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Soybean productivity as influenced by foliar application of nutrients

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Abstract
A field experiment was conducted at Birsa Agricultural University experimental farm (Kanke), Ranchi, Jharkhand for three consecutive years during kharif season of 2015, 2016 and 2017. The experiment was laid out in Randomized Block Design with nine treatments replicated thrice. Treatment comprised of foliar application of nutrients along with recommended dose of fertilizer i.e. water spray, urea 2% spray, DAP 2% spray, MOP 0.5% spray, 19:19:19 (N: P_2O_5:K_20) 2% spray, molybdenum 0.1% spray, boron 0.5% spray, zinc chelated 0.5% spray and RDF only. All the foliar applications were done at pod initiation stage of soybean and RDF (20:80:40 kg NPK/ha) was applied as basal at the time of sowing. Results clearly indicated that productivity of soybean was significantly influenced by foliar application of nutrients and foliar application of 19:19:19 (NPK) @ 2% along with RDF at pod initiation stage of soybean recorded highest grain yield (2189 kg /ha) which was significantly better than all the treatments except application of 2% urea along with RDF at pod initiation stage. Net return and benefit cost ratio was also significantly influenced by foliar application of nutrients and maximum net return (`40008) and B: C ratio (1.83) was recorded in application of 2% urea along with recommended dose of fertilizers.

Keywords: Soybean, Foliar nutrients, net return and B: C ratio

Introduction
Soybean (*Glycine max* (L.) Merril) has a prominent place among modern agricultural commodities, as the world's most important seed legume, which contributes about 25% to the global edible oil production, cultivated in an estimated global area of 121.53 million ha with a production reaching 314.81 million tones and productivity of 2.59 tones/ ha. Among the major soybean growing countries, India ranks fourth in terms of area (11.6 m ha) under soybean and fifth in terms of production (7.1 m tons). In Jharkhand, the estimated area under soybean production is 10000 ha with total production of 6000 metric tons (Anonymous, 2016).
Foliar spray of nutrients is the fastest way to boost up crop growth because the nutrients are available to plants quickly in the initial and critical stages of crop (Jamal *et al.*, 2006). Flower senescence and poor pod filling are the major drawbacks in soybean, which can be managed through foliar application of nutrient. It is being widely practiced to correct nutritional deficiencies in plants, which is better than soil application and also eco-friendly. Application of fertilizer as foliar spray resulted in efficient absorption and it is most economical way fertilization to achieve quality produce and higher productivity, especially when sink competition for carbohydrates among plant organs take place, while nutrient uptake from the soil is restricted. Foliar application of 2% diammonium phosphate (DAP) resulted in significantly higher number of pods per plant, number of seeds per pod, seed index and higher yield of soybean (Kumar *et al.*, 2013Foliar application of N:P:K improve the ability of the plant for synthesis, storage and translocation of nutrient in common bean. Foliar application of zinc increases the yield and protein content of soybean. Foliar spray of 0.1% borax significantly increased germination percentage, 1000 seed weight of soybean (Crak *et al.*, 2006). Foliar application of molybdenum had a positive effect on the activities of nitrate reductase and glutamine synthetase enzymes in shoots and it also reduces the inhibitory effect of molybdenum shortage on root nodulation, plant dry biomass and protein content of soybean.

Materials and Methods
A field experiment was conducted at Birsa Agricultural University experimental farm Ranchi, Jharkhand situated at an altitude of 625 m above MSL, 23º17"North latitude and 35 º 19"East longitudes for three consecutive years during *kharif* season of 2015, 2016 and 2017. The experiment was laid out in Randomized Block Design with nine treatments replicated thrice. Treatment comprised of foliar application of nutrients along with recommended dose of fertilizer i.e.

water spray, urea 2% spray, DAP 2% spray, MOP 0.5% spray, 19:19:19 (N: P_2O_5:K_20) 2% spray, molybdenum 0.1% spray, boron 0.5% spray, zinc chelated 0.5% spray and RDF only. All the foliar applications were done at pod initiation stage of soybean and RDF (20:80:40 kg NPK/ha) was applied as basal at the time of sowing. The experimental soil was sandy loam in texture, moderately acidic in reaction (pH 5.2), low in available N (198.50 kg/ha), medium in available phosphorus (14.75 kg/ha), available potassium (130 kg/ha), available boron (0.57 mg/kg), available molybdenum (0.24 mg/kg) and available zinc (0.61 mg/kg). Crop received recommended basal dose of nutrients @ 20:80:40: kg $N:P_2O_5:K_2O$ ha^{-1} through di-ammonium phosphate and muriate of potash, respectively. Soybean seed were inoculated with *Bradyrhizobium japonicum* culture @ 5 g kg^{-1} seed. Crop was harvested at physiological maturity, threshed and plot-wise seed and straw yields in kg/ ha was recorded. Final seed samples were taken from each plot for analysis of nitrogen by modified kjeldhal method as described by Black (1965). Protein content (%) was estimated by multiplying nitrogen content in grain with the factor 5.71(Sadasivam and Manickam, 1996). Oil content was estimated by Soxhlet extraction method. The biometric observations were taken from the 5 randomly selected plants of each plot demarcated with proper pegging. The plant dry weight destructive sampling procedure was followed and three plants were uprooted from the 2nd row at either side of the plots. Crop growth rate (CGR) was calculated by adopting the following formulae as suggested by Watson (1952).

$$\text{CGR (g day}^{-1}\text{ plant}^{-1}) = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{A}$$

Where, W_1 = Dry weight of plant (g) at time t_1

W_2 = Dry weight of plant (g) at time t_2

$t_2 - t_1$ = Time interval in days

A = Unit area occupied by plants (m^2)

Since data followed the homogeneity test, pooling of data was done over the seasons and mean data was statistically analyzed as per standard method prescribed by Cochran and Cox, 1957

Results and Discussion

Effect on Dry matter and CGR

Vegetative growth mainly consists of formation of somatic cells which results in growth and formation of new leaves, stems and roots and these meristmatic tissues have a very active protein metabolism. Plant dry matter increases progressively and was significantly influenced by foliar application of nutrients. Maximum dry matter at 75 days after sowing was observed with application of 19:19:19 (N: P: K) @ 2 % applied at pod initiation stage which was closely followed by application of Urea @ 2%. These two treatments were significantly better than water spray and RDF alone. Similarly crop growth rate was recorded maximum with 19:19:19 (N: P: K) @ 2 % at pod imitation stage. Dry matter production is the sum total effect of overall growth of the plant like plant height, nodule count and leaf area indicating higher chlorophilic area with improved photosynthetic efficiency of the plants which in turn resulted in higher dry matter accumulation.

Effect on Yield Attributes and Yield

Grain and straw yield of soybean was significantly influenced by foliar application of nutrients (Table 2) and maximum grain yield (2189.89 kg/ha) was recorded with application of RDF + 19:19:19 (N: P: K) 2% spray which was closely followed by RDF + Urea 2% spray and the increase was 22.22 % and 17.97% respectively over control (RDF only). Yield increased with the increase in the number of branches per plant, pods per plant and 100 seed weight due to 19:19:19 (N:P:K) has a profound effect on plant reproductive development and seed yield (Kaiser *et al.,* 2005). Urea increase the photosynthetic activity and delay the senescence of leaves, which enhances the supply of photosynthate available for grain filling, thus resulted in bigger grains and ultimately yield will be increased (Tiwari *et al.,* 2011).

Effect on Economics

Soybean crop fertilized with RDF and sprayed with 19:19:19 (N: P: K) 2% spray generate maximum and significantly higher gross return (73176 `/ha) than other nutrient except RDF + urea 2 % spray (69709 `/ha). Maximum net return and benefit: cost ratio was (45931`/ha and 1.93 respectively) was obtained with application of RDF + Urea 2% spray. It may be due to increase in yield with foliar application of Urea which involves low input cost (Kuttimani and Velayutham, 2011).

Table 1: Effect of foliar application of nutrients on dry weight and CGR of soybean

Treatments	Plant dry weight (g)			CGR	
	45 DAS	60 DAS	75DAS	45-60 DAS	60-75 DAS
RDF + water spray at pod initiation	10.23	16.80	18.88	0.438	0.139
RDF + Urea 2% spray at pod initiation	10.86	17.97	20.16	0.474	0.146
RDF + DAP 2% spray at pod initiation	10.18	17.61	20.10	0.496	0.166
RDF + MOP 0.5% at pod initiation	10.21	17.00	19.41	0.452	0.161
RDF + 19:19:19 (NPK) 2% at pod initiation	10.93	18.34	20.55	0.494	0.147
RDF + Molybdenum 0.1% at pod initiation	10.90	17.66	19.33	0.450	0.111
RDF + Boron 0.5% at pod initiation	10.14	17.38	18.87	0.483	0.099
RDF +Zinc chillated 0.5% at pod initiation	10.99	17.61	19.23	0.441	0.108
RDF only	10.24	16.53	18.80	0.419	0.152
SEm±	0.38	0.48	0.38	0.042	0.046
CD (P=0.05)	NS	1.45	1.15	NS	NS

Table 2: Effect of foliar application of nutrients on yield attributes grain and straw yield of soybean

Treatments	Branches/ plant	Pods/ plant	100 seed wt (g)	Seed yield (kg/ha)	Straw yield (kg/ha)
RDF + water spray at pod initiation	3.17	36.10	9.09	1861.02	3218
RDF + Urea 2% spray at pod initiation	3.40	40.40	9.28	2113.70	3488

RDF + DAP 2% spray at pod initiation	3.38	39.83	9.20	2054.19	3392
RDF + MOP 0.5% at pod initiation	3.12	38.63	9.18	1954.67	3278
RDF + 19:19:19 (NPK) 2% at pod initiation	3.41	41.87	9.37	2189.83	3486
RDF + Molybdenum 0.1% at pod initiation	3.06	37.77	9.13	2092.07	3239
RDF + Boron 0.5% at pod initiation	3.09	36.50	9.11	1965.59	3201
RDF +Zinc chillated 0.5% at pod initiation	3.11	36.23	9.10	2029.25	3232
RDF only	3.09	35.60	9.07	1791.75	3155
SEm±	0.11	1.10	0.09	58.70	59.99
CD (P=0.05)	NS	3.31	NS	176.00	179.86

Table 3: Effect of foliar application of nutrients on economics of soybean

Treatment	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
RDF + water spray at pod initiation	23648	62969	39321	1.66
RDF + Urea 2% spray at pod initiation	23778	69709	45931	1.93
RDF + DAP 2% spray at pod initiation	24128	69018	44890	1.86
RDF + MOP 0.5% at pod initiation	23738	66737	42999	1.81
RDF + 19:19:19 (NPK) 2% at pod initiation	26848	73166	46318	1.73
RDF + Molybdenum 0.1% at pod initiation	28398	66437	38039	1.34
RDF + Boron 0.5% at pod initiation	26148	65100	38952	1.49
RDF +Zinc chillated 0.5% at pod initiation	25148	64524	39376	1.57
RDF only	23160	62796	39636	1.71
SEm±	-	1969.34	1969.34	0.08
CD (P=0.05)	-	5904.33	5904.33	0.24

Conclusion

Based on the result of present investigation, it may be concluded that foliar application of Urea 2% spray along with RDF found most advantageous as it produced highest net return and benefit cost ratio making it economically viable for the farmers in upland situation of Jharkhand.

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