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Performance of nano-DAP under rice-wheat cropping system in Vertisol of Chhattisgarh

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Abstract

A field experiment was carried out in research farm, IGKV, Raipur, Chhattisgarh, India during *Rabi* 2021-2022 and *Kharif* 2022-2023 under rice-wheat cropping system at Research Farm, College of Agriculture, Raipur, (IGKV). The experiment was laid out with 12 treatments of rice and wheat in randomized block design. Treatments of rice in *Kharif* season includes (T₁) Absolute Control (N0:P0:K0), (T₂) 0% P (Control P0); (NPK @ 120:0:40), (T₃) 100% P through DAP (NPK @ RDF 120:60:40), (T₄) 75% P through DAP (NPK @ 120:45:40), (T₅) 50% P through DAP (NPK @ 120:30:40), (T₆) T₄ + Root Dipping @ 5 ml /L + Foliar Spray @ 2 ml/ L at 30 DAT with Nano DAP, (T₇) T₄ + Root Dipping @ 5 ml /L + Foliar Spray @ 4 ml/ L at 30 DAT with Nano DAP, (T₈) T₅ + Root Dipping @ 5 ml /L + Foliar Spray @ 2 ml/ L at 30 DAT with Nano DAP, (T₉) T₅ + Root Dipping @ 5 ml /L + Foliar Spray @ 4 ml/ L at 30 DAT with Nano DAP, (T₁₀) T₅ + Root Dipping @ 5 ml / L + Foliar Spray @ 2 ml / L at 25 and 45 DAT with Nano DAP, (T₁₁) T₅ + Root Dipping @ 5 ml / L + Foliar Spray @ 4 ml / L at 25 and 45 DAT with Nano DAP and (T₁₂) T₅ + Seed Treatment @ 5 ml / kg seed + Foliar Spray @ 4 ml / L at 30 DAT with Nano DAP. Treatments of wheat in *Rabi* season includes (T₁)0% NP (Control); N0P0K40, (T₂) 100% NP through G-DAP (NPK as RDF @ N120: P60: K40), (T₃) T₁+ ST with N-DAP @ 5 ml/ kg seed, (T₄) T₁+ ST with N-DAP @ 10 ml/ kg seed, (T₅) T₁ + FS with N-DAP @ 0.6% at 25-30 DAG, (T₆) T₁ + ST with N-DAP @ 5 ml/ kg seed + FS with N-DAP @ 0.6% at 25-30 DAG, (T₇) T₁₂ + FS with N-DAP @ 0.2% at 25-30 DAG, (T₈) T₁₂ + ST with N-DAP @ 5 ml/ kg seed + FS with N-DAP @ 0.2% at 25-30 DAG, (T₉) 50% NP (N60 P30 K40) + FS with N-DAP @ 0.4% at 25-30 DAG, (T₁₀) 50% NP (N60 P30 K40) + ST with N-DAP @ 5 ml/ kg seed + FS with N-DAP @ 0.4% at 25-30 DAG, (T₁₁) Absolute Control (0-0-0), (T₁₂) 75% NP through G-DAP (NPK @ 90:45:40). The results proved that the combined application of conventional and nano DAP had a positive influence on most of the growth parameters. In rice treatments (T₃) 100% P through DAP (NPK @ RDF 120:60:40), (T₆) T₄ + Root Dipping @ 5 ml /L + Foliar Spray @ 2 ml/ L at 30 DAT with Nano DAP and (T₇) T₄ + Root Dipping @ 5 ml /L + Foliar Spray @ 4 ml/ L at 30 DAT with Nano DAP obtained significantly higher plant height, effective tillers per hill, panicle length, panicles per meter square, grain yield and straw yield. In wheat treatments (T₂) 100% NP through DAP (NPK as RDF @ N120: P60: K40) and (T₈) 75% NP through DAP + ST with N-DAP @ 5 ml/ kg seed + FS with N-DAP @ 0.2% at 25-30 DAG obtained significantly higher plant height, ear heads per meter square, grain yield and straw yield.

Keywords: Nano DAP, DAP, rice wheat cropping system, growth parameters, foliar application

1. Introduction

The application of nanotechnology in form of nanofertilizer provides an innovative, efficient, and eco-friendly alternative to synthetic fertilizers. The nanofertilizers allow a slow and sustained release of nutrients that not only supports plant growth but also conserve the diversity of the beneficial microbiome. Such attributes may help the phytomicrobiome to efficiently mitigate both biotic and abiotic stress conditions. Unfortunately, despite, exceptional efficiency and ease of applications, certain limitations are also associated with the nanofertilizers such as their complicated production process, tenuous transport and dosage-sensitive efficiency. These bottlenecks are causing a delay in the large-scale applications of nanofertilizers in agriculture (M. Kalwani *et al.* 2022) [7].

Nano fertilizer had a positive impact on the Agri-food Sector minimizing problems on environment, human health, thus improving food security and productivity. Nano-materials may help to improve nutrient use efficiency because of their small size, more surface area and their slow rate of release, which facilitates the plants to take up most of the nutrients without any waste.

Nano Urea Liquid received brilliant response from the farmers and stakeholders around the country (Kumar, Singh, Kiran and Samal) and during the period of 1st April, 2022 to 10th August, 2022 nano urea production and dispatches had been 1.23 crore bottles its production touched 1.5 lakh bottles per day.

Looking to the significant results of nano-urea in the crops, new experiments on other nano fertilizers has also been started in the country. Nano-DAP as nano-phosphatic fertilizer developed by the IFFCO. Nano-DAP being in liquid form is more reliable to transportation and use. Management of P via nano-phosphatic fertilizer may be of great importance in the rice-wheat cropping system. The field experiments are needed to study the effect of Nano-DAP on the performance of agricultural crops as very few information is available on the performance of Nano-phosphatic fertilizer.

Rice and wheat (*Triticum aestivum* L.) grown sequentially in an annual rotation constitute most widely adopted cropping system in India. The rice-wheat cropping system is one of the world's largest agricultural production systems, occupying 26 Mha of cultivated land in the Indo-Gangetic Plains and in China. The rice-wheat system comprises about 13 Mha in area in the Indo-Gangetic Plains, of which the Indian part of IGP comprises about 10 Mha. In India, the production of rice and wheat grains during the year of 2020-21 was 121.46 million tons and 108.76 million tons, respectively (Ministry of Agriculture and Farmers Welfare 2020-21). Rice is the main cereal crop of Chhattisgarh, it covers an area of 4.33 Mha with a production and productivity of 9.24 MT and 21.3 q/ha. Wheat covers area of .315 Mha area with production and productivity of 0.259 MT and 8.22 q/ha. (Agriculture statistics table year 2021, Chhattisgarh Government). Nutrient management in the rice-wheat cropping system have a great importance for the maintenance of soil health. Both rice and wheat are exhaustive feeders, and this double cropping system is heavily depleting the soil of its nutrient content (Dhanda *et al.*).

2. Materials and Methods

The experiment was conducted at research farm of Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh, India during *Kharif* and *Rabi* season of the year

2020-21 and continued to 2022-23 to investigate the response of nano DAP application on the growth and yield of rice and wheat. The soil of the experimental area was clayey in nature falling under the category of Vertisol, which is a fine, hyperthermic, montmorillonitic chromustert soil. The experimental soil was clayey in texture, slightly alkaline (7.33) and normal in nature (0.23 dS m⁻¹). Rice (variety – Rajeshwari) and wheat (variety-Wheat) was used as test crop in the experiment. The trial was laid down in a randomized block design (RBD) corresponding to 12 treatments and three replications.

All the treatments consisted of a common dose of 0%, 50%, 75% and 100% recommended dose of P through DAP in rice and wheat. Urea, DAP, Muriate of potash (MOP) and nano DAP were used as fertilizers. The urea, DAP and MOP were administered through soil application as basal and split dose whereas, nano DAP was given 2 times (at tillering and panicle initiation stage) through foliar application, as per the treatments. For agronomic observations, five hills at random from each plot were selected and their mean was noted as the final reading of the respective plot.

3. Results and Discussion

The treatments comprising of both conventional DAP and its combination with foliar application of nano DAP had a significant effect on the final plant height and number of tillers per plant of the rice plants in both the years of experimentation (Table 1). The data on plant height in rice varied between 97.25 and 126.51 cm (in *kharif* 2021) and 91.90 and 121.14 cm (in *kharif* 2022). The highest plant height was obtained by 100% P through DAP (T₃) which was at par with all the treatments consisting foliar sprays and root dipping in combination with 50% (T₉ and T₁₁) and 75% P through DAP (T₆ and T₇) in both the seasons.

The data on effective tillers per hill in rice varied between 97.25 and 126.51 cm (in *kharif* 2021) and 91.90 and 121.14 cm (in *kharif* 2022). The highest effective tillers per hill was obtained by 100% P through DAP (T₃) which was at par with all the treatments consisting foliar sprays and root dipping in combination with 50% (T₉ and T₁₁) and 75% P through DAP (T₆ and T₇) in both the seasons.

Table 1: Effect of application of Nano-DAP fertilizer on plant height and total tillers at harvest of rice crop 2021 and 2022

Treatment Details	Plant height (cm)		Total tillers per hill (Nos.)	
	2021	2022	2021	2022
T ₁ Absolute Control (N0: P0: K0)	97.25d	91.90e	4.00f	4.03e
T ₂ 0% P (Control P0); (NPK 120:0:40 kg/ha)	107.79c	102.11d	5.01e	5.05d
T ₃ 100% P through DAP (NPK 120:60:40 kg/ha)	126.51a	121.14a	7.05a	7.07a
T ₄ 75% P through DAP (NPK 120:45:40 kg/ha)	122.11a	118.53a	5.34c	5.60c
T ₅ 50% P through DAP (NPK 120:30:40 kg/ha)	118.87b	113.27c	5.04e	5.10d
T ₆ T ₄ + Root Dip. @ 5 ml /L + Foliar Spray @ 2 ml / L at 30 DAT with Nano DAP	123.83a	119.07a	7.01a	7.03a
T ₇ T ₄ + Root Dip. @ 5 ml /L + FS @ 4 ml / L at 30 DAT with Nano DAP	124.87a	119.43a	7.02a	7.05a
T ₈ T ₅ + Root Dip. @ 5 ml /L + Foliar Spray @ 2 ml / L at 30 DAT with Nano DAP	120.40a	116.53b	5.33c	5.39c
T ₉ T ₅ + Root Dip. @ 5 ml /L + Foliar Spray @ 4 ml / L at 30 DAT with Nano DAP	121.80a	117.78ab	5.32c	5.34c
T ₁₀ T ₅ + Root Dip. @ 5 ml / L + Foliar Spray @ 2 ml / L at 25 and 45 DAT with Nano DAP	121.00a	116.65b	5.30cd	5.33c
T ₁₁ T ₅ + Root Dip. @ 5 ml / L + Foliar Spray @ 4 ml / L at 25 and 45 DAT with Nano DAP	122.20a	117.83a	6.16b	6.18b
T ₁₂ T ₅ + Seed Treat. @ 5 ml / kg seed + Foliar Spray @ 4 ml / L at 30 DAT with Nano DAP	120.27ab	116.27bc	5.09d	5.32cd
SEm (±)	3.49	2.05	2.48	3.15
C.D. (0.05)	7.03	3.97	0.24	0.30

The data on panicles per meter square in rice varied between 314.33 and 211.00 (in *kharif* 2021) and 315.33 and 213.12 (in *kharif* 2022). The highest panicles per meter square was

obtained by 100% P through DAP (T₃) which was at par with all the treatments consisting foliar sprays and root dipping in combination with 50% (T₉ and T₁₁) and 75% P through DAP

(T₆ and T₇) in both the seasons.

The data on panicle length in rice varied between 23.20 and 17.27 cm (in *kharif* 2021) 23.37 and 17.56 cm (in *kharif* 2022). The highest panicle length was obtained by 100% P

through DAP (T₃) which was at par with all the treatments consisting foliar sprays and root dipping in combination with 50% (T₉ and T₁₁) and 75% P through DAP (T₆ and T₇) in both the seasons.

Table 2: Effect of application of Nano-DAP fertilizer on panicles per meter square and Panicle Length of rice crop during 2021 and 2022

Treat	Treatment details	Panicle per meter square (Nos.)		Panicle Length (cm)	
		2021	2022	2021	2022
T ₁	Absolute Control (N0: P0: K0)	211.00e	213.12e	17.27c	17.56e
T ₂	0% P (Control P0); (NPK @ 120:0:40 kg/ha)	218.00de	220.20e	19.73b	19.41d
T ₃	100% P through DAP (120: 60: 40 kg/ha)	314.33a	315.33a	23.20a	23.37a
T ₄	75% P through DAP (NPK @ RDF 120:60:40 kg/ha)	256.00c	259.50c	21.17b	21.26c
T ₅	50% P through DAP (120: 60: 40 kg/ha)	231.67d	239.54d	20.17b	20.77c
T ₆	T ₄ + Root Dip. @ 5 ml /L + Foliar Spray @ 2 ml/ L at 30 DAT with Nano DAP	311.00ab	320.73a	23.10a	23.33a
T ₇	T ₄ + Root Dip. @ 5 ml /L + FS @ 4 ml/ L at 30 DAT with Nano DAP	313.00a	322.83a	23.17a	23.51a
T ₈	T ₅ + Root Dip. @ 5 ml /L + Foliar Spray @ 2 ml/ L at 30 DAT with Nano DAP	239.67cd	249.73cd	21.10b	21.24c
T ₉	T ₅ + Root Dip. @ 5 ml /L + Foliar Spray @ 4 ml/ L at 30 DAT with Nano DAP	251.67c	255.45c	21.07b	21.22c
T ₁₀	T ₅ + Root Dip. @ 5 ml / L + Foliar Spray @ 2 ml / L at 25 and 45 DAT with Nano DAP	253.00c	252.07c	21.03b	21.18c
T ₁₁	T ₅ + Root Dip. @ 5 ml / L + Foliar Spray @ 4 ml / L at 25 and 45 DAT with Nano DAP	287.67b	291.45b	21.33b	22.10b
T ₁₂	T ₅ + Seed Treat. @ 5 ml / kg seed + Foliar Spray @ 4 ml / L at 30 DAT with Nano DAP	240.00c	242.10d	20.93b	21.13c
	SEm (±)	8.07	4.73	0.57	0.26
	C.D. (0.05)	23.67	13.88	1.68	0.77

The data on panicles weight in rice varied between 2.94 and 1.75 g (in *kharif* 2021) and 2.96 and 1.75 (in *kharif* 2022). The highest panicles weight was obtained by 100% P through DAP (T₃) among all the treatments in both the years.

The data on test weight in rice varied between 23.20 and

17.27 cm (in *kharif* 2021), 23.37 and 17.56 cm (in *kharif* 2022). All the applications of Nano-DAP were also showed non-significant effect on the test weight. The highest test weight was obtained by 100% P through DAP (T₃) among all the treatments in both the years.

Table 3: Effect of application of Nano-DAP fertilizer on panicle weight and test weight of rice crop during 2021 and 2022 (gm)

Treat	Treatment details	Panicle weight (gm)		Test weight (gm)	
		2021	2022	2021	2022
T ₁	Absolute Control (N0: P0: K0)	1.63c	1.75g	31.17	32.04
T ₂	0% P (Control P0); (NPK @ 120:0:40 kg/ha)	1.83c	1.95f	31.77	32.10
T ₃	100% P through DAP (120: 60: 40 kg/ha)	2.94a	2.96a	33.20	32.90
T ₄	75% P through DAP (NPK @ RDF 120:60:40 kg/ha)	2.50b	2.53cd	32.47	32.68
T ₅	50% P through DAP (120: 60: 40 kg/ha)	2.43b	2.47e	32.13	32.13
T ₆	T ₄ + Root Dip. @ 5 ml /L + Foliar Spray @ 2 ml/ L at 30 DAT with Nano DAP	2.66ab	2.71b	32.57	32.85
T ₇	T ₄ + Root Dip. @ 5 ml /L + FS @ 4 ml/ L at 30 DAT with Nano DAP	2.62b	2.73b	32.67	32.89
T ₈	T ₅ + Root Dip. @ 5 ml /L + Foliar Spray @ 2 ml/ L at 30 DAT with Nano DAP	2.52b	2.56c	32.33	32.61
T ₉	T ₅ + Root Dip. @ 5 ml /L + Foliar Spray @ 4 ml/ L at 30 DAT with Nano DAP	2.51b	2.53cd	32.32	32.57
T ₁₀	T ₅ + Root Dip. @ 5 ml / L + Foliar Spray @ 2 ml / L at 25 and 45 DAT with Nano DAP	2.50b	2.52d	32.31	32.50
T ₁₁	T ₅ + Root Dip. @ 5 ml / L + Foliar Spray @ 4 ml / L at 25 and 45 DAT with Nano DAP	2.54b	2.57c	32.48	32.75
T ₁₂	T ₅ + Seed Treat. @ 5 ml / kg seed + Foliar Spray @ 4 ml / L at 30 DAT with Nano DAP	2.46b	2.50de	32.30	32.35
	SEm (±)	0.10	0.12	0.37	0.10
	C.D. (0.05)	0.30	0.04	N.S.	N.S.

In wheat the data of plant height varied between 72.42-87.48 cm (in *rabi* 2022) and 70.50-85.75 cm (in *rabi* 2022). In wheat the highest plant height was obtained by 100% P through DAP (T₂) which was at par with all the treatments consisting foliar sprays and seed treatment in combination with 75% P through DAP (T₇ and T₈) and 50% P through DAP (T₁₂) in both the seasons.

In wheat the data of ear heads per meter square varied between 263.67-298.00 (in *rabi* 2022), 255-284.00 (in *rabi* 2022). In wheat the highest ear heads per meter square was obtained by 100% P through DAP (T₂) which was at par with all the treatments consisting foliar sprays and seed treatment in combination with 75% P through DAP (T₇ and T₈) and 50% P through DAP (T₁₂) in both the seasons.

Table 4: Effect of application of Nano-DAP fertilizer on plant height and numbers of ear heads per meter square of wheat crop 2021 and 2022

Treat	Treatment Details	Plant height (cm)		Ear head per meter square (Nos.)	
		2021	2022	2021	2022
T ₁	0% NP (Control); N0: P0: K40 kg/ ha	74.42d	73.28b	270.00e	260.67c
T ₂	100% NP through DAP (N120: P60: K40 kg/ ha)	86.90a	85.75a	298.00a	284.00a
T ₃	T ₁ + ST with Nano-DAP @ 5 ml/ kg seed	75.57d	74.14b	281.67d	269.67bc
T ₄	T ₁ + ST with Nano-DAP @ 10 ml/ kg seed	76.41c	74.38b	283.00d	276.00ab
T ₅	T ₁ + FS with Nano-DAP @ 0.6% at 25-30 DAG	75.97cd	74.03b	282.33d	271.33b
T ₆	T ₁ + ST with Nano-DAP @ 5 ml/ kg seed + FS with Nano-DAP @ 0.6% at 25-30 DAG	76.19c	74.57b	282.67d	273.00b
T ₇	T ₁₂ + FS with Nano-DAP @ 0.2% at 25-30 DAG	87.36a	84.70a	297.33a	282.67a
T ₈	T ₁₂ + ST with Nano-DAP @ 5 ml/ kg seed + FS with Nano-DAP @ 0.2% at 25-30 DAG	87.48a	85.39a	296.33ab	283.00a
T ₉	50% NP (N60: P30: K40 kg/ ha) + FS with Nano-DAP @ 0.4% at 25-30 DAG	78.31bc	75.37b	291.33c	278.00a
T ₁₀	50% NP (N60: P30: K40 kg/ ha) + ST with Nano-DAP @ 5 ml/ kg seed + FS with Nano-DAP @ 0.4% at 25-30 DAG	79.40b	77.26b	292.33bc	279.00a
T ₁₁	Absolute Control (N0: P0: K0 kg/ ha)	72.24e	70.50c	263.67f	255.33d
T ₁₂	75% NP through DAP (N90: P45: K40 kg/ ha)	85.16a	83.63a	293.00e	280.00a
	SEm (±)	7.13	2.01	1.07	3.13
	C.D. (0.05)	2.43	5.90	4.98	9.17

In wheat the data of spike length varied between 8.10-8.66 cm (in *rabi* 2022) and 8.08-8.51 cm (in *rabi* 2022). All the applications of Nano-DAP were also showed non-significant effect on the spike length and the highest spike length was obtained by 100% P through DAP (T₂).

In wheat the data of spike weight varied between 1.12-1.69

cm (in *rabi* 2022), 1.03-1.60 cm (in *rabi* 2022). In wheat the highest spike weight was obtained by 100% P through DAP (T₂) which was at par with all the treatments consisting foliar sprays and seed treatment in combination with 75% P through DAP (T₇ and T₈) and 50% P through DAP (T₁₂) in both the seasons.

Table 5: Effect of application of Nano-DAP fertilizer on spike length (cm), spike weight (g) of wheat crop during 2021 and 2022

Treat	Treatment details	Spike length (cm)		Spike weight (g)	
		2021	2022	2021	2022
T ₁	0% NP (Control); N0: P0: K40 kg/ ha	8.10	8.08	1.22c	1.13c
T ₂	100% NP through DAP (N120: P60: K40 kg/ ha)	8.66	8.51	1.69a	1.60a
T ₃	T ₁ + ST with Nano-DAP @ 5 ml/ kg seed	8.21	8.11	1.26c	1.17c
T ₄	T ₁ + ST with Nano-DAP @ 10 ml/ kg seed	8.22	8.13	1.36bc	1.27bc
T ₅	T ₁ + FS with Nano-DAP @ 0.6% at 25-30 DAG	8.18	8.10	1.29c	1.20c
T ₆	T ₁ + ST with Nano-DAP @ 5 ml/ kg seed + FS with Nano-DAP @ 0.6% at 25-30 DAG	8.21	8.12	1.32c	1.23c
T ₇	T ₁₂ + FS with Nano-DAP @ 0.2% at 25-30 DAG	8.55	8.46	1.52ab	1.43ab
T ₈	T ₁₂ + ST with Nano-DAP @ 5 ml/ kg seed + FS with Nano-DAP @ 0.2% at 25-30 DAG	8.61	8.50	1.56a	1.47a
T ₉	50% NP (N60: P30: K40 kg/ ha) + FS with Nano-DAP @ 0.4% at 25-30 DAG	8.42	8.37	1.39b	1.30b
T ₁₀	50% NP (N60: P30: K40 kg/ ha) + ST with Nano-DAP @ 5 ml/ kg seed + FS with NANO-DAP @ 0.4% at 25-30 DAG	8.43	8.38	1.42b	1.33b
T ₁₁	Absolute Control (N0: P0: K0 kg/ ha)	8.15	8.00	1.12d	1.03d
T ₁₂	75% NP through DAP (N90: P45: K40 kg/ ha)	8.53	8.43	1.49c	1.40b
	SEm (±)	0.25	0.15	0.06	0.06
	C.D. (0.05)	N.S.	N.S.	0.17	0.17

In wheat the data of test weight varied between 35.11-40.06 cm (in *rabi* 2022) and 38.72-34.10 cm (in *rabi* 2022). All the applications of Nano-DAP were also showed non-significant

effect on the test weight and the highest test weight was obtained by 100% P through DAP (T₂).

Table 6: Effect of application of Nano-DAP fertilizer on test weight of wheat crop during 2021 and 2022 (gm)

Treat	Treatment details	Test weight (gm)	
		2021	2022
T ₁	0% NP (Control); N0: P0: K40 kg/ ha	35.43	34.21
T ₂	100% NP through DAP (N120: P60: K40 kg/ ha)	40.06	38.72
T ₃	T ₁ + ST with Nano-DAP @ 5 ml/ kg seed	36.62	34.49
T ₄	T ₁ + ST with Nano-DAP @ 10 ml/ kg seed	37.97	36.07
T ₅	T ₁ + FS with Nano-DAP @ 0.6% at 25-30 DAG	37.01	34.82
T ₆	T ₁ + ST with Nano-DAP @ 5 ml/ kg seed + FS with Nano-DAP @ 0.6% at 25-30 DAG	37.52	35.85
T ₇	T ₁₂ + FS with Nano-DAP @ 0.2% at 25-30 DAG	39.29	38.35
T ₈	T ₁₂ + ST with Nano-DAP @ 5 ml/ kg seed + FS with Nano-DAP @ 0.2% at 25-30 DAG	39.38	38.63
T ₉	50% NP (N60: P30: K40 kg/ ha) + FS with Nano-DAP @ 0.4% at 25-30 DAG	38.16	36.98
T ₁₀	50% NP (N60: P30: K40 kg/ ha) + ST with Nano-DAP @ 5 ml/ kg seed + FS with NANO-DAP @ 0.4% at 25-30 DAG	38.67	37.16
T ₁₁	Absolute Control (N0: P0: K0 kg/ ha)	35.11	34.10
T ₁₂	75% NP through DAP (N90: P45: K40 kg/ ha)	38.91	37.84
	SEm (±)	1.07	1.49
	C.D. (0.05)	N.S.	N.S.

4. Conclusion

The results showed that application of 75% P through DAP (T₆ and T₇) in combination with nano DAP and treatment with 100% P through DAP gave at par result in plant height, effective tillers per hill, panicle length, panicles per meter square, grain yield and straw yield in rice during both years. In wheat treatment with 75% NP through DAP in combination of Nano-DAP gave at par results with treatment having application of 100% NP through DAP in plant height, ear heads per meter square, grain yield and straw yield. The result reveals that 25% of DAP fertilizer can be saved by application through combination of nano DAP fertilizer with DAP in both rice and wheat.

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6. References

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