynthetic activity and effective translocation of assimilates to reproductive parts resulting in higher yield (Mengal, 1976) [6] and foliar application of zinc increased the leaf area, drymatter, length of flowering period, number of pods per plant and thereby yield (Khodadad Mostafavi, 2012) [4]. Similar results were reported by Beg *et al.* (2013) [2] in urdbean, Nalini *et al.* (2013) [7] in blackgram and Vaseghi *et al.* (2013) [17] in soybean. From these results, it can be concluded that foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS significantly increased the SCMR, total chlorophyll content, protein, oil content and seed yield in soybean by 29.12 per cent, 20.6 per cent, 12.82 per cent, 26.24 per cent and 28.59 per cent respectively over control.

Table 1: Effect of foliar application of potassium, boron and zinc at 30 and 60 DAS on quality parameters and seed yield in soybean

Treatments at 30 and 60 DAS	SCMR					Total chlorophyll content (mg g ⁻¹ f.wt.)					Protein content (%)	Oil content (%)	Seed yield (Kg ha ⁻¹)
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS			
T ₁ : Potassium nitrate @ 2%	29.83	38.00	44.50	42.00	32.00	1.42	1.54	1.75	1.55	1.40	41.67	18.00	2506.67
T ₂ : Boric acid @ 50 ppm	31.00	38.50	45.00	43.00	33.00	1.43	1.58	1.79	1.59	1.44	42.00	18.80	2600.00
T ₃ : Zinc sulphate @ 1%	31.67	37.17	43.50	41.02	31.67	1.40	1.53	1.72	1.50	1.38	41.00	18.25	2450.00
T ₄ : Potassium nitrate @ 2% + Boric acid @ 50 ppm	32.00	41.33	47.17	45.50	34.83	1.50	1.67	1.88	1.68	1.52	43.00	19.57	2817.27
T ₅ : Potassium nitrate @ 2% + Zinc sulphate @ 1%	31.77	39.00	45.17	44.00	33.50	1.45	1.64	1.82	1.64	1.47	42.33	19.00	2691.80
T ₆ : Boric acid @ 50 ppm + Zinc sulphate @ 1%	32.10	40.00	46.70	45.00	34.17	1.47	1.65	1.85	1.67	1.50	42.50	19.30	2723.00
T ₇ : Potassium nitrate @ 2% + Boric acid @ 50 ppm + Zinc sulphate @ 1%	32.53	43.30	51.67	48.07	36.00	1.51	1.78	1.99	1.73	1.63	44.00	20.83	2996.23
T ₈ : Control (water spray)	30.00	34.00	40.00	36.00	28.67	1.40	1.50	1.65	1.40	1.25	39.00	16.50	2330.00
SEm±	1.04	1.35	1.60	1.38	0.97	0.04	0.04	0.03	0.03	0.04	0.78	0.45	96.65
CD (P = 0.05)	NS	4.10	4.86	4.20	2.96	NS	0.13	0.10	0.09	0.12	2.38	1.37	293.12
CV(%)	5.73	6.02	6.11	5.57	5.12	4.71	4.70	3.23	3.39	4.64	3.24	4.18	6.34

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