Original Research Article

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

ABSTRACT

Improper nutrition being the major constraint of soybean fields in the state of Maharashtra, an 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). From the treatments chosen for the investigation, 1% foliar spray application with 19:19:19 recorded significantly higher growth and yield contributing characters namely, 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

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)

Soybean (*Glycine max* (L.) Merrill) known as Chinese pea belonging to the family *leguminaceae* and sub family *Papilionaceae* is one of the most important pulse and oilseed crop grown in *kharif* in the state of Maharashtra. This particular crop is considered as a miracle crop of 20th century and often designated as "Gold bean". It's vital importance in Indian Agriculture, is due to the 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. Hence, for the utmost care and concern on human health the crop is chosen for consumption as edible oil in the state.

Besides, Soybean production can meet the challenges of the vagaries of monsoon in view of its capacity to do well under both drought and waterlogged conditions which

adversely affect other *kharif* crops. In addition it enriches the fertility of soil by addition of organic matter through defoliation of leaves.

Foliar fertilization of soybean with N, P, K and S during the seed filling period promises to increase soybean yield. This approach helps to avoid the depletion of nutrients in the leaves and avoid 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 , *et al*., 2013).

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 textural class of the experimental plot was found to be clay loam and the nutrient composition is low available nitrogen (180.15 kg ha^{-1}), medium available phosphorus (22.17 kg ha^{-1}), high available potassium (380.73 kg ha^{-1}), low organic carbon content (0.41%). The pH and EC was noted to be 7.6 (alkaline) and 0.47 respectively. The experiment was laid out in factorial randomized block design with three replications. The treatment combinations consisted two factors in which the first factor comprised of two fertilizer levels *viz*., F_1- 100% GRDF (Gross Recommended Dose of Fertilizer), F_2- 75% GRDF (Gross Recommended Dose of Fertilizer). The second factor comprised of 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. The variety chosen for the research trail was KDS-726 (*Phule Sangam*) due to its better adaptability to the soil type and the growing season. The sowing was undertaken on 14th August, 2019 with a spacing of 45 × 5 cm^2 and the seed rate of 75 kg ha^{-1} as prescribed by the University. As mentioned above, the Gross Recommended dose of fertilizer for soybean was taken as 50:75:45 kg NPK + 5 t of FYM (Farm Yard Manure) ha^{-1}. The basal fertilizer application was undertook before sowing as per the different treatment combinations and also the foliar application at pre-flowering and pod initiation stage. 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. The crop was harvested on 26th November, 2019.

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 treatment combinations 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. This increase in dry matter production plant^{-1} is due to higher proportion of nutrients in the foliar fertilization that enhanced the crop growth and photosynthetic activity which leads to better supply of carbohydrates and ultimately 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$_{m.}$ ±	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$_{m.}$ ±	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$_{m.}$ ±	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. There was a significant influence of the nutrient levels with respect to grain and straw yield. The statistically higher grain and straw yield of 21.73 and 29.63 q ha^{-1}, respectively were recorded

with the application of 100% GRDF. The reason behind increase in seed yield of soybean might be due to adequate supply of nutrients which helped in better absorption and translocation inside plant system which increased the growth and yield contributing characters that lead to better pod and seed setting with proper development and ultimately the higher seed yield of soybean was achieved. Similar findings were 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 optimum amount of nutrients at proper growth stage may lead to increase in yield contributing characters. The application of 1% foliar spray of 19:19:19 has recorded the higher grain and straw yield of soybean (25.53 and 33.51 q ha^{-1}, respectively). The foliar supply of optimum amounts of nutrient source leads to better translocation of photosynthates from source to sink and there by better yield attributing characters and yield. The results are in line with findings of Dandge *et al*. (2018).

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
$S.E_{m.}$ ±	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
$S.E_{m.}$ ±	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)							
$S.E_{m.}$ ±	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 :

From the research trial undertaken, it was found that the higher gross monetary returns (83364 ₹ ha^{-1}), net monetary returns (40656 ₹ ha^{-1}) and benefit cost ratio (1.96) were obtained with the application of 100% GRDF which was more over the application of 75% GRDF (₹71649). The proper fertilization and fulfillment of nutrition gave maximum soybean yield which leads to better economics. These findings are in line with Malunjkar *et al.* (2013).

The 1% foliar spray of 19:19:19 recorded the higher gross monetary returns (97818 ₹ ha^{-1}), net monetary returns (54881 ₹ ha^{-1}) and benefit cost ratio (2.27) on comparison to the rest of the treatments. These findings are similar to the work of Kulkarni *et al.* (2016) and Ullasa *et al.* (2016). It is further proved in this research that the foliar fertilization improves all the growth and yield contributing characters and finally the yield of the crop as they are highly phloem mobile and are translocated to all parts of the plant.

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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