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Priyanka Dnyanoba Jadhavar
M.Sc. Student, Department of Agronomy, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

Pradeep Rajput
Assistant Professor, Department of Agronomy, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

Corresponding Author:
Priyanka Dnyanoba Jadhavar
M.Sc. Student, Department of Agronomy, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

Effect of foliar nutrition on growth parameters of soyabean (*Glycine max* L.)

Priyanka Dnyanoba Jadhavar and Pradeep Rajput

Abstract
The experiment was conducted to study the effect of foliar nutrition on growth parameters of soyabean during the kharif season 2022 at CRC Farm - 1, ITM University Gwalior (M.P.). The experiment was laid out in randomized block design (RBD) with three replications and 11 treatments namely T_1 [Control (Application of water in the form of spray)], T_2 [RDF (100%) @ at the time of sowing], T_3 [RDF + Urea 2% at veg.], T_4 [RDF + Urea 2% at pod.], T_5 [RDF + Urea 2% at veg + pod.], T_6 [RDF + DAP 2% at veg.], T_7 [RDF + DAP 2% at pod.], T_8 [RDF + DAP 2% at veg + pod.], T_9 [RDF + KNO3 2% at veg.], T_{10} [RDF + KNO3 2% at pod.], T_{11} [RDF + KNO3 2% at veg + pod.] The variety JS9560 was used in the experiment. Growth attributing characters that is initial plant population, plant height (cm), No. of leaves per plant, Number of branches per plant, Leaf area index (LAI), Days taken in 50% flowering and dry matter accumulation per plant (g) were significantly influenced with the different treatments and recorded higher value with the foliar application of RDF + DAP 2% at veg + pod stage. From this study it may be concluded that different treatments had positive effect on growth parameters of soyabean. The lowest was recorded in control treatment.

Keywords: Foliar nutrition, growth parameters, soyabean

Introduction
It is stated that pulses are both the rich man's and the poor man's meat. Pulses can also be thought of as a small-scale producer of fertiliser because they symbiotically fix atmospheric nitrogen. Due to its thick root structure and adequate ground cover, pulses are a crop that require less water and minimise soil erosion, earning them the nickname "Marval of Nature." Because they work well in crop rotation and crop combination, pulses are a crucial component of farmers' cropping systems across the nation.

The soybean (*Glycine max* L.), popularly known as the miracle crop or the golden bean. The soybean was first introduced to Europe in the USA and China in the 17th and 18th centuries. The legume family Fabaceae includes soybean, which is also referred to in India as Bhat, Kulthi, kalitur, Bhut, and Bhatman, among other names. Roughly 60% of the world's supply of vegetable protein and 30% of the world's oil are found in it, which has roughly 40% protein and 20% oil. It is grown in tropical, subtropical, and temperate climates Soybean account for about 60% of the total global oil seed production of 390-425 Mt with cotton seed, the closest competitor.

Turkey is ranked first in productivity, but the USA is ranked first in both area (30.91 m hectares) and production (91.42 mt). India is fifth in crop production (9.91 mt) and fourth in area (9.5 m hectares). In India MP ranks 1st in area (5.12 m ha) and production (5.85 mt) compare with other states. It also known as “Soya state.”

Soybean is basically short-day plant but response to the day length varies along with the variety and temperature. Soybean can be grown a wide range of well-drained soil, but thrives best on clay foams. The optimum pH for soybean production is the range of 6 to 6.5. In soybean, Initial varietal temperature through selections introduced from AVRDC, Taiwan and Thailand, subsequently. Several high yielding varieties has developed to suit and needs under various cropping system. In M.P. no of varieties of soybean are grown like Indira soy 9, Ahilya 4, Pratiksha, JS93-05, MAUS81, JS95-60, JS97-52.

In order to increase the grain production in pulses, nutrients are essential. Major plant nutrients like nitrogen and potassium can be applied topically to the leaves just as effectively as in the soil (Subramanian and Palaniappan, 1981) [5]. The use of fertilisers and the creation of specific soil complexes make it more challenging for plants to absorb essential nutrients. The plants do not fully utilise the applied fertilisers.

Foliar application of nutrients is crucial to preventing or eliminating this problem (Velu and Srinivasan, 1984) [7].

The ability of plants to use water-soluble nutrients from foliar sprays applied to their foliage is now a well-established phenomenon. Through the stomata in the leaf's cuticle, the nutrients enter the cells. Foliar application is the most efficient method of fertiliser delivery when significant nutrient leaching concerns are present. (Pandrangi *et al.*, 1991) [2]. Soybean is a member of pulses and probably the most valuable crop in world. Fertilization is one of the main economic and health-promoting factors in crop cultivation. In view of this it is very important to assess the effect of foliar nutrition on growth parameters of soyabean.

Materials and Methods

An evaluation-based experiment entitled "Effect of Foliar Nutrition on growth parameters of Soybean (*Glycine max* L.) under the gird region of Madhya Pradesh" was conducted at CRC Farm – 1, ITM University Gwalior (M.P.) during the kharif season 2022. The farm, situated at a latitude of 26014'N and a longitude of 78014'E, is positioned 206 meters above mean sea level. The area experiences extremely hot summers and cold winters. It is known for its semi-arid, subtropical climate. The annual rainfall in this region ranges from 600 to 700 mm, with uneven distribution patterns. Gwalior receives about 80 to 90% of the total rainfall between July to September. The mean relative humidity is nearly constant at over 80 to 90% from July to September and around 40-50% for the rest of the year. The soil exhibited a loamy sand texture, a slightly alkaline pH, a deficiency in organic carbon, and low levels of accessible N_2O and P_2O_5, while the K2O content was moderate. The experiment was laid out in randomized block design (RBD) with 11 treatments and three replications. The gross plot size is 12 sq meter and net plot size is 7.48 sq meter.

The 11 treatment details is as follows: T_1: Control (Application of water in the form of spray), T_2: RDF (100%) @ at the time of sowing, T_3: RDF + Urea 2% at veg., T_4: RDF + Urea 2% at pod., T_5: RDF + Urea 2% at veg + pod., T_6: RDF + DAP 2% at veg., T_7: RDF + DAP 2% at pod., T_8: RDF + DAP 2% at veg + pod., T_9: RDF + KNO3 2% at veg., T_{10}: RDF + KNO3 2% at pod., T_{11}: RDF + KNO3 2% at veg + pod. The variety JS9560 was used in the experiment. Observations are taken while carrying out the experiment, growth parameters like Initial plant population, plant height (cm), No. of leaves per plant, Number of branches per plant, Leaf area index (LAI), Days taken in 50% flowering and dry matter accumulation per plant (g).

Results and Discussion

Growth parameters

The observed initial plant population of 5.98 square per meter was slightly lower than the theoretical expectation of 6.21 square meter-1. This difference may be attributed to various factors, such as seed germination rates, planting density, or other environmental factors. Further investigation could help identify the specific causes of this discrepancy.

Plant height showed a significant increase between 40 and 60 days after sowing (DAS) but declined after 60 DAS. The highest plant height was observed in treatment T_8 (RDF + DAP 2% at veg + pod). This indicates that certain fertilizer treatments, specifically T_8, had a positive effect on plant height during the vegetative and early reproductive stages. However, it's essential to consider that excessive vegetative growth may not always translate to higher yields, as it could divert resources from reproductive structures like flowers and pods. The similar result was given by Sruthi *et al.* (2020) [4].

The number of green leaves plant-1 increased up to 60 DAS and then decreased until harvest, which is a typical pattern in many crops. Treatments T_8 (RDF + DAP 2% at veg + pod) and T_5 (RDF + Urea 2% at veg + pod) had the highest number of leaves, indicating that these treatments had a positive impact on leaf development. This could potentially contribute to increased photosynthetic capacity and overall plant health. The similar result was given by Sharifi *et al.*, (2018) [3].

The number of branches plant-1 increased with crop development but slowed down at physiological maturity. Treatment T_8 consistently resulted in higher branch numbers, suggesting that this specific fertilizer application had a favorable effect on branching. More branches can lead to increased reproductive structures, potentially resulting in higher yields. The similar result was given by Sharifi *et al.*, (2018) [3].

Leaf area index (LAI) increased with crop development, which is expected as the canopy grows denser. Treatment T8 had the highest LAI at various stages, indicating that this treatment promoted greater canopy development. This increase in LAI could contribute to higher photosynthesis rates and, consequently, greater dry matter accumulation. The similar result was given by Gutte *et al.*, (2018) [1].

Dry matter accumulation increased significantly between 40 DAS and harvest, with the highest accumulation in treatment T_8. This suggests that T_8, with the application of RDF + DAP 2% at veg + pod, was particularly effective in promoting vegetative growth and biomass production. The increase in dry matter can be seen as an indicator of plant health and potential yield. The similar result was given by Takankhar *et al.*, (2017) [6].

Both the number of days to flowering and maturity increased significantly with the dosage of fertilizers, with treatment T8 requiring the most time. This indicates that the higher fertilizer doses delayed flowering and maturity. Delayed flowering can be advantageous in certain cases as it extends the vegetative phase, potentially resulting in more robust plants. However, it's essential to balance this with the risk of exposure to adverse weather conditions or increased susceptibility to pests and diseases.

Table 1: Effect of foliar application on number of plant population, plant height and number of leaves plant-^{1} of soyabean

Treatment	Plant Population	Plant height (cm)				No of Leaves Plant^{-1}			
	At initial stage	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	AT HARVEST
Control	5.30	10.08	19.29	23.68	26.28	4.06	6.19	12.72	9.02
RDF	5.65	10.74	25.01	30.00	32.60	5.06	7.68	15.34	13.14
RDF + Urea 2% at veg.	5.85	11.11	31.02	37.18	39.78	5.62	10.86	19.36	15.59
RDF + Urea 2% at pod.	5.66	10.75	28.49	34.15	36.75	5.08	9.17	17.67	13.14
RDF + Urea 2% at veg + pod.	5.92	11.25	33.36	40.01	42.61	5.80	12.41	20.91	17.91
RDF + DAP 2% at veg.	5.80	11.01	28.70	34.40	37.00	5.22	9.31	17.81	13.34
RDF + DAP 2% at pod.	5.83	11.08	30.97	37.11	39.71	5.36	10.82	19.32	15.54
RDF + DAP 2% at veg + pod.	5.98	11.36	34.03	40.79	43.39	5.82	12.87	21.37	19.37
RDF + KNO_3 2% at veg.	5.79	11.00	28.65	34.34	36.94	5.25	9.28	17.78	13.21
RDF + KNO_3 2% at pod.	5.67	10.78	28.54	34.21	36.81	5.10	9.20	17.70	13.18
RDF + KNO_3 2% at veg + pod.	5.91	11.22	31.07	37.24	39.84	5.76	10.89	19.39	15.62
Sem (±)	0.39	0.75	1.28	1.85	1.90	0.35	0.49	0.78	0.71
C.D. (at 5%)	NS	NS	3.79	5.45	5.55	NS	1.59	2.31	2.10
C.V	11.95	11.55	7.68	9.19	8.56	11.52	10.09	7.5	8.53

Table 2: Effect of foliar application on no. of branches plant $^{-1}$ and leaf area index of soyabean

Treatment	Dry matter accumulation plant^{-1}					
	20 DAS	40 DAS	60 DAS	At harvest	Days of 50% flowering	Days taken in maturity
Control	5.16	7.52	13.10	14.37	33.51	70.53
RDF	6.52	9.63	13.84	15.11	35.32	75.18
RDF + Urea 2% at veg.	7.28	13.93	18.16	19.43	39.78	78.96
RDF + Urea 2% at pod.	6.54	11.77	15.76	17.03	35.41	75.28
RDF + Urea 2% at veg + pod.	7.34	16.23	20.32	21.58	40.16	80.61
RDF + DAP 2% at veg.	6.81	11.88	15.89	17.16	37.02	77.10
RDF + DAP 2% at pod.	7.11	13.84	18.00	19.27	38.80	77.54
RDF + DAP 2% at veg + pod.	7.87	16.96	20.42	21.69	43.24	82.31
RDF + KNO_3 2% at veg.	6.68	11.84	15.84	17.11	36.24	77.03
RDF + KNO_3 2% at pod.	6.65	11.80	15.78	17.05	36.07	75.43
RDF + KNO_3 2% at veg + pod.	7.33	13.96	18.29	19.56	40.08	79.45
Sem (±)	0.33	0.69	0.91	0.92	2.06	5.30
C.D. (at 5%)	NS	2.04	2.69	1.97	6.09	NS
C.V	8.36	9.49	9.39	8.74	9.47	11.45

Table 3: Effect of foliar application on dry matter accumulation plant^{-1} and days taken in 50% flowering and maturity of soyabean

Treatment	No of branches plant^{-1}			Leaf area index		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
Control	1.58	2.31	4.39	1.92	1.24	3.06
RDF	1.67	3.56	5.57	2.13	1.72	3.45
RDF + Urea 2% at veg.	1.79	5.51	7.50	2.27	2.96	4.49
RDF + Urea 2% at pod.	1.67	4.46	6.45	2.15	2.19	3.69
RDF + Urea 2% at veg + pod.	1.83	6.42	8.41	2.33	3.66	5.16
RDF + DAP 2% at veg.	1.74	4.56	6.55	2.22	2.31	3.81
RDF + DAP 2% at pod.	1.77	5.48	7.47	2.23	2.89	4.43
RDF + DAP 2% at veg + pod.	1.85	6.95	8.94	2.44	3.78	5.28
RDF + KNO_3 2% at veg.	1.71	4.52	6.52	2.21	2.27	3.77
RDF + KNO_3 2% at pod.	1.70	4.49	6.48	2.19	2.21	3.71
RDF + KNO_3 2% at veg + pod.	1.82	5.57	7.58	2.30	3.06	4.56
Sem (±)	0.096	0.25	0.34	0.18	0.14	0.44
C.D. (at 5%)	NS	0.74	1.01	NS	0.43	1.29
C.V	9.40	8.96	9.67	11.9	9.85	8.93

Conclusion

Based on the experiment it is concluded that among all the treatments T_8 (RDF + DAP 2% at veg + pod) recorded significantly highest growth.

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