Original Research Article

EFFECT OF FERTILIZER LEVELS AND FOLIAR NUTRITION ON GROWTH AND YIELD OF SOYBEAN (*Glycine max* (L.) Merrill)

ABSTRACT

The present investigation entitled "Effect of fertilizer levels and foliar nutrition on growth and yield of soybean (*Glycine max* (L.) Merrill)" was conducted during *Kharif* 2019 at Agronomy farm, College of Agriculture, Pune. The seven treatment combinations were laid out in factorial randomized block design and was replicated thrice. The results revealed that application of 100% GRDF has recorded significantly higher all the growth and yield contributing characters *viz*., plant height (58.94 cm), number of branches plant^{-1}(6.67), leaf area plant^{-1} (29.10 dm^2), dry matter plant^{-1} (24.30 g), number of pods plant^{-1} (62.80), number of seeds pod^{-1} (2.46), seed weight plant^{-1} (29.87 g), seed and straw yield (21.73 and 29.63 q ha^{-1}, respectively). Among the different foliar spray of nutrients application of 1% foliar spray of 19:19:19 recorded significantly higher growth and yield contributing characters *viz*., plant height (59.46 cm), number of branches plant^{-1} (6.95), leaf area (10.63 dm^2), dry matter plant^{-1} (26.07 g), number of pods plant^{-1} (68.25), number of seeds pod^{-1} (2.70), seed weight plant^{-1}(35.37 g), grain and straw yield (25.53 and 33.51 q ha^{-1}, respectively).

Keywords : *Foliar sprays, GRDF, Growth, Yield*

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is known as Chinese pea which belongs to family *leguminaceae* and sub family *Papilionaceae*. It is one of the most important pulse and oilseed crop grown in *kharif* which becomes a miracle crop of 20th century and often designated as "Gold bean". It has the vital importance in Indian Agriculture, but also plays a decisive role in oil economy of India. It is the cheapest and main source of dietary protein of majority vegetarian Indians. Soybean seed consists of 18-25 per cent oil and 30-50 per cent protein (Vahedi 2011). It is preferable for human nutrition due to its high protein content. It has been recognized as a potential supplementary source of edible oil. It is also highly adaptable to varying soil and climatic conditions, giving fairly high yield compared to other pulse crops. It is a good source of its flavones and therefore it helps in preventing heart diseases, cancer and HIVs (Kumar 2007). It helps in reducing the protein malnutrition and increasing the oil production.

Soybean production has an important advantage that it can meet the challenges of the vagaries of nature in view of its capacity to do well under both drought and waterlogged conditions which adversely affect other *kharif* crops and add organic matter in soil by defoliation of leaves. Imbalanced nutrition is one of the important constraint of soybean productivity in the North Indian plains (Tiwari, 2001). Continuous use of high level of chemical fertilizers has led to problems of soil degradation, which is proving detrimental to soybean production. Foliar fertilization is gaining importance in plant nutrition these days. The foliar applied nutrients are more effective as compared to soil applied nutrients. Because of higher uptake efficiency, foliar supply of nutrients can increase photosynthetic efficiency by delaying the leaf senescence. (Choudhary and Yadav, 2011)

Foliar fertilization of soybean with N, P, K and S during the seed filling period promises to increase soybean yield. Foliar application could be used to avoid the depletion of

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these nutrients in the leaves and the resulting reduction in photosynthetic rate during this period due to poor nutrient uptake from the soil and translocation of these elements from the leaves to the developing seeds. Foliar spray of nutrients is the fastest way to boost up crop growth because the nutrients are available to plants at the initial and critical stages. 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 to other methods of fertilization. Flower senescence and improper filling of pods are the major drawbacks in soybean, which can be managed through foliar application of nutrient and growth regulators. (Vinoth Kumar, *et al*., 2013).

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MATERIALS AND METHODS

The research experiment "Effect of fertilizer levels and foliar nutrition on growth and yield of soybean (*Glycine max* (L.) Merrill)" was conducted during *Kharif* 2019 at Agronomy Farm, Plot number 27, 'A' Division, College of Agriculture, Pune. The soil of the experimental field was clay loam, low in available nitrogen (180.15 kg ha^{-1}), medium in available phosphorus (22.17 kg ha^{-1}), high in available potassium (380.73 kg ha^{-1}) and was alkaline in reaction (pH-7.6), low in organic carbon content (0.41%), and EC was (0.47). The experiment was laid out in factorial randomized block design and replicated thrice. The treatment combinations consisted of two fertilizer levels *viz*., F_1- 100% GRDF, F_2- 75% GRDF and seven levels of foliar nutrition N_1- water spray at pod initiation, N_2- 2% foliar spray of urea, N_3- 2% foliar spray of SSP, N_4- 1% foliar spray of KCL, N_5- 2% foliar spray of DAP, N_6- 1% foliar spray of 19:19:19 and N_7- 1% foliar spray of Potassium nitrate. Soybean variety KDS-726 (*Phule Sangam*) was sown @ 75 kg ha^{-1} at the spacing 45 × 5 cm^2 on 14th August, 2019 and the crop was harvested on 26th November, 2019. Recommended dose of fertilizer was 50:75:45 kg NPK + 5 t of FYM ha^{-1}. Fertilizer dose was given as basal in soil before sowing as per the treatment. Foliar nutrition was given at pre-flowering and pod initiation stage as per the treatment. The growth attributing characters *viz*., plant height, number of branches $plant^{-1}$, leaf area $plant^{-1}$ and dry matter $plant^{-1}$ as well as yield contributing characters like number of pods $plant^{-1}$, number of seeds pod^{-1}, seed weight $plant^{-1}$, straw weight $plant^{-1}$, 100 seed weight, grain and straw yield ha^{-1} of soybean were recorded.

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RESULTS AND DISCUSSION

Growth parameters :

Among fertilizer levels, application of 100 % GRDF has recorded significantly higher growth parameters *viz*., plant height (58.94 cm), number of branches $plant^{-1}$(6.67), leaf area $plant^{-1}$ (29.10 dm^2) and dry matter $plant^{-1}$ (24.30 g). This was followed by application of 75% GRDF. Higher dry matter production at 100% GRDF might be obtained due to significantly recorded higher crop growth contributing characters at all the growth stages. The results are in line with the findings of Ayyadurai et al. (2017) and Pradhan et al. (2017).

Among the different foliar spray of nutrients the growth attributes *viz*., plant height (59.46 cm) obtained was significantly more due to 2% foliar spray of urea than the other treatments. It might be due to availability of nitrogen through foliar spray of urea. Nitrogen increases photosynthetic activity and helps in maintaining auxin level, which might have resulted in better plant height. Number of branches $plant^{-1}$ (6.95), leaf area (10.63 dm^2) and dry matter accumulation per plant (26.07 g) were found significantly maximum with the application of 1% foliar spray of 19:19:19. Increase in dry matter production $plant^{-1}$ might be due to higher proportion of nutrients in the foliar fertilization might have enhanced the crop growth, photosynthetic activity which led to better supply of carbohydrates and ultimately

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higher dry matter production per plant. Thakur et al. (2017) concluded that foliar spray of 2% 19:19:19 in blackgram recorded higher plant height (29.2 cm), leaf area index (2.83 dm^2) and dry matter $plant^{-1}$ over control. The results are in line with findings of Ullasa et al. (2016).

Table 1 : Effect of fertilizer levels and foliar spray of nutrients on growth attributes of soybean

Treatment	Plant height (cm)	Number of branches $plant^{-1}$	Leaf area $plant^{-1}$ (dm^2)	Dry matter $plant^{-1}$ (g)
I)Fertilizer levels				
F_1 : 100% GRDF	58.94	6.67	29.10	24.30
F_2 : 75% GRDF	54.56	6.34	26.73	20.52
$S.E_{m.} \pm$	0.57	0.08	0.59	0.56
C.D. at 5%	1.66	0.23	1.72	1.71
II) Foliar spray of nutrients				
N_1 : Water spray at pod initiation	53.43	6.08	25.19	19.13
N_2 : 2% Foliar spray of urea	59.46	6.45	26.69	20.55
N_3 : 2% Foliar spray of SSP	55.96	6.28	27.52	21.85
N_4 : 1% Foliar spray of KCL	56.10	6.56	27.30	22.91
N_5 : 2% Foliar spray of DAP	56.86	6.81	29.65	24.29
N_6 : 1% Foliar sprayof19:19:19	58.53	6.95	30.63	26.07
N_7 : 1% Foliar spray of KNO_3	56.90	6.43	28.41	23.40
$S.E_{m.} \pm$	1.07	0.15	1.10	1.04
C.D. at 5%	3.11	0.44	3.22	3.09
III) Interaction (F×N)				
$S.E_{m.} \pm$	1.51	0.21	1.56	1.47
C.D. at 5%	N.S.	N.S.	N.S.	N.S.
General Mean	56.74	6.50	27.91	22.55

Yield parameters :

The yield contributing characters like number of pods $plant^{-1}$ (62.80), number of seeds pod^{-1} (2.46), seed weight $plant^{-1}$ (29.87 g), straw weight $plant^{-1}$ (11.20 g), 100 seed weight (20.27 g) were found significantly higher with the application of 100% GRDF. This was followed by application of 75% GRDF. The increase in yield contributing characters and proper seed setting may leads to give more weight of 100 seed weight. The grain and straw yield of soybean was influenced significantly and the statistically higher grain and straw yield 21.73 and 29.63 q ha^{-1}, respectively were recorded with the application of 100% GRDF. The reason being increased in seed yield of soybean might be due to adequate supply of nutrients which helped in better absorption and translocation inside plant system efficiently increase growth and yield contributing characters which leads for better pod and seed setting with proper development which helped in higher seed yield of soybean. Similar findings were also reported by Joshi and Billore (2004).

Similarly, The yield attributes *viz*., number of pods $plant^{-1}$ (68.25), number of seeds pod^{-1} (2.70), seed weight $plant^{-1}$(35.37 g), straw weight $plant^{-1}$(13.99 g), 100 seed weight (21.51 g) were found significantly higher with the application of 1% foliar spray of 19:19:19 but it was found at par with the application of 2% foliar spray of DAP. Spraying of balance

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nutrients at proper growth stage may leads to increase yield contributing characters might leads more seed setting and development leads to record more weight of 100 seed weight. The grain and straw yield of soybean was influenced significantly and the statistically higher grain and straw yield (25.53 and 33.51 q ha^{-1}, respectively) were recorded with the application of 1% foliar spray of 19:19:19. The higher seed yield of soybean was obtained mainly due to spraying of balance nutrient source helped better translocation of photosynthates from source to sink which lead to better yield attributing characters like number of pods $plant^{-1}$, number of seeds pod^{-1} , which leads to get maximum yield. The results are in line with findings of Dandge et al. (2018).

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Table 2 : Effect of fertilizer levels and foliar spray of nutrients on yield attributes and yield of soybean

Treatment	Number of pods $plant^{-1}$	Number of seeds pod^{-1}	Seed weight $plant^{-1}$ (g)	Straw weight $plant^{-1}$ (g)	100 seed weight (g)	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})
I)Fertilizer levels							
F_1 : 100% GRDF	62.80	2.46	29.87	11.20	20.27	21.73	29.63
F_2 : 75% GRDF	58.17	2.27	27.62	9.87	18.95	18.65	26.35
$S.E_{m.} \pm$	0.91	0.05	0.76	0.39	0.23	0.41	0.47
C.D. at 5%	2.67	0.17	2.22	1.15	0.69	1.20	1.37
II) Foliar spray of nutrients							
N_1 : Water spray at pod initiation	50.78	1.96	19.10	8.32	17.58	16.81	23.75
N_2 : 2% Foliar spray of urea	56.33	2.23	24.33	9.29	18.79	17.40	25.24
N_3 : 2% Foliar spray of SSP	57.70	2.40	29.08	10.20	19.25	19.57	27.86
N_4 : 1% Foliar spray of KCL	59.36	2.26	29.11	9.49	19.36	18.30	26.17
N_5 : 2% Foliar spray of DAP	66.45	2.56	33.46	11.94	20.67	22.51	30.13
N_6 : 1% Foliar spray of 19:19:19	68.25	2.70	35.37	13.99	21.51	25.53	33.51
N_7 : 1% Foliar spray of KNO_3	64.53	2.46	30.74	10.51	20.10	21.19	29.28
$S.E_{m.} \pm$	1.72	0.11	1.43	0.74	0.44	0.77	0.88
C.D. at 5%	5.16	0.32	4.16	2.16	1.29	2.25	2.56
III) Interaction (F×N)							
$S.E_{m.} \pm$	2.43	0.15	2.02	1.05	0.63	1.09	1.24
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General Mean	60.48	2.36	28.74	10.53	19.60	20.18	27.99

Economics :

Among the fertilizer levels the application of 100% GRDF gave maximum gross monetary returns (83364 ₹ ha^{-1}), net monetary returns (40656 ₹ ha^{-1}) and benefit cost ratio (1.96) which was more over the application of 75% GRDF (₹71649). The proper fertilization and fulfilment of nutrition gave maximum soybean yield which leads to increase yield and returns. These findings are in line with Malunjkar *et al.* (2013).

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The maximum gross monetary returns (97818 ₹ ha^{-1}), net monetary returns (54881 ₹ ha^{-1}) and benefit cost ratio (2.27) were obtained with the application of 1% foliar spray of 19:19:19 than rest of the treatments. The foliar spray of nutrients enriched number of pods and final yield to get the maximum crop yield which finally gave maximum net returns. These findings are in line with Kulkarni *et al.* (2016) and Ullasa *et al.* (2016).

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Table 3 : Effect of fertilizer levels and foliar spray of nutrients on economics of soybean

Treatment	Gross monetary returns (₹ ha^{-1})	Cost of cultivation (₹ ha^{-1})	Net monetary returns (₹ ha^{-1})	B:C ratio
I)Fertilizer levels				
F_1 : 100% GRDF	83364	42522	40656	1.96
F_2 : 75% GRDF	71649	38436	32132	1.86
$S.E_{m.}\pm$	1577	-	1492	-
C.D. at 5%	4586	-	4338	-
II) Foliar spray of nutrients				
N_1 : Water spray at pod initiation	64578	41398	23180	1.55
N_2 : 2% Foliar spray of urea	66935	41575	25360	1.60
N_3 : 2% Foliar spray of SSP	75220	41899	33321	1.79
N_4 : 1% Foliar spray of KCL	70346	41726	28620	1.68
N_5 : 2% Foliar spray of DAP	86300	42522	43778	2.02
N_6 : 1% Foliar spray of 19:19:19	97818	42937	54881	2.27
N_7 : 1% Foliar spray of KNO_3	81350	42445	38905	1.91
$S.E_{m.}\pm$	2950	-	2834	-
C.D. at 5%	8579	-	8241	-
III) Interaction (F×N)				
$S.E_{m.}\pm$	4172	-	4008	-
C.D. at 5%	N.S.	-	N.S.	-
General Mean	77506	41718	35648	1.85

CONCLUSION

It can be inferred that application of 100% GRDF (50:75:45 NPK kg ha^{-1} + 5 t FYM ha^{-1}) with 1% foliar spray of 19:19:19 is suitable to the soybean crop. Application of 100% GRDF (50:75:45 NPK kg ha^{-1} + 5 t FYM ha^{-1}) with 1% foliar spray of 19:19:19 was found beneficial for obtaining higher net returns (₹ 54881 ha^{-1}) and B: C ratio (2.27) followed by 2% foliar spray of DAP.

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