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Canopy mediated growth and productivity in rice bean (*Vigna umbellata* L.) as influenced by foliar spray of Nano DAP

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Abstract

A field experiment was conducted at College of Agriculture, Kalaburagi during *kharif* season 2024 with an objective to study canopy mediated growth and productivity in rice bean (*Vigna umbellata* L.) as influenced by foliar spray of nano DAP. The soil was clayey in texture and experiment was laid out in randomized block design with three replications and comprised of 11 treatments. The treatments comprise of foliar application of nano DAP with varied levels of fertilizers. Foliar spray of nano DAP and conventional DAP was done on 30 DAS. The results revealed that, basal application of 100 per cent RDF + foliar spray of 4 ml l⁻¹ of nano DAP had resulted in higher seed yield (1160 kg ha⁻¹), however, it was statistically on par with the application of 100 per cent RDF + 2ml l⁻¹ nano DAP spray (1125 kg ha⁻¹), 100 per cent RDF + 2% DAP spray (1065 kg ha⁻¹) and 75% per cent RDF + 4 ml l⁻¹ nano DAP spray (1027 kg ha⁻¹). Similar trend has been followed in case of growth and yield parameters. These results confirms that 25 per cent of conventional DAP fertilizer can be replaced with nano DAP application of 4 ml l⁻¹ at 30 DAS in increasing the N and P use efficiency and productivity of rice bean.

Keywords: Rice bean, Nano DAP, canopy, growth and productivity

1. Introduction

Rice bean (*Vigna umbellata* L.) is cultivated in India, Myanmar, Malaysia, China, Korea, Indonesia and the Philippines. Additionally, the West Indies, the United States, Australia, East Africa, Java, Fiji, Bangladesh, Sri Lanka and Nepal cultivate this crop. The origin of the crop is thought to be in Hindustan. It is a neglected crop in India and is being cultivated on small areas by some hill farmers in North-Eastern India and its distribution is mainly confined to the tribal region of North-Eastern hills and hilly tracts of Western and Eastern Ghats. In the North-Eastern region of India (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura), it is grown predominantly under rainfed conditions in mixed farming system, under shifting cultivation, terraces, kitchen garden and backyards (Bepary *et al.*, 2016)^[3].

The ideal NPK usage ratio in India is 4:2:1, but the practical usage ratio is 7:2.8:1. This imbalanced application of fertilizer is the main reason for the deterioration of soil health. Some of the important problems that induced include low fertilizers response ratio and low nutrient use efficiency. During 1970s', the fertilizer response ratio was 13.4 and now it is reduced to only 2.7. It means over the years though our fertilizer consumption is increasing the yield is stagnated (Anon., 2020)^[2].

Nano fertilizers are defined as materials on a nanometer scale (1-100 nm) containing macro and micronutrients that are delivered to crops in a controlled mode. In general, one nm scale means one billionth of a meter (10⁻⁹ m). In comparison to conventional fertilizers, nano-fertilizers have a large surface area and particles that are smaller in size than the pores in the plant's leaves and roots, which can boost penetration into the plant from the applied surface and increase uptake and nutrients use efficiency. These efficient fertilizers are expected to enhance crop growth, production and quality by reducing environment footprint (Liu and Lal, 2015)^[7].

A study is proposed to assess the "Canopy mediated growth and productivity in rice bean (*Vigna*

umbellata L.) as influenced by foliar spray of nano DAP", focusing on its influence on canopy, growth, yield parameters and yield of rice bean cultivation under nano DAP application.

2. Material and Methods

The field experiment on the "Canopy mediated growth and productivity in rice bean (*Vigna umbellata* L.) as influenced by foliar spray of nano DAP" was conducted during the *kharif* 2024 season at College of Agriculture, Kalaburagi, UAS, Raichur. The experimental site is located in the North Eastern Dry Zone of Karnataka, with medium deep clay soil. Soil samples were analysed for physical and chemical properties before sowing of the crop.

The experiment consisted of 11 treatments in a randomized complete block design with three replications. The treatments includes: T₁: 50% RDF + nano DAP @ 2 ml l⁻¹, T₂: 50% RDF + nano DAP @ 4 ml l⁻¹, T₃: 75% RDF + nano DAP @ 2 ml l⁻¹, T₄: 75% RDF + nano DAP @ 4 ml l⁻¹, T₅: 100% RDF + nano DAP @ 2 ml l⁻¹, T₆: 100% RDF + nano DAP @ 4 ml l⁻¹, T₇: Nano DAP @ 2 ml l⁻¹, T₈: Nano DAP @ 4 ml l⁻¹, T₉: 100% RDF + water spray, T₁₀: 100% RDF + DAP @ 2% and T₁₁: Absolute control. The recommended dose of nitrogen (20 kg ha⁻¹) and phosphorus (40 kg ha⁻¹) was applied at the time of sowing.

Growth parameters like plant height, number of leaves, leaf area, Leaf Area Index (LAI), SPAD and NDVI reading were recorded at 25, 50, 75 DAS and at harvest. Leaf area was measured using the disc method and LAI was calculated by dividing the leaf area by the land area occupied by each plant. Yield parameters including the number of pods per plant, number of seeds per pod, seed yield per plant seed yield and stover yield, were recorded at harvest.

Statistical analysis of the data was performed using Fisher's method of analysis of variance at a 5% significance level, with critical differences estimated using the t-test and variance technique as given by Panse and Sukhatme (1967)^[8].

3. Results and Discussion

3.1 Effect of nano DAP on growth attributes

3.1.1 Plant height

Application of 100% RDF + foliar spray of nano DAP @ 4 ml l⁻¹ resulted in the taller plants (64.1 cm). It was in on par with 100% RDF + foliar spray of nano DAP @ 2 ml l⁻¹ (63.3 cm), 100% RDF + foliar spray of conventional DAP @ 2% (60.3 cm) and 75% RDF + foliar spray of nano DAP @ 4 ml l⁻¹ (60.5 cm). The observed enhancement in plant stature with increasing levels of RDF and foliar-applied nano DAP can be attributed to the synergistic role of nitrogen and phosphorus in promoting vegetative growth. These results align with those of Aniket *et al.* (2023)^[1], who found that nanoparticle-based phosphorus fertilization increased the plant height by 32.6% in soybean compared to traditional phosphorus fertilizers.

3.1.2 Clusters per plant

At harvest, the treatment involving 100% RDF + foliar spray of nano DAP @ 4 ml l⁻¹ resulted in the higher number of clusters (34.4 plant⁻¹). It was on par with 100% RDF + foliar spray of nano DAP @ 2 ml l⁻¹ (32.9 plant⁻¹), 100% RDF + foliar spray of conventional DAP @ 2% (32.8 plant⁻¹) and 75% RDF + foliar spray of nano DAP @ 4 ml l⁻¹ (32.2 plant⁻¹). Nano DAP likely enhanced the internal mobility of essential macronutrients, particularly phosphorus and nitrogen, which are pivotal in flower induction and reproductive differentiation as a result of cluster formation. Similar results were also reported by Khemshetty *et al.* (2024)^[6] for varied levels of RDF in

interaction with nano DAP in chickpea crop.

3.1.3 Leaves per plant

The higher number of leaves (65.2 plant⁻¹) was observed with the application of 100% RDF + nano DAP @ 4 ml l⁻¹, which was on par with 100% RDF + nano DAP @ 2 ml l⁻¹ (64.5 plant⁻¹), 100% RDF + conventional DAP @ 2% (62.4 plant⁻¹) and 75% RDF + nano DAP @ 4 ml l⁻¹ (61.6 plant⁻¹). The foliar application of nano DAP during early vegetative stages likely facilitated rapid nutrient absorption through stomatal and cuticular pathways, thereby augmenting physiological efficiency and promoting sustained leaf initiation and retention. Similar trends were reported by Prakash *et al.* (2023)^[10] and Srikanth *et al.* (2023)^[12].

3.1.4 Leaf area

The maximum leaf area (1277 cm² plant⁻¹) was recorded in the treatment with 100% RDF + nano DAP @ 4 ml l⁻¹, which was statistically on par with 100% RDF + nano DAP @ 2 ml l⁻¹ (1263 cm² plant⁻¹), 100% RDF + conventional DAP @ 2% (1221 cm² plant⁻¹) and 75% RDF + nano DAP @ 4 ml l⁻¹ (1206 cm² plant⁻¹). The application of foliar spray of nano DAP resulted in a higher leaf area, which has supported the initial establishment and growth of plants. The foliar application of nitrogen in its nano form, with its high concentration of nitrogen molecules and extensive surface area, facilitates enhanced nitrogen absorption. Similar findings was reported by Khemshetty *et al.* (2024)^[6].

3.1.5 Total dry matter production

100% RDF + nano DAP @ 4 ml l⁻¹ treatment maintained the higher biomass production at harvest (27.28 g plant⁻¹), closely comparable to 100% RDF + nano DAP @ 2 ml l⁻¹ (26.39 g plant⁻¹), 100% RDF + conventional DAP @ 2% (25.46 g plant⁻¹) and 75% RDF + nano DAP @ 4 ml l⁻¹ (25.18 g plant⁻¹). The absolute control showed the lower biomass production (11.13 g plant⁻¹), indicating limited nutrient availability. The superior dry matter production under 100% RDF + nano DAP @ 4 ml l⁻¹ treatment were attributed to enhanced nutrient delivery, particularly nitrogen and phosphorus *via* the foliar-applied nanoparticles aligning with the findings of Prakash *et al.* (2023)^[10] and Sanjayakumar *et al.* (2024)^[11].

3.2 Effect of nano DAP on yield attributes

3.2.1 Number of pods per plant

The treatment receiving 100% RDF + nano DAP @ 4 ml l⁻¹, exhibited a significantly higher number of pods (24.48 plant⁻¹). It was on par with 100% RDF + nano DAP @ 2 ml l⁻¹ (23.40 plant⁻¹), 100% RDF + conventional DAP @ 2% (22.93 plant⁻¹) and 75% RDF + nano DAP @ 4 ml l⁻¹ (22.37 plant⁻¹). The sustained nitrogen availability supported by nano DAP promoted pod initiation and development and integration with 100% RDF improved the nutrient uptake efficiency, contributing to greater reproductive success. Similar positive effects of nano DAP on pod formation and yield have been reported by Ibrahim and Fartoosi (2019)^[5].

3.2.2 Number of seeds per plant

The treatment receiving 100% RDF + nano DAP @ 4 ml l⁻¹ recorded a higher number of seeds per pod (8.65), which remained statistically on par with 100% RDF + nano DAP @ 2 ml l⁻¹ (8.29), 100% RDF + conventional DAP @ 2% (8.17) and 75% RDF + nano DAP @ 4 ml l⁻¹ (7.93 pod⁻¹). This is attributed to foliar applications that improved nutrient availability during the reproductive phase, which likely supported efficient

fertilization and seed set. This aligns with report of El-Azizy *et al.* (2021).

3.2.3 Seed yield per plant

The treatment receiving 100% RDF + nano DAP @ 4 ml l⁻¹ recorded the higher seed yield per plant (14.43 g), which was statistically comparable with 100% RDF + nano DAP @ 2 ml l⁻¹ (13.13 g), 100% RDF + conventional DAP @ 2% (12.56 g) and 75% RDF + nano DAP @ 4 ml l⁻¹ (11.85 g). The higher seed yield per plant in nutrient-optimized treatments can be attributed to improved nutrient uptake, enhanced photosynthetic efficiency and better assimilate translocation from source leaves to developing pods. Similar yield-enhancing effects of foliar nano phosphorus applications have been reported in legumes by Prakash (2023) and Pragathi *et al.* (2024) ^[10, 9] for its role in complementing basal fertilization for maximizing productivity.

3.2.4 Seed yield

The significantly higher seed yield (1160 kg ha⁻¹) was obtained with the application of 100% RDF as a basal dose + foliar spray of nano DAP @ 4 ml l⁻¹ at 30 DAS. It was statistically on par with 100% RDF + nano DAP @ 2 ml l⁻¹ (1125 kg ha⁻¹), 100% RDF + conventional DAP @ 2% (1065 kg ha⁻¹) and 75% RDF + nano DAP @ 4 ml l⁻¹ (1027 kg ha⁻¹). In contrast, the absolute control treatment recorded the lower seed yield (403 kg ha⁻¹). The foliar application of nano DAP extended leaf functional duration, delayed senescence and sustained photosynthetic period, thereby enhancing the source-to-sink relationship. This

might have contributed to better distribution of assimilates towards developing pods resulting in more pods per plant, heavier seeds and increased seed yield per plant. These observations align with the findings of Aniket *et al.* (2023) ^[1] who reported that nano nutrient supplementation in conjunction with conventional fertilization improved the physiological efficiency, nutrient utilization and yield performance in various crops.

3.2.5 Stover yield

The higher stover yield (2656 kg ha⁻¹) was recorded with 100% RDF + foliar spray of nano DAP @ 4 ml l⁻¹ at 30 DAS. This was statistically on par with 100% RDF + nano DAP @ 2 ml l⁻¹ (2567 kg ha⁻¹), 100% RDF + conventional DAP @ 2% (2411 kg ha⁻¹) and 75% RDF + nano DAP @ 4 ml l⁻¹ (2387 kg ha⁻¹). Conversely, the absolute control produced the lower stover yield (775 kg ha⁻¹). The application of nano-scale N and P offers a distinct advantage over conventional urea and DAP, as the reduced particle size increases surface area, improves nutrient absorption efficiency and enhances translocation. This superior uptake capacity translates into higher stover yield. The growth-promoting and yield-enhancing effects of nano-fertilizers have been substantiated by Srikanth *et al.* (2023) ^[12] who collectively demonstrated their efficacy in augmenting both vegetative and reproductive performance, underscoring the potential of advanced nutrient delivery systems in sustainable crop productivity.

Table 1: Growth parameters of rice bean as influenced by foliar spray of nano DAP

Treatment	Plant height (cm)	Clusters plant ⁻¹	Leaves plant ⁻¹	Leaf area (cm ² plant ⁻¹)	TDM production
T ₁ : 50% RDF + Nano DAP @ 2 ml l ⁻¹ water	46.2	24.8	44.4	869	17.19
T ₂ : 50% RDF + Nano DAP @ 4 ml l ⁻¹ water	46.6	26.1	46.3	911	17.77
T ₃ : 75% RDF + Nano DAP @ 2 ml l ⁻¹ water	55.3	30.3	54.1	1059	21.03
T ₄ : 75% RDF + Nano DAP @ 4 ml l ⁻¹ water	60.5	32.2	61.6	1206	25.18
T ₅ : 100% RDF + Nano DAP @ 2 ml l ⁻¹ water	63.3	32.9	64.5	1263	26.39
T ₆ : 100% RDF + Nano DAP @ 4 ml l ⁻¹ water	64.1	34.4	65.2	1277	27.28
T ₇ : Nano DAP @ 2 ml l ⁻¹ water	39.0	20.3	35.3	689	13.77
T ₈ : Nano DAP @ 4 ml l ⁻¹ water	39.8	21.6	36.3	710	14.54
T ₉ : 100% RDF + water spray	55.8	31.0	54.2	1060	21.45
T ₁₀ : 100% RDF + 2% DAP foliar spray	60.3	32.8	62.4	1221	25.46
T ₁₁ : Absolute control	31.0	15.9	27.1	530	11.13
S.Em. ±	2.1	1.0	2.1	41	0.85
CD @ 5%	6.2	2.9	6.1	122	2.50

Note: Nano DAP and DAP sprayed at 30 DAS

Table 2: Yield parameters of rice bean as influenced by foliar spray of nano DAP

Treatment	No. of pods plant ⁻¹	No. of seeds plant ⁻¹	Seed yield plant ⁻¹ (g)
T ₁ : 50% RDF + Nano DAP @ 2 ml l ⁻¹ water	46.2	24.8	44.4
T ₂ : 50% RDF + Nano DAP @ 4 ml l ⁻¹ water	46.6	26.1	46.3
T ₃ : 75% RDF + Nano DAP @ 2 ml l ⁻¹ water	55.3	30.3	54.1
T ₄ : 75% RDF + Nano DAP @ 4 ml l ⁻¹ water	60.5	32.2	61.6
T ₅ : 100% RDF + Nano DAP @ 2 ml l ⁻¹ water	63.3	32.9	64.5
T ₆ : 100% RDF + Nano DAP @ 4 ml l ⁻¹ water	64.1	34.4	65.2
T ₇ : Nano DAP @ 2 ml l ⁻¹ water	39.0	20.3	35.3
T ₈ : Nano DAP @ 4 ml l ⁻¹ water	39.8	21.6	36.3
T ₉ : 100% RDF + water spray	55.8	31.0	54.2
T ₁₀ : 100% RDF + 2% DAP foliar spray	60.3	32.8	62.4
T ₁₁ : Absolute control	31.0	15.9	27.1
S.Em. ±	2.1	1.0	2.1
CD @ 5%	6.2	2.9	6.1

Note: Nano DAP and DAP sprayed at 30 DAS

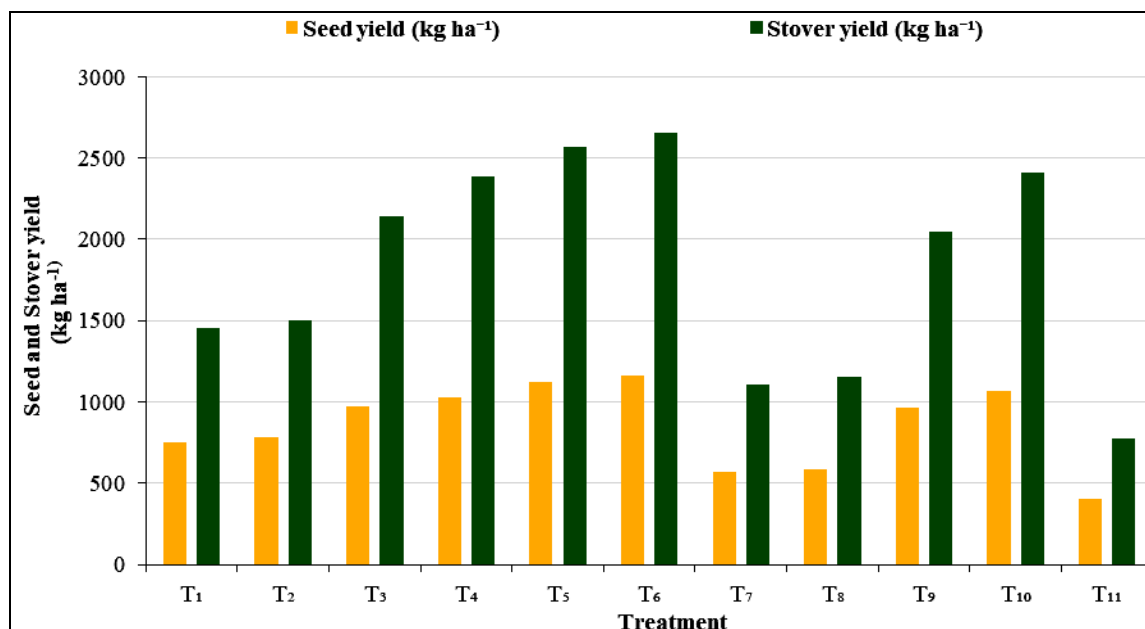


Fig 1: Yield of rice bean as influenced by foliar spray of Nano DAP

4. Conclusion

The application of 100% RDF as a basal dosage, coupled with a foliar spray of nano DAP at 4 ml l⁻¹ at 30 DAS, resulted in significantly enhanced growth and yield attributes, including plant height, number of leaves, leaf area, number of pods plant⁻¹, number of seeds pod⁻¹, seed yield and stover yield, compared to other treatments. However, 75% RDF combined with nano DAP @ 4 ml l⁻¹ was recommendable as it was on par with above mentioned treatment. This balanced approach, combining conventional soil-applied DAP fertilizer with the foliar application of nano DAP, increased nutrient availability for the plants, which played a crucial role in the observed improvements in growth and yield parameters. The synergistic effect of both nutrient sources facilitated better nutrient uptake and assimilation, ultimately leading to higher seed yield. This strategy underscores the effectiveness of integrating conventional and innovative fertilization techniques to optimize nutrient supply, enhance plant growth and improve overall crop productivity. The results clearly demonstrate that employing this dual-fertilization method significantly contributes to maximizing yield potential and achieving superior agricultural outcomes.

References

1. Aniket G, Anand N, Siddaram, Bhat SN, Bellakki MA. Effect of nano DAP on growth, yield and economics of pigeonpea under rainfed condition. *J Pharm Innov.* 2023;12(11):1536-1539.
2. Anonymous. <https://iffco.in/index.php/ourproducts/index/nano-DAP>. 2020.
3. Bepary RH, Wadikar DD, Neog SB, Patki PE. Studies on physico-chemical and cooking characteristics of rice bean varieties grown in NE region of India. *J Food Sci Technol.* 2016;54(4):973-986.
4. El-Azizy FA, Habib AAM, Abd-El Baset AM. Effect of nano phosphorus and potassium fertilizers on productivity and mineral content of broad bean in North Sinai. *J Soil Sci Agric Eng.* 2021;12(4):239-246.
5. Ibrahim NK, Farttoosi HAK. Response of mung bean to boron nanoparticles and spraying stages in *Vigna radiata* L. *Plant Arch.* 2019;19(2):712-715.
6. Khemshetty A, Patil DH, Rathod PS, Patil AS, Basavaraj K. Studies on nano DAP on growth, yield and quality of chickpea under rainfed conditions of northeastern dry zone of Karnataka. *J Exp Agri Int.* 2024;46(3):139-145.
7. Liu R, Lal R. Potentials of engineered nanoparticles as fertilizers for increasing agronomic productions. *Sci Total Environ.* 2015;514:131-139.
8. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR Publication, New Delhi. 1967;4(2):359.
9. Pragathi RP, Pandit SR, Patil DH, Dodamani BM, Anand N. Productivity, nutrient uptake, microbial activity and economics of pigeonpea (*Cajanus cajan* L.) as influenced by foliar application of nano fertilizers. *Int J Res Agron.* 2024;7(9):565-568.
10. Prakash A, Anand N, Siddaram, Ravi MV, Bellakki MA. Response of nano DAP on growth, yield and economics of soybean (*Glycine max* L.). *J Pharm Innov.* 2023;12(11):1985-1989.
11. Sanjayakumar S, Shyamrao K, Siddaram, Mohan C, Patil RP. Growth, productivity and economics of cowpea (*Vigna unguiculata* L.) as influenced by different levels of nano DAP in north eastern dry zone of Karnataka. *Int J Res Agron.* 2024;7(10):548-552.
12. Srikanth C, Shyamrao K, Mohan C, Siddaram, Rudramurthy HV. Effect of nano urea on growth and yield of soybean (*Glycine max* L.) as influenced by nano fertilizers. *Front Crop Improv.* 2023;11(6):2641-2649.