RESPONSE OF NANO DAP ON YIELD AND NUTRIENT CONTENT OF WHEAT GROWN IN LOAMY SAND SOIL

Abstract

A field experiment was conducted at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand to study the "Response of Nano DAP on Yield and Nutrient Content of Wheat Grown in Loamy Sand Soil" in *rabi* season during the year 2023-24. The experiment consisted of ten treatments and was arranged in a randomized block design with three replications. The results proved that the combined application of conventional and nano DAP had a positive impact on most of the growth parameters. The application of 100% RDF N and P (T_1), (75% RDF N and P + foliar spray with nano DAP @ 4 ml/L at 25 DAS) (T_6) and 50% RDF N and P + Seed treatment with nano DAP @ 5 ml/kg seed + First foliar spray with nano DAP @ 4 ml/L at 25 DAS(T_{10}) obtained significantly higher plant height, root length, root biomass, effective numbers of tillers, spike length, test weight, grain yield, straw yield. Similarly, nutrient content and uptake of N and P by grain and straw under T_2 and T_6 were significantly higher than rest of the treatments. Therefore, we may suggest for 75% RDF N and P + foliar spray with nano DAP @ 4 ml/L at 25 DAS and 50% RDF N and P + Seed treatment with nano DAP @ 5 ml/kg seed + First foliar spray with nano DAP @ 4 ml/L at 25 DAS for better realization of applied nutrients in terms yield responses.

Key words: Nano DAP, foliar application

Introduction

Wheat scientifically known as *Triticum aestivum* L., belongs to the Poaceae family and serves as a fundamental crop globally, holding particular significance in India as a primary winter crop. Wheat cultivation covered approximately 31.40 million hectares, resulting in a total production of around 110.55 million tonnes with average wheat productivity was recorded at 3248 kg/ha in 2022-23 (Anon., 2023). Nano fertilizers are synthesized or modified forms of traditional fertilizers, bulk materials or extracts from various vegetative or reproductive parts of plants. Nano fertilizers play a crucial role in enhancing nutrient uptake and nutrient use efficiency, reducing losses through leaching and gaseous emissions and minimizing the risk of nutrient toxicity. This contributes to ensuring food security achieved through higher

productivity and economic returns by practicing sustainable farming practices (Ahmadian *et al*., 2021).

Nano DAP is an efficient source of available nitrogen (N) and phosphorus (P_2O_5) for all crops, helping to correct nitrogen and phosphorus deficiencies in standing crops. The nano DAP formulation contains 8% nitrogen and 16% phosphorus (P_2O_5) by weight/volume. Nano DAP liquid has an advantage in terms of surface-area-to-volume ratio because its particle size is less than 100 nanometers (nm). Nano clusters of nitrogen and phosphorus in nano DAP are functionalized with bio-polymers and other excipients, enhancing spread ability and assimilation inside the plant system. This leads to higher seed vigor, increased chlorophyll and photosynthetic efficiency, improved quality and higher crop yields. (Anon., 2022).

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Materials and Methods

The experiment was carried at Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, India during *rabi* season of the year 2023-24 to examine the response of nano dap on yield and nutrient content of wheat. The experimental site had a smooth terrain with slight slopes and effective drainage. The soil type known as "Goradu" soil, is a true depiction of soils found in the middle Gujarat region. It is characterized by a loamy sand texture, good moisture retention and belongs to the Inceptisols soil order. wheat (variety-GW 496) was used as test crop in the experiment. The trial was laid down in a randomized block design (RBD) corresponding to 10 treatments and three replications. The details of treatments are as follows, T_1 (Absolute control), T_2 (100% RDF N and P), T_3 (75% RDF N and P), T_4 (50% RDF N and P), T_5 (T_3 + Foliar spray with Nano DAP @ 2 ml/L at 25 DAS), T_6 (T_3 + Foliar spray with Nano DAP @ 4 ml/L at 25 DAS), T_7 (T_4 + Foliar spray with Nano DAP @ 2 ml/L at 25 DAS), T_8 (T_4 + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS), T_9 (T_4 + Seed treatment with Nano DAP @ 2.5 ml/kg seed + First foliar spray with Nano DAP@ 2 ml/L 25 DAS) and T_{10} (T_4 + Seed treatment with Nano DAP @ 5 ml/kg seed + First foliar spray with Nano DAP@ 4 ml/L 25 DAS).Recommended basal dose of phosphorus (60 kg/ha) and nitrogen (120 kg/ha) was applied as per treatment *i.e*., 100%, 75% and 50% RDF. Half dose of 100%, 75% and 50% RDF was supplied through diammonium phosphate (DAP) and urea before sowing of seeds as basal application and the remaining half dose of nitrogen through urea was applied as top dressing at CRI stage. while, nano DAP was given at 25 DAS through foliar application, as per the treatments.

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3. Results and Discussion

3.1 Plant height

The applications of both conventional DAP and its combination with foliar spray of nano DAP had significant results on the plant height at 30 DAS and harvest. The treatment T_2 (100% RDF N and P) recorded significantly higher plant height (44.09 cm) at 30 DAS and it was remained at par with treatment T_6 (75% RDF N and P + foliar spray with nano DAP @ 4 ml/L at 25 DAS). While significantly higher plant height (105.51 cm) at harvest observed with T_2 (100% RDF N and P) and it was remained at par with treatments T_5, T_6 and T_{10}. Significantly lower plant height of 34.12 cm and 80.75 cm were recorded in treatment T_1 (Absolute control) at 30 DAS and harvest, respectively. The increase in plant height at 30 DAS and at harvest of wheat with the application of nano DAP might be due to the smaller size of nano DAP particles compared to regular fertilizer, allowing for better absorption by plants. This provides a readily available source of phosphorus (P) and nitrogen (N), which are essential for stem growth. This result is consistent with the findings of Sahithi *et al*. (2023), Chinnappa *et al*. (2023) and Prakash *et al*. (2023).

3.2 Root length and root biomass

The treatment T_2 (100% RDF N and P) recorded significantly higher root length (11.58 cm) at 30-35 DAS and it was remained at par with treatment T_5, T_6 and T_{10}. In contrast, the lower root length (8.71 cm) was recorded with treatment T_1 (Absolute control). The treatment T_2 (100% RDF N and P) recorded significantly higher root biomass (4.19 g/plant) at 30-35 DAS and it was remained at par with treatment T_5 and T_6. While the lower root biomass (2.41 g/plant) was recorded with treatment T_1 (Absolute control). These results were in close agreement with those found by Abdel-Aziz *et al*. (2016), Amira *et al*. (2016) and Maloth *et al*. (2024).

3.3 Number of Effective Tillers/m Row Length

Number of effective tillers per meter row length (108.25) at harvest was found significantly higher with treatment T_2 (100% RDF N and P) as compared to other treatments and was found to be at par with the treatments T_5, T_6 and T_{10}. In contrast, the lower number of effective tillers (89.49) per meter row length was recorded with treatment T_1 (Absolute control). The increase in the total number of tillers and effective tillers with nano DAP might be attributed to its smaller particle size enhances nutrient uptake, facilitating more efficient absorption of essential nutrients such as phosphorus (P) and nitrogen (N). This efficient uptake supports better root development, providing a robust foundation for multiple tillers, and stimulates growth

hormones that encourage tiller formation. Additionally, Nano DAP allows for more uniform nutrient distribution and enhances the plant's stress tolerance. Collectively, these factors lead to a significant increase in the number of effective tillers per plant. These results are in close accordance with those reported by Meena *et al.* (2021) and Sahu *et al.* (2023).

3.4 Spike Length

Significantly higher spike length (10.34 cm) with treatment T_2 (100% RDF N and P) compared to other treatments. This treatment was found to be statistically at par with treatments T_5, T_6, T_8 and T_{10}. The lower spike length (8.64 cm) was observed in treatment T_1 (Absolute control). These results closely align with those reported by Gomaa *et al*. (2018).

3.5 Test weight

The treatment T_2 (100% RDF N and P) recorded significantly higher test weight of wheat grain (42.52 g) than other treatments but was found statistically at par with the treatments T_3, T_5, T_6, T_8, T_9 and T_{10}.While treatment T_1 (Absolute control) recorded the lower test weight (36.29 g) as compared to other treatments.

3.6 Grain yield

The treatment T_2 (100% RDF N and P) recorded significantly higher grain yield of wheat (6315kg/ha) than other treatments and it was at par with treatment T_5, T_6 and T_{10}. In contrast lower grain yield of wheat (4425 kg/ha) was recorded with the treatment T_1 (Absolute control). The rise in wheat grain yield is mainly attributed to the improved growth of plant parts and metabolic activities like photosynthesis, resulting in increased accumulation and translocation of photosynthates to the plant's economic parts. Nano fertilizers raised broad bean production and yield components as a result of increased growth hormone activity and improved metabolic processes, which tend to increase flowering and grain formation (El-Azizy *et al*., 2021). Similar results were also reported by Rajput *et al*. (2022) and Sahu *et al.* (2023).

3.7 Straw yield

The treatment T_2 (100% RDF N and P) recorded significantly higher straw yield of wheat (8114kg/ha) than other treatments and it was at par with treatment T_5, T_6 and T_{10}. In contrast lower straw yield of wheat (5503 kg/ha) was recorded with the treatment T_1 (Absolute control). The increased grain and straw yield of wheat after the application of nano fertilizers may be attributed to increased growth hormone levels, enhanced metabolic processes and

improved photosynthetic activities due to the application of nano fertilizers (Meena *et al*. 2020). Similar results were found by Reddy *et al*. (2022) and Prakash *et al*. (2023).

3.8 Protein content (%)

The treatment T_2 (100% RDF N and P) recorded significantly higher protein content of wheat grain (11.94%) than other treatments but was found statistically at par with the treatments T_5, T_6, T_8 and T_{10}. Treatment T_1 **(**Absolute control) recorded the lower protein content of wheat grain (10.54%) as compared to other treatments. Nano DAP increases the protein content of wheat by enhancing nitrogen and phosphorus availability, which are crucial for protein synthesis and energy transfer. Its smaller particle size allows for more efficient nutrient absorption, boosting photosynthesis and overall plant health. This leads to better protein synthesis and accumulation in the wheat grains. These results are in conformity to those reported by Gomaa *et al*. (2018) and Dhansil *et al*. (2018).

3.9 Nitrogen content

The treatment T_2 (100% RDF N and P) recorded significantly higher N content of wheat grain (1.91%) than other treatments but was found statistically at par with the treatments T_5, T_6 and T_{10}. Treatment T_1 **(**Absolute control) recorded the lower N content of wheat grain (1.69%) as compared to other treatments while treatment T_2 (100% RDF N and P) recorded significantly higher N content of wheat straw (0.76%) than other treatments but was found statistically at par with the treatments T_5, T_6 and T_{10}. In contrast treatment T_1 (Absolute control) recorded lower N content in wheat straw (0.66%) compared to other treatments.

3.10 Phosphorus Content

The treatment T_2 (100% RDF N and P) recorded significantly higher P content of wheat grain (0.390%) than other treatments but was found statistically at par with the treatments T_5, T_6, T_8, T_9 and T_{10}. Treatment T_1 **(**Absolute control) recorded the lower P content of wheat grain (0.327%) as compared to other treatments while treatment T_2 (100% RDF N and P) recorded significantly maximum P content of wheat straw (0.187%) than other treatments but was found statistically at par with the treatments T_3, T_5, T_6, T_8, T_9 and T_{10}.Treatment T_1 (Absolute control) recorded lower P content in wheat grain (0.163%) compared to other treatments.

3.11 Nitrogen uptake by grain and straw

Nitrogen uptake by grain and straw of wheat was found to be significant under different nano DAP treatments. Significantly higher nitrogen uptake by grain and straw (122.49 kg/ha and 70.92 kg/ha respectively) was recorded with the treatment T_2 (100% RDF N and P) and was found to be at par with the treatments T_5, T_6 and T_{10}. Treatment T_1 **(**Absolute control)

recorded the lower N uptake of wheat grain and straw (76.48 kg/ha and 45.46 kg/ha respectively) as compared to other treatments.

3.12 Phosphorus uptake by grain and straw

Phosphorus uptake by grain and straw of wheat was found to be significant under different nano DAP treatments. Significantly higher phosphorus uptake by grain and straw (25.01 kg/ha and 17.69 kg/ha respectively) was recorded with the treatment T_2 (100% RDF N and P) and was found to be at par with the treatments T_5, T_6 and T_{10}. Treatment T_1 (Absolute control) recorded the lower P uptake of wheat grain and straw (14.76 kg/ha and 11.10 kg/ha respectively) as compared to other treatments.

3.13 Available N and P content in soil

The treatment T_2 (100% RDF N and P) recorded the higher available N (211 kg/ha) compared to other treatments but was statistically at par with treatments T_3, T_5 and T_6. whereas treatment T_1 (Absolute control) recorded significantly lower available nitrogen (178.3 kg/ha) as compared to other treatments. similarly, treatment T_2 (100% RDF N and P) recorded the higher available P_2O_5 (55.31 kg/ha) compared to other treatments but was statistically at par with treatments T_3, T_5 and T_6. In contrast treatment T_1 (Absolute control) recorded significantly lower available P_2O_5 (40.87 kg/ha) as compared to other treatments.

CONCLUSION

In light of the findings of the present investigation. It can be concluded that, the foliar application of nano DAP fertilizer in combination with conventional phosphatic fertilizer showed potential in reducing the soil application of phosphorus. It was observed that application of 100% RDF of N and P was superior. However, using 75% RDF N and P + foliar spray with nano DAP @ 4 ml/L at 25 DAS and 50% RDF N and P + Seed treatment with nano DAP @ 5 ml/kg seed + First foliar spray with nano DAP @ 4 ml/L at 25 DAS seems to be more effective for achieving higher growth and yield attributing characters of wheat.

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Table 1. Effect of different treatments on plant height, root length, root biomass and no. of effective tillers

Tr No.	Treatments	Plant height(cm)		Root length(cm)	Root biomass (g/plant)	No. of effective tillers/m row length
		30 DAS	Harvest			
T_1	Absolute Control	34.12	80.75	8.71	2.41	89.49
T_2	100% RDF N and P	44.09	105.51	11.58	4.19	108.25
T_3	75% RDF N and P	36.37	84.38	9.36	2.75	94.07
T_4	50% RDF N and P	35.15	82.85	9.63	2.49	92.80
T_5	T_3 + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS	38.06	98.31	11.03	3.95	104.69
T_6	T_3 + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS	39.17	98.80	11.21	3.97	106.97
T_7	T_4 + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS	35.30	82.91	9.33	2.73	93.87
T_8	T_4 + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS	37.37	87.86	10.68	3.57	95.28
T_9	T_4 + Seed treatment with Nano DAP @ 2.5 ml/kg seed + First foliar spray with Nano DAP@ 2 ml/L 25 DAS.	37.11	86.05	9.80	3.36	95.26
T_{10}	T_4 + Seed treatment with Nano DAP @ 5 ml/kg seed + First foliar spray with Nano DAP@ 4 ml/L 25 DAS	37.42	96.54	10.85	3.57	104.03
	S. Em. ±	**1.72**	**4.31**	**0.43**	**0.14**	**4.20**
	C.D. at 5%	**5.10**	**12.82**	**1.29**	**0.42**	**12.47**
	C.V. (%)	**7.95**	**8.27**	**7.34**	**7.39**	**7.38**

Table 2. Effect of different treatments on spike length, grain yield, straw yield, test weight and protein content

Tr No.	Treatments	Spike length (cm)	Grain yield (kg/ha)	Straw yield (kg/ha)	Test weight(g)	Protein content (%)
T_1	Absolute Control	8.64	4425	5503	36.29	10.54
T_2	100% RDF N and P	10.34	6315	8114	42.85	11.94
T_3	75% RDF N and P	9.09	5290	6471	38.03	11.02
T_4	50% RDF N and P	8.74	4708	5783	36.33	10.75
T_5	T_3 + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS	9.97	5810	7268	41.51	11.54
T_6	T_3 + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS	10.18	6064	7869	42.12	11.79
T_7	T_4 + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS	8.88	5221	6270	37.80	10.96
T_8	T_4 + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS	9.22	5299	6536	37.84	11.19
T_9	T_4 + Seed treatment with Nano DAP @ 2.5 ml/kg seed + First foliar spray with Nano DAP@ 2 ml/L 25 DAS.	9.16	5291	6518	38.42	11.10
T_{10}	T_4 + Seed treatment with Nano DAP @ 5 ml/kg seed + First foliar spray with Nano DAP@ 4 ml/L 25 DAS	9.95	5664	6971	41.14	11.48
	S. Em. ±	**0.40**	**333**	**524**	**1.46**	**0.27**
	C.D. at 5%	**1.18**	**988**	**1557**	**4.34**	**0.79**
	C.V. (%)	**7.32**	**10.65**	**13.49**	**6.45**	**4.09**

Table 3. Effect of different treatments on nitrogen and phosphorus content in grain and straw as well as N and P uptake by grain and straw

Tr No.	Treatments	N content (%)		P content (%)		N uptake (kg/ha)		P uptake (kg/ha)	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	Absolute Control	1.69	0.66	0.327	0.163	76.48	45.46	14.76	11.10
T_2	100% RDF N and P	1.91	0.76	0.390	0.187	122.49	70.92	25.01	17.69
T_3	75% RDF N and P	1.76	0.69	0.347	0.169	94.81	54.99	18.74	13.10
T_4	50% RDF N and P	1.72	0.68	0.330	0.163	82.51	48.61	15.94	11.63
T_5	T_3 + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS	1.85	0.74	0.377	0.180	109.36	64.02	22.27	15.48
T_6	T_3 + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS	1.89	0.75	0.387	0.186	116.47	68.85	23.85	17.13
T_7	T_4 + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS	1.75	0.67	0.340	0.167	93.20	53.82	18.21	12.65
T_8	T_4 + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS	1.80	0.68	0.367	0.171	96.70	56.34	19.80	13.37
T_9	T_4 + Seed treatment with Nano DAP @ 2.5 ml/kg seed + First foliar spray with Nano DAP@ 2 ml/L 25 DAS	1.78	0.69	0.367	0.170	95.75	56.19	19.75	13.38
T_{10}	T_4 + Seed treatment with Nano DAP @ 5 ml/kg seed + First foliar spray with Nano DAP@ 4 ml/L 25 DAS	1.84	0.73	0.370	0.177	107.12	61.46	21.31	14.68
	S. Em. ±	**0.04**	**0.02**	**0.01**	**0.01**	**6.63**	**3.55**	**1.43**	**0.99**
	C.D. at 5%	**0.11**	**0.05**	**0.03**	**0.02**	**19.69**	**10.54**	**4.25**	**2.93**
	C.V. (%)	**4.09**	**4.11**	**4.54**	**5.04**	**11.54**	**10.58**	**12.40**	**12.20**

Table 4. Effect of different treatments on available nitrogen and phosphorus of soil after harvest of wheat

Tr No.	Treatments	Available nutrient status(kg/ha)	
		N	P_2O_5
T_1	Absolute Control	178.3	40.87
T_2	100% RDF N and P	211.0	55.31
T_3	75% RDF N and P	195.7	51.74
T_4	50% RDF N and P	183.2	48.47
T_5	T_3 + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS	200.0	52.23
T_6	T_3 + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS	203.7	53.93
T_7	T_4 + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS	184.7	46.31
T_8	T_4 + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS	188.0	48.83
T_9	T_4 + Seed treatment with Nano DAP @ 2.5 ml/kg seed + First foliar spray with Nano DAP@ 2 ml/L 25 DAS	189.9	51.27
T_{10}	T_4 + Seed treatment with Nano DAP @ 5 ml/kg seed + First foliar spray with Nano DAP@ 4 ml/L 25 DAS	192.3	52.85
	S. Em. ±	**5.32**	**1.39**
	C.D. at 5%	**15.81**	**4.12**
	C.V. (%)	**4.78**	**4.79**