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Synergistic Effects of Nano DAP and Pulse Magic on Growth Dynamics and Yield of Pigeonpea [*Cajanus cajan* (L.) Millsp]

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Abstract

A field experiment entitled 'Synergistic effects of nano DAP and pulse magic on growth dynamics and yield of pigeonpea [*Cajanus cajan* (L.) Millsp]' was conducted during *Kharif* 2022 and 2023 at K block, Zonal Agricultural Research Station, UAS, GKVK, Bengaluru. The experiment was laid out in randomized complete block design (RCBD) consisting of 8 treatments and 3 replications. The results of the study revealed that, the application of 100 per cent recommended dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage recorded significantly higher plant height (119.0, 139.3 and 143.4 cm, respectively at 80, 120 DAS and at harvest), number of branches per plant (9.12, 13.33 and 15.05, respectively at 80, 120 DAS and at harvest), leaf area per plant (220.2, 1622.3 and 1418.3 cm^2 $plant^{1}$, respectively at 40, 80 and 120 DAS), leaf area index (0.084, 0.601 and 0.525, respectively at 40, 80 and 120 DAS) and total dry matter accumulation (21.8, 77.4, 118.1 and 142.9 g $plant^{-1}$, respectively at 40, 80, 120 DAS and at harvest) as compared to other treatments. Significantly higher seed and stalk yield (1393 kg ha^{-1} and 3462 kg ha^{-1}, respectively) as compared to other treatments.

Keywords : Pigeonpea, Nano DAP, Pulse magic, Growth dynamics and Grain yield

Pigeonpea (*Cajanus cajan*), commonly referred to as redgram, is one of the most important leguminous crop cultivated across tropical and subtropical regions. It holds a significant position in agriculture, owing to its dual role as a major source of protein and an essential component of sustainable farming systems. Its adaptability to diverse agro-climatic conditions, combined with its ability to fix atmospheric nitrogen, makes it a preferred crop in resource-limited and marginal lands. However, despite of its resilience and ecological importance, pigeonpea productivity has remained stagnant over the years, primarily due to challenges related to nutrient management, abiotic stresses and suboptimal crop practices (Saxena *et al*., 2010).

Efficient nutrient management is one of the most critical factors influencing the growth and yield of pigeonpea. Traditional fertilizers like diammonium phosphate (DAP), a widely used source of nitrogen

(N) and phosphorus (P), play a pivotal role in supporting the crop's early growth stages, root development and energy transfer processes. However, conventional fertilizers often suffer from low nutrient-use efficiency with significant losses due to leaching, runoff and volatilization (Hegde *et al*., 2007). These inefficiencies not only increase production costs but also pose environmental concerns, such as water eutrophication and greenhouse gas emissions.

Recent advances in agricultural technology have led to the development of nano-fertilizers, which offer promising solutions to these challenges. Nano-fertilizers, such as Nano DAP engineered with particles on a nano-scale, significantly enhancing their surface area and reactivity. This allows for better nutrient delivery, reduced losses, improved uptake and efficiency compared to traditional fertilizers (Rame Gowda *et al*., 2022). Nano DAP releases nutrients more slowly and uniformly, ensuring a sustained supply to the crop throughout its growth cycle. These attributes make Nano DAP a sustainable and efficient alternative to conventional fertilizers for boosting pigeonpea productivity (Jakhar *et al*., 2022).

While soil-applied fertilizers are essential for providing baseline nutrition, foliar applications of nutrient-rich sprays like pulse magic have emerged as a complementary approach to address crop nutrient demands during critical growth stages. Pulse magic is a proprietary formulation containing a balanced mix of macro and micronutrients, amino acids and plant growth regulators. It is designed to enhance physiological processes such as photosynthesis, nutrient assimilation and reproductive development (Sachin *et al*., 2024). Foliar sprays are particularly effective in overcoming temporary nutrient deficiencies and reducing stress caused by unfavourable environmental conditions.

Pulse magic plays a crucial role during the flowering and pod-filling stages of pigeonpea, where nutrient demand peaks. By providing essential nutrients directly to the plant's canopy, it ensures better flowering, reduced flower drop and improved pod setting (Patil *et al*., 2020). Additionally, the presence of growth hormones in pulse magic helps mitigate the effects of abiotic stress, such as drought or heat, by enhancing the plant's internal defense mechanisms.

The study aims to provide insights into sustainable practices for boosting pigeonpea productivity, addressing food security and minimizing environmental impact. By integrating advanced nano-technology and foliar nutrient delivery systems, the field experiment entitled 'Synergistic effects of nano DAP and pulse magic on growth dynamics and yield of pigeonpea [*Cajanus cajan* (L.) Millsp]' was conducted during the *Kharif* season of 2022 and 2023 at UAS, GKVK, Bengaluru.

Material and Methods

The field experiment was conducted at K Block, Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bengaluru during *Kharif* 2022 and 2023. The experimental site is located in Eastern Dry Zone (Zone-V) of Karnataka and situated between 12º 51' North latitude and 77º 35' East longitude at an altitude of 930 m above mean sea level (MSL). The textural class of the soil was red sandy loam, consisting of 53.4 per cent coarse sand, 14.8 per cent fine sand, 16.6 per cent silt and 15.2 per cent of clay. The soil was slightly acidic (5.2) in reaction with an electrical conductivity of 0.12 dSm^{-1}. The organic carbon content was 0.43 per cent. The soil was medium in available nitrogen (285.5 kg ha^{-1}), phosphorous (35.5 kg ha^{-1}) and potassium (258.5 kg ha^{-1}).

The experiment was laid out on Randomized Complete Block Design with eight treatments, replicated thrice summing up to 24 plots. Bunds of 30 cm width and height were erected between each plot and one meter space was maintained between replications. The treatments were T_1: 75% RD (N & P Basal) + FS (Nano DAP) + PM, T_2: 75% RD (N & P Basal) + FS (Normal DAP) + PM, T_3: 75% RD (N & P Basal) + 25% RD (N & P) as top dressing + PM, T_4: 100% RD (N & P Basal) + FS (Nano DAP) + PM, T_5: 100% RD (N & P Basal) + FS (Normal DAP) + PM, T_6: 100% RD (N & P Basal) + 25% RD

(N & P) as top dressing + PM, T_7: 100% RD (N & P Basal) + PM and T_8: 100% RD (N & P Basal).

The treatments were imposed to each plot in split application and first imposition was done through foliar application of nano/normal DAP at branching and second imposition was done through foliar application of pulse magic at flowering and pod formation stage. Soil application of RDF was done as per the treatment details. Other cultural operations were carried out to keep the plot clean and plant protection measures were taken up at regular intervals. Observations on growth as well as yield were recorded as per the protocol. The experimental data was analyzed statistically and presented at five per cent level of significance for making comparison between treatments.

Results and Discussion

Influence of Foliar Application of Nano/Normal DAP and Pulse Magic on Growth Parameters of Pigeonpea

Plant Height of Pigeonpea

The plant height (cm) of pigeonpea at different stages (40, 80, 120 DAS and at harvest) was significantly influenced by foliar application of nano/normal DAP and pulse magic along with RDF. The two season data and pooled data is given in Table 1.

Among different treatments, foliar application of nano /normal DAP along and pulse magic with RDF did not show any significant difference at 40 DAS (pooled data). Numerically the higher plant height (50.5 cm) was observed in application of 100 per cent recommended dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage followed by application of 100 per cent recommended dose of N & P as basal + foliar spray of normal DAP @ 2 per cent at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (47.5 cm) and it was lower (41.9 cm) in 100 per cent recommended dose of N & P alone as basal.

The plant height at 80, 120 DAS and at harvest (pooled data). Among the different treatments, application of 100 per cent recommended dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage recorded significantly higher plant height (119.0, 139.3 and 143.4 cm, respectively), which was on par with application of 100 per cent recommended dose of N & P as basal + foliar spray of normal DAP @ 2 per cent at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (115.1, 135.9 and 140.4 cm, respectively) and 100 per cent recommended dose of N & P only as basal recorded significantly lower plant height (92.3, 118.6 and 122.6 cm, respectively)

The higher plant height might be due to the combined application of chemical and nano fertilizers increased the availability of nitrogen and phosphorous which accelerated the enzymatic activity of photosynthesis, carbohydrate metabolism, synthesis of protein and cell division and cell elongation which inturn enhanced the plant height. This is in conformity with the works of Hagagg *et al*. (2018), Mallikarjun (2021) and Balachandrakumar *et al*. (2024) ascribed that nano fertilizers promote the uptake of water and nutrients, which is reflected in plant growth.

Number of Branches Per Plant

The data pertaining to the number of branches per plant at different growth stages of pigeonpea as influenced by different nutrient management practices for both the seasons and pooled data is presented in Fig. 1. Number of branches increased progressively with the age of the crop. The number of branches per plant differed significantly at 80 and 120 DAS and at harvest except at 40 DAS with different nutrient management practices in pigeonpea.

At 40 DAS, there was no significant difference observed with respect to number of branches per plant (pooled data). The numerically higher number of branches per plant recorded in treatment with application of 100 per cent recommended dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at

TABLE 1

Influence of foliar application of nano/normal DAP and pulse magic on plant height of pigeonpea

Treatments	Plant height (cm)											
	40 DAS			80 DAS			120 DAS			At harvest		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1: 75 % RD (N & P Basal) + FS (Nano DAP) + PM	43.5	47.3	45.4	104.5	112.2	108.4	128.0	134.2	131.1	130.2	138.6	134.4
T_2: 75 % RD (N & P Basal) + FS (Normal DAP) + PM	43.2	46.2	44.7	100.4	108.2	104.3	125.9	131.8	128.9	128.6	136.2	132.4
T_3: 75 % RD (N & P Basal) + 25 % RD (N & P) at top dressing + PM	42.4	45.6	44.0	98.5	105.4	102.0	122.4	128.3	125.4	125.3	132.8	129.1
T_4: 100 % RD (N & P Basal) + FS (Nano DAP) + PM	46.5	50.5	48.5	114.1	123.9	119.0	135.4	143.3	139.3	140.2	146.7	143.4
T_5: 100 % RD (N & P Basal) + FS (Normal DAP) + PM	45.7	49.4	47.5	111.3	118.8	115.1	132.3	139.5	135.9	137.6	143.2	140.4
T_6: 100 % RD (N & P Basal) + 25 % RD (N & P) at top dressing + PM	44.3	48.1	46.2	109.6	114.2	111.9	130.6	136.8	133.7	132.9	140.8	136.8
T_7: 100 % RD (N & P Basal) + PM	41.9	43.3	42.6	88.4	100.0	94.2	120.0	125.6	122.8	123.4	128.4	125.9
T_8: 100 % RD (N & P Basal)	41.0	42.8	41.9	86.9	97.8	92.3	115.7	121.6	118.6	120.6	124.6	122.6
S.Em.±	1.47	1.74	1.60	3.35	3.64	3.49	3.98	4.37	4.08	4.09	4.47	4.12
CD (5%)	NS	NS	NS	10.16	11.04	10.60	12.08	13.25	12.38	12.40	13.56	12.50

Note: FS: Foliar spray of nano DAP @ 4 ml L^{-1} and Normal DAP @ 2 per cent at branching; PM: Pulse magic @ 1 per cent at flower initiation & Pod formation; 100 % K is common to all the treatments

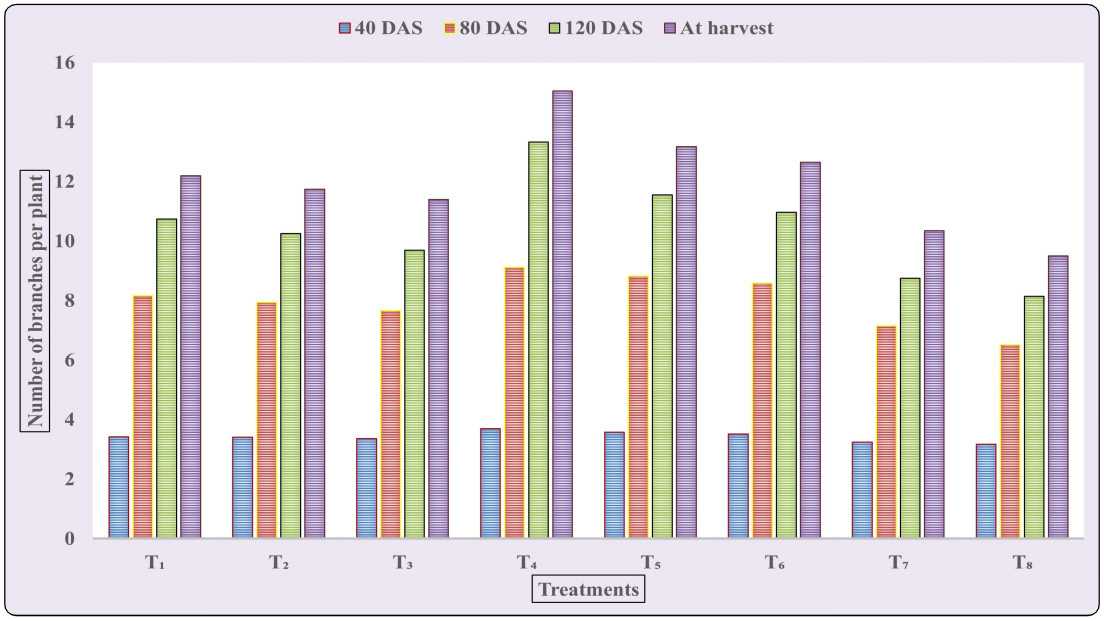

Fig. 1 : Influence of foliar application of nano/normal DAP and pulse magic on number of branches per plant of pigeonpea

Note: FS: Foliar spray of nano DAP @ 4 ml L^{-1} and Normal DAP @ 2 per cent at branching; PM: Pulse magic @ 1 per cent at flower initiation & Pod formation; 100 % K is common to all the treatments

branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (3.70) and lower number of branches per plant recorded in treatment with 100 per cent recommended dose of N & P only as basal (3.18).

Number of branches per plant at 80, 120 DAS and at harvest was significantly higher (pooled data) with application of 100 per cent recommended dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (9.12, 13.33 and 15.05, respectively) followed by application of 100 per cent recommended dose of N & P as basal + foliar spray of normal DAP @ 2 per cent at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (8.82, 11.56 and 13.17, respectively). Among all treatments significantly lower number of branches per plant were recorded with 100 per cent recommended dose of N & P as basal only (6.52, 8.15 and 9.50, respectively).

The increase in the number of branches per plant at different growth due to the application of nano DAP and pulse magic along 100 per RDF might be due to the tiny size of nano DAP helps absorb nutrients directly into the leaves, where nutrients can be absorbed more quickly and efficiently, adequate nutrients may lead to increased cell division and elongation. Nutrient uptake in plants increases with more branches per plant due to more leaf area. Similar observations were also recorded by Manjunath (2018), Mallikarjun (2021) and Balachandrakumar *et al.* (2024).

Leaf Area Per Plant

The data pertaining to the leaf area (cm^2 $plant^{-1}$) of pigeonpea as influenced by different nutrient management practices for both the seasons and pooled data is presented in Table 2.

At 40, 80 and 120 DAS significantly higher leaf area (pooled data) was recorded with application of 100 per cent recommended dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (225.7, 1622.3 and 1418.3 cm^2 $plant^{-1}$, respectively) which was at par with application of 100 per cent recommended dose of N & P as basal + foliar spray of normal DAP @ 2 per cent at

TABLE 2

Influence of foliar application of nano/normal DAP and pulse magic on leaf area per plant of pigeonpea

Treatments	Leaf area (cm^2 $plant^{-1}$)								
	40 DAS			80 DAS			120 DAS		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1: 75 % RD (N & P Basal)196.1 + FS (Nano DAP) + PM	196.1	220.8	208.4	1252.0	1501.1	1376.6	1079.3	1238.4	1158.9
T_2: 75 % RD (N & P Basal) + FS (Normal DAP) + PM	187.3	214.2	200.8	1168.0	1438.4	1303.2	1009.2	1216.8	1113.0
T_3: 75 % RD (N & P Basal) + 25 % RD (N & P) at top dressing + PM	182.2	210.6	196.4	1102.0	1374.1	1238.1	998.1	1185.6	1091.8
T_4: 100 % RD (N & P Basal) + FS (Nano DAP) + PM	212.7	238.7	225.7	1534.4	1710.2	1622.3	1306.5	1530.2	1418.3
T_5: 100 % RD (N & P Basal) + FS (Normal DAP) + PM	208.1	232.4	220.2	1439.1	1602.6	1520.8	1216.9	1446.0	1331.5
T_6: 100 % RD (N & P Basal) + 25 % RD (N & P) at top dressing + PM	202.1	224.6	213.3	1374.7	1553.2	1464.0	1178.5	1338.6	1258.6
T_7: 100 % RD (N & P Basal) + PM	160.3	189.8	175.0	1086.0	1216.0	1151.0	992.0	1078.3	1035.2
T_8: 100 % RD (N & P Basal)	152.0	182.6	167.3	1040.0	1108.4	1074.2	980.1	1008.6	994.4
S.Em.±	6.16	6.58	6.62	41.95	58.91	44.96	31.76	42.12	39.38
CD (5%)	18.67	19.95	20.08	127.26	178.70	136.36	96.32	127.76	119.44

Note : FS : Foliar spray of nano DAP @ 4 ml L^{-1} and Normal DAP @ 2 per cent at branching; PM: Pulse magic @ 1 per cent at flower initiation & Pod formation; 100 % K is common to all the treatments

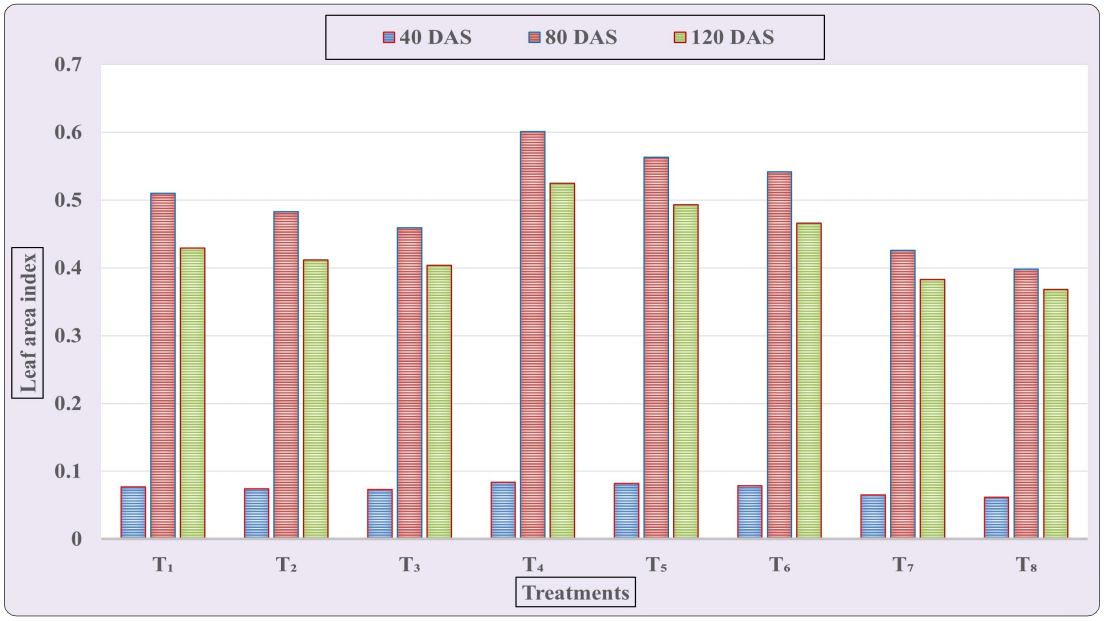

Fig. 2 : Influence of foliar application of nano/normal DAP and pulse magic on leaf area index of pigeonpea

Note : FS : Foliar spray of nano DAP @ 4 ml L^{-1} and Normal DAP @ 2 per cent at branching; PM: Pulse magic @ 1 per cent at flower initiation & Pod formation; 100 % K is common to all the treatments

branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (220.2, 1520.8 and 1331.5 cm^2 $plant^{-1}$, respectively). Whereas, significantly lower leaf area was recorded by 100 per cent recommended dose of N & P as basal only (167.3, 1074.2 and 994.4 cm^2 $plant^{-1}$, respectively).

Leaf Area Index

The data pertaining to the leaf area index of pigeonpea as influenced by different nutrient management practices for both the seasons and pooled data is presented in Fig. 2.

The leaf area index at 40, 80 and 102 DAS (pooled data), among the different treatments, application of 100 per cent recommended dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage recorded significantly higher leaf area index (0.084, 0.601 and 0.525, respectively) which was at par with application of 100 per cent recommended dose of N & P as basal + foliar spray of normal DAP @ 2 per cent at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (0.082, 0.563 and 0.493, respectively). Whereas, significantly lower leaf area index was recorded by 100 per cent recommended dose of N & P as basal only (0.062, 0.398 and 0.368, respectively).

The increase in the leaf area per plant and leaf area index at different growth stages due to the application of nano DAP and pulse magic along 100 per RDF might be due to the nano fertilizer easily enters leaves through stomata and other apertures, thus promoting the growth and elongation of the leaf by regulating the rate of cell division or size. Phosphorus influences plant growth from the cellular to the whole plant level, by increasing leaf area through the processes of cell division and enlargement. Phosphorus increases leaf area and number along with acceleration of cell division by accumulating at meristematic areas results in more leaf area and leaf area index. The findings aligned with the findings of Sharma *et al.* (2022), Venkatesh *et al.* (2022) and Sruthy *et al.* (2023).

TABLE 3

Influence of foliar application of nano/normal DAP and pulse magic on total dry matter production per plant of pigeonpea

Treatments	Total dry matter production (g plant^{-1})											
	40 DAS			80 DAS			120 DAS			At harvest		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1: 75 % RD (N & P Basal) + FS (Nano DAP) + PM	18.5	20.3	19.4	60.2	76.2	68.2	96.5	108.9	102.7	125.2	134.2	129.7
T_2: 75 % RD (N & P Basal) + FS (Normal DAP) + PM	18.1	19.9	19.0	58.8	72.6	65.7	94.3	106.7	100.5	122.6	132.6	127.6
T_3: 75 % RD (N & P Basal) + 25% RD (N & P) at top dressing + PM	17.8	19.6	18.7	57.4	69.4	63.4	92.2	103.4	97.8	120.4	130.1	125.3
T_4: 100 % RD (N & P Basal) + FS (Nano DAP) + PM	19.2	24.4	21.8	68.6	86.1	77.4	107.5	128.7	118.1	137.7	148.1	142.9
T_5: 100 % RD (N & P Basal) + FS (Normal DAP) + PM	18.9	23.6	21.3	64.2	82.5	73.4	102.1	122.4	112.3	132.5	142.6	137.6
T_6: 100 % RD (N & P Basal) + 25% RD (N & P) at top dressing + PM	18.6	21.3	20.0	61.4	79.4	70.4	98.8	118.6	108.7	128.5	138.8	133.7
T_7: 100 % RD (N & P Basal) + PM	16.5	18.2	17.4	55.1	66.2	60.6	90.0	96.5	93.3	116.1	125.1	120.6
T_8: 100 % RD (N & P Basal)	15.2	16.8	16.0	53.0	62.1	57.6	88.0	92.8	90.4	110.7	120.4	115.5
S.Em.±	0.62	0.68	0.63	2.59	2.78	2.23	3.65	3.63	3.41	5.23	4.55	4.25
CD (5%)	1.87	2.08	1.92	7.85	8.488	6.75	11.07	11.01	10.35	15.86	13.81	12.90

Note: FS: Foliar spray of nano DAP @ 4 ml L^{-1} and Normal DAP @ 2 per cent at branching; PM: Pulse magic @ 1 per cent at flower initiation & Pod formation; 100 % K is common to all the treatments

Total Dry Matter Accumulation Per Plant

The data pertaining to the total dry matter (g plant^{-1}) accumulation at different growth stages of pigeonpea as influenced by different nutrient management practices for both the seasons and pooled data is presented in Table 3.

The total dry matter (g plant^{-1}) accumulation at 40, 80, 120 DAS and at harvest (pooled data) was recorded and significantly higher total dry matter was recorded with the application of 100 per cent recommended dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (21.8, 77.4, 118.1 and 142.9 g plant^{-1}, respectively) which was at par with application of 100 per cent recommended dose of N & P as basal + foliar spray of normal DAP @ 2 per cent at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (21.3, 73.4, 112.3 and 137.6 g plant^{-1}, respectively). Recommended dose of N & P as basal only recorded significantly lower total dry matter weight (16.0, 57.6, 90.4 and 115.5 g plant^{-1}, respectively).

This is due to the application of 100 per cent RDF and foliar spray of nano DAP and pulse magic might have favourably influenced carbohydrate metabolism and also enhanced the synthesis of amino acids, RNA and DNA, as well as leaf area, which has increased photosynthesis and thus increased the plant's ability to promote vegetative growth and dry matter. Nano DAP fertilizer have higher nutrient use efficiency which lead to higher growth and dry matter production. These findings were in accordance with Mishra *et al.* (2020), Aziz & Zrar (2021) and Prakash *et al.* (2023).

Influence of Foliar Application of Nano/Normal DAP and Pulse Magic on Yield of Pigeonpea

Seed and Stalk Yield (kg ha^{-1})

Seed and stalk yield (kg ha^{-1}) of pigeonpea was significantly affected by different nutrient management practices is depicted in Table 4 for two seasons and pooled data.

The pooled data indicates that the application of 100 per cent recommended dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage resulted in significantly higher seed and stalk yield (1393 kg ha^{-1} and 3462 kg ha^{-1}, respectively) which was at par with application of 100 per cent recommended dose of N & P as basal + foliar spray of normal DAP @ 2 per cent at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage (1286 kg ha^{-1} and 3175 kg ha^{-1}, respectively). Recommended dose of N & P as basal only recorded significantly lower seed and stalk yield (919 kg ha^{-1} and 3175 kg ha^{-1}, respectively).

The higher seed and stalk yield per hectare might be due to combined application of conventional fertilizer, nano DAP and pulse magic ensured optimum and balanced nutrient availability throughout the crop period. This is due to smaller size and larger effective surface area of nano particles which can easily penetrate into the plant and lead to better uptake of nitrogen and phosphorus. The higher uptake results in optimal growth of plant parts and metabolic processes like photosynthesis that increase photosynthates accumulation and translocation to the economically productive parts of the plant which results in increased biomass, yield attributing characters and finally yield by amplifying the translocation of assimilates to seeds. Similar results were reported by Kailas *et al*. (2017), Mehta & Bharat (2019), Mirji *et al*. (2023) and Prakash *et al.* (2023).

Harvest Index

Nutrient management practices influence the harvest index of the crop. The harvest index is a measure of the proportion of total plant biomass allocated to the consumable portion of the plant (seeds). The seasonal and pooled data is depicted in Table 4.

The application of 100 per cent recommended dose of N & P as basal + foliar spray of normal DAP @ 2 per cent at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage recorded numerically highest harvest index of 0.288, followed by application of 100 per cent recommended

TABLE 4

Influence of foliar application of nano/normal DAP and pulse magic on seed yield, stalk yield and harvest index of pigeonpea

Treatments	Seed yield (kg ha^{-1})			Stalk yield (kg ha^{-1})			Harvest index (HI)		
	2022	2023	Pooled	2022	2023	Pooled	2022	2023	Pooled
T_1: 75 % RD (N & P Basal) + FS (Nano DAP) + PM	1075	1230	1153	2912	3068	2990	0.270	0.286	0.278
T_2: 75 % RD (N & P Basal) + FS (Normal DAP) + PM	1044	1182	1113	2868	2985	2927	0.267	0.284	0.275
T_3: 75 % RD (N & P Basal) + 25 % RD (N & P) at top dressing + PM	1028	1133	1081	2842	2876	2859	0.266	0.283	0.274
T_4: 100 % RD (N & P Basal) + FS (Nano DAP) + PM	1310	1476	1393	3306	3618	3462	0.284	0.290	0.287
T_5: 100 % RD (N & P Basal) + FS (Normal DAP) + PM	1202	1370	1286	3054	3296	3175	0.282	0.294	0.288
T_6: 100 % RD (N & P Basal) + 25 % RD (N & P) at top dressing + PM	1115	1304	1210	2986	3146	3066	0.272	0.293	0.283
T_7: 100 % RD (N & P Basal) + PM	1012	1048	1030	2816	2857	2837	0.264	0.268	0.266
T_8: 100 % RD (N & P Basal)	892	946	919	2563	2678	2621	0.258	0.261	0.260
S.Em.±	36.46	40.65	38.55	96.90	102.60	99.74	0.009	0.009	0.009
CD (5%)	110.58	123.29	116.92	293.93	311.22	302.54	NS	NS	NS

Note: FS: Foliar spray of nano DAP @ 4 ml L^{-1} and Normal DAP @ 2 per cent at branching; PM: Pulse magic @ 1 per cent at flower initiation & Pod formation; 100 % K is common to all the treatments

dose of N & P as basal + foliar spray of nano DAP @ 4 ml L^{-1} at branching stage + pulse magic @ 1 per cent at flower initiation & pod formation stage with harvest index of 0.287. Lower harvest index was recorded by the application of recommended dose of N & P as basal only with 0.260.

References

AZIZ, B. R. AND ZRAR, D. B., 2021, Effect of foliar application of nano-NPK fertilizer on growth and yield of broadbean (*Vicia faba* L.). *J. Pure App. Sci.,* **33** (4) : 90 - 99.

BALACHANDRAKUMAR, V., SOWMIYA, K., SHOFIYA, M., GOPIKA, K. AND NITHIKA, M., 2024, Impact of Nano DAP and Zn EDTA on Cowpea Growth and Yield. *Int. J. Plant & Soil Sci.*, **36** (6) : 317 - 326.

HAGAGG, L. F., MUSTAFA, N. S., GENAIDY EAE. AND EL-HADY, E. S., 2018, Effect of spraying nano-NPK on growth performance and nutrients status for (Kalamat cv.) olive seedling. *Biosci. Res.,* **15** (2) : 1297 - 1303.

HEGDE, D. M., BABU, S. N., QURESHI, A. A. AND MURTHY, I. Y. L. N., 2007, Enhancing nutrient-use efficiency in crop production-A review. *Indian J. Agron.,* **52** (4) : 261 - 274.

JAKHAR, A. M., AZIZ, I., KALERI, A. R., HASNAIN, M., HAIDER, G., MA, J. AND ABIDEEN, Z., 2022, Nano-fertilizers: A sustainable technology for improving crop nutrition and food security. *Nano Impact*, **27** : 100411.

KAILAS, H., RAO, K. N., BALAGOUDAR, S. AND SHARANGOUDA, H., 2017, Effect of conventional and nano micronutrient fertilizers on yield and economics of pigeonpea [*Cajanus cajan* (L.)]. *Int. J. Curr. Microbiol. App. Sci*., **8** (9) : 185 - 193.

MALLIKARJUN, P. R., 2021, Effect of nano nitrogen and nano zinc nutrition on nutrient uptake, growth and yield of irrigated maize during summer in the Southern Transition Zone of Karnataka. *M.Sc. (Agri.) Thesis,* Keladi Shivappa Nayaka Univ. Agric. Sci., Shivmogga, India.

MANJUNATH, G., 2018, Effect of nano nutrients on growth, seed yield and quality in cowpea (*Vigna unguiculata* (L.) Walp.). *M.Sc. (Agri) Thesis,* Univ. Agric. Sci., GKVK, Bengaluru.

MEHTA, S. AND BHARAT, R., 2019, Effect of integrated use of nano and non-nano fertilizers on yield and yield attributes of wheat (*Triticum aestivum* L.). *Int. J. Curr. Microbiol. App. Sci.,* **8** (12) : 598 - 606.

MIRJI, P., MUKUNDA, G. K. AND SRINIVASAPPA, K. N., 2023, Effect of nano NPK fertilizers on growth, yield and fruit quality of sapota [*Manilkara achrus* (Mill.). Fosberg] Cv. Kalipatti. *Mysore J. Agric. Sci*., **57** (1) : 245 - 250.

MISHRA, B., SAHU, G. S., MOHANTY, L. K., SWAIN, B. C. AND HATI, S., 2020, Effect of nano fertilizers on growth, yield and economics of tomato variety Arka Rakshak. *Int. J. Pure Appl. Biosci.,* **8** (6) : 200 - 204.

PATIL, J. R., PATIL, R. P. AND RATHOD, S. P., 2020, Influence of foliar application of pulse magic, PGRs & nutrients on growth parameters and yield of Pigeonpea. *J. Pharmacog. Phytochemi.*, **9** (5) : 3304 - 3307.

PRAKASH, ANAND NAIK, SIDDARAM, RAVI, M. V. AND BELLAKKI, M. A., 2023, Response of nano DAP on growth, yield and economics of Soybean (*Glycine max* L.). *The Pharma Innov. J.,* **12** (12) : 1985 - 1989.

RAME GOWDA, UMA RANI, K. AND ROOPASHREE, B., 2022, Application of nanotechnology in improving seed quality and crop productivity: prospects and developments - A review. *Mysore J. Agric. Sci.,* **56** (4) : 10 - 20.

SACHIN, R., PATIL, S., YADAHALLI, G., NANDAGAVI, R. AND VIDYAVATHI, G., 2024, Assessing the growth and yield responses of rainfed pigeonpea (*Cajanus cajan* (L.) Millsp.) to nano-DAP fertilizer application. *J. Farm Sci.,* **37** (02) : 129 - 136.

SAXENA, K. B., KUMAR, R. V. AND GOWDA, C. L. L., 2010, Vegetable pigeonpea - a review. *J. Food Legumes*, **23** (2) : 91 - 98.

SHARMA, S. K., SHARMA, P. K., RAMESHWAR, L. M., SHARMA, V., CHAUDHARY, R. AND PANDEY, R., 2022, Effect of foliar application of nano-urea under different nitrogen levels on growth and nutrient content of

pearl millet (*Pennisetum glaucum* L.). *Int. J. Plant Soil Sci.,* **34** (20) : 149 - 155.

SRUTHY, H., PILLAI, P. S., SHIMI, G. J., BINDHU, J. S. AND SAJEENA, A., 2023, Growth and yield of grain cowpea (*Vigna unguiculata* sub sp. Cylindrica) in Response to foliar nutrition and graded levels of phosphorus and potassium. *Int. J. Environ. Clim. Change,* **13** (11) : 4001 - 4014.

VENKATESH, M., BABU, K. K., PRASANTH, P., LAKSHMI NARAYANA, D. AND KUMAR, S. P., 2022, Study on effect of different levels of nitrogen in combination with nano urea on growth and yield of marigold (*Tagetes erecta* L.) Cv. Pusa Narangi Gainda. *Pharma Innov. J.,* **11** (11) : 1313 - 1317.