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Effect of foliar nutrition on, light interception, production efficiency, productivity rating index and energetic of soybean [*Glycine max* (L.) Merrill]

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Abstract
The present investigation entitled ‘‘Effect of foliar nutrition on light interception, production efficiency, production rating index and energetic of soybean [*Glycine max* (L.) Merrill]’’ was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur during *Kharif* season of 2016. Experiment was laid out in Randomized Block Design (RBD) with three replications. The soybean variety JS-97 52 tested under different foliar application of nutrients. The result revealed application of RDF + spray of DAP @ 2% at pre flowering and pod initiations stages of crop resulted significantly higher percentage of Productivity rating index and production efficiency. The higher Energy use Efficiency (MJ 10^{-3} ha^{-1}) recorded under the spray of RDF + Urea 2% spray at pod initiation and light interception getting non-significant of all the treatments.

Keywords: Flowering, energetic, soybean, light interception, production efficiency

Introduction
The protein quality of soybean is equivalent to that of meat, milk products and eggs. It is generally grown as a rainy season crop under *rainfed* situation. Soybean is an annual legume and producing for edible oil and feeding livestock. Its crude protein content ranges from 41% to 50% (dry matter basis) (Liener 1994; Balat and Balat, 2010) [4, 1]. It contains about 40% protein, well balanced in essential amino acids, 20% oil rich with poly unsaturated fatty acids specially Omega 6 and Omega 3 fatty acids, 6-7% total mineral, 5-6% crude fiber and 17-19% carbohydrates. Soybean is recognized as golden bean because of its high nutritional values and economic importance. Foliar spraying is one alternative approach through micro nutrients are made to crop in liquid form through foliage. Foliar application of microelements is more beneficial than soil application. Since application rates are lesser as compared to soil application, same application could be obtained easily and crop reacts to nutrient application immediately (Zayed *et al.,* 2011) [8]. Foliar spraying of microelements is very helpful when the roots cannot provide essential micro nutrients to the crop (Kinaci and Gulmezoglu, 2007) [2]. Keeping the above fact in mind, the present investigation entitled “Effect of foliar nutrition on Chlorophyll content, light interception and Energetic of soybean [*Glycine max* (L.) Merrill]’’.

Materials and Methods
A field experiment was conducted at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur to evaluate the “Effect of foliar nutrition on light interception, production efficiency, production rating index and energetic of soybean [*Glycine max* (L.) Merrill]’’. Under Vertisols of Chhattisgarh plains. The soil was clayey in nature, neutral in pH and had low nitrogen, medium phosphorus and high in potassium content. The experiment was laid out in Randomized Block Design with three replications. The treatments were allotted in field follow the random methods. The nine treatments consisted of various combination of nutrition application of RDF + Water spray at pod initiation, RDF + Urea 2% spray at pod initiation RDF + DAP 2% spray at pod initiation, RDF + MOP 0.5% at pod initiation, RDF + NPK (19:19:19) 2% at pod initiation, RDF + Molybdenum 0.5% at pod initiation, RDF + Boron 0.5% at pod initiation, RDF + Zinc Chelated 0.5% at pod initiation, RDF alone.

Recommended dose of fertilizer applied as basal dose and micronutrients applied as foliar spray at pre flowering and pod initiation stage of soybean. Growth parameters for the crop recorded during the crop growth periods.

Productivity Rating Index (PRI) - The actual yield data were used for calculating the PRI. It was calculated by using the following formula. Standard yield was taken 15 q ha^{-1} as reported by Ramana *et al.* 2007 [6].

$$\text{Productivity rating index} = \frac{\text{Yield obtained from experimental plot (kg ha}^{-1})}{\text{Standard yield (kg ha}^{-1})}$$

Production Efficiency (PE) - Production efficiency of soybean was calculated by using the formula given by Tomar and Tiwari (1990) [7].

$$\text{Production efficiency (kg ha}^{-1}\text{ day}^{-1}) = \frac{\text{Seed yield (kg ha}^{-1})}{\text{Duration of the crop (days)}}$$

Result and Discussion

Light Interception (%) on soybean

Light interception $plant^{-1}$ under different foliar nutrition on soybean has been given below; In general light interception was reduced with the advancement of crop age. At 40 DAS the highest Light Interception (%) in soybean under spray of RDF + DAP 2% spray and after the spray of nutrition light interception (%) non-significant effect of all the treatments. light interception effect decreasing with increasing the plant age because plant of leaf also going to reduce photosynthesis or curling so leaf enable to intercept the light.

Yield indices

Productivity rating index and Production efficiency (%)

Higher productivity rating index and Production efficiency (%) of soybean under the application of RDF + DAP 2% spray at pre flowering stage and pod initiation stage. this may be that production efficiency of soybean was increased because of increase in seed yield. The improved nutrional environment as a result of increased absorption of nutrients by their genetic ability. This favourable characterization to increased translocation of photoassimilation to sink resulting information of bold and better quality seeds. Foliar spray of DAP had effect in improving number of pods per plant, number of clusters per plant, 100- seed weight, yield and harvest index which ultimately increased the significant yield. Reported by Kumar, *et al.*, (2013) [4].

Table1: Effect of foliar nutrition on light interception (%) of soybean.

Treatments	Light Interception	
	40 DAS	80 DAS
T_1: RDF + Water spray at pod initiation	74.00	50.17
T_2: RDF + Urea 2% spray at pod initiation	73.97	55.80
T_3: RDF + DAP 2% spray at pod initiation	74.90	56.00
T_4: RDF + MOP 0.5% at pod initiation	74.20	55.00
T_5: RDF+19:19:19 (NPK) 2% at pod initiation	73.90	56.10
T_6: RDF +Molybdenum 0.5% at pod initiation	72.90	56.90
T_7: RDF + Boron 0.5% at pod initiation	74.80	55.80
T_8: RDF + Zinc Chelated 0.5% at pod initiation	73.90	55.10
T_9: RDF only	73.53	53.50
SE m±	0.428	1.441
CD (P=0.05)	1.285	NS

Table 2: Effect of foliar nutrition on productivity rating index and production efficiency of soybean

Treatments	Productivity rating index	Production efficiency (%)
T_1: RDF + Water spray at pod initiation	1.36	18.50
T_2: RDF + Urea 2% spray at pod initiation	1.40	19.20
T_3: RDF + DAP 2% spray at pod initiation	1.44	19.60
T_4: RDF + MOP 0.5% at pod initiation	1.41	19.20
T_5: RDF+19:19:19 (NPK) 2% at pod initiation	1.36	18.60
T_6: RDF +Molybdenum 0.5% at pod initiation	1.21	16.50
T_7: RDF + Boron 0.5% at pod initiation	1.31	17.90
T_8: RDF +Zinc Chelated 0.5% at pod initiation	1.33	18.10
T_9: RDF only	1.29	17.40
SE m±	0.019	0.066
CD (P=0.05)	0.057	0.199

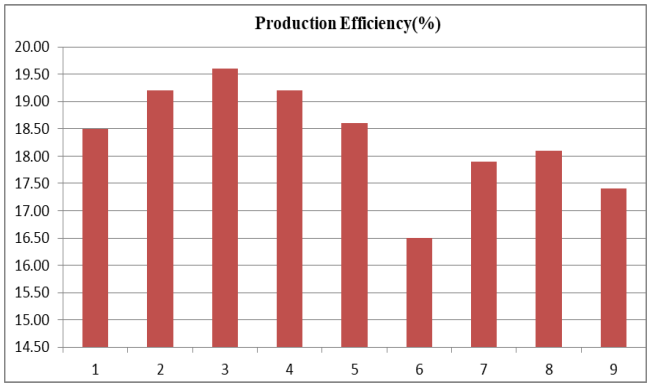

Fig 1: Production Efficiency (%) of soybean

Energetic of soybean

The maximum energy output: input ratio and energy use efficiency was recorded under treatment of RDF + Urea 2% spray and minimum value of above parameter was recorded under treatment of RDF +Molybdenum 0.5% at pod initiation It shows that soybean production depends on non-renewable energy and mainly electricity. So deposit of rising electricity price optimum usage of electricity is necessary. Cost energy ratio can be increased by raising the crop yield, optimal usage of inputs and improving renewable energy consumption. Although, timing of any operations and use of the inputs is not significant issue, it is an important factor to reducing energy consumption. Therefore, there is a need to develop a new policy to encourage farmers to on time planting. Fortunately, in recent years soybean yield has increased, The maximum energy use efficiency was recorded under the spray of RDF + Urea 2% spray at pod initiation it is due to cost energy ratio can be increased by raising the crop yield, optimal usage of inputs and improving renewable energy consumption reported by Peyman *et al.*, (2013).

Conclusion

The total energy requirement for cultivating soybean was found to be 13.362MJha^{-1} which is higher as compared to other treatments, and also higher energy use efficiency found under application of RDF + Urea 2% spray at pre flowering and pod initiation stage. So on the basis of this experiments we suggest to farmer they use spray of RDF + Urea 2% at pre flowering and pod initiation stage for getting high energy use efficiency on their farm.

Table 3: Effect of foliar nutrition on energetic of soybean

Treatments	Energy input (MJ 10^{-3})	Energy output (MJ 10^{-3})	Energy input output ratio	Energy use Efficiency (MJ 10^{-3}ha^{-1})
T_1: RDF + Water spray at pod initiation	12.763	64.43	5.04	12.78
T_2: RDF + Urea 2% spray at pod initiation	13.362	66.43	4.97	13.36
T_3: RDF + DAP 2% spray at pod initiation	12.875	68.8	5.34	12.88
T_4: RDF + MOP 0.5% at pod initiation	12.779	66.82	5.22	12.80
T_5: RDF+19:19:19 (NPK) 2% at pod initiation	13.012	64.46	4.95	13.02
T_6: RDF +Molybdenum 0.5% at pod initiation	12.868	57.59	4.47	12.88
T_7: RDF + Boron 0.5% at pod initiation	12.769	61.87	4.84	12.76
T_8: RDF + Zinc Chelated 0.5% at pod initiation	12.945	62.80	4.85	12.94
T_9: RDF only	12.747	60.88	4.70	12.95

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