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Effect of Nitrogen and Phosphorus Levels with Nano DAP on Yield and Quality of Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was conducted in a Randomised Complete Block Design with nine treatments, during *kharif* 2024, to study the effect of nitrogen and phosphorus levels and Nano Di-Ammonium Phosphate (DAP) application on the quality and yield of groundnuts. Application of 75% NP + seed treatment of Nano DAP @ 5 mL kg^{-1} of seed + foliar spray of Nano DAP @ 4 mL $litre^{-1}$ at 30 Days After Germination (DAG) recorded significantly higher pod, kernel and haulm yield as well as highest oil and protein content in kernels which was at par with 100% NP, 75% NP, 75% NP + seed treatment with Nano DAP, 75% NP + foliar spray with Nano DAP, and 50% NP + seed treatment with Nano DAP + foliar spray with Nano DAP (T_9). Results indicated that about 25% of the recommended dose of NP can be substituted with the use of Nano DAP.

Keywords: Nano DAP, Groundnut, Grain quality, Fertiliser, Crop production

India is the world's third-largest producer of oilseeds. Oilseeds contribute over 5% of the gross national product and account for nearly 10% of the total value of all agricultural commodities in the country. Oilseeds are the country's second-largest agricultural commodity after cereals. Among oilseed crops, groundnut ranks among the top three in India in terms of area and production. In India, groundnut is grown on an area of 4.71 million hectares with a total annual production of 10.18 million tonnes and an average productivity of 2163kg ha^{1} (Anonymous 2024). In India, groundnut is considered as "King of Oilseeds". It is also recognised as a peanut, earthnut, monkey nut and poor men's cashew nut. Groundnut seeds contain 45-50 % oil and about 25-30 % protein, making it a dual-purpose crop making it valued for both oil extraction and direct consumption.

Successful cultivation of groundnut, achieving good results, and harnessing its full potential requires proper nutrient management. It is perceived as promising technology by the majority of the stakeholders (Mukherjee *et al.* 2019). Nutrients are vital elements of nucleotides, proteins, chlorophyll, and enzymes, and hence facilitate numerous metabolic developments in plants, resulting in improved output (Chandel *et al.* 2022; Noori *et al.* 2023). Nutrients supplied through synthetic fertilisers suffer various losses in the soil

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due to different processes or immobilisation, all of which reduce the efficiency of synthetic fertilisers. Simultaneously, excessive and indiscriminate use of synthetic fertilisers has become a major anthropogenic cause of eutrophication problems worldwide, pollution of water resources, and soil degradation due to accumulation of salts in soils (Sharma *et al.* 2014; Sharma *et al.* 2016; Chandel *et al.* 2023). The major macronutrients that are applied to the soil (nitrogen, phosphorus and potassium) are observed to be lost at a rapid rate. Nanotechnology can precisely identify and provide a certain amount of nutrients to a crop, thereby improving resource use efficiency, while keeping safety into consideration. This also reduces the adverse impact of fertiliser applications on soil (Bajya *et al.* 2025).

Nanotechnology has become an important tool for research in agriculture (Pramanik *et al.* 2020). The size of nanoparticles ranges from 1-100nm, and the use of Nano-fertilisers can reduce the amount of chemical fertilisers by 50% and increase crop yields by 15 to 30 %. At the same time, Nano-fertilisers improve soil health and reduce greenhouse gas emissions. Nano-fertilisers are efficiently absorbed by plants due to their extremely high absorption properties and high surface-to-volume ratio (Elemike *et al.* 2019). The application of Nano-fertiliser on seed and plant through the seed treatment and foliar spray in a small amount has shown a positive response on grain quality and crop production (Akhtar *et al.* 2022).

In recent years, revolutionary Nano-based products like IFFCO Nano DAP have gained significant attention. These advanced liquid fertilisers not only enhance crop yield and nutritional quality but also align with sustainable agriculture goals. Their low dosage requirements, ease of application and compatibility with existing farm practices make them a promising solution for small holder and marginal farmers. According to IFFCO, Nano DAP contains 8.0% nitrogen (N) and 16.0% phosphorus (P_2O_5) by weight/volume. Very little work has been done to study the effect of Nano-DAP application on groundnut, and hence, the present study was carried out to fill this gap in available knowledge.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* 2024 at Krishi Vigyan Kandra, Una (Himachal Pradesh). The soil of the field experimentation was sandy loam in texture having pH of 8.10. The soil was medium in available nitrogen (376.10 kg ha^{-1}), available phosphorus (20.16 kg ha^{-1}) and available potassium (250.6 kg ha^{-1}). The experiment was conducted in Randomised Block Design with nine treatments which included T_1: 100% NP (100% of recommended nitrogen and phosphorus), T_2: 75% NP (75% of recommended nitrogen and phosphorus), T_3: 50% NP (50% of recommended nitrogen and phosphorus), T_4: 75% NP + seed treatment with Nano DAP @ 5mL kg^{-1} seed, T_5: 75% NP + foliar spray with Nano DAP @ 4 mL $litre^{-1}$ at 30 days after germination (DAG), T_6: 75% NP + seed treatment with Nano DAP @ 5mL kg^{-1} seed + foliar spray with Nano DAP @ 4mL $litre^{-1}$ at 30 DAG, T_7: 50% NP + seed treatment with Nano DAP @ 5mL kg^{-1} seed, T_8: 50 % NP + foliar spray with Nano DAP @ 4mL $litre^{-1}$ at 30 DAG and T_9: 50 % NP + seed treatment with Nano DAP @ 5 mL kg^{-1} seed + foliar spray with Nano DAP @ 4mL $litre^{-1}$ at 30 DAG and were replicated thrice with grass plot size of 10.8m^2. The Nitrogen, Phosphorus, and Potassium were applied through urea (46%), SSP (16%) and MOP (60%). The recommended dose of fertiliser was 20 kg N, 40 kg P_2O_5 and 25 kg K_2O ha^{-1}. Manual sowing of the "TAG-24" variety was done using the kera method, with row spacing of 30 cm and plant-to-plant spacing of around 15 cm. The seed rate used was 100 kg per hectare. The crude protein content in groundnut kernels was computed by multiplying the per cent nitrogen content of the kernel by the factor 5.46, and the oil content in the seeds of groundnut was determined by using Soxhlet's extraction method.

The data obtained on various crop parameters during the experimentation were subjected to statistical analysis using the *Analysis of Variance (ANOVA)* technique as described by Cochran and Cox (1957). The significance of treatment effects was tested at the 5 % probability level using the *t*-test, and the Critical Difference (CD) method was employed to separate the means where significant differences were detected.

RESULTS AND DISCUSSION

Fertilisers provide the essential primary nutrients such as N, P and K that help in vegetative and reproductive

growth. The response of graded levels of nitrogen and phosphorus along with the use of Nano-DAP on plant height of groundnut (Table 1) revealed that at 60 days after sowing significantly taller plant were observed with the application of 75 % NP in combination with Nano-DAP as a seed treatment @ 5mL kg^{-1} seed and foliar spray of Nano-DAP @ 4mL $litre^{-1}$ at 30 days after germination (T_6) though this treatment was at par with application of 100% of recommended nitrogen and phosphorus (T_1), 75% of recommended nitrogen and phosphorus (T_2), 75% NP along with Nano-DAP as a seed treatment @ 5mL kg^{-1} seed (T_4), 75% NP along with foliar spray of Nano-DAP @ 4 mL $litre^{-1}$ at 30 days after germination (T_5) and 50% NP in combination with Nano-DAP as a seed treatment @ 5mL kg^{-1} seed and foliar spray of Nano-DAP @ 4mL $litre^{-1}$ at 30 days after germination (T_9). Further treatment with 50% of NP (T_3) recorded significantly lower plant height at 60 days after sowing through this treatment was also statistically at par with application of 75% NP (T_2), application of 50% NP with seed treatment with Nano-DAP (T_7) and foliar spray of Nano-DAP (T_8) as well as with 50% NP with 50% NP application supplemented with both seed treatment and foliar spray with Nano-DAP (T_9). A similar trend was witnessed at 90 DAS as well as at harvest with application of 75% NP along with seed treatment and foliar spray with Nano-DAP (T_6), recording significantly higher plant height, while treatment in which only 50% NP was applied recorded significantly lower plant height of groundnut.

A perusal of the data (Table 1) revealed that significantly higher pod yield, kernel yield and haulm yield were obtained from 75 % NP with seed treatment with Nano DAP @ 5mL kg^{-1} seed supplemented with foliar spray with Nano DAP @ 4mL $litre^{-1}$ at 30 DAG (T_6). However, this treatment was statistically at par with 100% of recommended nitrogen and phosphorus (T_1), 75% of recommended nitrogen and phosphorus (T_2), 75% NP with seed treatment with Nano DAP @ 5mL kg^{-1} seed (T_4), 75% NP with foliar spray with Nano DAP @ 4mL $litre^{-1}$ at 30 DAG (T_5) and 50% NP along with seed treatment with Nano

Table 1. Effect of treatments on plant height (cm) and yield of groundnut

Sr. No	Treatment	Plant height cm			Pod yield (q ha^{-1})	Kernel yield (q ha^{-1})	Haulm yield (q ha^{-1})	Harvest index (%)
		60 DAS	90 DAS	At harvest				
T_1	100% NP (100% of recommended nitrogen and phosphorus)	35.3	53.5	57.3	31.30	22.85	39.59	32.18
T_2	75% NP (75% of recommended nitrogen and phosphorus)	33.3	51.8	54.9	29.08	21.09	37.68	31.54
T_3	50% NP (50% of the recommended nitrogen and phosphorus)	30.1	49.0	51.7	26.50	18.40	33.56	30.63
T_4	75% NP + seed treatment with Nano DAP @ 5mL kg^{-1} seed	34.6	52.6	56.4	30.53	22.21	38.81	32.08
T_5	75% NP+ foliar spray with Nano DAP @ 4mL $litre^{-1}$ at 30 DAG	34.4	52.4	55.7	30.10	21.90	38.73	31.81
T_6	75% NP + seed treatment with Nano DAP @ 5mL kg^{-1} seed + foliar spray with Nano-DAP @ 4mL $litre^{-1}$ at 30 DAG	35.6	53.9	57.9	31.50	23.01	39.84	32.24
T_7	50% NP + seed treatment with Nano DAP @ 5mL kg^{-1} seed	32.3	51.0	54.3	28.22	20.21	36.30	31.31
T_8	50% NP + foliar spray with Nano DAP @ 4 mL $litre^{-1}$	31.5	50.8	54.0	27.62	19.52	35.67	30.87
T_9	50% NP+ seed treatment with Nano DAP @ 5mL kg^{-1} seed + foliar spray with Nano DAP @ 4mL $litre^{-1}$ at 30 DAG	33.2	51.4	55.0	29.25	21.16	37.94	31.42
	SE m±	1.1	0.9	1.2	0.87	0.69	1.17	1.02
	CD (P=0.05)	3.2	2.8	3.5	2.60	2.07	3.50	NS

DAP @ 5mL kg $^{-1}$ seed with foliar spray with Nano DAP @ 4mL litre^{-1} at 30 DAG (T_9). Significantly lower values of pod yield, kernel yield and haulm yield was recorded from 50% of recommended nitrogen and phosphorus (T_3) through this treatment was also at par with treatments in which 75% of recommended nitrogen and phosphorus (T_2) was applied, 50 % NP was applied supplemented either with seed treatment with Nano-DAP @ 5mL kg^{-1} seed (T_7) or foliar spray of Nano-DAP @ 4mL litre^{-1} at 30 days after germination (T_8). The increase in pod, kernel, haulm and biological yield with the increment in Nano DAP was due to an increase in the vegetative growth, flowering, high peg formation, pod formation and root growth, which increased the number of pods per plant and number of kernels per pod, thus ultimately increasing the pod and kernel yield. Haulm yield was also highest in this treatment, which may be due to the use of 75% recommended dose of nitrogen and phosphorus with the seed treatment and foliar spray of Nano DAP, as this increases vegetative growth and biomass during the crop period and resulting in stronger plants with more foliage, thicker stems, thus ultimately increased haulm yields. The data further revealed that the harvest index of groundnut was not significantly influenced by nitrogen and phosphorus levels, as well as Nano DAP application. The results of this investigation align with the findings of Baghla *et al.* (2023), Thakur *et al.* (2024), and Saqib *et al.* (2025) in other crops.

The effect of graded fertiliser dose along with Nano-DAP application on the quality parameters of groundnut (Table 2) showed a significant impact on oil content was observed with the application of Nano-DAP. Significantly higher oil content was obtained by application of 75% NP along with seed treatment with Nano DAP @ 5 mL kg^{-1} seed with foliar spray with Nano DAP @ 4 mL litre^{-1} at 30 DAG though this treatment was at par with treatment in which 100 % of recommended nitrogen and phosphorus (T_1), 75 % NP with seed treatment with Nano DAP @ 5mL kg^{-1} seed (T_4) and 75% NP along with foliar spray with Nano DAP @ 4mL litre^{-1} at 30 DAG (T_5). It may be due to the Nano DAP application ensures sustained and targeted nutrient delivery, which improves photosynthesis and enzyme activation, particularly during the seed filling stage, leading to increased oil accumulation in seeds.

Table 2. Effect of treatments on quality parameters of groundnut

Sr. No.	Treatment	Oil content (%)	Protein content (%)
T_1	100% NP (100 % of recommended nitrogen and phosphorus)	49.88	24.41
T_2	75% NP (75 % of recommended nitrogen and phosphorus)	48.03	23.51
T_3	50% NP (50 % of the recommended nitrogen and phosphorus)	47.12	22.48
T_4	75% NP + seed treatment with Nano DAP @ 5 mL kg^{-1} seed	49.59	24.24
T_5	75% NP + foliar spray with Nano DAP @ 4 mL litre^{-1} at 30 DAG*	48.96	24.02
T_6	75% NP + seed treatment with Nano DAP @ 5 mL kg^{-1} seed + foliar spray with Nano DAP @ 4 mL litre^{-1} at 30 DAG*	50.09	24.70
T_7	50% NP + seed treatment with Nano DAP @ 5 mL kg^{-1} seed	48.19	23.31
T_8	50% NP + foliar spray with Nano DAP @ 4 mL litre^{-1} at 30 DAG*	47.65	22.88
T_9	50% NP + seed treatment with Nano DAP @ 5 mL kg^{-1} seed + foliar spray with Nano DAP @ 4 mL litre^{-1} at 30 DAG*	48.11	23.59
	SE m±	0.55	0.47
	CD (P=0.05)	1.65	1.42

*DAG - days after germination

A significant impact of nitrogen and phosphorus levels and Nano DAP application was observed on protein content. Significantly higher protein content was obtained by application of 75 % NP along with seed treatment with Nano DAP @ 5mL kg^{-1} seed with foliar spray with Nano DAP @ 4mL litre^{-1} at 30 DAG though this treatment remained statistically alike with all the treatment except T_3 (50 % recommended dose of nitrogen and phosphorus) and T_8 (50 % of NP along with foliar spray with Nano DAP @ 4mL litre^{-1} at 30 DAG in this regard. It may be due to improved nitrogen availability and more nitrogen uptake, which enhances amino acid synthesis and protein metabolism in plants. These results were in close conformity with Kumari *et al.* (2017) and Kumara *et al.* (2025).

CONCLUSION

Based on the findings of the investigation, it can be concluded that the combined use of Nano DAP as well as seed treatment and foliar spray could substitute for about 25-30 % of the recommended nitrogen and phosphorus in groundnut.

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