

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

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## 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<sub>1</sub>), (75% RDF N and P + foliar spray with nano DAP @ 4 ml/L at 25 DAS) (T<sub>6</sub>) 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<sub>10</sub>) 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<sub>2</sub> and T<sub>6</sub> 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).

### 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<sub>1</sub> (Absolute control), T<sub>2</sub> (100% RDF N and P), T<sub>3</sub> (75% RDF N and P), T<sub>4</sub> (50% RDF N and P), T<sub>5</sub> (T<sub>3</sub> + Foliar spray with Nano DAP @ 2 ml/L at 25 DAS), T<sub>6</sub> (T<sub>3</sub> + Foliar spray with Nano DAP @ 4 ml/L at 25 DAS), T<sub>7</sub> (T<sub>4</sub> + Foliar spray with Nano DAP @ 2 ml/L at 25 DAS), T<sub>8</sub> (T<sub>4</sub> + Foliar spray with Nano DAP @ 4 ml/L at 25 DAS), T<sub>9</sub> (T<sub>4</sub> + Seed treatment with Nano DAP @ 2.5 ml/kg seed + First foliar spray with Nano DAP @ 2 ml/L 25 DAS) and T<sub>10</sub> (T<sub>4</sub> + 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.

### 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<sub>2</sub> (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<sub>6</sub> (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<sub>2</sub> (100% RDF N and P) and it was remained at par with treatments T<sub>5</sub>, T<sub>6</sub> and T<sub>10</sub>. Significantly lower plant height of 34.12 cm and 80.75 cm were recorded in treatment T<sub>1</sub> (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<sub>2</sub> (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<sub>5</sub>, T<sub>6</sub> and T<sub>10</sub>. In contrast, the lower root length (8.71 cm) was recorded with treatment T<sub>1</sub> (Absolute control). The treatment T<sub>2</sub> (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<sub>5</sub> and T<sub>6</sub>. While the lower root biomass (2.41 g/plant) was recorded with treatment T<sub>1</sub> (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<sub>2</sub> (100% RDF N and P) as compared to other treatments and was found to be at par with the treatments T<sub>5</sub>, T<sub>6</sub> and T<sub>10</sub>. In contrast, the lower number of effective tillers (89.49) per meter row length was recorded with treatment T<sub>1</sub> (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<sub>2</sub> (100% RDF N and P) compared to other treatments. This treatment was found to be statistically at par with treatments T<sub>5</sub>, T<sub>6</sub>, T<sub>8</sub> and T<sub>10</sub>. The lower spike length (8.64 cm) was observed in treatment T<sub>1</sub> (Absolute control). These results closely align with those reported by [Gomaa \*et al.\* \(2018\)](#).

### **3.5 Test weight**

The treatment T<sub>2</sub> (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<sub>3</sub>, T<sub>5</sub>, T<sub>6</sub>, T<sub>8</sub>, T<sub>9</sub> and T<sub>10</sub>. While treatment T<sub>1</sub> (Absolute control) recorded the lower test weight (36.29 g) as compared to other treatments.

### **3.6 Grain yield**

The treatment T<sub>2</sub> (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<sub>5</sub>, T<sub>6</sub> and T<sub>10</sub>. In contrast lower grain yield of wheat (4425 kg/ha) was recorded with the treatment T<sub>1</sub> (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<sub>2</sub> (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<sub>5</sub>, T<sub>6</sub> and T<sub>10</sub>. In contrast lower straw yield of wheat (5503 kg/ha) was recorded with the treatment T<sub>1</sub> (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<sub>2</sub> (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<sub>5</sub>, T<sub>6</sub>, T<sub>8</sub> and T<sub>10</sub>. Treatment T<sub>1</sub> (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<sub>2</sub> (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<sub>5</sub>, T<sub>6</sub> and T<sub>10</sub>. Treatment T<sub>1</sub> (Absolute control) recorded the lower N content of wheat grain (1.69%) as compared to other treatments while treatment T<sub>2</sub> (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<sub>5</sub>, T<sub>6</sub> and T<sub>10</sub>. In contrast treatment T<sub>1</sub> (Absolute control) recorded lower N content in wheat straw (0.66%) compared to other treatments.

### **3.10 Phosphorus Content**

The treatment T<sub>2</sub> (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<sub>5</sub>, T<sub>6</sub>, T<sub>8</sub>, T<sub>9</sub> and T<sub>10</sub>. Treatment T<sub>1</sub> (Absolute control) recorded the lower P content of wheat grain (0.327%) as compared to other treatments while treatment T<sub>2</sub> (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<sub>3</sub>, T<sub>5</sub>, T<sub>6</sub>, T<sub>8</sub>, T<sub>9</sub> and T<sub>10</sub>. Treatment T<sub>1</sub> (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<sub>2</sub> (100% RDF N and P) and was found to be at par with the treatments T<sub>5</sub>, T<sub>6</sub> and T<sub>10</sub>. Treatment T<sub>1</sub> (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<sub>2</sub> (100% RDF N and P) and was found to be at par with the treatments T<sub>5</sub>, T<sub>6</sub> and T<sub>10</sub>. Treatment T<sub>1</sub> (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<sub>2</sub> (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<sub>3</sub>, T<sub>5</sub> and T<sub>6</sub>. whereas treatment T<sub>1</sub> (Absolute control) recorded significantly lower available nitrogen (178.3 kg/ha) as compared to other treatments. similarly, treatment T<sub>2</sub> (100% RDF N and P) recorded the higher available P<sub>2</sub>O<sub>5</sub> (55.31 kg/ha) compared to other treatments but was statistically at par with treatments T<sub>3</sub>, T<sub>5</sub> and T<sub>6</sub>. In contrast treatment T<sub>1</sub> (Absolute control) recorded significantly lower available P<sub>2</sub>O<sub>5</sub> (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.

## **REFERENCES**

- Abdel-Aziz, H.M., Hasaneen, M.N., & Omer, A.M. (2016). Nano chitosan-NPK fertilizer enhances the growth and productivity of wheat plants grown in sandy soils. *Spanish Journal of Agricultural Research*, 14 (1), 0902.
- Ahmadian, K., Jalilian, J. & Pirzad, A. (2021). Nano-fertilizers improved drought tolerance in wheat under deficit irrigation. *Agricultural Water Management*, 244, 106544.

- Amira Sh. Soliman, M., Hassan, F. A. E., Hanafy, A. H., & Souad, A. E. F. (2016). Effect of Nano and molecular phosphorus fertilizers on growth and chemical composition of baobab (*Adansonia digitata* L.). *Journal of Plant Science*, 11, 52-60.
- Anonymous 2023. Centre for Monitoring Indian Economy- Commodities. Retrieved from <https://commodities.cmie.com>
- Anonymous 2022. IFFCO Nano DAP Fertilizer for Sustainable Farming. Retrieved from <https://www.sagarika.com/en/nano-dap>
- Chinnappa, S. A., Krishnamurthy, D., Ajayakumar, M. Y., Ramesha, Y. M. & Ravi, S. (2023). Response of nano fertilizers on growth, yield and economics of kharif sorghum. *The Pharma Innovation Journal*, 12 (9), 761-765.
- Dhansil, A., Zalawadia, N., Prajapat, B. S. & Yadav, K. (2018). Effect of Nano phosphatic fertilizer on nutrient content and uptake by pearl millet (*Pennisetum glaucum* L.) crop. *International Journal of Current Microbiology and Applied Science*, 7 (12), 2327-2337.
- Gomaa, M. A., Radwan, F. I., Kandil, E. E. & Al-Msari, M. A. F. (2018). Response of Some Egyptian and Iraqi Wheat Cultivars to Mineral and Nano Fertilization. *Egyptian Academic Journal of Biological Sciences, H. Botany*, 9 (1), 19-26.
- Maloth, A., Thatikunta, R., Parida, B. K., Naik, D. S. & Varma, N. (2024). Evaluation of Nano-DAP on Plant Growth, Enzymatic Activity and Yield in Paddy (*Oryza sativa* L.). *International Journal of Environment and Climate Change*, 14 (1), 890-897.
- Meena, M., Jat, G., Meena, R. H., Sharma, S. K., Choudhary, R., Yadav, S. K., Jain, D., Choudhary, R.S., Chhippa, B.G. & Jat, H. (2021). Effect of phospho enriched compost and zinc on soil properties and productivity of blackgram (*Vigna mungo*). *Indian Journal of Agricultural Sciences*, 91 (9), 1333-6.
- Prakash, A. N., Siddaram, R. & Bellakki, M. A. (2023). Response of nano DAP on growth, yield and economics of Soybean (*Glycine max* L.). *The Pharma Innovation Journal*, 12 (12), 1985-1989.

- Rajput, J. S., Thakur, A. K., Nag, N. K., Chandrakar, T. & Singh, D. P. (2022). Effect of Nano fertilizer in relation to growth, yield and economics of little millet (*Panicum sumatrense roth*) under rainfed conditions. *The Pharma Innovation Journal*, 11 (7), 153-156.
- Reddy, B. M., Elankavi, S., Kumar, M. S., Sai, M. V. & Vani, B. D. (2022). Effects of conventional and nano fertilizers on growth and yield of maize (*Zea mays* L.). *Bhartiya Krishi Anusandhan Patrika*, 37 (4), 379-382.
- Sahithi, B., Babu, K. K., Prasanth, P., Lakshminarayana, D. & Gouthami, P. (2023). Studies on effect of nano urea and nano dap alone and in combination with different levels of nitrogen and phosphorus on growth and yield of marigold (*Tagetes erecta* L.) Cv. superball. *The Pharma Innovation Journal*, 12 (11), 901-906.
- Sahu, D., Banwasi, R., Shrivastava, L. K., Chowdhury, T., Jatav, G. & Kumar, H. (2023). Performance of Nano-DAP under Rice-Wheat Cropping System in Vertisol of Chhattisgarh, India. *International Journal of Environment and Climate Change*, 13 (9), 2864-2875.
- Singh, M. D. (2017). Nano fertilizer is a New Way to Increase Nutrient Use Efficiency in Crop Production. *International Journal of Agriculture Science*, 9 (7), 3831-3833.

**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 <sub>1</sub>  | Absolute Control  | 34.12            | 80.75        | 8.71            | 2.41                   | 89.49                                 |
| T <sub>2</sub>  | 100% RDF N and P  | 44.09            | 105.51       | 11.58           | 4.19                   | 108.25                                |
| T <sub>3</sub>  | 75% RDF N and P   | 36.37            | 84.38        | 9.36            | 2.75                   | 94.07                                 |
| T <sub>4</sub>  | 50% RDF N and P   | 35.15            | 82.85        | 9.63            | 2.49                   | 92.80                                 |
| T <sub>5</sub>  | T <sub>3</sub> + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS   | 38.06            | 98.31        | 11.03           | 3.95                   | 104.69                                |
| T <sub>6</sub>  | T <sub>3</sub> + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS   | 39.17            | 98.80        | 11.21           | 3.97                   | 106.97                                |
| T <sub>7</sub>  | T <sub>4</sub> + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS   | 35.30            | 82.91        | 9.33            | 2.73                   | 93.87                                 |
| T <sub>8</sub>  | T <sub>4</sub> + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS   | 37.37            | 87.86        | 10.68           | 3.57                   | 95.28                                 |
| T <sub>9</sub>  | T <sub>4</sub> + 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 <sub>10</sub> | T <sub>4</sub> + 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                                |
|                 | <b>S. Em. ±</b>   | <b>1.72</b>      | <b>4.31</b>  | <b>0.43</b>     | <b>0.14</b>            | <b>4.20</b>                           |
|                 | <b>C.D. at 5%</b>   | <b>5.10</b>      | <b>12.82</b> | <b>1.29</b>     | <b>0.42</b>            | <b>12.47</b>                          |
|                 | <b>C.V. (%)</b>   | <b>7.95</b>      | <b>8.27</b>  | <b>7.34</b>     | <b>7.39</b>            | <b>7.38</b>                           |

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

| <b>Tr No.</b>         | <b>Treatments</b>   | <b>Spike length (cm)</b> | <b>Grain yield (kg/ha)</b> | <b>Straw yield (kg/ha)</b> | <b>Test weight(g)</b> | <b>Protein content (%)</b> |
|-----------------------|---|--------------------------|----------------------------|----------------------------|-----------------------|----------------------------|
| <b>T<sub>1</sub></b>  | Absolute Control  | 8.64                     | 4425                       | 5503                       | 36.29                 | 10.54                      |
| <b>T<sub>2</sub></b>  | 100% RDF N and P  | 10.34                    | 6315                       | 8114                       | 42.85                 | 11.94                      |
| <b>T<sub>3</sub></b>  | 75% RDF N and P   | 9.09                     | 5290                       | 6471                       | 38.03                 | 11.02                      |
| <b>T<sub>4</sub></b>  | 50% RDF N and P   | 8.74                     | 4708                       | 5783                       | 36.33                 | 10.75                      |
| <b>T<sub>5</sub></b>  | T <sub>3</sub> + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS   | 9.97                     | 5810                       | 7268                       | 41.51                 | 11.54                      |
| <b>T<sub>6</sub></b>  | T <sub>3</sub> + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS   | 10.18                    | 6064                       | 7869                       | 42.12                 | 11.79                      |
| <b>T<sub>7</sub></b>  | T <sub>4</sub> + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS   | 8.88                     | 5221                       | 6270                       | 37.80                 | 10.96                      |
| <b>T<sub>8</sub></b>  | T <sub>4</sub> + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS   | 9.22                     | 5299                       | 6536                       | 37.84                 | 11.19                      |
| <b>T<sub>9</sub></b>  | T <sub>4</sub> + 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                      |
| <b>T<sub>10</sub></b> | T <sub>4</sub> + 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                      |
|                       | <b>S. Em. ±</b>   | <b>0.40</b>              | <b>333</b>                 | <b>524</b>                 | <b>1.46</b>           | <b>0.27</b>                |
|                       | <b>C.D. at 5%</b>   | <b>1.18</b>              | <b>988</b>                 | <b>1557</b>                | <b>4.34</b>           | <b>0.79</b>                |
|                       | <b>C.V. (%)</b>   | <b>7.32</b>              | <b>10.65</b>               | <b>13.49</b>               | <b>6.45</b>           | <b>4.09</b>                |

**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 <sub>1</sub>  | Absolute Control   | 1.69          | 0.66        | 0.327         | 0.163       | 76.48            | 45.46        | 14.76            | 11.10        |
| T <sub>2</sub>  | 100% RDF N and P   | 1.91          | 0.76        | 0.390         | 0.187       | 122.49           | 70.92        | 25.01            | 17.69        |
| T <sub>3</sub>  | 75% RDF N and P  | 1.76          | 0.69        | 0.347         | 0.169       | 94.81            | 54.99        | 18.74            | 13.10        |
| T <sub>4</sub>  | 50% RDF N and P  | 1.72          | 0.68        | 0.330         | 0.163       | 82.51            | 48.61        | 15.94            | 11.63        |
| T <sub>5</sub>  | T <sub>3</sub> + 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 <sub>6</sub>  | T <sub>3</sub> + 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 <sub>7</sub>  | T <sub>4</sub> + 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 <sub>8</sub>  | T <sub>4</sub> + 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 <sub>9</sub>  | T <sub>4</sub> + 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 <sub>10</sub> | T <sub>4</sub> + 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        |
|                 | <b>S. Em. ±</b>  | <b>0.04</b>   | <b>0.02</b> | <b>0.01</b>   | <b>0.01</b> | <b>6.63</b>      | <b>3.55</b>  | <b>1.43</b>      | <b>0.99</b>  |
|                 | <b>C.D. at 5%</b>  | <b>0.11</b>   | <b>0.05</b> | <b>0.03</b>   | <b>0.02</b> | <b>19.69</b>     | <b>10.54</b> | <b>4.25</b>      | <b>2.93</b>  |
|                 | <b>C.V. (%)</b>  | <b>4.09</b>   | <b>4.11</b> | <b>4.54</b>   | <b>5.04</b> | <b>11.54</b>     | <b>10.58</b> | <b>12.40</b>     | <b>12.20</b> |

**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 <sub>2</sub> O <sub>5</sub> |
| T <sub>1</sub>  | Absolute Control   | 178.3                            | 40.87                         |
| T <sub>2</sub>  | 100% RDF N and P   | 211.0                            | 55.31                         |
| T <sub>3</sub>  | 75% RDF N and P  | 195.7                            | 51.74                         |
| T <sub>4</sub>  | 50% RDF N and P  | 183.2                            | 48.47                         |
| T <sub>5</sub>  | T <sub>3</sub> + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS  | 200.0                            | 52.23                         |
| T <sub>6</sub>  | T <sub>3</sub> + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS  | 203.7                            | 53.93                         |
| T <sub>7</sub>  | T <sub>4</sub> + Foliar spray with Nano DAP@ 2 ml/L at 25 DAS  | 184.7                            | 46.31                         |
| T <sub>8</sub>  | T <sub>4</sub> + Foliar spray with Nano DAP@ 4 ml/L at 25 DAS  | 188.0                            | 48.83                         |
| T <sub>9</sub>  | T <sub>4</sub> + 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 <sub>10</sub> | T <sub>4</sub> + Seed treatment with Nano DAP @ 5 ml/kg seed + First foliar spray with Nano DAP@ 4 ml/L 25 DAS   | 192.3                            | 52.85                         |
|                 | <b>S. Em. ±</b>  | <b>5.32</b>                      | <b>1.39</b>                   |
|                 | <b>C.D. at 5%</b>  | <b>15.81</b>                     | <b>4.12</b>                   |
|                 | <b>C.V. (%)</b>  | <b>4.78</b>                      | <b>4.79</b>                   |

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