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Effect of foliar fertilization of water soluble fertilizers on growth and economics of soybean in a vertisol

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Abstract

A field experiment was conducted at University of Agricultural Sciences, Dharwad on medium black soil during *kharif* season of 2015 to study the effect of foliar feeding of water soluble fertilizers on growth and economics of soybean in a Vertisol. Among different treatments, two foliar sprays of 1.0 per cent 19:19:19 produced significantly higher growth parameters like number of branches per plant (5.20), total drymatter production (60.35 g plant⁻¹ at 55, 75 DAS and harvest), higher B: C ratio. This was closely followed by treatment which received urea (1 %) and KNO₃ (2 %) and one spray of 19:19:19 (1 %) at 60 DAS. Lower values were recorded in control.

Keywords: water soluble fertilizers, foliar spray, growth parameters

Introduction

Foliar application of nutrients constitutes one of the important milestones in the progress of agricultural production. It is gaining more importance in recent years due to availability of soluble fertilizers and is of great significance in rainfed areas and under changing climatic conditions. Research studies have indicated positive effect of foliar nutrition in enhancing yield and quality of crops. Nutrients applied through the fertilizers at the time of sowing are not fully utilized by the crop and are lost through leaching, fixation etc. and the crop may suffer from want of nutrients at the later stage. Foliar application of nutrients for increasing and exploiting genetic potential of the crop is considered as an efficient and economic method of supplementing the nutrient requirement of crop. Application of inorganic nutrients through foliage will enhance the nutrient availability due to quick absorption through leaves and in turn increases the crop productivity. Nutrients applied through foliage play a pivotal role in increasing the seed yield in pulses and oilseeds (Chandrasekhar and Bangarusamy, 2003) [2]. Hence, foliar nutrition is recognized as an important method of fertilization in modern agriculture.

Polyfeed nutrient 19:19:19 fertilizer is a hundred per cent water soluble complete fertilizer containing nitrogen in three forms of namely, NO₃-N (45.0%), NH₄-N (4.5%) and NH₂-N (10.5%) including water soluble phosphorus and potassium each containing 19 per cent with low salt index. Therefore, it causes rapid and healthy crop growth and alleviate nutrients deficiencies quickly. It increases resistance against pest and diseases by keeping plants healthy, ultimately causing reduced use of pesticides and fungicides and uniform flowering with their reduced droppings resulting in higher crop yield. It is made of high quality ingredients providing balanced and complete nutrition to plants and virtually free of chloride, sodium and other detrimental elements. Potassium nitrate is a water soluble potassic fertilizer suitable for foliar application containing 44 and 32 per cent K₂O and NO₃-N, respectively (Yawalkar *et al.* 1996) [13]. This is especially the case when foliar analysis shows lower nutritional levels than the desired optimum levels. Urea contains 46 per cent nitrogen in amide form. It is usually taken up rapidly through the leaf cuticle. It can be supplied to plants through the foliage, facilitating optimal nitrogen management, which minimizes nitrogen losses to the environment.

Soybean (*Glycine max* L.) is an important oilseed crop and finds its place in policy agenda of industrial, medical and food sector in India due to wide spectrum of its chemical composition. In India, the crop contributes 33 and 21 per cent of our commercial oil seeds and total pulse production, respectively. Soybean being a potentially high yielding crop can play a greater role in boosting oil seed production in the country. It is a source of high quality protein for human consumption containing about 40 and 20 per cent protein and oil, respectively and is also rich in lysine (6%), vitamins (A, B and D) and mineral salts. Soybean exerts considerable residual

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effects on the succeeding crop; leaves the soil with better physical conditions and improves soil fertility by adding residual nitrogen to the extent of 35-40 kg ha⁻¹ through fixation of atmospheric nitrogen. As soybean is an exhaustive crop, optimization of mineral nutrition is a key to maximize its production.

Material and Methods

A field experiment was laid out with 10 treatments replicated thrice during *khariif*, 2015 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. This study area is located in Northern Transition Zone (Zone VIII) of Karnataka and is situated at 15° 26' North latitude, 75° 07' East longitude and at an altitude of 678 m above mean sea level (MSL). The treatment details T₁; control, T₂; 2% urea at 40 DAS, T₃; 1% KNO₃ at 60 DAS, T₄; 2% urea at 40 DAS and 1% KNO₃ at 60 DAS, T₅; 0.5% 19:19:19 at 40 DAS, T₆; 0.5%:19:19:19 at 60 DAS, T₇; 0.5% 19:19:19 at 40 and 60 DAS, T₈;1.0% 19:19:19 at 40 DAS, T₉; 1.0% 19:19:19 at 60 DAS, T₁₀; 1.0% 19:19:19 at 40 and 60 DAS. The experiment was laid out in Randomized Block Design (RBD). The soil of the experimental site was Typic Haplustert with clay texture, medium in organic carbon (0.55%), low in available nitrogen (178.3 kg ha⁻¹), medium in available phosphorus (28.69 kg ha⁻¹), high in available potassium (381.26 kg ha⁻¹). The crop was raised as per the recommended package of practices. Available N was estimated by alkaline permanganate method (Sharawat and Burford, 1982) [10], available P by Olsen's method, available K by ammonium acetate extraction method and organic carbon by wet oxidation method described by (Sparks, 1996) [11]. The Available micronutrients was extracted with DTPA and determined by atomic absorption spectrophotometer as described by (Lindsay and Norvell,

1978) [8]. The analysis of variance was carried out using the randomized complete block design (Gomez and Gomez, 1984) [5].

Results and Discussion

Foliar nutrition with water soluble fertilizers namely urea (2%), KNO₃ (1%) and 19:19:19 at 0.5 and 1.0 per cent significantly influenced the growth characters in soybean. The treatment with two sprays of 1.0 per cent 19:19:19 at 40 and 60 DAS (T₁₀) produced higher number of branches (5.20) and total dry matter (25.77, 50.27 and 60.35 g at 55, 75 DAS and harvest, respectively) per plant. However, plant height, leaf chlorophyll content, nodules number and their weight. The higher dry matter accumulation by soybean crop was attributed to beneficial effect of nutrients particularly N, P and K in water soluble fertilizers in readily available form which were supplied through foliar spray. These nutrients were directly absorbed by plant either through cuticle or stomata and might have participated in photosynthesis activity in plant leaves leading to increased dry matter yield. Foliar spray resulted in timely supply of optimum quantity of nutrients to the plant and their subsequent absorption by soybean leaves resulting in better assimilation and translocation of nutrients. Increased photosynthetic activity might have caused more number of auxiliary buds and ultimately resulted in more number of branches. Further, phosphorus present in 19:19:19 fertilizer absorbed directly by the plant might have increased cell division and cell development leading to more number of branches. The values for growth characteristics were lower in control. The present findings corroborated the observations of Chohan and Raina (2010) [4] in soybean, Yadav and Choudhary (2011) [12] in cowpea and Karpagam *et al.* (2002) [6] in brinjal.

Table 1: Effect of foliar feeding of water soluble fertilizers on growth parameters of soybean

Treatments	Plant height (cm)			Total drymatter (g plant ⁻¹)			Number of branches plant ⁻¹
	55 DAS	75 DAS	Harvest	55 DAS	75 DAS	Harvest	
T ₁ : RPP (Control)	35.07	49.23	49.89	15.84	35.12	50.51	3.97
T ₂ : RPP+2% Urea at 40 DAS	35.40	54.77	58.17	21.51	45.45	55.21	4.78
T ₃ : RPP+1% KNO ₃ at 60 DAS	35.79	56.13	56.83	20.83	45.64	55.36	4.90
T ₄ : RPP+ 2% Urea at 40 DAS and 1% KNO ₃ at 60 DAS	35.57	56.30	58.83	21.99	48.87	59.40	5.11
T ₅ : RPP+0.5% 19:19:19 at 40 DAS	41.18	51.13	51.79	21.49	42.03	52.96	4.17
T ₆ : RPP+0.5% 19:19:19 at 60 DAS	36.74	56.17	55.10	20.50	43.91	53.58	4.43
T ₇ : RPP+0.5% 19:19:19 at 40 and 60 DAS	42.14	56.60	56.17	18.71	45.07	54.50	4.53
T ₈ : RPP 1% 19:19:19 at 40 DAS	41.59	52.12	56.28	23.65	45.57	55.08	4.87
T ₉ : RPP+1% 19:19:19 at 60 DAS	36.75	57.51	58.27	20.99	45.77	55.45	5.03
T ₁₀ : RPP+1% 19:19:19 at 40 and 60 DAS	44.99	59.79	60.71	25.77	50.27	60.35	5.20
S.Em±	2.53	2.45	2.67	1.27	1.44	1.62	0.24
CD (0.05)	NS	NS	NS	3.79	4.28	4.82	0.71

DAS- Days after sowings

Application of urea (2 %) and KNO₃ (1 %) respectively at 40 and 60 DAS which are the critical stages produced more number of branches resulting in higher drymatter in soybean.

Perusal of the data also indicated that foliar nutrition of 19:19:19 either at 0.5 or 1.0 per cent produced higher number of branches in soybean than urea (2 %) and KNO₃ (1 %).

Table 2: Effect of foliar feeding of water soluble fertilizers on economics of soybean

Treatments	Cost of cultivation (Rs. ha ⁻¹)	Gross returns (Rs. ha ⁻¹)	Net returns (Rs. ha ⁻¹)	B: C ratio
T ₁ : RPP (Control)	23552	67080	43528	1.84
T ₂ : RPP+2% Urea at 40 DAS	23794	74070	50276	2.11
T ₃ : RPP+1% KNO ₃ at 60 DAS	23853	74130	50277	2.10
T ₄ : RPP+ 2% Urea at 40 DAS and 1% KNO ₃ at 60 DAS	23859	81240	57381	2.40
T ₅ : RPP+0.5% 19:19:19 at 40 DAS	23816	73350	49535	2.07
T ₆ : RPP+0.5% 19:19:19 at 60 DAS	23816	74460	50645	2.12
T ₇ : RPP+0.5% 19:19:19 at 40 and 60 DAS	23843	74820	50977	2.13
T ₈ : RPP 1% 19:19:19 at 40 DAS	23843	77970	54127	2.27

T ₉ : RPP+1% 19:19:19 at 60 DAS	23843	80520	56677	2.37
T ₁₀ : RPP+1% 19:19:19 at 40 and 60 DAS	23898	82500	58602	2.45

Foliar fertilization with different water soluble fertilizers in soybean increased the gross and net returns over control. Two foliar sprays of 1.0 per cent 19:19:19 recorded higher gross (Rs. 82500 ha⁻¹) and net (Rs.58602 ha⁻¹) returns and B: C ratio (2.45) followed by foliar spray of 2.0 per cent urea at 40 DAS and 1.0 per cent KNO₃ at 60 DAS (net returns Rs. 57381 ha⁻¹ and B: C ratio 2.40). This might be due to higher economic yield obtained as a result of better utilization of nutrients through foliage. These results are in conformity with the findings of Chaurasia *et al.* (2005)^[3] and Singh (2013)^[9].

Conclusions

Economic analysis revealed that two foliar sprays of 1.0 per cent 19:19:19 at 40 and 60 DAS recorded higher gross returns (Rs. 82,500 ha⁻¹), net returns (Rs. 58,602 ha⁻¹) and benefit cost ratio (2.45). The next best treatment was combined application of 2.0 per cent urea at 40 DAS and 1.0 per cent KNO₃ at 60 DAS (net returns Rs. 57,381 and B: C ratio 2.4) was found to be superior over control.

- Foliar nutrition with water soluble fertilizers namely urea (2.0 %), KNO₃ (1.0 %) and 19:19:19 each at 0.5 and 1.0 per cent significantly influenced the growth characters in soybean. Treatment T₁₀ with 1.0 per cent 19:19:19 at 40 and 60 DAS recorded more number of branches per plant (5.20) and higher dry matter production (25.77, 50.27 and 60.35 g plant⁻¹ at 55, 75 DAS and harvest, respectively) and lowest values were recorded in control with no foliar spray.

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