RESEARCH ARTICLE

EFFECT OF FOLIAR APPLICATION OF NUTRIENTS ON SOYBEAN

Pratima Kumari*, A.K. Singh, P.K. Dewangan, S.C. Pankaj and A.K. Lakra

Department of Agronomy, Birsa Agricultural University, Ranchi-834006 Jharkhand
Email: pratimakumari08812@gmail.com

Received-16.02.2017, Revised-08.03.2017

Abstract: An experiment was conducted at BAU experimental farm (Kanke), Ranchi, Jharkhand during (Soybean) *Kharif* season 2015 on sandy loam soil with low organic carbon (4.10 gkg^{-1}) and available nitrogen (192.5 $kgha^{-1}$), moderately acidic (pH 5.1) in nature, medium potassium (128 $kgha^{-1}$), phosphorus (13.65 $kgha^{-1}$), boron (0.58 $mgkg^{-1}$), molybdenum (0.25 $mgkg^{-1}$) and zinc (0.60 $mgkg^{-1}$), with 9 treatments replicated thrice. Results revealed that the productivity of soybean was influenced by foliar application of nutrients. Among application of nutrients, RDF along with molybdenum 0.5% spray produced higher grain (1524 $kgha^{-1}$) and straw (2062 $kgha^{-1}$) yield, which was significantly higher than all other treatment but it was at par with RDF + zinc chealted 0.5% spray and RDF + 19:19:19 ($N:P_2O_5:K_2O$) 2% spray. However, foliar application of zinc chelated 0.5% spray along with RDF gave highest net return (22630 $Rs.ha^{-1}$) and benefit: cost ratio (1.19).

Keywords: Economics, Soybean, Foliar, Nutrient

INTRODUCTION

Soybean is worldwide grown important oilseed crop, because it has a wide range of geographical adaption. Soybean plays a major role in the world food trade. It constitutes about 42% area and 56% production of total oilseeds. Production of soybean in India at present time restricted mainly to Madhya Pradesh and alone it contributes about 67 and 56% in total area and production of soybean respectively and is called as "Soya state". It is also grown in Uttar Pradesh, Maharashtra and Gujarat. In Chhotanagpur region of Jharkhand it is grown as rainfed crop. In global Soybean production India's rank fifth and in acreage fourth, occupying 12.22 million ha area with production of 11.86 MT and productivity 971 kg/ha, whereas in Jharkhand soybean occupies 6000 ha area with production of 2400 ton and productivity 400 kg/ha (AICRPS, 2014) which is about 41% less than national average.

To meet out increasing demand to feed the ever growing population farmeruse more and more chemical fertilizer to increase productivity. Abundant use of chemical fertilizer degrade the soil physico-chemical properties consequently factor productivity declining. In order to avoid or minimize the severity of such condition, foliar application of nutrients is imperative and it is being widely practiced to correctnutritionaldeficiencies in plants, which is better than soil application with increased fertilizer use efficiency (Silberbush*et.al.*, 2002) and also eco-friendly (Abou-El-nour, 2002). Under rainfed condition when the moisture availability is scarce, the application of fertilizer as foliar spray resulted in efficient absorption and it is most economical way of 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 (Kannan, 1986 and Singh, 2007). Flower senescence and poor filling of pods are the major drawbacks in soybean, which can be managed through foliar application of nutrient. Several workers reported that foliar application of nutrient is most effective way to achieve higher yield of crop. Foliar application of 1% urea during pod development stage resulted in better yield of soybean (Ashour and Thalooth, 2003). Similarly, foliar applications of urea in chickpea before terminal drought, at 50% flowering increased yield and seed protein content (Jairo*et al.*, 2005). Foliar application of murate of potash (MOP) increased the yield of soybean (Kelly *et al.*, 2005). Foliar application of N:P:K improve the ability of the plant for synthesis, storage and translocation of nutrient in common bean **(**Rahman*et al.*, 2014). Foliar applicationof zinc (Zn) increases the yield and protein content of soybean (Hugar and Kurdikeri, 2000).

MATERIAL AND METHOD

A field experiment was conducted on representative medium land soil of Jharkhand plateau of Birsa Agricultural University farm, Kanke, Ranchi (23^0 17' N latitude, $85^0$10' E longitude and 625 m above the mean sea level) during the *Kharif* season of 2015. The experimental plots had assured irrigation facility coupled with uniform topography, good drainage and soil characteristics which is typical suitable for soybean cultivation. The experimental site was a typical medium land with good soil depth and drainage facility. The soil was red type which belongs to the red yellow- light-grey category association group representing the major soil order (*alfisols*) of Jharkhand state, with moderately acidic in reaction (pH 5.1), low in organic carbon (4.10 gkg^{-1}) and available N (192.5 $kgha^{-1}$), medium in available phosphorus (13.65 $kgha^{-1}$), available potassium (128$kgha^{-1}$), available boron (0.58 $mgkg^{-1}$), available molybdenum (0.25 $mgkg^{-1}$) and available zinc (0.60

*Corresponding Author

mgkg^{-1}).The experiment was laid out in Randomized Block Design with nine treatments replicated thrice. Treatment comprised ofT_1- RDF + water spray, T_2- RDF + urea 2% spray, T_3- RDF + DAP 2% spray, T_4- RDF + MOP 0.5% spray, T_5- RDF + 19:19:19 ($N:P_2O_5:K_2O$) 2% spray, T_6- RDF + molybdenum 0.5% spray, T_7- RDF + boron 0.5% spray, T_8- RDF + zinc chelated 0.5% spray and T_9- RDF only.Here recommended dose of fertilizer (RDF)- 20:60:40:30 ($N:P_2O_5:K_2O:S$) and all the spray was given at pod initiation stage

The experimental soybean (**JS-97-52**) crop was sown on 15th July 2015 using seeds75 kg ha^{-1}.

RESULT AND DISCUSSION

Yield attributing characters and yield

Examination of the data revealed that the foliar application of nutrients significantly influenced the number of branches per plant. The maximum number of branches per plant (2.33) was recorded in RDF + molybdenum 0.5% spray, which was at par with RDF + zinc chelated 0.5% spray (2.30), RDF + 19:19:19 ($N:P_2O_5:K_2O$) 2% spray (2.29), RDF + urea 2% spray (2.25), RDF + DAP 2% spray (2.23), RDF + boron 0.5% spray (2.13) and RDF + MOP 0.5% spray. Maximum number of pods plant^{-1} (31) recorded with application of 0.5% molybdenum spray along with RDF and zinc chelated 0.5% spray along with RDF, which was significantly higher than all other treatment except RDF + 19:19:19 ($N:P_2O_5:K_2O$) 2% spray (30). Foliar application of molybdenum 0.5% spray, zinc chelated 0.5% spray, 19:19:19 ($N:P_2O_5:K_2O$) 2% spray along with RDF produced 63.15%, 63.15% and 57.89% higher number of pods plant^{-1} than control (RDF only) respectively. Analysis of data revealed that the different treatment failed to cause significant variation in number of seeds pod^{-1} and were non-significant. The highest number of seeds pod^{-1} (2.2) was recorded with application of RDF + 19:19:19 ($N:P_2O_5:K_2O$), RDF + molybdenum 0.5% spray and RDF + zinc chelated 0.5% spray while the lowest was with RDF alone (2.00). Among different foliar application, RDF + molybdenum 0.5% spray recorded maximum 100 seed weight (8.29 g) which was significantly higher than all other treatment except RDF + zinc chelated 0.5% spray (8.27 g), RDF + 19:19:19 ($N:P_20_5:K_2O$) 2% spray (8.21 g) and RDF + urea 2% spray (7.84 g). The minimum number of branches plant^{-1} (2.02), number of pods plant^{-1}(19), number of seeds pod^{-1} (2.00) and 100 seed weight (7.42 g) was recorded with RDF only.

Table 1. Effect of foliar application on yield attributes of soybean

Treatment	Yield attributes			
	Branches plant^{-1}	Pods plant^{-1}	Seeds pod^{-1}	100 seed weight (g)
RDF + Water spray	2.07	22.00	2.10	7.54
RDF + Urea 2% spray	2.25	27.00	2.10	7.84
RDF +DAP 2% spray	2.23	26.00	2.10	7.59
RDF + MOP 0.5% spray	2.12	24.00	2.10	7.70
RDF + 19: 19:19 ($N:P_2O_5:K_2O$) 2% spray	2.29	30.00	2.20	8.21
RDF + Molybdenum 0.5% spray	2.33	31.00	2.20	8.29
RDF + Boron 0.5% spray	2.13	25.00	2.10	7.83
RDF + Zinc chelated 0.5% spray	2.30	31.00	2.20	8.27
RDF only	2.02	19.00	2.00	7.42
SEm±	**0.07**	**1.04**	**0.11**	**0.18**
CD (P= 0.05)	**0.21**	**3.13**	**NS**	**0.54**
CV (%)	**5.57**	**6.94**	**8.68**	**3.98**

It is evident from the data (Table 2) that soybean crop fertilized with RDF along with molybdenum 0.5 % spray produced significantly higher grain yield (1524 kgha^{-1}) than all other combination of nutrients except RDF + zinc chelated 0.5% spray (1435 kg/ha) and RDF + 19:19:19 ($N:P_2O_5:K_2O$) 2% spray (1365 kgha^{-1}). The application of molybdenum 0.5% spray, zinc chelated 0.5% spray and 19:19:19 ($N:P_2O_5:K_2O$) 2% spray along with RDF brought 67.66%, 57.86% and 50.16% increase in grain yield of soybean over control (RDF only) and application of RDF along with molybdenum 0.5% spray produced significantly higher straw yield (2062 kgha^{-1}) than all other treatment except RDF + zinc chelated 0.5% spray (2010 kgha^{-1}). The straw yield of soybean increased by 42.80% and 39.20% when crop fertilized with RDF and sprayed with molybdenum 0.5% and zinc chelated 0.5% respectively over control (RDF only).The lowest grain yield (909 kgha^{-1}) and straw yield (1444 kgha^{-1}) was recorded in RDF alone.It is apparent from the data on harvest index revealed that the different treatment failed to cause significant variation in the harvest index and were non-significant. The highest harvest index was obtained with application of RDF+19:19:19 ($N:P_2O_5:K_2O$) 2% spray (42.81 %) while the lowest harvest index was recorded with RDF alone (38.66 %).

Yield increased with the increase in the number of branches plant^{-1}, pods plant^{-1} and 100 seed weight due to molybdenum (Mo) has a profound effect on plant reproductive development and seed yield (Kaiser *et al.,* 2005). Zinc (Zn) 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). Similar finding was reported by Sary*et al.,* 2014;Babaeian*et al.,* 2012 and Elankavi *et al.* (2009).

Table 2. Effect of foliar application on yield of soybean

Treatment	Yield		Harvest index (%)
	Grain yield ($kgha^{-1}$)	Straw yield ($kgha^{-1}$)	
RDF + Water spray	1102	1602	40.86
RDF + Urea 2% spray	1259	1818	40.75
RDF +DAP 2% spray	1233	1722	41.85
RDF + MOP 0.5% spray	1102	1648	40.07
RDF + 19: 19:19 ($N:P_2O_5:K_2O$) 2% spray	1365	1824	42.81
RDF + Molybdenum 0.5% spray	1524	2062	42.50
RDF + Boron 0.5% spray	1207	1721	41.37
RDF + Zinc chelated 0.5% spray	1435	2010	41.64
RDF only	909	1444	38.66
SEm±	**54**	**77**	**1.64**
CD (P= 0.05)	**163**	**229**	**4.91**
CV (%)	**7.62**	**7.51**	**6.89**

Economics of soybean

Data pertaining (Table 3) to cost of cultivation revealed that higher cost of cultivation was obtained with RDF + molybdenum 0.5% spray (23675 Rs ha^{-1}) while the minimum cost of cultivation (18550 Rs ha^{-1}) was found in control (RDF only).Soybean crop fertilized with RDF and sprayed with molybdenum 0.5% generate maximum and significantly higher gross return (45716 Rs ha^{-1}) than all other combination of nutrient except RDF + zinc chelated 0.5% spray (43055 Rs ha^{-1})and RDF + 19:19:19 ($N:P_2O_5:K_2O$) 2% spray (40952 Rs ha^{-1}).Minimum gross return (27268 Rs ha^{-1}) was recorded with control (RDF only). The gross return of soybean increased by 67.65%, 57.89% and 50.18% when crop fertilized with RDF and sprayed with molybdenum 0.5% spray, zinc chelated 0.5% spray and 19:19:19 ($N:P_2O_5:K_2O$) 2% spray respectively over control (RDF only). Among different treatment of nutrition, maximum net return (22630 `/ha) was recorded with application of zinc chelated along with RDF which remained at par with RDF + molybdenum 0.5% spray (22041 Rs ha^{-1}) RDF + urea 2% spray (18712 Rs ha^{-1}), RDF + 19:19:19 ($N:P_2O_5:K_2O$) 2% spray (18627 Rs ha^{-1}).The lowest net return (8718 Rs ha^{-1}) was obtained with control (RDF only). The application of zinc chelated 0.5% spray, molybdenum 0.5% spray, urea 2% spray and 19:19:19 ($N:P_2O_5:K_2O$) 2% spray along with RDF produced 159.58%, 152.82%, 114.63% and 113.65% higher net return over control (RDF only).

Table 3. Effect of foliar application on economics of soybean

Treatments	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B: C ratio
RDF + Water spray	18925	33055	14130	0.84
RDF + Urea 2% spray	19065	37777	18712	1.07
RDF +DAP 2% spray	19465	36990	17525	0.99
RDF + MOP 0.5% spray	19015	33055	14040	0.83
RDF + 19: 19:19 ($N:P_2O_5:K_2O$) 2% spray	22325	40952	18627	0.91
RDF + Molybdenum 0.5% spray	23675	45716	22041	1.00
RDF + Boron 0.5% spray	21425	36203	14778	0.77
RDF + Zinc chelated 0.5% spray	20425	43055	22630	1.19
RDF only	18550	27268	8718	0.56
SEm±	**-**	**1633**	**1633**	**0.08**
CD (P= 0.05)	**-**	**4896**	**4896**	**0.25**
CV (%)	**-**	**7.62**	**16.84**	**16.04**

Scrutiny of the data revealed that benefit: cost ratio of soybean was significantly influenced by the foliar application of nutrients. The maximum benefit: cost ratio (1.19) was observed with application of RDF + zinc chelated 0.5% spray which was significantly superior over all the other combination except RDF + urea 2% spray (1.07), RDF + molybdenum 0.5% spray (1.00) and RDF + DAP 2% spray (0.99). The lowest benefit: cost ratio (0.56) was recorded with control (RDF only) similar results reported by Kuttimani and Velayutham, 2011 and Zakaria*et al.,* 2008.

CONCLUSION

Foliar application of molybdenum 0.5% spray along with RDF produced higher yield attributes, grain yield as well as straw yield of soybean BUT foliar application of zinc chelated 0.5% spray along with RDF to soybean crop 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. Based on the result of present investigation, it may be concluded that foliar application of zinc chelated 0.5% spray along with RDF proved to be more productive and economically viable for soybean cultivation.

REFERENCES

Abou El-nour, E.A.A. (2002). Can supplemented potassium foliar feeding reduce the recommended soil potassium? *Pakistan journal of Biological Science* 5: 259–62.

Ashour, N.I. and Thalooth, A.T. (2003). Effect of soil and foliar application of nitrogen during pod development on the yield of soybean (*Glycine max* (L.)Merry) Plants.*Field Crops Research*, 6: 261-66.

Babaeian, M., Tavassoli, A., Essmaeilian, Y. and Javaheri, M. (2012). Effects of Fe, Zn, Mg and manure on seed germination characters of barley.*African Journal of Microbiological Research.* **6(46):** 7302-05.

Elankavi, S., Kupuswamy, G., Vijaypuri, V. and Raman, R. (2009). Effect of phytohormones on growth and yield of rice.*Rice Science* 46: 310-13.

Hugar, A.B. and Kurdikeri, M.B. (2000). Effect of application methods and levels of Zn and Mo on field performance and seed yield in soybean.*Karnataka Journal of Agricultural Science* **13(2):** 439-41.

Jairo A. Palta., Ajit S., KumariSunita., Neil, C. and Turner (2005). Foliar nitrogen applications increase the seed yield and protein content in chickpea (*Cicerarietinum*L.) subject to terminal drought, *Aus. J. Agric. Res.* **56(2):** 105–12.

Kaiser B. N., Gridley, K. L., Nbrady, J., Phillips, T. and Tyerman, S. D. (2005). The role of Mo in agricultural plant production.*Annals of Botany* 96: 745-54.

Kannan, S. (1986). Foliar absorption and transport inorganic nutrients CRC *Crit.Rev. Plant Sci. J*. 341-75.

Kelly, A., Nelson, P., Motavalli, P. and Manjula Nathan (2005). Response of no-till soybean (*Glycine max* L.) to timing of preplant and fliar potassium applications in a clay pan soil. *Agron. J.*97: 832-38.

Kuttimani, R. and Velayutham, A. (2011). Foliar application of nutrients and growth regulators on yield and economics of green gram.*Madras Agricultural Journal* **98(4-6):** 141-43.

Rahman, Inayat.,Afzal, Aftab., Iqbal, Zafar., Ijaz, Farhana., Manan, Shafiul., Sohali., Ali, Asghar., Khan, Khalid., Karim, Sumaira. And Qadir, Ghulam. (2014). Growth and yield of common bean as influenced by different nutrients treatment in Mansehra. *International Journal of Agronomy and Agricultural Research* **4(3):** 20-26.

Sary, G. A., El- Deepah, H. R.A., El- Gizway, N.K.H.B., Gobarh, E. Mirvat., Tawfik, M. M. and Khedr, Howida, H. (2014). Impact of organic manures and foliar spraying with micronutrients on growth, yield and yield components of barley grown in newly reclaimed sandy soil.*American- Eurasian Journal of Agricultural and Environmental Science* **14(11):** 1130-40.

Silberbush, M., Waisel, Y., Eshel, A. and Kafkafi (2002). Simulation of ion uptake from the soil in Plant Roots. *The Hidden Half, 3rd edition New York*.651-61.

Singh, M.V. (2007). Efficiency of seed treatment for ameliorating zinc deficiency in crops.Proceeding of Zinc Crop Conference, Istanbul, Turkey.

Tiwari, D. K., Pandey, P., Giri, S.P. and Dwivedi, J. L. (2011). Effect of foliar application of GA_3 and other plant growth regulators on hybrid rice seed production.*Asian Journal of Plant Sciences* 10: 133-39.

Zakaria M.S., Mahmoud H. Mahmoud. andAmal H. El-Guibali (2008). Influence of potassium fertilization and foliar application of zinc and phosphorus on growth, yield components, yield and fiber properties of Egyptian cotton (*Gossypiumbarbadense*L.). *Journal of Plant Ecology* **1(4):** 259-70.