International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 2306-2309

Received: 18-05-2018
Accepted: 25-06-2018

Sharifi SK
Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Bengaluru, Karnataka, India

Lalitha BS
Associate Professor, Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Bengaluru, Karnataka, India

Prajwal Kumar GK
Ph. D. Scholar, Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Bengaluru, Karnataka, India

Qasimullah R
Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Bengaluru, Karnataka, India

Correspondence
Lalitha BS
Associate Professor, Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Bengaluru, Karnataka, India

Effect of foliar application of water soluble fertilizer on nutrient uptake and economics of soybean (*Glycine max* L. Merrill)

Sharifi SK, Lalitha BS, Prajwal Kumar GK and Qasimullah R

Abstract
The field experiment was conducted during 2016-17 at Zonal Agricultural Research Station GKVK, Bengaluru to study the effect of water soluble fertilizer on nutrient uptake and economics benefits of soybean (*Glycine max* L. Merrill). The experiment was laid out in Randomized Complete Block Design with seven treatments replicated thrice. Recommended dose of fertilizer (RDF) in combination with foliar spray of macro nutrients were taken into study. The results revealed that RDF + foliar application of WSF @ 2 % at flowering and pod filling stage recorded significantly higher nutrient uptake *viz.*, nitrogen uptake (121.53 kg ha^{-1}), phosphorus uptake (16.74 kg ha^{-1}), potassium uptake (107.50 kg ha^{-1}), and higher net returns (₹ 50526 ha^{-1}), benefit cost ration (2.71) was recorded with significantly higher values.

Keywords: Foliar application, water soluble fertilizer, nutrient uptake, economics, soybean

Introduction
Soybean (*Glycine max* L.) Merrill is a dual purpose, most important rainy season crop to meet the pulse and oil requirements. It has 40 per cent protein with well-balanced essential amino acids and 20 per cent oil with polyunsaturated fatty acids, 6-7 per cent minerals, 5-6 per cent crude fiber and 17-19 per cent carbohydrates. The protein quality of soybean is equivalent to that of meat, milk and egg and recognized as a potential supplementary source of oil. The crop also helps in improving the fertility status of soil through symbiotic nitrogen fixation. Thus, it is miracle bean having many advantages and the crop in fact has made revolution in the agricultural economy with its immense potential utility as food, feed, numerous industrials products and export commodity in addition to improving soil fertility.

Nitrogen is one of the most recognized plant nutrient required in abundant put forth more vegetative growth, reproductive parts and also integral part of protein molecule. It plays an important role in synthesis of the plant constituents through the action of different enzymes. Phosphorus requirement is high in young cells, such as shoot and root tips, where metabolism is high and cell division occurs rapidly. Root development, flower initiation, seed and fruit development is aided by phosphorus and it has been shown to reduce disease incidence in some plants and found to improve the quality of certain crops. Potassium is an important macro-nutrient and the most abundant cation in higher plants and essential for enzyme activation.

Jyothi *et al.* (2013) [3] reported that foliar spray of 2 % urea at pod development and flowering stage significantly increased uptake of Zn, N by soybean and also soil application of NPK fertilizer was found to be more beneficial to improve the productivity of soybean than NPK application alone in soybean. Kumar *et al.* (2013) [4] reported that the foliar application of soluble starter NPK @ 2 per cent + sulphur spray 2 per cent at 45 DAS and soluble booster NPK 2 per cent + boron spray 0.15 per cent at 65 DAS resulted in significantly higher oil content, oil yield, protein content.

Materials and Methods
The present investigation was carried out during 2016-17, in the department of agronomy, College of Agriculture, UAS GKVK, Bengaluru, Karnataka, India. The experiments were laid out in RCBD (Randomized Complete Block Design), Soybean (*Glycine max* L. Merrill), KBS-23 variety were taken into study.

The experiments consist of seven treatment which was replicated thrice, recommended dose of fertilizer (RDF) and in combination with foliar spray of macro nutrients were taken into study *viz.*, T_1 Recommended fertilizer dose, T_2- RDF (50 % N as basal and 50 % N as top dressing), T_3- RDF + foliar application of WSF @ 2 % at 8-12 leaf stage, T_4- RDF + foliar application of WSF @ 2 % at flowering stage, T_5-RDF + foliar application of WSF @ 2 % at pod filling stage, T_6- RDF + foliar application of WSF @ 2 % at flowering and pod filling stage, T_7- Recommended dose of nitrogen through FYM only.

Digestion of plant samples

One gram plant sample was collected from each treatment and was digested with nitric acid and perchloric acid (9:4). The filtered digested sample was filtered and made up to 50 ml volume with 6 N HCl and was used for the analysis of all mineral elements.

Nitrogen uptake (kg ha^{-1})

Nitrogen content was estimated by modified micro-kjeldhal's method as outlined by Jackson (1967) [2] and expressed in percentage. Nitrogen uptake (kg ha^{-1}) by crop was calculated for each treatment separately using the following formula.

$$\text{Nitrogen uptake (kg ha}^{-1}\text{)} = \frac{\text{Nitrogen concentration (\%)}}{100} \text{ X Dry matter (kg ha}^{-1}\text{)}$$

Phosphorus uptake (kg ha^{-1})

Phosphorus content in the digested plant sample was estimated by vanadomolybdate phosphoric yellow colour method in nitric acid medium and the colour intensity was measured at 660 nm wave length as outlined by Jackson (1967) [2]. It was calculated using the following formula.

$$\text{Phosphorus uptake(kg p}_2\text{o}_5\text{ ha}^{-1}\text{)} = \frac{\text{Phosphorus concentration (\%)}}{100} \text{ x Dry matter (kg ha}^{-1}\text{)}$$

Potassium uptake (kg ha^{-1})

Potassium in the plant and tuber samples digest was estimated by atomizing the diluted acid extract in a flame photometer as described by Jackson (1967) [2]. It is calculated using the following formula.

$$\text{Potassium uptake (kg K}_2\text{O ha}^{-1}\text{)} = \frac{\text{Potassium concentration (\%)}}{100} \times \text{Dry matter (kg ha}^{-1}\text{)}$$

Economics

The economics of soybean crop production pertaining to each of the treatment has been worked out in terms of cost of cultivation. Gross return (Rs ha^{-1}) was obtained by converting the harvest into monetary terms at the prevailing market rate during the course of investigation for every treatment. Net return (Rs ha^{-1}) was obtained by deducting cost of cultivation from gross return. The additional return over control and benefit: cost ratio was calculated with the help of following formula:

$$\text{Net return (Rs. ha}^{-1}\text{)} = \text{Gross return (Rs. ha}^{-1}\text{)} - \text{Cost of cultivation (Rs. ha}^{-1}\text{)}$$

Table 1: Physical and chemical properties of soil of the experimental site at ZARS, GKVK, UAS, Bengaluru

Particulars	Methods followed	Values
A. Physical properties		
Mechanical analysis (oven dry weight basis)		
Coarse sand (%)	International pipette method (Piper, 1966) [8]	33.20
Fine sand (%)		36.36
Silt (%)		7.26
Clay (%)		23.18
Texture class	Sandy clay loam	
B. Chemical properties		
pH	Buckman's zerometric pH meter (Piper, 1966) [8]	6.56
EC (dSm^{-1})	Conductometry (Jackson, 1967) [2]	0.14
Organic carbon (%)	Walkey and Black wet oxidation method (Subbiah and Asija, 1956) [10]	0.43
Available N (kg ha^{-1})	Alkaline permanganate method (Subbiah and Asija, 1956) [10]	175.61
Available P_2O_5 (kg ha^{-1})	Olsen's method (Jackson, 1967) [2]	43.56
Available K_2O (kg ha^{-1})	Neutral normal ammonium acetate method (Jackson, 1967) [2]	273.24

Result and Discussion

The data on nitrogen uptake, Phosphorus uptake and Potassium uptake, as influenced by foliar application of water soluble fertilizer are presented in Table 2. The results indicated that significantly higher nutrient uptake *viz.*, nitrogen uptake (121.53 kg ha^{-1}), Phosphorus uptake (16.74 kg ha^{-1}), Potassium uptake (107.50 kg ha^{-1}), were recorded with application of RDF + foliar application of WSF @ 2 % at flowering + pod filling stage (T_6) over all other treatments. Followed by application of RDF + foliar application of WSF @ 2 % at pod filling stage (T_5), which was on par with RDF + foliar application of WSF @ 2 % at flowering stage (T_4). Whereas, the recommended dose of nitrogen through FYM only (T_7) had the least effect in all the parameters.

The significant increase in nitrogen uptake was mainly due to increase in P and B level. The increased uptake may also be accounted for synergistic effect between N and P. Higher level of P must have enhanced the root growth, which helped in better absorption of nitrogen through symbiotic nitrogen fixation process (Veerabhadrappa, 2003) [11]. Muthuvel *et al.*

(1985) [6] reported that, foliar spray of 2 per cent DAP and 1 per cent urea at flowering stage, soil nutrient status was increased with the available N, P and K status of soil (131, 6.3 and 134 kg ha^{-1}, respectively) of rainfed black gram compared to no foliar spray.

The greater mobilization of phosphorus in presence of nitrogen was reported by Hocking and Pinkerton (1993) [1]. Specially in case of P and K, applied P and K will be absorbed within 20-25 days after application so there will be less P in soils. At this stage top up NPK will lead to increase in the uptake of nutrients. Singh and Kamath (1989) [9] found that foliar application of 1.5 kg P_2O_5 in two sprays significantly increased the P uptake (20.5 mg $plot^{-1}$) and dry matter (7.71 gm $plot^{-1}$) of Mustard.

This higher uptake of Potassium might be attributed due to significantly higher dry matter accumulation as a result of application of other deficient nutrients such as N, P, S and B. The results confirm that micronutrients application enhanced the potassium uptake. Nelson *et al.* (2005) [7] reported that foliar application of potassium sulphate @ 36 $kgha^{-1}$ on soybean leaves acts as an excellent method of supplementary fertilization when edaphic climatic condition do not favor the satisfactory uptake of potassium from soil thus resulting in increased yield.

Economics

The data on economics benefits of soybean as influenced by foliar application of water soluble fertilizer are presented in Table 3. The results indicated that significantly higher. Net returns (₹ 50526 ha^{-1}), benefit cost ration (2.71) was, recorded with application of RDF + foliar application of WSF @ 2 % at flowering + pod filling stage (T_6) over all other treatments. Followed by application of RDF + foliar application of WSF @ 2 % at pod filling stage (T_5), which was on par with RDF + foliar application of WSF @ 2 % at flowering stage (T_4). Whereas, the recommended dose of nitrogen through FYM only (T_7) had the least effect in all the parameters. This may be attributed due to lower cost of cultivation with increased seed yield kg ha^{-1} compared to other treatment combinations which provided the acceptable gross returns. The benefit cost ratio was higher than one in all the treatments, suggesting that foliar application of RDF + foliar application of WSF @ 2 % at flowering + pod filling stage.

Kumar *et al.* (2013) [5] reported that foliar spray of 2 % of DAP twice at flowering initiation and pod formation stage of crop growth resulted in significantly higher net return of Rs 20,090 with B: C Ratio of 2.22 in soybean. Similarly, Vinothkumar *et al.* (2013) [12] revealed that foliar spray of 2 per cent DAP twice at flower initiation and pod formation stages of crop growth resulted in significantly higher grain yield (1460 kg ha^{-1}) and it was on par with 2 per cent urea phosphate and TNAU pulse wonder spray. The foliar spray of 2 per cent DAP also recorded significantly higher net returns of Rs. 20,090 with B:C ratio of 2.22

Table 2: NPK uptake of soybean as influenced by foliar application of water soluble fertilizer NPK (19:19:19) fertilizer

Treatments	N (kg ha^{-1})	P_2O_5(kg ha^{-1})	K_2O (kg ha^{-1})
T_1	76.67	9.24	68.78
T_2	77.60	9.93	66.47
T_3	88.11	10.22	75.18
T_4	93.88	12.05	81.20
T_5	103.94	14.30	91.03
T_6	121.13	16.74	107.50
T_7	67.92	8.00	55.55
S.Em±	5.56	0.64	5.23
CD. (p=0.05)	16.12	1.98	16.13

Table 3: Economics of soybean as influenced by foliar application of water soluble (NPK) fertilizer

Treatments	Yield (kg ha^{-1})	Price (₹ kg^{-1})	Gross income ₹ ha^{-1}	Total cost ₹ ha^{-1}	Net income ₹ ha^{-1}	B:C ratio
T_1	1533	35	53660	26075	27585	2.05
T_2	1518	35	53148	26075	27073	2.03
T_3	1637	35	57296	27743	29553	2.06
T_4	1782	35	62405	27743	34662	2.24
T_5	2006	35	70230	27743	42487	2.53
T_6	2283	35	79936	29410	50526	2.71
T_7	1296	35	45370	29547	15823	1.53

References

1. Hocking PJ, Pinkerton A. Phosphorous nutrition of linseed (*Linum usitatissimum* L.) as affected by nitrogen supply: effects on vegetative development and yield components. Field crops research. 1993; 32(1-2):101-114.
2. Jackson ML. Soil chemical analysis, Prentice Hall of India, Pvt. Ltd., New Delhi, 1967.
3. Jyothi CN, Ravichandra K, Babu SK. Effect of Foliar Supplementation of Nitrogen and Zinc on Soybean (*Glycine max.* L.) Yield, Quality and Nutrient Uptake. Indian J Dryland Agric. Res. Dev. 2013; 28(2):46-48.
4. Kumar CV, Vaiyapuri K, Amanullah MM, Gopalaswamy G. Influence of Foliar Spray of Nutrients on Yield and Economics of Soybean (*Glycine max* L. Merill). J Bio.l Sci. 2013; 13(6):563-565.
5. Kumar S, Basavarajappa R, Salakinkop SR, Hebbar M, Basavarajappa MP, Patil HY. Influence of Foliar Nutrition on Performance of Blackgram (*Vigna mungo* L.), Nutrient Uptake and Economics under Dry Land Ecology. *Legume Res.* 2013; 36:5-12.
6. Muthuvel P, Sivasamy R, Subramanian V. Mitigating the adverse effect of drought in rainfed blackgram. J Madras Agric. 1985; 72(1):22-24.
7. Nelson KA, Motavalli PP, Nathan M. Response of No-till soybean to [*Glycine max* (L) Merrill] to timing of pre-plant and foliar potassium application in a clay pan soil. J Agron. 2005; 97(3):832-838.

8. Piper CS. Soil and Plant Analysis, Academic Press, New York, 1966, 236.
9. Singh S, Kamath MB. Phosphate utilization from full basal, split and foliar application by mustard. J Oilseed Res. 1989; 6:133-135.
10. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Curr. Sci. 1956; 25(8):259-260.
11. Veerabhadrappa BH. Effect of foliar nutrition (N, P, K, Ca and S) on growth and yield of groundnut. M. Sc (Agri) Thesis, Univ. Agric. Sci., Dharwad, Karnataka (India), 2003.
12. Vinothkumar C, Vaiyapuri M, Mahamed A, Gopalswamy. Influence of foliar spray of nutrients on yield and economics of soybean (*Glycine max* L. Merril). J Bi. Sci. 2013; 13(6):563-565.