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Research Article

INFLUENCE OF FOLIAR APPLICATION POTASSIUM, BORON AND ZINC ON GROWTH AND YIELD OF SOYBEAN

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ABSTRACT
A field experiment was conducted at Agricultural College Farm, Bapatla during *Kharif* 2013-14 to study the effect of foliar application of potassium, boron and zinc on growth and seed yield of soybean. The results revealed that foliar application of potassium nitrate @ 2 % + boric acid @ 50 ppm + zinc sulphate @ 1 % (T_7) at 30 and 60 DAS was found to be superior in increasing plant height, number of branches, number of leaves, leaf area, total drymatter, number of pods per plant, test weight and seed yield followed by potassium nitrate @ 2 % + boric acid @ 50 ppm at 30 and 60 DAS (T_4), boric acid @ 50 ppm + zinc sulphate @ 1 % at 30 and 60 DAS (T_6) and potassium nitrate @ 2 % + zinc sulphate @ 1 % at 30 and 60 DAS (T_5) where as lower values were recorded in control.

Keywords: *Foliar Application, Growth, Nutrients, Seed Yield, Soybean*

INTRODUCTION
Soybean is recognized as golden bean because of its high nutritional values and economic importance. Soybean cultivar JS-335 is the most popular variety of the transitional tract of Karnataka, Telangana and coastal Andhra Pradesh. It has high yield potential; hence it is necessary to develop methods to improve its production. Foliar application of macro and micro nutrients was more beneficial to legumes (Zayed *et al*., 2011). Adequate information on the effect of foliar application of potassium, boron and zinc on soybean was not available. Keeping this in view, it has been proposed to investigate the effect of foliar application of potassium, boron and zinc on growth and yield of soybean.

MATERIALS AND METHODS
A field experiment was conducted at College Farm, Agricultural College, Bapatla during *Kharif* 2013-14. The experiment was laid out in clay loam soil in a Randomized Block Design with eight treatments and three replications.
Treatments consists of T_1- Foliar application of potassium nitrate @ 2 per cent at 30 and 60 DAS, T_2- Foliar application of boric acid @ 50 ppm at 30 and 60 DAS, T_3- Foliar application of zinc sulphate @ 1 per cent at 30 and 60 DAS, T_4- Foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm at 30 and 60 DAS, T_5- Foliar application of potassium nitrate @ 2 per cent + zinc sulphate @ 1 per cent at 30 and 60 DAS, T_6- Foliar application of boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS, T_7- Foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS, T_8- Control.
The plot size was 4m x 3m with a spacing of 30 cm x 10 cm. The data on plant height, number of branches, leaves, leaf area, and total dry matter were taken from 30 DAS to 90 DAS and yield and yield components were recorded at harvest.

RESULTS AND DISCUSSION
The plant height increases from 30 DAS to 90 DAS but the rate of increase was declined from 60 DAS irrespective of the treatments (Table 1). Significant differences were not observed among the treatments at 30 DAS as foliar application was effected from 30 DAS. From 45 to 60 DAS there was an exponential increase in the plant height and the treatments also differed significantly from each other.

Table 1: Influence of foliar application of potassium, boron and zinc on plant height, number of branches and leaves in soybean

Treatments at 30 and 60 DAS	Plant height (cm)					Number of branches					Number of leaves				
	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	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%	25.67	33.00	37.83	40.33	41.00	2.07	5.10	6.75	7.80	7.90	10.07	24.93	40.50	36.00	26.50
T_2 : Boric acid @ 50 ppm	26.67	34.00	38.00	40.83	41.67	2.17	5.30	7.00	7.90	8.00	10.60	25.37	41.00	36.50	27.00
T_3: Zinc sulphate @ 1%	25.17	32.73	37.50	40.00	40.83	1.93	5.00	6.70	7.70	7.80	9.87	24.25	39.00	35.00	26.00
T_4: Potassium nitrate @ 2% + Boric acid @ 50 ppm	26.33	36.33	40.00	42.00	43.67	2.20	5.83	8.00	9.30	9.40	10.53	28.50	43.50	38.70	29.28
T_5: Potassium nitrate @ 2% + Zinc sulphate @ 1%	25.50	35.00	38.67	41.00	42.00	1.97	5.50	7.80	8.67	8.87	10.00	27.50	42.50	37.67	27.67
T_6: Boric acid @ 50 ppm + Zinc sulphate @ 1%	26.17	36.00	39.33	41.33	42.33	2.13	5.65	7.90	8.93	9.03	10.17	28.00	43.00	38.00	28.90
T_7: Potassium nitrate @ 2% + Boric acid @ 50 ppm + Zinc sulphate @ 1%	26.83	40.00	45.50	48.00	48.83	2.27	6.00	8.33	9.57	9.63	10.87	29.50	46.00	40.67	31.00
T_8: Control	25.23	31.00	35.23	37.50	38.00	1.90	4.67	6.40	7.33	7.40	9.80	23.00	36.00	32.00	24.00
CD (P = 0.05)	NS	3.86	3.95	4.06	4.55	NS	0.51	0.60	0.78	0.96	NS	2.62	3.73	3.60	3.00

Table 2: Influence of foliar application of potassium, boron and zinc on leaf area, total dry matter and seed yield in soybean

Treatments at 30 and 60 DAS	Leaf area (cm^2 $plant^{-1}$)					Total dry matter (g $plant^{-1}$)					Number of pods $plant^{-1}$	Number of seeds pod^{-1}	Test weight (g)	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%	566	1076	1264	1020	858	5.46	15.00	26.50	29.14	30.25	82.00	2.50	8.30	2506
T_2: Boric acid @ 50 ppm	576	1095	1286	1053	892	5.48	15.27	27.34	30.56	32.36	84.00	2.60	8.54	2600
T_3: Zinc sulphate @ 1%	560	1050	1225	975	811	5.43	14.60	25.53	27.69	28.56	80.00	2.50	8.10	2450
T_4: Potassium nitrate @ 2% + Boric acid @ 50 ppm	592	1300	1503	1309	1175	5.58	17.58	32.85	38.23	41.31	92.00	2.65	9.70	2817
T_5: Potassium nitrate @ 2% + Zinc sulphate @ 1%	578	1194	1396	1170	1029	5.48	16.56	29.98	33.65	35.35	87.00	2.62	8.97	2691
T_6: Boric acid @ 50 ppm + Zinc sulphate @ 1%	587	1245	1449	1228	1094	5.56	17.02	31.56	36.12	38.67	89.50	2.63	9.30	2723
T_7: Potassium nitrate @ 2% + Boric acid @ 50 ppm + Zinc sulphate @ 1%	596	1350	1555	1394	1255	5.80	18.12	34.52	41.25	44.72	98.00	2.70	10.10	2996
T_8: Control	558	980	1133	875	717	5.42	14.07	24.00	25.58	26.23	76.00	2.50	7.84	2330
CD (P = 0.05)	NS	150	146	193	147	NS	1.88	3.82	5.24	5.96	9.89	NS	1.02	293

At 45 DAS, foliar application of Foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS(T_7) recorded higher plant height (40 cm) followed by Foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm at 30 and 60 DAS (36.33 cm) and the remaining treatments were on par with each other while lower plant height was observed in control (31.0 cm). Higher plant height in T_7 might be due to the role of nutrients in various physiological and biochemical processes contributing to the growth of the meristematic regions (Cakmak *et al*., 1989). The above results were in harmony with the observations of Mahmoud *et al.*, (2006) in fababean and Ali and Adel (2013) in mungbean.

The increase in number of branches was at a greater rate from 30 DAS to 60 DAS and thereafter the rate of increase was slow down (Table 1). Among the treatments, the treatment receiving foliar spray with combination of three nutrients at 30 and 60 DAS showed higher number of branches compared to other treatments and control at all stages. At 90 DAS, foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS (T_7) recorded higher number of branches (9.63) which was 30.13 per cent higher over control (7.40). The treatment potassium nitrate @ 2 per cent + boric acid @ 50 ppm (9.40), boric acid @ 50 ppm + zinc sulphate @ 1 per cent (9.03), potassium nitrate @ 2 per cent + zinc sulphate @ 1 per cent (8.87) were on par with the treatment T_7 while the treatment boric acid @ 50 ppm (8.00), potassium nitrate @ 2 per cent (7.90) and zinc sulphate @ 1 per cent (7.80) were on par with control (7.40). The higher number of branches in T_7 might be due to the role of nutrients in various physiological and biological processes contributing to the proper growth of plants to their maximum potential (Pradeep and Elamathi, 2007).

The number of leaves and leaf area increased from 30 DAS to 60 DAS and later on they declined irrespective of the treatments (Table 1). Among the treatments, effective increment in number of leaves and leaf area was observed from 45 to 60 DAS as the spraying was effected from 30 DAS. At 60 DAS, foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS (T_7) showed an effective increase in number of leaves (46.00) and leaf area (1555 cm^2 $plant^{-1}$) over control (36.00 and 1133 cm^2 $plant^{-1}$) by 27.78 per cent and 37.00 per cent respectively. The treatments potassium nitrate @ 2 per cent + boric acid @ 50 ppm recorded (43.50 and 1503 cm^2 $plant^{-1}$), boric acid @ 50 ppm + zinc sulphate @ 1 per cent (43.00 and 1449 cm^2 $plant^{-1}$), potassium nitrate @ 2 per cent + zinc sulphate @ 1 per cent (42.50 and 1396 cm^2 $plant^{-1}$) were on par with the T_7 treatment. The higher number of leaves and leaf area in T_7 might be due to the role of nutrients in enhancing the growth of the plant by supplementing the soil available nutrients (Menjel, 1976) and role of nutrients in various physiological processes there by delaying senescence and abscission as zinc helps in the production of auxins (Seifinadergholi *et al*., 2011). The above results were in support with the finding of Mahmoud *et al.*, (2006) in fababean.

The drymatter accumulation was increased from 30 DAS to harvest, however it was exponential from 45 DAS to 60 DAS irrespective of the treatments (Table 2). Significant differences for total drymatter was observed from 45 DAS to harvest as spraying were affected at 30 and 60 DAS. Among the treatments, foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS(T_7) recorded significantly higher total drymatter per plant at harvest (44.72 g $plant^{-1}$) followed by potassium nitrate @ 2 per cent + boric acid @ 50 ppm (41.31 g $plant^{-1}$) and boric acid @ 50 ppm + zinc sulphate @ 1 per cent (38.67 g $plant^{-1}$). Higher total drymatter in T_7 might be due to the role of boron in cell division, cell differentiation, development, calcium utilization, translocation of photosynthates and growth regulators from source to sink, thus helping in maintaining higher leaf area, leaf area index and higher number of pods and pod weight per plant (Kalyani *et al*., 1993). Similar results were reported by Pradeep and Elamathi (2007) in greengram.

The number of pods per plant, test weight and seed yield were greatly influenced by foliar application of nutrients (Table 2). Significant differences were observed among treatments for number of pods, test weight and seed yield in soybean. Among the treatments foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS (T_7) enhanced the number of

pods per plant (98), test weight (10.10 g) and seed yield (2996 kg ha^{-1}) by 28.94, 22.60, 28.59 per cent higher over control (76, 7.84 g, 2330 kg ha^{-1} respectively).

The treatments potassium nitrate @ 2 per cent + zinc sulphate @ 1 per cent, boric acid @ 50 ppm, potassium nitrate @ 2 per cent and zinc sulphate @ 1 per cent also recorded significantly higher number of pods per plant, test weight and seed yield over control and were on par with each other. The higher number of pods per plant in T_7 might be due to the balanced nutrition supplied and due to the role of boron in preventing flower and pod drop, thereby retaining higher number of pods per plant (Seifinadergholi *et al*., 2011). Higher test weight in T_7 might be due to the role of boron in translocation of assimilates (Pradeep and Elamathi, 2007). Higher seed yield in T_7 might be due to the significant effect of nutrient sprays enhancing number of pods per plant and the role of boron in increasing drymatter and efficiency of translocation of translocation of assimilates to developing sink leading to increased pods and higher seed yield (Pradeep and Elamathi, 2007) and due to role of potassium in improving pod filling and phytomass production by improving photosynthetic activity and effective translocation of assimilates to reproductive parts resulting in higher yield (Mengal, 1976) and foliar application of zinc increased the leaf area, drymatter, length of flowering period, number of pods per plant and thereby yield (Khodadad, 2012). Similar results were reported by Beg *et al*., (2013) in urdbean, Nalini *et al*., (2013) in blackgram and Vaseghi *et al*., (2013) 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 increased the growth and seed yield in soybean.

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