**Effect of Nano Urea on Growth and Productivity of Wheat (*Triticum aestivum* L) under Vidarbha Condition.**

Abstract

 A field experiment was conducted at Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during *rabi* season of 2023-24. The soil of experimental site was slightly saline with clay in texture. The experimental design was randomize block design with 10 treatment and replicated thrice. The treatments were T1 - One spray Nano urea (4 ml litre-1)  at maximum tillering, T2 - Two spray Nano urea (4 ml litre-1) at tillering and jointing, T3 -Recommended N (1/3rd basal, 2/3rd CRI – Recommended N), T4 - Recommended N + one spray of Nano urea (4 ml litre-1) at tillering, T5 - Recommended N + two spray of Nano urea (4 ml litre-1) at tillering and jointing, T6 - Recommended N+ one spray of urea (2%) at tillering, T7 - Recommended N + two spray of urea (2%) at tillering and jointing, T8 - Recommended N + one spray of urea (2%) + Nano urea (4 ml litre-1) at tillering, T9 - Recommended N + one spray of urea (2%) +DAP (2%) + Nano urea (4 ml litre-1) at tillering, T10 - Absolute control (No nitrogen). The recommended dose of fertilizers for wheat was 80:40:40 NPK kg ha-1, which was applied in the form of urea, single super phosphate and murate of potash respectively. Growth attributes like plant height, dry matter production per plant, spike length, yield per plant were significantly influenced due to different nitrogen management treatments. Various management treatments significantly influenced the grain yield of wheat. The treatment T7 recorded maximum and significantly higher grain (5098 kg ha-1) and straw yield (5559 kg ha-1) which was at par with the treatments T3, T4, T5, T6, T8 and T9. The maximum values for growth and yield attributes with economics were found in treatment T7 which is at par with T3, T4, T5, T6, T8 and T9 in all treatments.

**Key word:** DAP, nano urea, nitrogen use efficiency, urea, wheat

**1. Introduction**

Wheat, scientifically known as *Triticum aestivum* L., is a versatile grain cultivated in diverse climatic and soil conditions, primarily thriving in temperate regions with annual rainfall ranging from 30 to 90 mm. The predominant variety of wheat cultivated worldwide is hexaploid bread wheat *(Triticum aestivum* L.), constituting approximately 95 per cent of global wheat production. This common or bread wheat variety is highly prized for its suitability in bread making. The remaining 5 per cent comprises tetraploid durum wheat, which serves various culinary purposes Recent assessments indicate that approximately 30 percent of total crop yield can be attributed to fertilizer usage, with the remaining 70 percent relying on the effective implementation of various

factors and agricultural inputs. However, a significant portion of applied fertilizers either become fixed in the soil or are lost to the environment through processes such as volatilization, leaching, and water runoff. Specifically, between 50 to 70 percent of nitrogenous fertilizers administered through conventional methods are either lost as water-soluble nitrates, gaseous ammonia, nitrogen oxides, or are assimilated as minerals in the soil via microbial activity. Nitrogen stands out as the most critical nutrient for crop productivity and plays a pivotal role in agriculture.

In India, the total consumption, production, and import of nitrogen as fertilizer are reported as 191.01, 136.85, and 51.91 lakh tonnes, respectively  (Anonymous, 2020). The predominant nitrogenous fertilizer used presently is urea, constituting roughly 82 percent of India's overall fertilizer usage and about 55 percent of the global nitrogen fertilizer consumption. Urea is favoured due to its high solubility in water, non-polarity, rapid leaf absorption, and minimal phytotoxicity (Bondada *et al*., 2001). However, the use of urea has been associated with reduced fertilizer efficiency, leading to increased costs. Paradoxically, the imbalanced and indiscriminate application of inorganic fertilizers has negatively impacted nutrient availability to plants, soil fertility, and soil health, resulting in decreased crop productivity and contributing to chronic human health issues.

Fertilizers, which are nutrients contained within Nano porous materials at a size of 10^-9 meters, coated with a thin polymer film, or delivered as particles or emulsions of Nano scale dimensions, are referred to as Nano-fertilizers. Their application offers the advantage of specifically releasing nutrients within the plant, thereby minimizing losses and preventing rapid alterations in their chemical properties. Nano-fertilizers can gradually release their nutrients over a period of 40 to 50 days, contrasting with synthetic fertilizers, which achieve similar release within 4 to 10 days. Consequently, synthetic urea fertilizers can lose over 70 percent of their nitrogen content shortly after field application due to leaching and volatilization, leaving less than 20 percent readily available for plant uptake

A single Nano urea particle measures approximately 30 nanometres in diameter (IFFCO, 2021), possessing a surface area to volume ratio approximately 10,000 times greater than that of regular urea. Due to its remarkably small size and surface-penetrating properties, Nano urea is readily absorbed by plants when applied as a spray on their leaves. These nanoparticles have the ability to penetrate to specific areas within the plant where nitrogen is required, facilitating the controlled release of nutrients. This targeted and controlled release mechanism inherent in Nano-formulated agricultural inputs helps to mitigate excess runoff, prevent eutrophication, and eliminate residual contamination, contributing to improved environmental sustainability.

**2. Materials and method**

 The field experiment was conducted at Plot No. 7, Wheat Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during *rabi* season of 2023-24. The soil of experimental site was slightly saline in texture with pH (8.1), organic carbon (0.52%), electric conductivity (0.32 dSm-1), Available nitrogen (191 kg ha-1), Available phosphorus (17.32 kg ha-1) and Available potassium (359 kg ha-1). The design was randomize block design with 10 treatment combination replicated thrice. For the present investigation ,Treatments were T1 - One spray Nano urea (4 ml litre-1)  at maximum tillering, T2 - Two spray Nano urea (4 ml litre-1) at tillering and jointing, T3 - Recommended N (1/3rd basal, 2/3rd CRI – Recommended N), T4 - Recommended N + one spray of Nano urea (4 ml litre-1) at tillering, T5 - Recommended N + two spray of Nano urea (4 ml litre-1) at tillering and jointing, T6 - Recommended N+ one spray of urea (2%) at tillering, T7 - Recommended N + two spray of urea (2%) at tillering and jointing, T8 - Recommended N + one spray of urea (2%) + Nano urea (4 ml litre-1) at tillering, T9 - Recommended N + one spray of urea (2%) +DAP (2%) + Nano urea (4 ml litre-1) at tillering, T10 - Absolute control (No nitrogen). The gross size of experimental plot was 1.80 m x 8 m and wheat cultivar ‘AKAW-4627’ was sown with spacing 20 cm between row to row. It was sown with seed rate of 125 kg ha-1. Recommended dose of fertilizers for wheat was 80:40:40 NPK kg ha-1, which was applied in the form of urea, single super phosphate and murate of potash respectively. Data was recorded from five plants selected randomly from each replication of treatment.

**3. Results and discussion**

 The treatment T7 - Recommended N + two spray of urea (2%) at tillering and jointing recorded significantly higher plant height (86.93 cm) and number of tillers per plant (9.7) at harvest. This was at par with only treatment T9 - Recommended N + one spray of urea (2%) +DAP (2%) + Nano urea (4 ml litre-1) at tillering which was recorded 82.33 cm, respectively. These findings were in close agreement with those reported by Benzon et al. (2015) who found that when nano-urea fertilizers were applied in combination with that of conventional fertilizers even at lower application rate results in enhanced plant height. Similar findings were found by Rathnayaka *et al*. (2018) in paddy.  From the table, it is observed that highest dry matter production per plant was recorded with treatment T7 - Recommended N + two spray of urea (2%) at tillering and jointing. Significantly highest dry matter production per plant was recorded at harvest (15.4 g). However, it was at par with treatment T8 - Recommended N + one spray of urea (2%) + Nano urea (4 ml litre-1) at tillering and T9 -Recommended N + one spray of urea (2%) +DAP (2%) + Nano urea (4 ml litre-1) at tillering, respectively. Foliar application of nano-urea fertilizers significantly improved the dry matter accumulation. The reason might be due to the fact that nano-urea fertilizers show more activity as a result of higher surface area and enhanced activity might have resulted in improved the nutrient uptake in plants which eventually led to the cumulative increase in the plant height, leaf area, number of tillers m-1 row. Increased leaf area aids in better solar radiation utilization and available nutrients which are vital for more photosynthetic surface area which might have resulted in more accumulation and translocation of photosynthates that eventually increased the biomass production. These findings are in line with those found by Rawate *et al*. (2022) in wheat. the significantly highest spike length (48.47) was recorded with treatment T7 - Recommended N + two spray of urea (2%) at tillering and jointing. However, spike length was significantly at par with treatment T3, T4, T5, T6, T8 and T9, respectively.

**Table 1. Plant height (cm), No of tillers, Dry matter/ plant and spike length of wheat at harvest was influenced by various treatments.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Plant height (cm)** | **No of tillers plant-1** | **Dry matter plant-1** | **Spike length** |
| T1 - One spray Nano urea (4 ml litre-1) at maximum tillering | 67.93 | 8.6 | 10.8 | 37.07 |
| T2 -Two spray Nano urea (4 ml litre-1) at tillering and jointing | 69.40 | 8.6 | 11.5 | 37.53 |
| T3 - Recommended N (1/3rd basal, 2/3rd CRI – Recommended N) | 70.60 | 8.9 | 11.8 | 40.27 |
| T4 - Recommended N + one spray of Nano urea (4 ml litre-1) at tillering | 71.33 | 9.0 | 12.6 | 44.73 |
| T5 - Recommended N + two spray of Nano urea (4 ml litre-1) at tillering and jointing | 73.20 | 9.1 | 12.6 | 45.33 |
| T6 - Recommended N+ one spray of urea (2%) at tillering | 75.00 | 9.2 | 13.5 | 46.87 |
| T7 - Recommended N + two spray of urea (2%) at tillering and jointing | 86.93 | 9.7 | 15.4 | 48.47 |
| T8 - Recommended N + one spray of urea (2%) + Nano urea (4 ml litre-1) at tillering | 76.80 | 9.3 | 14.1 | 47.13 |
| T9 - Recommended N + one spray of urea (2%) +DAP (2%) + Nano urea (4 ml litre-1) at tillering | 82.33 | 9.4 | 14.9 | 48.27 |
| T10 - Absolute control (No nitrogen) | 64.93 | 8.47 | 10.0 | 36.27 |
| SE (m) ± | 2.490 | 0.704 | 0.45 | 2.96 |
| CD (P = 0.05) | 7.29 | NS | 1.30 | 8.66 |
| GM | 73.84 | 9.05 | 13.0 | 43 |

Various management treatments significantly influenced the grain and straw yield of wheat. The treatment T7 recorded maximum and significantly higher grain yield (5098 kg ha-1) which was at par with the treatments T3, T4, T5, T6, T8 and T9. Sarkar *et al*. (2023) also found significantly higher yield of wheat with 100% recommended nitrogen application through conventional urea over various nano urea application treatments supports the present findings. Dhamankar *et al*. (2022) in rice also reported no significant change due to nano urea application over the conventional urea in rice. Similar results are also reported by Choudhary *et al*. (2023). Significantly higher straw yield (5559 kg ha-1) was recorded with treatment T6 - Recommended N+ one spray of urea (2%) at tillering which was at par with the treatments T3, T4, T5, T6, T8 and T9. Harvest index was found to be non-significant with respect to different treatments. However, highest harvest index (49.92) was recorded with treatment T9 - Recommended N + one spray of urea (2%) + DAP (2%) + Nano urea (4 ml litre-1) at tillering. Singh *et al*. (2023) also reported no significant change in harvest index due to conventional urea and nano urea treatments which supports the present findings.

**Table 2. Yield attributes of wheat affected by the various treatments.**

|  |  |
| --- | --- |
| **Treatments** | **Yield attributes of wheat at harvest after various treatments.** |
| **Grain yield** | **Straw yield** | **Harvest index** |
| **Kg plot-1** | **Kg ha-1** | **Kg plot-1** | **Kg ha-1** |
| T1 - One spray Nano urea (4 ml litre-1) at maximum tillering | 3.40 | 3467 | 3.51 | 3586 | 49.23 |
| T2 -Two spray Nano urea (4 ml litre-1) at tillering and jointing | 3.41 | 3480 | 3.59 | 3661 | 48.72 |
| T3 - Recommended N (1/3rd basal, 2/3rd CRI – Recommended N) | 4.30 | 4388 | 4.42 | 4510 | 49.30 |
| T4 - Recommended N + one spray of Nano urea (4 ml litre-1) at tillering | 4.33 | 4418 | 4.45 | 4536 | 49.38 |
| T5 - Recommended N + two spray of Nano urea (4 ml litre-1) at tillering and jointing | 4.76 | 4853 | 4.78 | 4874 | 49.83 |
| T6 - Recommended N+ one spray of urea (2%) at tillering | 4.80 | 4893 | 5.45 | 5559 | 46.84 |
| T7 - Recommended N + two spray of urea (2%) at tillering and jointing | 5.00 | 5098 | 5.38 | 5485 | 48.14 |
| T8 - Recommended N + one spray of urea (2%) + Nano urea (4 ml litre-1) at tillering | 4.87 | 4965 | 5.20 | 5302 | 48.41 |
| T9 - Recommended N + one spray of urea (2%) +DAP (2%) + Nano urea (4 ml litre-1) at tillering | 4.94 | 5036 | 4.97 | 5066 | 49.92 |
| T10 - Absolute control (No nitrogen) | 3.20 | 3265 | 3.39 | 3454 | 48.64 |
| SE (m) ± | 0.46 | 467 | 0.51 | 515 | 0.78 |
| CD (P = 0.05) | 1.34 | 1367 | 1.48 | 1509 | NS |
| GM | 4.3 | 4387 | 4.5 | 4604 | 48.8 |

The estimated cost of cultivation data presented in Table 6 showed that the lower cost of cultivation was recorded in treatment T10 - Absolute control (No nitrogen) as no fertilizer cost was required. Absolute control was followed by T1 -One spray Nano urea (4 ml litre-1) at maximum tillering (30-35 DAS). In treatment T5, the cost of cultivation was highest due to increase in the cost of application as per the number of split application and cost of nano urea. The average cost of cultivation in the present findings found to be 36942 ₹ ha-1. Significantly highest gross monetary return (113826 ₹ ha-1), net monetary return (76529 ₹ ha-1) and highest B:C ratio (3.1) was observed in the treatment T7 - Recommended N + two spray of urea (2%) at tillering (30-35 DAS) and jointing (40-45 DAS) over T1, T2 and T10. However, T3 - Recommended N (1/3rd basal, 2/3rd CRI – Recommended N), T4 -Recommended N + one spray of Nano urea (4 ml litre-1) at tillering, T5 - Recommended N + two spray of Nano urea (4 ml litre-1) at tillering and jointing, T6 - Recommended N+ one spray of urea (2%) at tillering, T8 - Recommended N + one spray of urea (2%) + Nano urea (4 ml litre-1) at tillering and T9- Recommended N + one spray of urea (2%) +DAP (2%) + Nano urea (4 ml litre-1) at tillering were at par with treatment T7. This might be due to the higher grain and straw yield obtained by the application of conventional urea fertilizers and later supported by nano urea foliar application. These findings are in conformation with the findings of Kumar *et al*. (2023), Choudhary *et al*. (2023) and Khatik *et al*. (2021).

**Table 3. COC, GMR, NMR and B:C ratio of wheat as influence by different Treatments.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **CoC** **(₹ ha-1)** | **GMR** **(₹ ha-1)** | **NMR** **(₹ ha-1)** | **B:C ratio** |
| T1 - One spray Nano urea (4 ml litre-1) at maximum tillering | 36235 | 77280 | 41046 | 2.1 |
| T2 -Two spray Nano urea (4 ml litre-1) at tillering and jointing | 37495 | 77617 | 39672 | 2.1 |
| T3 - Recommended N (1/3rd basal, 2/3rd CRI – Recommended N) | 35690 | 97759 | 62070 | 2.7 |
| T4 - Recommended N + one spray of Nano urea (4 ml litre-1) at tillering | 37400 | 98423 | 61024 | 2.7 |
| T5 - Recommended N + two spray of Nano urea (4 ml litre-1) at tillering and jointing | 39110 | 108008 | 68898 | 2.8 |
| T6 - Recommended N+ one spray of urea (2%) at tillering | 36493 | 109552 | 73059 | 3.0 |
| T7 - Recommended N + two spray of urea (2%) at tillering and jointing | 37297 | 113826 | 76529 | 3.1 |
| T8 - Recommended N + one spray of urea (2%) + Nano urea (4 ml litre-1) at tillering | 37453 | 110814 | 73361 | 3.0 |
| T9 - Recommended N + one spray of urea (2%) +DAP (2%) + Nano urea (4 ml litre-1) at tillering | 37723 | 112095 | 74371 | 3.0 |
| T10 - Absolute control (No nitrogen) | 34525 | 72848 | 38323 | 2.1 |
| SE (m) ± | - | 10428 | 10428 | - |
| CD (P = 0.05) | - | 30512 | 30512 | - |
| GM | 36942 | 97823 | 60836 | 2.7 |

 The estimated cost of cultivation data presented in Table 3 showed that the lower cost of cultivation was recorded in treatment T10 - Absolute control (No nitrogen) as no fertilizer cost was required. Absolute control was followed by T1 -One spray Nano urea (4 ml litre-1) at maximum tillering (30-35 DAS). In treatment T5, the cost of cultivation was highest due to increase in the cost of application as per the number of split application and cost of nano urea. The average cost of cultivation in the present findings found to be 36942 ₹ ha-1. Significantly highest gross monetary return (113826 ₹ ha-1), net monetary return (76529 ₹ ha-1) and highest B:C ratio (3.1) was observed in the treatment T7 - Recommended N + two spray of urea (2%) at tillering (30-35 DAS) and jointing (40-45 DAS) over T1, T2 and T10. However, T3 - Recommended N (1/3rd basal, 2/3rd CRI – Recommended N), T4-Recommended N + one spray of Nano urea (4 ml litre-1) at tillering, T5 - Recommended N + two spray of Nano urea (4 ml litre-1) at tillering and jointing, T6 - Recommended N+ one spray of urea (2%) at tillering, T8 - Recommended N + one spray of urea (2%) + Nano urea (4 ml litre-1) at tillering and T9- Recommended N + one spray of urea (2%) +DAP (2%) + Nano urea (4 ml litre-1) at tillering were at par with treatment T7. This might be due to the higher grain and straw yield obtained by the application of conventional urea fertilizers and later supported by nano urea foliar application. These findings are in conformation with the findings of Kumar *et al*. (2023), Choudhary *et al*. (2023) and Khatik *et al*. (2021).

**conclusion**

For optimizing the nitrogen doses under restricted irrigation condition application of recommended nitrogen with combination of 2 % spray of urea at tillering and jointing recorded highest productivity which was at par with nano urea spray combinations. Application of recommended nitrogen with combination of 2 % spray of urea at tillering and jointing recorded highest gross and net monitory return of 113826 and 76529 ₹ ha-1. Growth parameter like plant height, number of tillers, dry matter production per plant and yield parameters like spike length, test weight, tillers per plant and yield per plant recorded highest with application of recommended nitrogen with combination of 2 % spray of urea at tillering and jointing.

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