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Effect of foliar feeding of 19:19:19 and potassium nitrate water soluble fertilizers on major nutrient status 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 19:19:19 and potassium nitrate water soluble fertilizers on major nutrient status of soybean in a Vertisol. Among different treatments, two foliar sprays of 1.0 per cent 19:19:19 recorded significantly higher uptake of nitrogen (196.80 kg ha^{-1}), phosphorus (29.77 kg ha^{-1}), potassium (96.87 kg ha^{-1}) and Sulphur (31.69 kg ha^{-1}). This was closely followed by treatment which received urea (1 %) and KNO_3 (2 %) and one spray of 19:19:19 (1 %) at 60 DAS (26.84 and 35.41 q ha^{-1}, respectively). Lower uptake values were recorded in control.

Keywords: Soybean, water soluble fertilizers, foliar spray, yield, quality

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. Hence, supplemental foliar fertilization is one of the techniques to increase productivity and quality of crops. Nutrients applied through foliage play a pivotal role in increasing the seed yield in pulses and oilseeds (Chandrasekhar and Bangarusamy, 2003). Supplemental foliar nutrition of major and micronutrients is more advantageous than soil application due to better translocation from the leaves to the developing seeds and efficient utilization of nutrients (Manonmani and Srimathi, 2009).

Recently, new generation fertilizers in the form of speciality fertilizers have been introduced exclusively for foliar feeding. Polyfeed nutrient 19:19:19 fertilizer is a hundred per cent water soluble complete fertilizer containing nitrogen in three forms of namely, NO_3-N (45.0%), NH_4-N (4.5%) and NH_2-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. Potassium nitrate is a water soluble potassic fertilizer suitable for foliar application containing 44 and 32 per cent K_2O and NO_3-N, respectively (Yawalkar *et al.* 1996) [9]. Urea contains 46 per cent nitrogen in an amide form and 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. 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 is a major oil seed crop of the world grown in an area of 118.01 million hectare with production of 315.06 million tonnes and productivity of 2.67 t ha^{-1} (Anon., 2015) [1]. The main producers of soybean are the United States (36 %), Brazil (36 %), and Argentina (18

%), China (5 %) and India (4 %). In India, the crop is grown over an area of 10.02 million hectare with production of 11.64 million tonnes and productivity of 1062 kg ha^{-1} (Anon., 2015) [1]. Predominant soybean growing states in India are Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, Karnataka and Gujarat. In Karnataka soybean occupies an area of 0.29 million hectare with production of 0.24 million tonnes and productivity of 868 kg ha^{-1} (Anon., 2015) [1]. Belagavi, Bidar, Dharwad, Haveri and parts of Bagalkot are the major soybean growing districts of Karnataka.

Material and methods

A field experiment was laid out with 10 treatments replicated thrice during *kharif*, 2015 at Main Agricultural Research Station, University of Agricultural Sciences, and Dharwad. This study area is located in Northern Transition Zone (Zone VIII) of Karnataka and is situated at 15^0 26' North latitude, 75^0 07' East longitude and at an altitude of 678 m above mean sea level (MSL). The treatment details T_1; control, T_2; 2% urea at 40 DAS, T_3; 1% KNO_3 at 60 DAS, T_4; 2% urea at 40 DAS and 1% KNO_3 at 60 DAS, T_5; 0.5% 19:19:19 at 40 DAS, T_6; 0.5%:19:19:19 at 60 DAS, T_7; 0.5% 19:19:19 at 40 and 60 DAS, T_8;1.0% 19:19:19 at 40 DAS, T_9; 1.0% 19:19:19 at 60 DAS, T_{10}; 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 soil was sufficient in all micronutrients Fe (3.61 mg kg^{-1}), Cu (0.70 mg kg^{-1}), Mn (0.70 mg kg^{-1}) and Zn (0.62 mg kg^{-1}). The crop was raised as per the recommended package of practices.

The uptake of nutrients at 90 DAS (at harvest of Soybean) were worked out using the following formulae.

$$\text{Macronutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient concentration (\%)}}{100} \times \text{Dry matter yield (kg ha}^{-1})$$

Table 1: Effect of foliar feeding of water soluble fertilizers on uptake of N, P, K and S at harvest (seed + haulm) by soybean

Treatments	Uptake (kg ha^{-1})			
	N	P	K	S
T_1: RPP (Control)	134.30	13.60	50.05	23.77
T_2: RPP+2% Urea at 40 DAS	180.70	21.13	60.43	25.24
T_3: RPP+1% KNO_3 60 DAS	174.93	23.27	89.98	27.42
T_4: RPP+ 2% Urea at 40 DAS and 1% KNO_3 at 60 DAS	185.23	25.27	92.89	28.82
T_5: RPP+0.5% 19:19:19 at 40 DAS	148.27	17.53	64.07	26.38
T_6: RPP+0.5% 19:19:19 at 60 DAS	157.03	19.77	68.77	26.87
T_7: RPP+0.5% 19:19:19 at 40 and 60 DAS	166.80	23.67	76.87	27.44
T_8: RPP 1% 19:19:19 at 40 DAS	174.53	24.57	84.47	28.80
T_9: RPP+1% 19:19:19 at 60 DAS	181.20	25.90	88.06	29.15
T_{10}: RPP+1% 19:19:19 at 40 and 60 DAS	196.80	29.77	96.87	31.69
S.Em±	5.01	0.86	2.32	0.87
CD (0.05)	14.88	2.56	6.89	2.60

DAS-Daysafte rsowing NS- Non significant

Results and discussion

Foliar nutrition with water soluble fertilizers namely urea (2%), KNO_3 (1%) and 19:19:19 at 0.5 and 1.0 per cent significantly influenced the uptake of nutrients in soybean. Further, the treatments receiving 19:19:19 fertilizer recorded higher nitrogen uptake than KNO_3. This is because of six per cent more nitrogen supply to crop from 19:19:19 than KNO_3. The uptake of nitrogen increased with advancement of crop growth due to the production of higher biomass. Findings of the present studies were in accordance with the observations of Lalitha *et al.* (2008) [5] in Niger, Samui *et al.* (1981) [7] in mustard and Prabhavathi *et al.* (2008) [6] in chilli. It was observed that irrespective of the type of water soluble fertilizer, 1.0 per cent solution recorded higher nitrogen uptake by the crop than 0.5 per cent which might be due to higher supply of nitrogen through foliage resulting in higher drymatter yield.

Similar to nitrogen uptake, phosphorus uptake was significantly influenced by foliar application of fertilizers. It was observed that treatments that received foliar sprays of 19:19:19 (T_5, T_6, T_7, T_8, T_9 and T_{10}) recorded higher phosphorus uptake by soybean crop than treatments with KNO_3 and urea spray (T_2, T_3 and T_4). This was because of the presence of phosphorus in 19:19:19 fertilizer and its absence in other water soluble fertilizers namely urea and KNO_3. The phosphorus assimilated along with nitrogen enhances cell division and cell elongation leading to increased drymatter yield. Since KNO_3 lacks phosphorus, there might be less absorption of phosphorus and the phosphorus applied through basal dose at sowing might not be available at later stages because of fixation in required quantity and precipitation in the soil, consequently resulting in its lower availability and lower uptake. Treatments receiving two foliar sprays of 1.0 per cent 19:19:19 fertilizer recorded higher P uptake by the crop at harvest compared to one foliar spray at 0.5 per cent concentration. This was mainly because of higher phosphorus supply through 1.0 per cent spray of fertilizer solution of 19:19:19 which was sufficient to meet the P requirement of soybean.

Potassium and Sulphur uptake was significantly influenced by foliar application of KNO_3, urea and 19:19:19 fertilizers. Perusal of the data indicated that the treatments received foliar sprays of 19:19:19 (T_5, T_6, T_7, T_8, T_9 and T_{10}) recorded higher potassium and sulphur uptake. The higher uptake of these nutrients by soybean crop was attributed to the higher drymatter production. Similar results of increased uptake of nutrients due to foliar nutrition were recorded by Raman and Venkataramana (2006) [8] in greengram and Chapgain and Wiseman (2004) [3] in tomato.

Control recorded lowest uptake of nitrogen, phosphorus, potassium and sulphur because basal application of nutrients at the time of sowing might have been subjected to fixation and leaching losses which might have reduced their availability to the crop at later growth stages and hence lower drymatter accumulation was recorded in control.

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