**Effect of nano urea liquid fertilizer application in paddy in different agroclimatic zones of Odisha**

**Abstract**

A field experiment was conducted in the three agroclimatic zones of Odisha located in East & South coastal plain regions (Jagatsinghpur), North Eastern coastal plain regions (Jajpur) & Western central table land regions (Bargarh) of Odisha to study about the nano urea effect on transplanted rice. Three treatments 100 per cent NPK, 50 per cent N + 100 pec cent PK +Nano urea and 75 per cent N + 100 pec cent PK +Nano urea were used in the study. The experiment was replicated seven times in a RBD design. From the above experiment it was concluded that the effect of nano urea increased the plant height at different stages of transplanted rice. The 75 per cent recommended N with 100 per cent PK and two sprays of nano urea @ 0.4 per cent at tillering & PI stages increased plant height at active tillering, panicle initiation, flowering, maturity stages in almost similar with application of 100 per cent NPK at Bargarh, Jagatsinghpur & Jajpur district of Odisha. Similarly, the average yield was recorded almost nearer to similar in both the 100 per cent NPK with nano urea + 75 per cent N + 100 per cent PK. The nano urea application two times with 75 per cent less urea increases the net income of the farmer per hectare as well as reduce the 25 per cent urea application which is beneficial for soil health management. So, the nano urea application is best and can be recommended to the farmers to minimize the chemical urea application and efficient use of nitrogen to the paddy for better crop growth, development & increasing yield.

Keywords: Nano urea, plant height, yield, net income, urea & rice etc.

**Introduction:**

Rice (Oryza sativa L.) belongs to Poaceae familyand it was initially assumed to have originated from South- East Asia. Rice is one of the major cereal crops of tropics and certain regions of the temperate world. It is grown in different types of agro ecologies, from irrigated uplands and rainfed lowlands to flood prone rice ecosystems. India ranks second to China in terms of area and production among the world's major rice producing nations. Rice plants require a lot of mineral nutrients, especially nitrogen, to grow, develop, and produce grains. Nitrogen is one of the important elements in plant owing to its major part in chlorophyll production, which is essential for the photosynthesis process. Nitrogen is part of different enzymatic proteins that catalyze and regulate plant development processes (Sinfield et al., 2010). Liquid nano fertilizer on the other hand is currently the best alternative to urea fertilizer. One bottle of nano urea (500 ml) is equivalent to a bag of urea fertilizer (45 kg), 10% lower than a bag of conventional urea. It may reduce the importing of urea fertilizer. One nano urea liquid particle of 30 nano meters in diameters has a surface area up to 10,000 times higher size than normal size of granular urea. Nano urea liquid is applied through foliar by spraying at critical crop growth stages. It effectively meets the nitrogen requirement and leads to higher crop productivity and quality compared to traditional urea. Nano-urea has been designed and extensively tested by agricultural scientists and organizations. Researchers like Ramesh Chander Prasad and others (2020) have pointed out the enormous potential of nanotechnology for making fertilizers more effective. Nano-urea is one such product that comes in this category, having highly reactive nanoparticles that are bioavailable in nature.

The Indian Farmers Fertilizer Cooperative Limited (IFFCO) pioneered the development of liquid nano urea, extensively testing its performance across various crops. According to IFFCO (2021), nano urea reduces the need for conventional granular urea by up to 50%, significantly decreasing environmental and economic costs. Nano urea works by delivering nitrogen directly to plant leaves through foliar application. The nanosized particles directly penetrate the plant through stomata and cuticles, thereby entering metabolic pathways directly. This bypasses most of the soil-mediated nitrogen losses such as volatilization and leaching as commonly associated with traditional urea fertilizers. The Rathore et al. (2022) have shown nano urea increases NUE by up to 80% while conventional urea raises it by 30-50%. Such efficiency further translates into better crop yields as well as reduced impacts on the environment. Nano urea strongly promotes NUE, meaning more application of nitrogen is utilized by the plant. A smaller amount of applied nitrogen is required for better crops, as demonstrated in Singh et al. (2021) field studies. Applications of nano urea enhanced the yield of rice, wheat, and maize, as determined by Kumar et al. (2021). These gains are as a result of the constant and efficient supply of nitrogen at the critical growth stages. However, researchers like Prasad et al. (2020) observe that nano urea is one of the latest innovations in fertilizer science. The future research direction should be the optimization of formulation, upscaling production, and linking nano urea with other sustainable farming practices.

**Materials & Methods:**

**Study area:** The field experiment has been conducted in three districts of Odisha. i.e Bargarh, Jagatsinghpur and Jajpur etc. The details of agroclimatic zones are given below.

* Jagatsinghpur district is located in East & South coastal plain regions. The climate is hot & humid with mean annual rainfall of 1577 mm. The mean maximum summer temperature is 39oC and mean minimum winter temperature is 11.5oC. Broad soil groups in the district is saline, lateritic alluvial, red & mixed red and black etc.
* Jajpur district is located in North Eastern coastal plain regions. The climate is moist sub-humid with mean annual rainfall of 1568 mm. The mean maximum summer temperature is 36oC and mean minimum winter temperature is 14.8oC. Broad soil groups in the district is red, lateritic, deltaic alluvial, coastal alluvial and saline etc.
* Bargarh district is located in Western central table land regions. The climate is moist sub mid with mean annual rainfall 1514 mm. The mean maximum summer temperature is 40oC and mean minimum winter temperature is 12.4oC. Broad soil groups in the district is red & yellow, red & black, black, brown forest and lateritic etc.

**Nano urea:** In this experiment we have utilized IFFCO nano urea (liquid) which is covered under the Fertilizer Control Order (FCO) issued by the Government of India. Nano nitrogen particle size ranges from 20-50 nm and it contains 4.0 % total nitrogen (w/v) evenly dispersed in water (IFFCO). When applied on leaves at critical crop growth stages, as reported, nano urea easily enters through stomata and other openings and is assimilated by the plant cells. It is the ability to easily distribute through phloem from source to sink inside the plant as per its need.

**Field experiment:** In order to evaluate the foliar application of nano urea (liquid) in transplanted rice, a field experiment was conducted during June-October, 2024. The experiment was conducted in RBD design with three treatments & seven replications. The details of treatments are given below.

**List 1:** **Treatment details**

|  |  |
| --- | --- |
| **Treatments** | **Treatment details** |
| FP | 100 % N(25% basal + 50% tillering + 25% PI stage) + 100 % P & K |
| TO1 | 50 % recommended N + 100 % P and K as basal application and two sprays  Nano urea @ 0.4 % tillering and PI stage |
| TO2 | 75 % recommended N + 100 %P and K as application and two sprays Nano  urea @ 0.4 % at tillering and PI stage |

**Observations:** Plant growth parameters like plant height, number of tillers, leaves, root length, root mass and shoot mass were recorded at active tillering and panicle initiation stages. Crop yield was taken after the harvest of rice. Before harvesting, soil samples were taken and after the experiment to take down the physicochemical properties of soil.

**Results & Discussion:**

* The effect of nano urea liquid fertilizer application on plant height of transplanted rice at different stages i,e 30 DAS, 60 DAS, 90 DAS and 120 DAS has been presented in Table-1.

During active tillering stage the FP (100 % NPK) gave higher plant height at Bargarh district 39.7 cm followed by Jajpur district with 39.2 cm and then Jagatsinghpur with 38.6 cm. Similar results were found in the panicle initiation stage (Jagatsinghpur-71.6, Bargarh-70.8, Jajpur-70.2), flowering stage (Bargarh-86.9, Jajpur-86.2, Jagatsinghpur-85.3) and maturity stage (Jagatsinghpur-99.3, Jajpur-98.4, Bargarh-98.1). Among the three district the plant height varied between 33.9 and 39.7 cm in active tillering stage, 65.7 and 71.6 cm in panicle initiation stage, 80.9 and 86.9 cm in flowering stage and 93.1 and 99.3 cm in maturity stage. The highest plant height was shown in the maturity stage at 120 days after showing.

**Table-1 : Effect of nano urea on plant height (cm) of transplanted rice at different stages**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Active tillering**  **(30 DAS)** | | | **Panicle Initiation**  **(60 DAS)** | | | **Flowering**  **(90 DAS)** | | | **Maturity**  **(120 DAS)** | | | |
| **BR** | **JG** | **JJ** | **BR** | **JG** | **JJ** | **BR** | **JG** | **JJ** | **BR** | **JG** | **JJ** |
| **FP** | 39.7 | 38.6 | 39.2 | 70.8 | 71.6 | 70.2 | 86.9 | 85.3 | 86.2 | 98.1 | 99.3 | 98.4 |
| **TO1** | 35.1 | 34.3 | 33.9 | 63.2 | 64.8 | 65.7 | 81.3 | 80.9 | 81.4 | 94.2 | 93.1 | 93.6 |
| **TO2** | 38.4 | 38.2 | 37.5 | 68.6 | 69.1 | 69.4 | 85.8 | 84.8 | 85.3 | 96.5 | 98.8 | 97.3 |

\*BR = Bargarh, JG = Jagatsinghpur, JJ = Jajpur

* The effect of nano urea liquid fertilizer application on yield of rice has been presented in the Table-2.

The results from the field experiment of nano urea application in paddy varied between 43.7 and 47.6 q/ha in Jagatsinghpur district, 41.3 and 46.1 q/ha in Jajpur district and 42.3 and 44.8 q/ha in Bargarh district. Irrespective of the treatments in the experiment the farmers practice (100 % NPK) gave higher result compare to the other treatments (TO1 & TO2). The record of higher yield in Bargarh district shown in FP (44.8 q/ha) followed by TO2 (44.3 q/ha) followed by TO1 (42.3 q/ha). Similar results were observed in Jagatsinghpur as FP (47.6 q/ha) followed by TO2 (44.5 q/ha) followed by TO1 (43.7 q/ha) and in Jajpur as FP (46.1 q/ha) followed by TO2(45.3 q/ha) followed by TO1 (41.3 q/ha) respectively. We found that almost nearer to the similar results found between application of 100 per cent NPK (FP) and 75 per cent N + 100 per cent P & K + two sprays of nano urea as 0.4 per cent (TO2). The TO2 treatment gives very less decrease in yield where -1.1 per cent in Bargarh, -6.5 per cent in Jagatsinghpur and -1.7 per cent in Jajpur in comparison with the FP.

**Table – 2 : Effect of nano urea on yield of rice**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Bargarh** | | **Jagatsinghpur** | | **Jajpur** | |
| **Treatments** | **Yield**  **(q/ha)** | **% increase in yield** | **Yield**  **(q/ha)** | **% increase in yield** | **Yield**  **(q/ha)** | **% increase in yield** |
| **FP** | 44.8 | - | 47.6 | - | 46.1 | - |
| **TO1** | 42.3 | -5.6 | 43.7 | -8.1 | 41.3 | -10.4 |
| **TO2** | 44.3 | -1.1 | 44.5 | -6.5 | 45.3 | -1.7 |

* The effect of nano urea liquid fertilizer application on average economic study has been presented in the Table-3.

The average economic study was recorded between the three districts. The highest net return was recorded in the FP (Rs. 54,880/ha) followed by TO2 (Rs. 54,530/ha) followed by TO1 (Rs. 49,630/ha), respectively. Similarly, the average B: C ratio found highest in FP (1.65) followed by TO2 (1.64) followed by TO1 (1.60). Irrespective of the treatments the FP (100 % NPK) gives higher net return and B : C ratio in comparison with the other treatments (TO1 & TO2). The application of nano urea (0.4 %) with 75 per cent N & 100 per cent P, K gives similar results (net return and B : C ratio) with application of 100 % NPK. The average net return in TO1 was -9.6 per cent decrease over FP and TO2 was -0.6 per cent over FP. Similarly the average B : C ratio in TO1 was -3.0 per cent decrease over FP and TO2 was -0.6 per cent over FP respectively.

**Table-3 : Effect of nano urea on average economic study**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Gross cost (Rs/ha)** | **Gross return (Rs/ha)** | **Net return (Rs/ha)** | **B : C ratio** |
| **FP** | 84,000 | 1,38,880 | 54,880 | 1.65 |
| **TO1** | 81,500 | 1,31,130 | 49,630 | 1.60 |
| **TO2** | 82,800 | 1,37,330 | 54,530 | 1.64 |

* The effect of nano urea liquid fertilizer application on post harvest properties of soil has been presented in the Table-4.

In this field experiment of nano urea application in paddy, there was no effect in soil. In the three district of experimental area the pH was varied between 5.7 and 6.3, OC between 0.37 and 0.43 %, N between 212 and 253 kg/ha, P between 11 and 19 kg/ha, K between 102 and 123 kg/ha, B between 0.41 and 0.48 ppm and 0.49 and 0.58 ppm. We found that the pH was acidic in nature and OC, N, P, K, B, Zn shown low status in post harvest soil. The post harvest soil properties shown low in status in comparison with initial soil properties due to crop uptake.

**Table-4 : Effect of nano urea on post harvest properties of soil**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **pH** | **OC (%)** | **N (kg/ha)** | **P (kg/ha)** | **K (kg/ha)** | **B (ppm)** | **Zn (ppm)** |
| **Bargarh** | **Post harvest** | 5.7 | 0.37 | 242 | 13 | 117 | 0.41 | 0.52 |
| **Initial** | 5.9 | 0.43 | 253 | 19 | 123 | 0.46 | 0.57 |
| **Jagatsinghpur** | **Post harvest** | 5.8 | 0.38 | 208 | 12 | 102 | 0.42 | 0.51 |
| **Initial** | 6.1 | 0.41 | 216 | 18 | 110 | 0.47 | 0.58 |
| **Jajpur** | **Post harvest** | 6.0 | 0.40 | 212 | 11 | 111 | 0.41 | 0.49 |
| **Initial** | 6.3 | 0.43 | 229 | 14 | 115 | 0.48 | 0.54 |

**Conclusion:**

From the above experiment it can be concluded that the effect of nano urea increased the plant height at different stages of transplanted rice. The 75 per cent recommended N with 100 per cent PK and two sprays of nano urea @ 0.4 per cent at tillering & PI stages increased plant height at active tillering, panicle initiation, flowering, maturity stages in almost similar with application of 100 per cent NPK at Bargarh, Jagatsinghpur & Jajpur district of Odisha. Similarly, the average yield was recorded almost nearer to similar in both the 100 per cent NPK with nano urea + 75 per cent N + 100 per cent PK. The nano urea application two times with 75 per cent less urea increased the net income of the farmer per hectare as well as reduce the 25 per cent urea application which is beneficial for soil health management. So, the nano urea application is best and can be recommended to the farmers to minimize the chemical urea application and efficient use of nitrogen to the paddy for better crop growth, development & increasing yield.

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