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INFLUENCE OF NANO UREA AND NANO DAP ON CROP NUTRIENT CONTENT, UPTAKE AND SOIL FERTILITY STATUS IN BLACKGRAM (*VIGNA MUNGO*)

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ABSTRACT

The experiment was conducted at Agriculture College Research Farm, Banda University of Agriculture and Technology, Banda (U.P.) in Kharif 2023. The experiment was consisted of six treatments: T_1-Control, T_2-100 % Recommended dose of Fertilizers, T_3-50 % Recommended dose of Fertilizers, T_4- 50% Recommended dose of N + 100% Recommended dose of P&K + Two Foliar Sprays of Nano Urea, T_5- 50% Recommended dose of P + 100% Recommended dose of N&K + Two Foliar Sprays of Nano DAP, T_6- 50% Recommended dose of N&P + 100% Recommended dose of K + Two Foliar Sprays of Nano Urea and Nano DAP. They were undertaken in RBD with three replications. 100% RDF is 25:50:30 N:P: K kg ha^{-1}; doses of Nano Urea (4 ml/ liter of water), Nano DAP (10 ml/liter water). The variety Pant Urd 10 was used with a seed rate of 20 kg/ha, a depth of 4 to 5 cm, and a spacing of 30 × 10 cm^2. This study applied 50% of the recommended nitrogen, phosphorus, and 100% potassium at 20 and 40 DAS along with two foliar sprays of Nano Urea and Nano DAP. These results were significantly associated with higher grain yields (q ha^{-1}), higher crop nutrient content, uptake, and soil fertility status.

Key words : Blackgram, Nano Fertilizers, Nano Urea, Nano DAP, NPK.

Introduction

Blackgram is one of the most important pulse crops in India. It is a dicotyledonous plant in the Leguminosae famil,y which belongs to the genus (*Vigna mungo* L. Hepper). Although, Blackgram is normally grown in tropical regions, it is cultivated throughout the three seasons in India: rainy (*Kharif*), winter (*Rabi*) and summer. It originates in India, where it is the most common and most highly valued grain legume (Chatterjee *et al*., 1986). Blackgram is used to make dal, curries, soup, desserts and snacks. In South India, blackgram flour and rice are used to make the most popular idli and dosa. It is the high and easily digestible protein content is what makes it a valuable food (Sharma *et al.*, 2011). On a dry weight basis, blackgram has around 25-26% protein, 1.0-1.5% fat, 62-65% carbs, 1.0-1.5% oil, 3.5-4.5% fiber, 4.5-5.5% ash, 4% minerals and 0.4% vitamins and amino acids. It also includes iron (7.57 mg), calcium (138 mg), potassium (983 mg), niacin (1.447 mg), thiamine (0.273 mg) and riboflavin (0.254 mg) per 100g of seeds (Chatterjee *et al*., 1986).

About 70% of the world's blackgram is produced in India. In India, it is the fourth most important pulse crop, grown on 48.07 lakh ha, and produced 27.39 lakh tons with a productivity of 570 kg ha^{-1}. In Uttar Pradesh, blackgram is grown on 5.89 lakh hectares, yielding 3.11 lakh tonnes and average productivity of 528 kg ha^{-1} in 2020-21. Madhya Pradesh, Uttar Pradesh, Punjab, Maharashtra, West Bengal, Andhra Pradesh, Orissa, Tamil Nadu and Karnataka are the major blackgram-

producing states (Anonymous, 2022). Crop productivity has declined throughout the years due to variety of reasons. Among all yield-limiting factors, fertility management is critical to improving crop productivity on depleted soils. There is no regional prescription for foliar nutrition throughout the crop growth phase, so farmers often start their crops with the appropriate basal application of nutrients. Soil application of nutrients is often insufficient to meet the growing crop demand, particularly in short-duration crops like Blackgram, because it is indeterminate in its habit of flowering and pod formation, there is a continuous competition for available assimilates between vegetative and reproductive sinks throughout the growth period (Gifford *et al.*, 1984). Assimilation translocation to the developing reproductive portions is reduced due to the source's severe limitation. Thus, leaf area is a crucial factor in determining crop productivity, determining light interception, and obtaining a greater source in terms of higher assimilation production (Koester *et al.*, 2014). Foliar spray fertilizer application produced effective absorption as moisture availability became limited. Though foliar spray is not a substitute for soil application, it should be considered a supplement to soil application fertilizers and the availability of soluble fertilizers makes the task easy (Upadhyay *et al*., 1992). Among fertilizer application methods, foliar nutrition is recognized as a very effective method of fertilization, because foliar nutrients usually penetrate the leaf cuticle or stomata and enter the cells, facilitating easy and rapid nutrient utilization (Latha *et al*., 2003). Foliar nutrition is important to ensure that the crop obtains balanced nutrition at the appropriate time since this prevents potential yield from being realized. Consequently, applications of nutrients through foliar spray at appropriate stages of growth become important for their efficient utilization and better crop performance, as balanced fertilization with nutrients in plant nutrition is very important in the production of high yield with high-quality seeds (Sawan *et al*., 2001). It has been well established that the fertilizer elements that are absorbed through roots can also be absorbed with equal efficiency through foliage (Ganapathy *et al*., 2008). Blackgram yield potential is extremely low due to several physiological, biochemical, and intrinsic crop characteristics, as well as the fact that the crop is primarily cultivated in rainfed conditions with improper management practices. Apart from the genetic makeup, the physiological factor *viz*., insufficient portioning of assimilates, poor pod setting due to flower abscission, and lack of nutrients during critical stages of crop growth play a major role in declined blackgram production was coupled with several diseases and pests (Mahala *et al*., 2001). Nano fertilizers provide increased yield, decrease expenditure on costly fertilizer inputs, enhance physical qualities of soil, are efficient in adding nutrients, and at the same time ensure good soil health and are not harmful to the environment (Kumpawat, 2010). Several measures were implemented to increase the productivity of Blackgram. One of the methods could be the foliar application of Nano fertilizers to maximize the crop's genetic potential. This can be considered an efficient and cost-effective means of supplementing most of the nutrient requirements during critical periods. Nutrients play an important role in enhancing the seed production of pulses (Chandrasekhar *et al.*, 2003). Foliar nutrition fertilization is widely acknowledged as a significant technique because foliar nutrients quickly enter the cells after penetrating the leaf cuticle, allowing for rapid nutrient absorption. The benefits of this approach include fixing nutrients, preventing leaching losses, regulating plant absorption of nutrients, and effectively utilizing nutrients (Manonmani *et al.*, 2009). However, there is a scarcity of research on how Blackgram responds to fertilizer applications in the soil as well as foliar spraying of Nano Urea and Nano DAP. Considering the facts above, the experiment was planned to study the effect of Nano Urea and Nano DAP on crop nutrient uptake and soil nutrient status in Blackgram.

Materials and Methods

The experiment was carried out during the kharif season of 2023 at the Agriculture College Research Farm, BUAT, Banda, Uttar Pradesh, India. The experiment site was geographically situated at 24° 53' and 25° 55'N latitudes and 80° 07' and 81° 34' E longitudes with an altitude of 168 meters above sea level. Meteorological data showed that the total rainfall was 554 mm, with mean maximum temperatures ranging from 27.1 to 36.0°C, minimum temperatures from 22.2 to 30.9°C and relative humidity between 68.3 and 96.2%. The soil was low in organic carbon (0.35%) and available nutrients contained: nitrogen (187.32 kg ha^{-1}), phosphorus (18.16 kg ha^{-1}) and potassium (230.80 kg ha^{-1}). The soil had a pH of 8.55, electrical conductivity of 0.281 dSm^{-1}, bulk density of 1.27g cm^{-3} and particle density of 2.62g cm^{-3}.

The experiment was laid out in Randomized Block Design with six treatments and three replications. The treatment comprised of T_1: Control, T_2: 100% Recommended dose of Fertilizers, T_3: 50% Recommended dose of Fertilizers, T_4: 50% Recommended dose of N + 100% Recommended dose of P&K + Two Foliar Sprays of Nano Urea, T_5: 50% Recommended dose of P + 100% Recommended dose

of N&K + Two Foliar Sprays of Nano DAP, T6: 50% Recommended dose of N&P + 100% Recommended dose of K + Two Foliar Sprays of Nano Urea and Nano DAP. Source of Fertilizers is used Urea, DAP, MOP, Nano Urea (4% N) @ 1 liter/ha., Nano DAP (8% N, 16% P) @ 2.5 liter/ha; 100% RDF is 25:50:30 N:P: K kg ha^{-1}, Nano Urea (4 ml/liter of water), Nano DAP (10 ml/ liter of water). The variety Pant Urd 10 was used with a seed rate of 20 kg/ha, a depth of 4 to 5 cm, and a spacing of 30 × 10 cm^2.

The crop was harvested manually during harvesting a representative plant sample was collected from each plot to analyze the nutrients. The surface soil samples from 0 to 15 cm depth were also collected from every experimental plot after harvest of the crop and were air dried in shade, powdered with a wooden mallet, sieved and analyzed for pH, EC, organic carbon, available nitrogen, phosphorus and potassium content of the soil. All data recorded were analyzed as per the statistically standardized principle of the ANOVA technique described by Gomez and Gomez (1984) at 5% level of significance.

Results and Discussion

Yield

Increased plant growth and development, a greater rate of photosynthetic activity, improved photosynthate translocation in improved source-sink associations and improved yield expression all contribute to improved crop production. A significantly greater grain yield was observed when 50% RDF of N&P and 100% RDF of K (T_6) were applied to foliar with nano urea and nano DAP. This data is presented by a graphical diagram (Fig. 1). Applying nano urea and nano DAP fertilizer foliar led to increased starch translocation from the active site of leaves (source) to the grain (sink). Additionally, the higher nitrogen supplied by nano urea throughout the growth stages resulted in a greater amount of photosynthetically active radiations being intercepted. Because the seed yield characteristic is a function of the yield components, the increase in the number of pods per plant is what caused the increase in seed yield. The present finding is consistent with previous research (Drostkar *et al.*, 2016; Gomma *et al.*, 2016) and studies by Kumar *et al.* (2020) that show the beneficial impact of nitrogen on seed yield and for several legume crops. Blackgram's maximum stover yield was 100%. A larger straw production may have occurred from the RDF treatment because of the plant's absorption and ease of translocation, which improved photosynthetic rates and increased dry matter buildup. The total number of plants/ha and the dry matter generated by each plant, which includes plant height and the number of branches per plant, determine the overall stover output. Improved dry matter partitioning into straw may be the reason for the harvest index improvement shown after applying 100% nitrogen (Singh *et al.*, 2013; El-Azizy *et al.*, 2021; Nair *et al.*, 2010).

Nutrient Status in soil

The data shown in Table 1 and Fig. 2 revealed that foliar application of Nano Urea and Nano DAP did not show any significant effects in pH, EC, Organic Carbon and Bulk Density, Particle Density. The application of Nano fertilizers had significant effects on available nitrogen, phosphorus and potassium. Those are described below-

Available N (kg ha^{-1}) : Significantly highest available N of soil was found in treatment 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP (T_6), which found to be at par with treatment 100 % RDF (T_2), treatment 50% RDF of N & 100% RDF of P&K with two application of Nano urea (T_4) and treatment 50% RDF of P & 100% RDF of N&K with application of Nano DAP (T_5).

Available P (kg ha^{-1}) : The data indicated that the significantly highest available P of soil was observed in treatment with 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP (T_6). However, it was at par with treatment of 100 % RDF (T_2), treatment 50% RDF of P & 100% RDF of N&K with two applications of Nano DAP (T_5) and treatment 50% RDF of N & 100% RDF of P&K with two applications of Nano urea (T_4).

Available K (kg ha^{-1}) : Data shown significantly highest available K of soil was found in treatment 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP (T_6), which found to be at par with treatment 100 % RDF (T_2), treatment 50% RDF of N & 100% RDF of P&K with two applications of Nano urea (T_4), treatment 50% RDF of P & 100% RDF of N&K with two application of Nano DAP (T_5) and treatment 50% RDF (T_3).

Application of 50% RDF of N&P & 100% RDF of K with foliar application of nano urea and nano DAP recorded significantly higher available N, P and K which might be because a higher rate of nutrients was applied through two sources, *viz.*, soil application of conventional fertilizers @ 50% RDF and foliar application of Nano fertilizers which might have resulted in higher levels of available nutrients after meeting the crop nutrient requirement at different crop growth stages. Further, it was observed that increased root growth of blackgram

Table 1 : Effect of Nano Urea and Nano DAP on Soil nutrient status after harvest in Blackgram field.

Treatments	Soil pH	EC (dSm^{-1})	O C (%)	Bulk density ($g\ cc^{-1}$)	Particle density ($g\ cc^{-1}$)	Available N ($kg\ ha^{-1}$)	Available P_2O_5 ($kg\ ha^{-1}$)	Available K_2O ($kg\ ha^{-1}$)
T_1: Control	8.55	0.27	0.35	1.26	2.61	184.10	15.59	188.51
T_2: 100% RDF	8.55	0.28	0.38	1.27	2.62	228.02	19.47	239.26
T_3: 50% RDF	8.55	0.28	0.36	1.27	2.62	204.54	17.54	218.82
T_4: 50% RDF of N + 100% RDF of P&K +foliar application of Nano Urea at 20 DAS & 40 DAS	8.54	0.28	0.37	1.27	2.62	221.11	18.57	237.64
T_5: 50% RDF of P + 100% RDF of N&K+ foliar application of Nano DAP at 20 DAS & 40 DAS	8.54	0.28	0.37	1.27	2.62	220.34	18.63	237.21
T_6: 50% RDF of N&P + 100% RDF of K+ foliar application of Nano Urea and Nano DAP at 20 DAS & 40 DAS	8.55	0.28	0.38	1.27	2.62	229.23	19.54	239.43
SE(m)±	0.091	0.005	0.009	0.026	0.052	3.026	0.451	7.315
CD at 5%	NS	NS	NS	NS	NS	9.534	1.421	23.051
CV (%)	1.84	3.31	4.01	3.54	3.46	2.44	4.29	5.59

with increased application of fertilizers added nutrients to soil after decaying (Devi *et al*., 2012). These results are in close conformity to the findings of Choudhary *et al*. (2014) and Malav *et al*. (2017).

Nutrient content in seed and straw of Blackgram

The data in Table 2 revealed that the content of the N, P and K in seed and straw of blackgram was significantly influenced by different treatments described below-

Nitrogen Contents : The application of Nano fertilizers significantly influenced N content in the seed and straw of Blackgram. Significantly higher N content of seed and straw was observed in treatment of 50% RDF of N&P & 100% of K with two applications of Nano urea and Nano DAP (T_6). It was at par with treatment 50% RDF of N & 100% of P&K with two applications of Nano urea (T_4) and treatment 50% RDF of P & 100% RDF of N&K with two application of Nano DAP (T_5).

Phosphorus contents : The application of Nano fertilizers significantly influenced the P content in the seed and straw of Blackgram. Significantly higher P content in seed and straw was observed in treatment 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP (T_6), which was at par with treatment 50% RDF of P & 100% RDF of N&K with application of Nano DAP (T_5) and treatment 50% RDF of N & 100% RDF of P&K with two application of Nano urea (T_4).

Potassium contents : Nano fertilizers application significantly influenced K content in the seed and straw of Blackgram. Significantly higher seed K content was observed in treatment 50% RDF of N&P & 100% RDF of K with two application of Nano urea and Nano DAP (T_6), which was equally at par with treatment 50% RDF of N & 100% RDF of P&K with two application of Nano urea (T_4) and treatment 50% RDF of P & 100% RDF of N&K with two application of Nano DAP (T_5). The lowest seed K content was observed in treatment control. Significantly higher straw K content was observed in 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP (T_6). However, it was at par with treatment 100% RDF (T_2).

Significantly higher N, P and K concentrations in seed recorded in treatment 50% RDF of N&P & 100% RDF of K with foliar application of nano urea and nano DAP. The increase in nitrogen content is due to Nano urea and Nano DAP which contains nitrogen and reduces nitrogen loss, with potential synergistic interactions between nitrogen and phosphorus further enhancing nitrogen

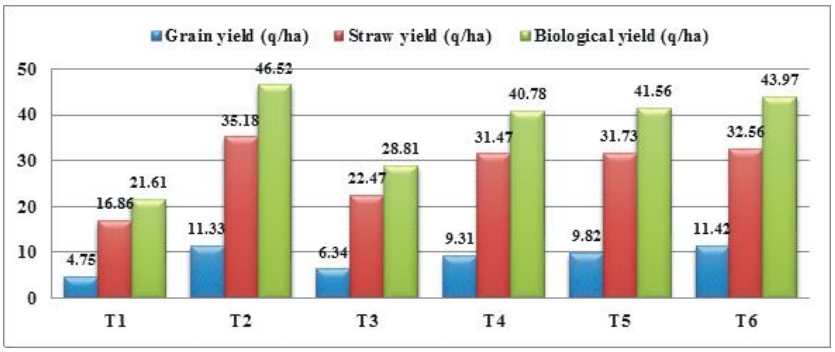

Fig. 1 : Effect of nano Urea and nano DAP on grains, straw yield and biological yield of blackgram.

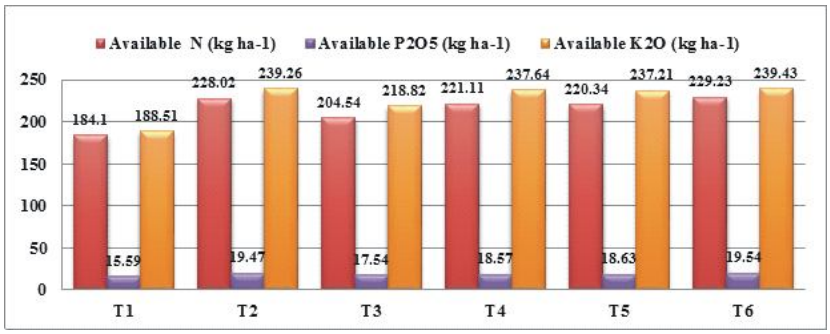

Fig. 2 : Effect of nano Urea and nano DAP on available N, P, K status in soil at post-harvest of blackgram.

concentration. Nanoparticles might have been absorbed through blackgram leaf stomata and distributed throughout the plant. Nano fertilizers mainly help overcome limitation leaching, immobilization and more nutrient availability. Nano urea and Nano DAP made direct nutrients available to plants as a supply of nitrogen and phosphorus. A similar result was found by Sharma *et al.* (2022). The increase in phosphorus concentration due to application of Nano DAP may be due to diameter of 25-50 nm helps to retain phosphorus as a result of increased total surface area and protects phosphorus from fixation resulting in the controlled release of nutrients, making phosphorus available for a longer time due to increased concentration of phosphorus. A similar result was found by Satyashraya *et al.* (2022). Potassium content increases due to synergistic interaction between N and P, increasing in concentration of potassium in grains and stalk. A similar result was found by Merghanya *et al.* (2019).

Nutrients Uptake by seed and straw of blackgram

Nitrogen Uptake (Kg ha^{-1}) : The data in Table 3 revealed that the application of Nano fertilizers significantly influenced N uptake by seed, straw and total uptake by blackgram. Seed N uptake was significantly highest in treatment 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP, which was at par with treatment 100% RDF (T_2). N uptake by the straw of blackgram was significantly highest in treatment 100% RDF (T_2). Total N uptake was significantly highest in treatment 100% RDF (T_2), which was at par with treatment 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP (T_6).

Phosphorus Uptake (Kg ha^{-1}) : The application of nano fertilizers significantly influenced P uptake by the seed, straw, and total uptake in blackgram, as shown by the data in Table 3. The data in Table 3 revealed that application of Nano fertilizers significantly influenced P uptake by seed, straw and total uptake by blackgram. P uptake by seeds was significantly highest in treatment 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP (T_6), which was at par with treatment 100 % RDF (T_2) and treatment 50% RDF of P & 100% RDF of N&K with two applications of Nano DAP (T_5). P uptake by the straw of blackgram was significantly highest in treatment 100 % RDF (T_2). Total P uptake was significantly highest in treatment 100 % RDF (T_2), which was at par with treatment 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP (T_6).

Potassium Uptake (Kg ha^{-1}) : The application of nano fertilizers, as shown by the data in Table 3, significantly influenced K uptake by the seed, straw, and total uptake in blackgram. K uptake by seeds of blackgram was significantly highest in treatment with 50% RDF of N&P & 100% RDF of K with two applications of Nano urea and Nano DAP (T_6), which was at par with treatment 100 % RDF (T_2). Total K uptake and K uptake by straw were significantly highest in treatment 100 % RDF (T_2).

Nutrient uptake of N, P_2O_5, and K_2O by of blackgram crop was analyzed and represented in Table 3. The grain had higher nutrient uptake compared to the stalk after harvest, in line with findings by Sharma *et al.* (2022) on blackgram with nano-urea and nano DAP foliar application. Significantly higher uptake by grain of nitrogen, phosphorus and potassium was recorded with the application of treatment 50% RDF of N&P & 100% RDF of K with foliar application of nano urea and nano DAP (T_6). The highest N, P_2O_5, and K_2O content in straw was recorded in treatment 100% RDF (T_2). This might be due to the foliar application of nano urea and

Table 2 : Effect of Nano Urea and Nano DAP on N, P and K content in seed and straw of blackgram.

Treatments	Plant Nutrient Content (%)					
	Seed			Straw		
	N	P	K	N	P	K
T_1: Control	3.12	0.50	0.63	1.05	0.30	1.32
T_2: 100 % RDF	3.16	0.52	0.66	1.08	0.31	1.35
T_3: 50 % RDF	3.16	0.51	0.65	1.07	0.32	1.33
T_4: 50% RDF of N + 100% RDF of P&K + foliar application of Nano Urea at 20 DAS & 40 DAS	3.19	0.52	0.67	1.09	0.32	1.34
T_5: 50% RDF of P + 100% RDF of N&K + foliar application of Nano DAP at 20 DAS & 40 DAS	3.17	0.54	0.67	1.08	0.33	1.34
T_6: 50% RDF of N&P + 100% RDF of K + foliar application of Nano Urea and Nano DAP at 20 DAS & 40 DAS	3.20	0.54	0.68	1.10	0.33	1.36
SE(m) ±	0.008	0.004	0.004	0.006	0.003	0.003
CD at 5%	0.026	0.014	0.011	0.017	0.011	0.009
CV (%)	0.46	1.43	0.94	0.89	1.89	0.38

Table 3 : Effect of Nano Urea and Nano DAP on Nitrogen, Phosphorus, Potassium uptake in seed and straw of blackgram.

Treatments	Nitrogen Uptake (Kg ha^{-1})			Phosphorus Uptake (Kg ha^{-1})			Potassium Uptake (Kg ha^{-1})		
	Seed	Straw	Total	Seed	Straw	Total	Seed	Straw	Total
T_1: Control	14.80	17.71	32.51	2.36	5.01	7.37	3.01	22.20	25.21
T_2: 100% RDF	35.81	38.00	73.81	5.85	11.02	16.88	7.48	47.38	54.86
T_3: 50% RDF	20.06	23.97	44.03	3.25	7.12	10.37	4.15	29.81	33.96
T_4: 50% RDF of N + 100% RDF of P&K + foliar application of Nano Urea at 20 DAS & 40 DAS	29.68	34.20	63.87	4.81	9.97	14.78	6.27	42.17	48.44
T_5: 50% RDF of P+100% RDF of N&K + foliar application of Nano DAP at 20 DAS & 40 DAS	31.14	34.27	65.41	5.34	10.58	15.92	6.55	42.63	49.18
T_6: 50% RDF of N&P+100% RDF of K + foliar application of Nano Urea and Nano DAP at 20 DAS & 40 DAS	36.57	35.81	72.39	6.13	10.63	16.76	7.73	44.39	52.11
SE(m)±	1.534	0.267	1.540	0.253	0.115	0.203	0.327	0.328	0.454
CD at 5%	4.834	0.842	4.852	0.798	0.363	0.640	1.031	1.032	1.430
CV (%)	9.49	1.51	4.55	9.48	2.20	2.57	9.66	1.49	1.79

Nano DAP covering a larger surface area and particles that are smaller than the pores in the plant leaves can penetrate the plant from the applied surface more deeply and improve nutrient uptake. Application of Nano DAP also helps in improving the organic acid concentration in the rhizosphere and P uptake by the plants compared to other conventional sources of P fertilizers. Similar to N and P, K uptake increased as N and P levels increased, which may be explained by a larger loss of soil nutrients during the growth stages and increased dry matter formation in the presence of high N and P levels Pande *et al*. (1985), nutrient uptake was regulated by the application of nitrogen (N), which in turn was influenced by trends in dry matter production. Similarly, Kumar *et al*. (2020), the greater dry matter yields at higher levels of N have led to noticeably larger uptakes of N, P, K. Similar results were noticed by Burhan *et al*. (2019); Rashmi *et al*. (2022); Shankaralingappa *et al*. (2000); Krishna (2014) and Gupta *et al*. (2022).

Conclusion

This study revealed that the application of 50% of the recommended dose of nitrogen and phosphorus, 100% potassium, and two foliar sprays of Nano Urea and Nano DAP at 20 DAS and 40 DAS significantly improved grain yield, crop nutrient content, nutrient uptake and soil nutrient status in blackgram. These results indicate that this combined approach can be effective for enhancing crop growth and productivity. Based on this experiment, it is recommended to adopt this nutrient management practice for higher yield and economic benefits in blackgram cultivation. However, further validation under varying soil types, climatic conditions, and crop management practices is essential to confirm the findings.

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Conflict of interest

All authors declared that there is no conflict of interest.

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