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RESEARCH ARTICLE :

Growth and yield of soybean [*Glycine max* (L.) Merrill] as influenced by foliar application of micronutrients and potassium nitrate

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SUMMARY : The experiment was conducted during *Kharif* season of the year 2015-16 at Experimental Farm, Department of Agronomy, College of Agriculture, Latur, to study the effect of foliar application of micronutrients and potassium nitrate on growth, yield and economics of soybean. The soil was clayey in texture, low in available nitrogen (108 kg ha^{-1}), low in available phosphorus (8.18 kg ha^{-1}), very high in available potassium (430 kg ha^{-1}) and slightly alkaline in reaction (7.45 pH). The experiment laid out in Factorial Randomized Block Design consisting three foliar applications both of micronutrients and potassium nitrate at different growth stagesAmong different application of micronutrients, the application of micronutrients @ 0.5 % at 40 and 60 DAS (M_3) and among different application of potassium nitrate, application of KNO_3 @ 1 % at 60 DAS (K_1) produced significantly higher growth, yield contributing characters and yield of soybean.

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KEY WORDS :
Soybean, Multi micro nutrient, Potassium nitrate

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BACKGROUND AND OBJECTIVES

Soybean [*Glycine max* (L.) Merrill] belongs to the family *fabaceae*, subfamily *fabiodeae*. and is a herbeceous annual crop. Soybean is recognised as golden bean because of its dietetic, industrial, medicinal and economoical importance. It is economially profitable as compared to the cereals and other oilseed crops. It is highly remunerative crop with comparatively less input demand.

In order to optimize soybean yield, it is therefore necessary to improve the plant environment and more efficient fertilization is one of such possibilities. Despite the known abillity of legume to fix atmospheric nitrogen, in symbiotic association with rhizobia, it has demonstrated that supplementary fertilization can improve performance of these crops (Tayo, 1981 and Ashour and Thalooth, 1983). Apart from soil application, foliar spray of nutrients has been shown to be a practical means of replenshing the reservoir of nutrients in the leaves of legumes during pod development, since the efficiency of nutrient uptake by roots, as well as symbiotic fixation

activities are known to at this stage (Ashour and Thalooth, 1983).Foliar spray of nutrients is the fastest way to boost up crop growth because the nutrients application is uniform and crop reacts to nutrient application immediately. Under rainfed condition when the availability of moisture becomes scarce, the application of fertilizers as foliar spray resulted in efficient absorption and usage which are economical in respect the other methods of fertilization. Flower senescence and ill filling of pods are the major drawbacks in soybean, which can be managed through foliar application of nutrient.The objective of this study therefore was to assess the effect of foliar spray ofmicronutrients (Grade-II) and potassium nitrate on growth, yield, quality and economics of soybean.

RESOURCES AND METHODS

The experiment was conducted during *Kharif* season of the year 2015-16 at Experimental Farm, Department of Agronomy, College of Agriculture, Latur, to study the effect of foliar application of micronutrients and potassium nitrate on growth, yield and economics of soybean.The experimental field was levelled and well drained. The soil was clayey in texture, low in available nitrogen (108 kg ha^{-1}), low in available phosphorus (8.18 kg ha^{-1}), very high in available potassium (430 kg ha^{-1}) and slightly alkaline in reaction (7.45 pH). The less rainfall during period of experiment was insufficient to growth and development of soybean which resulted in lower yield. Water stress during pod formation stage resulted in forced maturity of crop. Overall the thermo-aero-hydro-dynamic properties during crop season were not favorable for physiological activities of crop and its phenophysic development. The experiment laid out in Factorial Randomized Block Design consisting three foliar application both of micronutrients and potassium nitrate at different growth stages *viz.*, Micronutrients @ 0.5 % at 40 DAS (M_1), Micronutrients @ 0.5 % at 60 DAS (M_2), Micronutrients @ 0.5 % at 40 and 60 DAS (M_3) and KNO_3 @ 1 % at 60 DAS (K_1), KNO_3 @ 1 % at 75 DAS (K_2), KNO_3 @ 1 % at 60 and 75 DAS (K_3), replicated thrice. Micronutrients were applied through commercial product of Grade-II which contains Fe 2.50 %, Mn1.00 %, Zn 3.00 %, Cu 1.00 %, B 0.50 % and M 0.10 %. Sowing was done on 13th August, 2015 with soybean variety MAUS-81. The recommended dose of fertilizer (RDF) was 30: 60: 30 NPK kg ha^{-1}. The recommended cultural practices and plant protection measures were under taken as per recommendation.Data on various variables were analyzed by analysis of variance (Panse and Sukhatme, 1967).

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Growth attributes :

The growth attributes of soybean *viz.*, plant height (cm), leaf area (dm^2), number of branches and total dry matter per plant was influenced significantly due to foliar application of micronutrients.

The foliar application of micronutrients @ 0.5 % at 40 and 60 DAS (M_3) recorded significantly higher plant height (cm) and number of branches per plant over the application of micronutrients @ 0.5 % at 40 DAS (M_1) and found at par with the application of micronutrients @ 0.5 % at 60 DAS (M_2) (Table 1).The increase in plant height may be due to better uptake and translocation of plant nutrients to growing plants which boosted the plant for producing better plant height and number of branches. Similar kind of observations was recorded by Nagaraja and Mohankumar (2010); Kobraee and Shamsi (2013); Ghare (2014) and Mandlic *et al.* (2015).

The foliar application of micronutrients @ 0.5 % at 40 and 60 DAS (M_3) recorded significantly higher leaf area (dm^2) over the application of micronutrients @ 0.5 % at 60 DAS (M_2) and found at par with the application of micronutrients @ 0.5 % at 40 DAS (M_1).The highest total dry matter per plant was recorded with the application of micronutrients @ 0.5 % at 40 and 60 DAS (M_3) which was significantly superior over both the treatments of micronutrients. It may be due to better utilization of available resources with the foliar application of micronutrients which resulted in more photosynthesis and hence more dry matter was produced. Similar kinds of results were reported by Ravi *et al.* (2008) and Nagaraja and Mohankumar (2010).

The foliar application of potassium nitrate @ 1.0 % at 60 DAS (K_1) recorded highest plant height (cm), number of branches and total dry matter per plant which was significantly superior over the application of potassium nitrate @ 1.0 % at 75 DAS (K_2) and found at par with the application of potassium nitrate @ 1.0 % at 60 and 75 DAS (K_3).The application of potassium nitrate

supplied N and K which are absorbed as anion and cation by plants, and might have delayed the synthesis of abscisic acid and promoted cytokinin activity causing higher chlorophyll retationwhich turn promoted growth attributes.Odeleye *et al.* (2007) and Thalooth *et al.* (2006) also reported similar results. The leaf area (dm^2) per plant does not differed significantly due to application of potassium nitrate.

Yield attributes :

Significant differences were observed on yield attributes and yield due to foliar application of micronutrients. The application of micronutrients @ 0.5 % at 40 and 60 (M_3) DAS gave highest number of pods per plantwhich was significantly superior overthe application of micronutrients @ 0.5 % at 40 DAS (M_1) and found at par with the application of micronutrients

Table 1 : Growth attributes of soybean as influenced by different treatments at various crop growth stages

Treatments	Plant height (cm) at harvest	Leaf area (dm^2) $plant^{-1}$ at 60 DAS	No. of branches $plant^{-1}$ 60 DAS	Total dry matter (g) $plant^{-1}$ at harvest
Micronutrients (M)				
M_1-Micronutrients @ 0.5 % at 40 DAS	29.71	8.78	11.36	18.22
M_2-Micronutrients @ 0.5 % at 60 DAS	30.91	7.81	12.62	18.36
M_3-Micronutrients @ 0.5 % at 40 & 60 DAS	31.68	8.85	12.86	19.66
S.E. $\pm$	0.48	0.26	0.34	0.34
C.D. (P=0.05)	1.40	0.78	1.02	1.03
Potassium nitrate				
K_1-KNO_3 @ 1 % at 60 DAS	31.71	8.45	12.86	19.58
K_2-KNO_3 @ 1 % at 75 DAS	29.69	8.42	11.52	17.56
K_3-KNO_3 @ 1 % at 60 and 75 DAS	30.89	8.56	12.47	19.10
S.E. $\pm$	0.48	0.26	0.34	0.34
C.D. (P=0.05)	1.40	NS	1.02	1.03
Interaction (M x K)				
S.E. $\pm$	0.84	0.45	0.59	0.59
C.D. (P=0.05)	NS	NS	NS	NS
General mean	30.76	8.48	12.28	18.75

NS=Non-significant

Table 2 : Number of pods, Pod yield, number of seeds, seed yield (g) $plant^{-1}$and test weight (g) of soybean as influenced by various treatments at harvest

Treatments	No. of pods $plant^{-1}$	Pod yield (g)$plant^{-1}$	No. seeds$plant^{-1}$	Seed yield (kg ha^{-1})	Test weight (g)
Micronutrients (M)					
M_1-Micronutrients @ 0.5 % at 40 DAS	28.91	6.12	36.13	971	73.26
M_2-Micronutrients @ 0.5 % at 60 DAS	33.12	6.40	41.62	1048	74.09
M_3-Micronutrients @ 0.5 % at 40 and 60 DAS	35.80	7.41	48.04	1137	75.65
S.E. $\pm$	1.25	0.31	1.72	24	2.46
C.D. (P=0.05)	3.76	0.95	5.16	71	NS
Potassium Nitrate					
K_1-KNO_3 @ 1 % at 60 DAS	35.33	7.46	45.24	1121	74.97
K_2-KNO_3 @ 1 % at 75 DAS	28.46	5.94	37.96	967	73.97
K_3-KNO_3 @ 1 % at 60 and 75 DAS	34.04	6.53	42.60	1068	74.07
S.E. $\pm$	1.25	0.31	1.72	24	2.46
C.D. (P=0.05)	3.76	0.95	5.16	71	NS
Interaction (M x K)					
S.E. $\pm$	2.5	0.54	2.98	41	4.26
C.D. (P=0.05)	NS	NS	NS	NS	NS
General mean	32.61	6.64	41.43	1052	74.07

NS=Non-significant

@ 0.5 % at 60 DAS (M_2).

The foliar application of micronutrients @ 0.5 % at 40 and 60 DAS (M_3) was significantly superior over both the treatments of micronutrients in producing more pod yield (g), number of seeds per plant and seed yield (kg/ha). More pod yield due to application of micronutrients through foliar application may be due to more growth and photosynthates which resulted in better filling of pod with more pod yield per plant (g) and number of seeds per plant was obtained. Beneficial effect of micronutrients on pod yield was also reported by Odeleye *et al.* (2007).

The yield attributing characters and yield *viz.*, number of pods, pod yield and number of seeds per plant and seed yield were significantly higher with the application of potassium nitrate @ 1.0 % at 60 DAS (K_1) as compared to the application of potassium nitrate @ 1.0 % at 75 DAS (K_2) (Table 2) and it was at par with the application of potassium nitrate @ 1.0 % at 60 and 75 DAS (K_3).The application of potassium nitratesupplied N and K which are absorbed as anion and cation by plants, and might have delayed the synthesis of abscisic acid and promoted cytokinin activity causing higher chlorophyll retentionwhich in turn promoted more leaf area. This may secure higher phosynthetic activity in effective leaves and suppliedto developing pods with current photosynthates for proper filling, resulting in higher yield. Thalooth *et al.* (2006); Venkaria (2013) and Gowda *et al.* (2014) also reported similar results.

From the results it may be inferred that foliar application of micronutrients (Grade-II) @ 0.5 % at 40 and 60 DAS and potassium nitrate @ 1.0 % at 60 DASwas found to be beneficial for getting higher growth, yield contributing characters and yield (kg/ha) of soybean

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