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ASSESSMENT OF PHOTOSYNTHETIC INDICATORS AS INFLUENCED BY CANOPY MEDIATED FOLIAR SPRAY OF NANO DAP IN RICE BEAN (*VIGNA UMBELLATA* L.)

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ABSTRACT

A field experiment was conducted at College of Agriculture, Kalaburagi during *kharif* season 2024 with an objective to study the photosynthetic indicators as influenced by canopy mediated foliar spray of nano DAP in rice bean. The soil was clayey in texture and experiment was laid out in randomized complete 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 SPAD and NDVI values at 75 DAS (58.5 and 0.641, respectively). However, it was on par with the application of 75% per cent RDF + 4 ml l^{-1} nano DAP spray (53.9 and 0.591, respectively). 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 chlorophyll content of rice bean.
Keywords: SPAD, NDVI, Rice bean, Nano DAP, Canopy.

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).

Nano fertilizers are defined as materials on a nanometre 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).

Hence, a study is proposed to study "Accessing photosynthetic indicators as influenced by canopy mediated foliar spray of nano DAP in rice bean (*Vigna umbellata* L.)"

Material and Methods

The field experiment on "Accessing photosynthetic indicators as influenced by canopy mediated foliar spray of nano DAP in rice bean (*Vigna umbellata* L.)" 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. The experiment consisted of 11 treatments in a randomized complete block design with three replications. The treatments includes: T_1: 50% RDF + nano DAP @ 2 ml l^{-1}, T_2: 50% RDF + nano DAP @ 4 ml l^{-1}, T_3: 75% RDF + nano DAP @ 2 ml l^{-1}, T_4: 75% RDF + nano DAP @ 4 ml l^{-1}, T_5: 100% RDF + nano DAP @ 2 ml l^{-1}, T_6: 100% RDF + nano DAP @ 4 ml l^{-1}, T_7: Nano DAP @ 2 ml l^{-1}, T_8: Nano DAP @ 4 ml l^{-1}, T_9: 100% RDF + water spray, T_{10}: 100% RDF + DAP @ 2% and T_{11}: Absolute control. The recommended dose of nitrogen (20 kg ha^{-1}) and phosphorus (40 kg ha^{-1}) was applied at the time of sowing.

Soil Plant Analysis Development (SPAD) and Normalized Difference Vegetation Index (NDVI) reading were recorded at 25, 50, 75 DAS and at harvest. The SPAD chlorophyll meter (SPAD-502 Plus, make: Konica Minolta® Inc., Tokyo, Japan) was used for recording the chlorophyll content from representative plant leaves (Photosynthetically Active Leaf) during the sunny days from 9:30 to 11:30 h IST. The meter works by emitting two frequencies of light, one at a wavelength of 660 nm (red) and another at 940 nm (infrared). Leaf chlorophyll absorbs red light but not infrared, the difference in absorption is measured by the meter and termed as "Optical Density Difference".

NDVI reading was recorded using a hand-held device (GreenSeeker®, Trimble, United States) from 1.0 m above the soil surface of the experimental plot. By measuring the reflectance of the red light (660 nm) as emitter and near infra-red (770 nm) from crop canopy, NDVI is measured without relying on sunlight or external light sources. Mathematically, NDVI is expressed as follows.

$$NDVI = \frac{NIR-R}{NIR+R}$$

Where, NIR-Near infrared, R- Red

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).

Results and Discussion

SPAD reading

At 75 DAS, SPAD readings peaked across treatments (ref. Table 1 and Fig. 1), corresponding with the crop's active vegetative growth and maximum chlorophyll content. The treatment receiving 100% RDF + nano DAP @ 4 ml l^{-1} continued to exhibit superior SPAD value (58.5), nonetheless it remained statistically comparable with those receiving 100% RDF + nano DAP @ 2 ml l^{-1} (57.4), 100% RDF + conventional DAP @ 2% (54.3) and 75% RDF + nano DAP @ 4 ml l^{-1} (53.9). At harvest, SPAD values declined considerably across all treatments, primarily due to leaf senescence and the onset of physiological maturity. Consequently, differences among treatments were statistically non-significant during this stage.

Higher SPAD values observed at 75 DAS, underline the positive role of nano DAP in enhancing chlorophyll synthesis and canopy vigour. Since SPAD is a reliable indicator of chlorophyll concentration and nitrogen assimilation, the elevated values imply improved photosynthetic activity and healthier foliage. Foliar application of nano DAP, particularly in combination with 100% RDF, facilitated better nutrient use efficiency, which translated into robust canopy development. Such enhancements in canopy structure not only supported vegetative biomass accumulation but also laid the foundation for improved seed yield potential. These findings corroborate earlier studies by Gondi (2018) and Khemshetty *et al*. (2024), which emphasized the beneficial effects of nano-formulations on chlorophyll retention and overall plant productivity.

NDVI reading

At 75 DAS, higher NDVI reading (0.641) was observed in the treatment receiving 100% RDF + nano DAP @ 4 ml l^{-1}, which remained statistically comparable to receiving 100% RDF + nano DAP @ 2 ml l^{-1} (0.621), 100% RDF + conventional DAP @ 2% (0.601) and 75% RDF + nano DAP @ 4 ml l^{-1} (0.591). These elevated NDVI readings (ref. Table 2 and Fig. 2) reflected a well-developed canopy, characterized by dense foliage and active photosynthesis. On the other hand, the control plot continued to show poor performance with significantly lower NDVI values (0.260). At harvest, NDVI values declined across all treatments due to natural leaf senescence and chlorophyll degradation. Consequently, differences between treatments were no longer significant at this stage.

NDVI, as a reliable remote sensing index, reflects canopy vigour, biomass density and photosynthetic efficiency. The NDVI readings observed in treatments involving nano DAP, can be attributed to improved nutrient assimilation, leading to enhanced foliage expansion. It promotes nutrient delivery and utilization, thereby boosting chlorophyll retention and canopy health and reflecting its sustainability in plant vigour and yield potential. Similar results were reported by Khemshetty *et al.* (2024) correlating to leaf canopy in chickpea crop.

Table 1 : SPAD reading of rice bean at different growth stages as influenced by foliar spray of Nano DAP

Treatment	25 DAS	50 DAS	75 DAS	At harvest
T_1 : 50 % RDF + Nano DAP @ 2 ml l^{-1} water	36.0	41.3	39.3	50.0
T_2 : 50 % RDF + Nano DAP @ 4 ml l^{-1} water	36.2	42.4	40.8	50.3
T_3 : 75% RDF + Nano DAP @ 2 ml l^{-1} water	36.6	50.2	49.3	50.7
T_4 : 75% RDF + Nano DAP @ 4 ml l^{-1} water	36.9	55.1	53.9	50.9
T_5 : 100% RDF + Nano DAP @ 2 ml l^{-1} water	37.7	56.0	57.4	51.8
T_6 : 100% RDF + Nano DAP @ 4 ml l^{-1} water	37.9	57.1	58.5	52.0
T_7 : Nano DAP @ 2 ml l^{-1} water	35.7	33.7	29.1	49.3
T_8 : Nano DAP @ 4 ml l^{-1} water	35.9	33.8	31.0	49.8
T_9 : 100% RDF + water spray	36.7	50.3	49.5	51.1
T_{10} : 100% RDF + 2% DAP foliar spray	37.2	55.2	54.3	51.4
T_{11} : Absolute control	35.0	36.1	40.1	42.1
S.Em. ±	**1.3**	**1.9**	**2.7**	**1.8**
C.D. at 5%	**NS**	**5.6**	**7.9**	**NS**

Note: Nano DAP and DAP sprayed at 30 DAS, SPAD- Soil Plant Analysis Development

Table 2 : NDVI reading of rice bean at different growth stages as influenced by foliar spray of nano DAP

Treatment	25 DAS	50 DAS	75 DAS	At harvest
T_1 : 50 % RDF + Nano DAP @ 2 ml l^{-1} water	0.343	0.401	0.431	0.360
T_2 : 50 % RDF + Nano DAP @ 4 ml l^{-1} water	0.337	0.413	0.443	0.360
T_3 : 75% RDF + Nano DAP @ 2 ml l^{-1} water	0.340	0.481	0.551	0.370
T_4 : 75% RDF + Nano DAP @ 4 ml l^{-1} water	0.340	0.511	0.591	0.370
T_5 : 100% RDF + Nano DAP @ 2 ml l^{-1} water	0.360	0.551	0.621	0.390
T_6 : 100% RDF + Nano DAP @ 4 ml l^{-1} water	0.360	0.551	0.641	0.390
T_7 : Nano DAP @ 2 ml l^{-1} water	0.350	0.310	0.270	0.360
T_8 : Nano DAP @ 4 ml l^{-1} water	0.360	0.320	0.320	0.357
T_9 : 100% RDF + water spray	0.353	0.481	0.527	0.380
T_{10} : 100% RDF + 2% DAP foliar spray	0.350	0.531	0.601	0.380
T_{11} : Absolute control	0.343	0.310	0.260	0.357
S.Em. ±	**0.013**	**0.020**	**0.026**	**0.017**
C.D. at 5%	**NS**	**0.060**	**0.075**	**NS**

Note: Nano DAP and DAP sprayed at 30 DAS, NDVI-Normalized Difference Vegetation Index

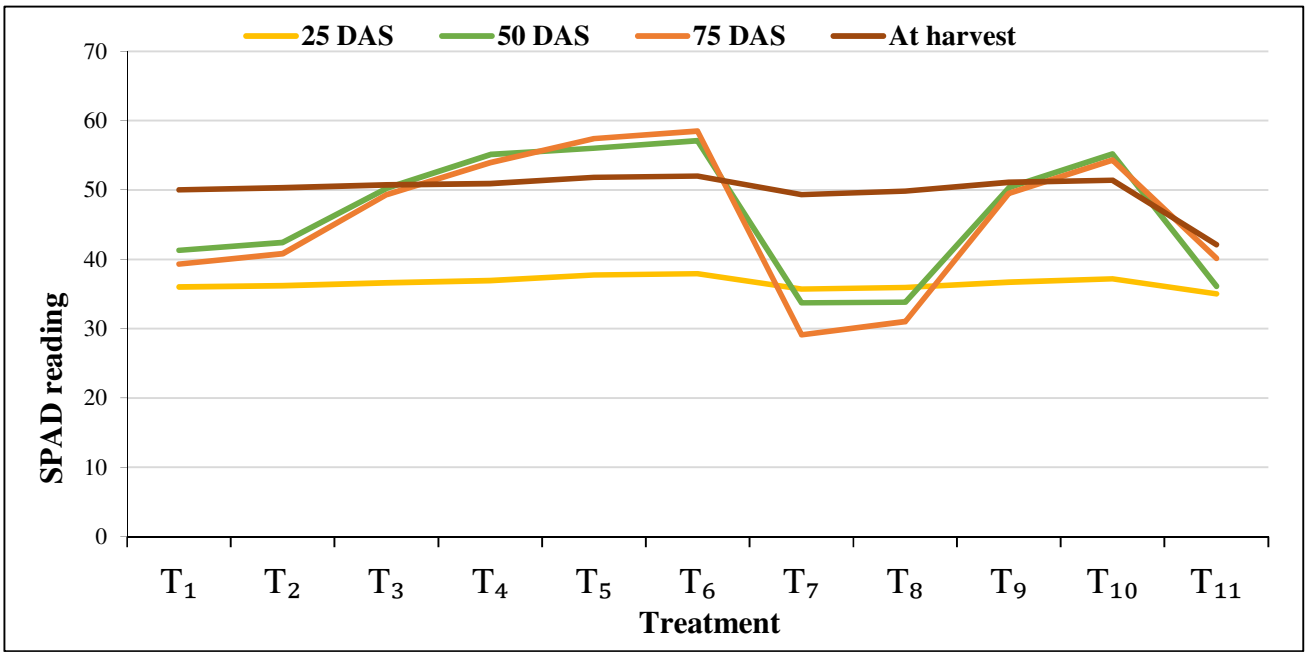

Fig. 1: SPAD reading of rice bean as influenced by foliar spray of nano DAP

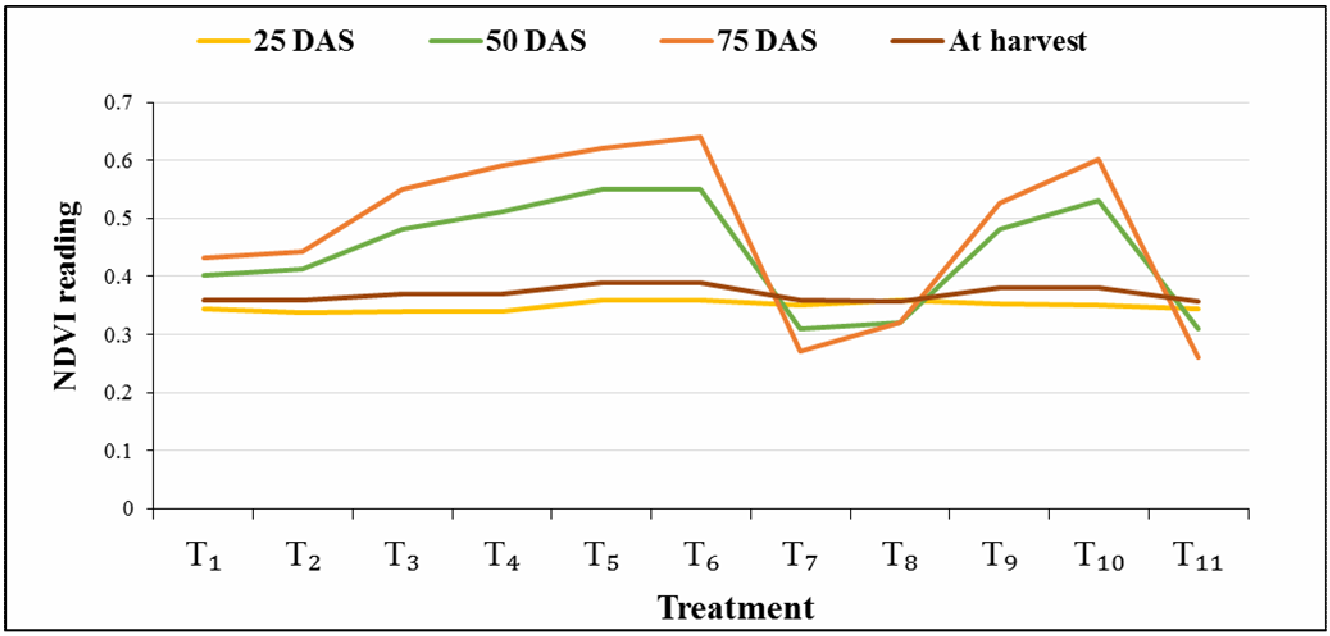

Fig. 2: NDVI reading of rice bean as influenced by foliar spray of nano DAP

Conclusion

The application of 100% RDF as basal dose combined with foliar spray of nano DAP at 4 ml l^{-1} at 30 DAS, led to significantly higher chlorophyll content and nitrogen levels compared to other treatments which is indirect measure of SPAD reading. However, the treatment with 75% RDF + nano DAP @ 4 ml l^{-1} proved equally effective and is therefore recommended. This balanced approach, integrating conventional DAP with foliar sprayed nano DAP, enhancing nutrient availability which played a key role in improving plant growth. The findings highlight the value of combining conventional and modern fertilization methods to optimize nutrient supply, boost growth and improve overall crop performance. Overall, the results clearly show that this dual-fertilization strategy greatly contributes to maximizing canopy characteristics and achieving superior agricultural outcomes.

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