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Effect of soil and foliar application of nano fertilizers on growth and yield of soybean (*Glycine max* L. Merrill)

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Abstract
A field experiment was conducted at Research farm, Department of Agronomy, VNMKV, Parbhani during *kharif* season of 2024-25 to study the effect of soil and foliar application of nano fertilizers on growth and yield of soybean (*Glyine max* L.). The experiment was laid out in randomized block design with three replication and ten treatments *viz*. T_1-Control, T_2-RDF (30:60:30:20 NPKS Kg/ha), T_3 -Solid Nano NPK (8:8:12) (@100 Kg/ha) +SSP (189 Kg/ha), T_4- Solid Nano NPK (8:8:12) (@100 Kg/ha) + Foliar spray of Nano DAP at 30 DAS, T_5 -Solid Nano NPK (8:8:12) (@ 50 Kg/ha) + Foliar spray of Nano NPK at 30 DAS, T_6-75% RDF + Foliar sprays of Nano NPK at 30 and 45 DAS, T_7-75% RDF + Foliar sprays of Nano DAP at 30 and 45 DAS, T_8- 50% RDF + Foliar sprays of Nano NPK at 30 and 45 DAS, T_9 -50% RDF + Foliar sprays of Nano DAP at 30 and 45 DAS, T_{10}-Three foliar sprays of Nano NPK at 30,45,60 DAS. The results indicated that the treatment use of 75% RDF + foliar sprays of Nano DAP at 30 and 45 DAS recorded influence on growth parameters such as plant height, number of branches, leaf area, dry matter. While seed yield of soybean was highest with 75% RDF + foliar sprays of Nano DAP at 30 and 45 and was at par with RDF (30:60:30:20 NPKS Kg/ha) and application of Solid Nano NPK (8:8:12) (@100 Kg/ha) + Foliar spray of Nano DAP at 30 DAS.

Keywords: Nano fertilizers, foliar spray, soil application, growth, yield

Introduction
Soybean (*Glycine max* L. Merill), often called the “wonder crop,” is a leguminous plant from the family Leguminaceae and subfamily Papilionaceae. It is valued as an exceptional health food, containing about 40% high-quality protein, 23% carbohydrates, and 20% cholesterol-free oil, along with 4% minerals, 2% phospholipids and a notable proportion of polyunsaturated fatty acids. The crop also provides a good amount of vitamin C and approximately 5–6% crude fiber. Its protein is abundant in essential amino acids, especially lysine, which is usually limited in cereal grains. Importantly, soybean protein is regarded as the only plant-derived protein with quality comparable to animal protein. In addition, soybean improves soil fertility through biological nitrogen fixation in partnership with the bacterium Rhizobium japonicum, contributing roughly 65–115 kg of nitrogen per hectare. (Velu and Srinivasan, 1984) [7].
Nanofertilizers are produced from conventional fertilizers, bulk fertilizer sources, or plant extracts, and are coated with nanomaterials to allow for controlled and gradual nutrient release. This method enhances soil fertility, increases crop yields and improves the quality of agricultural products. (Zulfiqar *et al*., 2019) [9]. Nanofertilizers (NFs) dissolve in the soil solution and are absorbed by plants, but their smaller particle size often makes them more soluble than bulk materials in the rhizosphere. They are more effective at reducing nitrogen losses caused by leaching, volatilization, and microbial immobilization. Additionally, controlled-release NFs improve fertilizer use efficiency (FUE) and help prevent soil degradation by minimizing the harmful impacts linked to excessive use of traditional fertilizers. (Ditta and Muhammad 2016) [1].

Materials and Methods
A field experiment was carried out in *kharif* season of 2024-25 at Research farm, Department of

Agronomy, VNMKV, Parbhani. The experiment was laid out in randomized block design with three replication and ten treatments *viz*. T_1-Control, T_2-RDF (30:60:30:20 NPKS Kg/ha), T_3 -Solid Nano NPK (8:8:12) (@100 Kg/ha) +SSP (189 Kg/ha), T_4- Solid Nano NPK (8:8:12) (@100 Kg/ha) + Foliar spray of Nano DAP at 30 DAS, T_5 -Solid Nano NPK (8:8:12) (@ 50 Kg/ha) + Foliar spray of Nano NPK at 30 DAS, T_6-75% RDF + Foliar sprays of Nano NPK at 30 and 45 DAS, T_7-75% RDF + Foliar sprays of Nano DAP at 30 and 45 DAS, T_8- 50% RDF + Foliar sprays of Nano NPK at 30 and 45 DAS, T_9 -50% RDF + Foliar sprays of Nano DAP at 30 and 45 DAS, T_{10}-Three foliar sprays of Nano NPK at 30,45,60 DAS.

Growth parameters were recorded from five randomly selected plant in different treatment plots. While in yield parameters, oduce harvested from the net plot before threshing was recorded as the biological yield.

Results and Discussion

Growth parameters

The data shows that the maximum plant height of soybean was recorded in treatmentT_7i.e, application of 75% RDF along with foliar sprays of Nano DAP at 30 and 45 DAS which was at par with treatment T_6 i.e, application of 75% RDF along with foliar sprays of Nano NPK at 30 and 45 DAS and treatment T_2 recommended dose of fertilizers and found significantly superior over rest of the treatment. The lowest plant height was observed in treatment (T_1) i.e, control. Similar finding was reported by Gholinezad (2017) [4], that application of nano fertilizers increased plant height by 20% in comparing to control condition. Similar was the trend for number of branches per plant and dry mater accumulation.

Table 1: Effect of soil and foliar application of nano fertilizers on plant hight, number of branches and dry matter accumulation plant $^{-1}$

Sr. No.	Treatments	Plant height (cm)	No. of branches	Leaf area (dm^2)	Dry matter Plant^{-1} (g)	Seed yield (kg ha^{-1})
1	T_1 – Control	49.27	3.93	8.40	7.22	1173
2	T_2 - RDF (30:60:30:20 NPKS Kg/ha)	55.77	5.67	12.80	10.52	1935
3	T_3 - Solid Nano NPK (8:8:12) (@100 Kg/ha) +SSP (187.5 Kg/ha)	51.67	5.06	11.56	9.44	1722
4	T_4 - Solid Nano NPK (8:8:12) (@100 Kg/ha) + Foliar spray of Nano DAP at 30 DAS	53.80	5.57	11.92	9.67	1808
5	T_5 - Solid Nano NPK (8:8:12) (@ 50 Kg/ha) + Foliar spray of Nano NPK at 30 DAS	52.37	5.43	10.93	9.41	1685
6	T_6 - 75% RDF + Foliar sprays of Nano NPK at 30 and 45 DAS	60.13	5.92	12.85	10.96	1938
7	T_7 - 75% RDF + Foliar sprays of Nano DAP at 30 and 45 DAS	60.70	6.17	14.04	11.75	2018
8	T_8 - 50% RDF + Foliar sprays of Nano NPK at 30 and 45 DAS	52.33	5.30	10.80	8.88	1704
9	T_9 - 50% RDF + Foliar sprays of Nano DAP at 30 and 45 DAS	53.33	5.29	11.67	9.66	1721
10	T_{10} - Three foliar sprays of Nano NPK at 30,45,60 DAS	50.73	5.23	9.65	8.50	1588
	S.E. m±	1.98	0.21	0.45	0.45	76.91
	C.D. @ 5%	5.89	0.69	1.34	1.34	228.53
	General mean	54.01	5.35	11.46	9.60	

This might be due to the increased nutrient absorption might have increased the photosynthetic efficiency. Thus, higher number of leaves contributed to higher leaf area per plant Patil *et.al*. (2024) [6]. Results analogous to this have also been reported by Daware *et.al* (2024) [3].

Seed yield (kg ha^{-1})

The data revealed that among the different treatments maximum seed yield was recorded in treatment 75% RDF + Foliar sprays of Nano DAP at 30 and 45 DAS (T_7) and it was statistically at par with 75% RDF + Foliar sprays of Nano NPK at 30 and 45 DAS (T_6), recommended dose of fertilizers (T_2) and solid Nano NPK (8:8:12) (@100 Kg ha^{-1}) + Foliar spray of Nano DAP at 30 DAS (T_4). The lowest seed yield (1173 Kg ha^{-1}) among different treatments was recorded with treatment control (T_1). This might be due the combined use of conventional fertilizer and nano DAP, which ensures steady nutrient supply throughout the crop cycle. The nano particles, due to their small size and high surface area, enhance nitrogen and phosphorus uptake, boosting photosynthesis and plant metabolism. This leads to increased biomass and better nutrient allocation to seeds, ultimately improving yield. Similar results were reported by Choudhary *et al*., (2018) [2] and Kailas *et al*., (2017) [5].

Conclusion

The findings of this one year research study indicate that application of nano fertilizers in combination with the recommended dose of fertilizers has significant effect on growth and yield attributes of soybean crop. The treatment involving 75% RDF along with foliar sprays of Nano DAP recorded highest mean values for all growth and yield parameters.

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