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Effect of nano urea application on growth and productivity of rice (*Oryza sativa* L.) under midland situation of Bastar region

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Abstract
A field experiment was conducted on "Effect of nano urea application on growth and productivity of rice (*Oryza sativa* L.) under midland situation of Bastar region" at Research cum Instructional Farm S.G. College of Agriculture and Research Station, (IGKV) Jagdalpur, Chhattisgarh during *Kharif* season of 2021 in randomized block design (RBD) with ten treatments and three replications. The results showed that highest number of panicles m^{-2}, total number of grains $panicle^{-1}$, number of filled grains $panicle^{-1}$, test weight (g), grain (5195.83 kg ha^{-1}), straw yield (6250 kg ha^{-1}) and nutrient uptake was significantly highest under treatment T_5 75% of RDN + Two foliar sprays of nano urea (AT and PI) which was at par with treatment T_4 50% of RDN + Two foliar sprays of nano urea (AT and PI) and T_6 100% of RDN + Two foliar sprays of nano urea (AT and PI). The lowest grain and straw yield (2558.33 and 3656.25 kg ha^{-1}) was recorded under control.

Keywords: Rice, Nano urea, grain and straw yield

Introduction
Rice (*Oryza sativa* L.) belong to family Poaceae and rice was believed to have originated from South-East Asia. It is one of the most important cereal crops in tropics as well as parts of temperate region of the globe. Rice is being cultivated under diverse agro ecologies varying from irrigated uplands and rainfed lowlands to flood- prone rice ecosystems. India comes second to China in terms of area and production among the world's major rice producing nations. Out of 782 million tonnes of global rice production from 167.1 million hectares, India produced 116.42 m t in 44.5 m ha (rainy season: 102.13 m t from 39.27 m ha) (FAO, 2020; GOI2020) [3]. Rice production in Chhattisgarh, the total area of production was reported to about 3.87 million hectares with production accounting to be 11.63 million tonnes and a productivity of 3.0 t ha^{-1} (Anonymous, 2021) [2].

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. Whilst, nitrogen is part of different enzymatic proteins that catalyze and regulate plant development processes (Sinfield *et al*., 2010) [11].

Liquid nano fertilizer which 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 can bring down the import of urea fertilizer. One nano urea liquid particle is 30 nano meters in diameter, with 10,000 times higher surface area to volume size than normal granular urea. Foliar application of nano urea liquid at critical crop growth stages of a plant effectively fulfils its nitrogen requirement and leads to higher crop productivity and quality in comparison to conventional urea.

Material and Methods
A field experiment was carried out during *kharif* season of 2021 at Research cum Instructional Farm S.G. College of Agriculture and Research Station, (IGKV) Jagdalpur, Chhattisgarh. The experiment was laid out in Randomized Block Design with ten treatments and three replications. The treatment comprised of T_1: RDF (N_{100}:P_{50}:K_{30} kg ha^{-1}), T_2: 150% of RDF (N_{150}:P_{75}:K_{45} kg ha^{-1}), T_3: 125% of RDF (N_{125}:$P_{62.5}$:$K_{37.5}$ kg ha^{-1}), T_4: 50% of RDN + Two foliar sprays of nano urea (AT and PI), T_5: 75% of RDN + Two foliar sprays of nano urea

(AT and PI), T_6: 100% of RDN + Two foliar sprays of nano urea (AT and PI), T_7: 125% of RDN + Two foliar sprays of nano urea (AT and PI), T_8: 150% of RDN + Two foliar sprays of nano urea (AT and PI), T_9: 50% of RDN (Basal as well as two split doses after 25 days), T_{10}: Control. The experiment site was geographically situated at $17^0 30`$ and $24^0 45`$ N latitude and $70^0 30`$ and $84^0 15`$E longitude whereas Bastar lies at $19^0 10`$ N Latitude and $81^0 95`$E longitude with an altitude of 552 meters above mean sea level. The weekly average sunshine hour varied from, a total of 1.1-7.4 hours day^{-1}. Total rainfall received during the July, August, September, October and November months are 317.6, 354.9, 188.9, 57.7 and 150.5 mm respectively. The evapo-transpiration is 2.4 to 3.8 mm, maximum and minimum temperature ranged between 32 to 14.9ºC respectively. The recommended spacing (20cm x 15cm), Gross plot size (4m x 4m).

Results and Discussion

Yield attributes

The significantly highest number of panicles m^{-2} (343.67) , total number of grains panicle^{-1} (183.17) and number of filled grains panicle^{-1} (173.87) were recorded under treatment T_5 75% of RDN + Two foliar sprays of nano urea (AT and PI) which was at par with treatment T_4 50% of RDN + Two foliar sprays of nano urea (AT and PI) and T_6 100% of RDN + Two foliar sprays of nano urea (AT and PI) (Table 1). The highest number of panicles m^{-2} might be due to sufficient amount of nitrogen through nano urea at critical stage which would have maintained continuous supply of nitrogen, led to the meristematic activity and stimulation of cell elongation in plants which resulted in higher number of panicles m^{-2}. These result findings were in close agreement with the findings of Jassim *et al.* (2019) [6]. The total number of grains panicle^{-1} might be due to the foliar spray of nano urea leading to more photosynthate assimilation and translocation of photosynthates from the source to the sink in addition timely supply of nitrogen stimulates the initiation of grain formation which helped to increase the number of grains panicle^{-1}. Nearly similar results were found by Algym *et al.* (2020) [1]. The number of filled grains panicle^{-1} was found to be increased with the foliar application of nano urea fertilizer which might be due to the higher translocation of starch both from the active site of leaves and also straw to grain (sink) and also higher nitrogen supplied by nano urea throughout the growth stages that resulted in increased amount of interception of photosynthetically active radiations and greater photosynthesis. Similar results were found by Gewaily *et al.* (2019) [4].

The test weight did not show any significant difference among treatments imposed because seed are almost similar in size and morphology which mostly shows similar weight. Further, numerically highest test weight (27.20) was observed under treatment T_5 75% of RDN + Two foliar sprays of nano urea (AT and PI) (Table 1). Nearly similar results were found by Jassim *et al.* (2019) [6].

Grain, straw yield and harvest index of rice

The significantly higher grain yield (5195.83 kg ha^{-1}) was observed under treatment T_5 75% of RDN + Two foliar sprays of nano urea (AT and PI) which was at par with treatment T_4 50% of RDN + Two foliar sprays of nano urea (AT and PI) and T_6 100% of RDN + Two foliar sprays of nano urea (AT and PI). The lowest grain yield (2558.33 kg ha^{-1}) was recorded under treatment T_{10} control (Table 1). Nano fertilizers increase rice grain yield it is mainly because of increasing growth of plant parts and metabolic process such as photosynthesis leads to higher photosynthates accumulation and translocation to the economic parts of the plant. These result findings were in close agreement with the findings of Kumar *et al.* (2020) [8].

The highest straw yield (6250 kg ha^{-1}) recorded under treatment T_5 75% of RDN + Two foliar sprays of nano urea (AT and PI) which was at par with treatment T_4 50% of RDN + Two foliar sprays of nano urea (AT and PI) and T_6 100% of RDN + Two foliar sprays of nano urea (AT and PI). The significantly least straw yield (3656.25 kg ha^{-1}) was recorded under treatment T_{10} control (Table 1). Increased straw yield with foliar spray of nano urea fertilizer might be due to nano fertilizer' quick absorption by the plant and easiness of translocation, which aided in better rates of photosynthesis and more dry matter accumulation, resulting in higher straw yield. Nearly similar results were found by Khalil *et al.* (2019) [7].

Harvest index of rice did not differ significantly among the different treatments. However, numerically higher harvest index (45.42) was recorded T_5 75% of RDN + Two foliar sprays of nano urea (AT and PI) (Table 1). These result findings were in close agreement with the findings of Mehta and Bharat (2019) [10].

Nutrient uptake

N, P and K nutrient uptake in grain (57.16, 16.10 and 18.72 kg ha-1) and straw (39.36, 11.24 and 81.89 kg ha-1) were significantly higher under treatment T5 75% of RDN + Two foliar sprays of nano urea (AT and PI) which was at par with treatment T4 50% of RDN + Two foliar sprays of nano urea (AT and PI) and T6 100% of RDN + Two foliar sprays of nano urea (AT and PI) (Table 2). The nutrient uptake of rice was found to be increased with the foliar application of nano urea which might be due to nano fertilizer have large surface area and particle size is less than the pore size of root and leaves of the plant which can increase their penetration into the plant from applied surface and improve nutrient uptake. These result findings were in close agreement with the findings of Lahari *et al.* (2021) [9].

Table 1: Yield attributing characters, grain, straw yield and harvest index of rice as influenced by application of nano urea

Treatments		No. of panicles m^{-2}	Total no. of grains panicle^{1}	No. of filled grains panicle^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)
T_1	RDF (N_{100}:P_{50}:K_{30} kg ha^{-1})	289.50	161.77	152.03	26.13	3947.92	5308.33	42.68
T_2	150% of RDF (N_{150}:P_{75}:K_{45} kg ha^{-1})	281.83	162.53	151.60	26.09	3812.5	5143.75	42.59
T_3	125% of RDF (N_{125}:$P_{62.5}$:$K_{37.5}$ kg ha^{-1})	287.03	161.90	150.10	26.15	3908.33	5258.33	42.66
T_4	50% of RDN + Two foliar sprays of nano urea (AT and PI)	339.33	178.27	170.03	27.11	5077.08	6164.58	45.18
T_5	75% of RDN + Two foliar sprays of nano urea (AT and PI)	343.67	183.17	173.87	27.20	5195.83	6250.00	45.42

T_6	100% of RDN +Two foliar sprays of nano urea (AT and PI)	336.40	175.47	168.70	27.08	5020.83	6097.92	45.15
T_7	125% of RDN +Two foliar sprays of nano urea (AT and PI)	312.17	166.13	157.30	27.02	4491.66	5693.75	44.10
T_8	150% of RDN +Two foliar sprays of nano urea (AT and PI)	311.07	165.10	156.17	26.18	4402.08	5597.92	44.07
T_9	50% of RDN (Basal as well as two split doses after 25 days)	280.17	162.87	152.53	26.03	3781.25	4952.08	42.79
T_{10}	Control	238.13	140.23	132.17	26.01	2558.33	3656.25	41.20
S.Em±		9.01	5.59	5.39	0.76	183.08	167.08	1.35
CD (P = 0.05)		26.99	16.73	16.14	NS	548.19	500.28	NS

Table 2: Effect of nano urea application on nutrient uptake in grain and straw of rice crop (kg ha^{-1})

Treatments		N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})	
		Grain	Straw	Grain	Straw	Grain	Straw
T_1	RDF (N_{100}:P_{50}:K_{30} kg ha^{-1})	41.83	30.94	11.03	6.87	12.62	68.09
T_2	150% of RDF (N_{150}:P_{75}:K_{45} kg ha^{-1})	40.43	29.36	10.31	6.75	11.84	65.43
T_3	125% of RDF (N_{125}:$P_{62.5}$:$K_{37.5}$ kg ha^{-1})	41.45	30.43	10.57	6.81	12.10	66.73
T_4	50% of RDN + Two foliar sprays of nano urea (AT and PI)	55.30	38.25	15.22	10.51	17.75	80.17
T_5	75% of RDN + Two foliar sprays of nano urea (AT and PI)	57.16	39.36	16.10	11.24	18.72	81.89
T_6	100% of RDN + Two foliar sprays of nano urea (AT and PI)	54.27	37.19	15.07	10.37	17.11	79.27
T_7	125% of RDN + Two foliar sprays of nano urea (AT and PI)	48.05	33.02	13.01	9.12	14.83	73.45
T_8	150% of RDN + Two foliar sprays of nano urea (AT and PI)	47.10	32.89	12.78	8.93	14.52	72.13
T_9	50% of RDN (Basal as well as two split doses after 25 days)	39.77	27.77	9.50	7.46	11.85	61.86
T_{10}	Control	25.83	18.29	6.13	5.16	6.92	39.53
S.Em±		2.10	1.89	0.76	0.47	0.97	2.79
CD (P = 0.05)		6.29	5.67	2.30	1.43	2.92	8.35

Conclusion

The highest number of panicles m^{-2}, total number of grains panicle^{-1}, number of filled grains panicle^{-1}, test weight (g), grain, straw yield and nutrient uptake was recorded under treatment T_5 75% of RDN + Two foliar sprays of nano urea (AT and PI) which was at par with treatment T_4 50% of RDN + Two foliar sprays of nano urea (AT and PI) and T_6 100% of RDN + Two foliar sprays of nano urea (AT and PI). The lowest number of panicles m^{-2}, total number of grains panicle^{-1}, number of filled grains panicle^{-1}, test weight (g), grain and straw yield and nutrient uptake was recorded under control.

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