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The effect of nano urea on growth of drilled paddy

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Abstract
A field experiment was conducted during *kharif* season of 2022-23 Agronomy Farm, College of Agriculture, Nagpur, to study the effect of nano urea on growth of drilled paddy. In respect of growth attributes, treatment [T_4] 100% RDN through nano-urea (two splits foliar application at 15 and 45 DAS), recorded significantly higher plant height, number of tillers m^{-1} row and dry matter accumulation $plant^{-1}$ of paddy followed by treatment Control - 100% RDN through urea two split – 50% at sowing- basal + 25% at 25 to 30 DAS and 25% at 60 DAS (booting stage) (top dressing) [T_1] and 75% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS) [T_6] and was found at par with 100% RDN through nano-urea (two splits foliar application at 15 and 45 DAS) [T_4].

Keywords: Nano-urea, foliar application, splits, booting stage, top dressing

Introduction
Rice is originated in South-east Asia. Under the area of rice cultivation, India rank first with 41.31 million hectares followed by China 30.4 million hectare, during 2021-2022. In rice production, China ranks first with 148.99 million tons and India occupies the second position in production with 129.00 million tons and productivity of rice is highest in China with 6710 kg ha^{-1} followed by Vietnam 5573 kg ha^{-1}. (Anonymous 2021) [1].

Rice is the main staple food over half of the population worldwide. Fertilizers have a crucial role in enhancing food production and quality particularly when the introduction of high-yielding and fertilizer- 3 responsive varieties. Majority of the crops grown such as rice need large quantities of inorganic inputs. Rice yield mostly depend on soil conditions and furthermore on the supply of the accessible nutrients like nitrogen, phosphorus, potassium, sulphur and zinc. Rice plants require large amounts of mineral nutrients including nitrogen for their growth, development, and grain production (Ma, 2004) [3].

Granular urea is not only costly for the producer but may be harmful to humans and the environment. Furthermore, nano-urea may also be used for enhancing abiotic stress tolerance. Nano-urea prevents environmental pollution and improves physiological traits of rice grown under drought stress conditions. The nano urea consists of higher surface area because lesser in size of the nano particle and have high reactivity, solubility in water.

The unique properties of nano particles, such as high sorption capacity, the increased surface to volume ratio, and controlled-release kinetics to targeted sites, make them a potential plant growth enhancer. Because of these characteristic features, nano-structured fertilizers can be used as a smart delivery system of nutrients to the plant. Nano-fertilizers are released very slowly in comparison to conventional fertilizers. This approach improves nutritional management, i.e., increasing the nutrient-use efficiency and decreasing nutrient leaching into groundwater.

Nano-fertilizers are specifically designed to release active ingredients in response to biological demands and environmental stress. Scientists have further stated that nano-fertilizers increase agricultural productivity by improving photosynthetic activity, seedling growth, rate of seed germination, nitrogen metabolism, and carbohydrate and protein synthesis.

Benzon *et al*. (2015) [2] revealed that, nano-fertilizers effects on the growth, development and chemical properties of rice. The result showed that full recommended rate of conventional and nano-fertilizers at 15-30 DAT enhanced the plant height, number of reproductive tillers, spikelet and panicles. In view of above the present investigation is planned to evaluate the effect of nano urea on growth of drilled paddy.

Materials and Methods

A field experiment was conducted during *kharif* season of 2022-23 Agronomy Research Farm, College of Agriculture, Nagpur. The investigation was carried out to find out the effect of nano-urea on growth of drilled paddy. The experiment was laid out in RBD with 8 treatments replicated thrice. The treatments comprised of Control (T_1) - 100% RDN through urea two split – 50% at sowing- basal + 25% at 25 to 30 DAS and 25% at 60 DAS (booting stage) (top dressing), (T_2) 75% RDN through urea two split – 50% at sowing – basal + 50% at 25 to 30 DAS (top dressing) + one foliar application of 2% urea at 45 DAS, (T_3) 75% RDN through urea two splits – 50% at sowing – basal + 50% at 25 to 30 DAS (top dressing) + two foliar application of 2% urea at 45 DAS and 60 DAS, (T_4) 100% RDN through nano-urea (two splits foliar application at 15 and 45 DAS), (T_5) 75% RDN through nano-urea (two splits foliar application at 15 and 45 DAS), (T_6) 75% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS), (T_7) 50% RDN through nano-urea (two splits foliar application at 15 and 45 DAS) and (T_8) 50% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS).

The soil of experimental plot was clay in texture having slightly alkaline pH (7.6). As regards to fertility status it was medium in organic carbon (0.55%), low in available nitrogen (264.30 kg ha^{-1}), medium in available phosphorus (21.16 kg ha^{-1}) and very high in available potassium (394.22 kg ha^{-1}). Paddy variety PDKV- Tilak was sown on 29th June 2022 and harvested on 27th Nov 2022 with row to row spacing of 30 cm and recommended dose of fertilizer was given at the time of sowing. The nutrient management treatments were imposed as per treatments.

Results and Discussion

Growth Attributes

The treatment 100% RDN through nano-urea (two splits foliar application at 15 and 45 DAS) (T_4) recorded significantly maximum plant height, number of tillers m^{-1} row length and dry matter accumulation plant^{-1} over all other treatments at all the periodical observations. Amongst various treatments, treatment Control - 100% RDN through urea two split – 50% at sowing- basal + 25% at 25 to 30 DAS and 25% at 60 DAS (booting stage) (top dressing) (T_1) and 75% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS) (T_6) being at par with each other and recorded significantly maximum plant height, number of tillers m^{-1} row length and dry matter accumulation plant^{-1} over all other treatments at all the periodical observations.

Foliar application of nano-urea even at the reduced rate of 75% also reported at par height with control might be as result of improved absorption and transport of nutrients that might have enhanced the cell division and cell protein content which eventually resulted in taller plants. These findings were in close agreement with those reported by Benzon *et al.* (2015) [2] 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) [5] in paddy.

Foliar application of nano urea fertilizer enhanced the growth resulting in higher number of tillers. These findings were in accordance with the findings of Rathnayaka *et al.* (2018) [5] who stated that higher number of tiller in rice were obtained with the application of nano fertilizers. Similar result were found by Saud *et al.* (2022) [7] and Yomso and Menon (2021) [8] on paddy crop.

Foliar application of nano urea fertilizer significantly improved the dry matter accumulation. The reason might be due to the fact that nano urea fertilizer 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, and number of tillers m^{-1} row length. These findings are in line with those found by Yomso and Menon (2021) [8] on paddy, Rawate *et al.* (2022) [6] in wheat and Rahman *et al.* (2014) [4] in wheat.

Table 1: Plant height of paddy at 30, 60, 90, 120 DAS and at harvest as influenced by different treatments

	Treatments	Plant height at different growth stages (cm)				
		30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T_1	Control - 100% RDN through urea two split – 50% at sowing- basal + 25% at 25 to 30 DAS and 25% at 60 DAS (booting stage) (top dressing)	41.0	66.4	92.1	107.0	115.0
T_2	75% RDN through urea two split – 50% at sowing – basal + 50% at 25 to 30 DAS (topdressing) + one foliar application of 2% urea at 45 DAS	39.6	51.5	76.6	82.5	90.2
T_3	75% RDN through urea two splits – 50% at sowing – basal + 50% at 25 to 30 DAS (top dressing) + two foliar application of 2% urea at 45 DAS and 60 DAS	34.2	47.9	68.6	77.7	83.5
T_4	100% RDN through nano-urea (two splits foliar application at 15 and 45 DAS)	38.8	68.6	94.2	108.7	118.5
T_5	75% RDN through nano-urea (two splits foliar application at 15 and 45 DAS)	36.7	57.1	78.3	92.4	99.3
T_6	75% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS)	37.2	60.7	88.3	105.3	114.0
T_7	50% RDN through nano-urea (two splits foliar application at 15 and 45 DAS)	33.6	43.2	68.0	74.0	79.2
T_8	50% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS)	32.1	40.8	64.2	71.8	73.5
	SE (m) ±	1.9	1.2	3.7	3.9	3.6
	CD at 5%	N.S.	3.8	11.2	11.9	10.9

Table 2: Number of tillers m^{-1} row length of paddy at 60, 90, 120 DAS and at harvest as influenced by different treatments

Treatments		Number of tillers m^{-1} row length at different growth stages			
		60 DAS	90 DAS	120 DAS	At harvest
T_1	Control - 100% RDN through urea two split – 50% at sowing- basal + 25% at 25 to 30 DAS and 25% at 60 DAS (booting stage) (top dressing)	88.0	98.0	95.3	96.0
T_2	75% RDN through urea two split – 50% at sowing – basal + 50% at 25 to 30 DAS (topdressing) + one foliar application of 2% urea at 45 DAS	76.3	83.7	83.0	84.2
T_3	75% RDN through urea two splits – 50% at sowing – basal + 50% at 25 to 30 DAS (top dressing) + two foliar application of 2% urea at 45 DAS and 60 DAS	74.0	77.0	82.1	83.2
T_4	100% RDN through nano-urea (two splits foliar application at 15 and 45 DAS)	88.7	100.7	97.3	98.2
T_5	75% RDN through nano-urea (two splits foliar application at 15 and 45 DAS)	81.3	87.3	87.0	87.4
T_6	75% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS)	87.3	97.3	94.7	95.7
T_7	50% RDN through nano-urea (two splits foliar application at 15 and 45 DAS)	73.3	76.3	74.3	75.2
T_8	50% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS)	69.0	71.7	70.0	70.3
	SE (m) ±	1.8	3.5	2.4	1.6
	CD at 5%	5.5	10.6	7.3	4.9

Table 3: Dry matter accumulation $plant^{-1}$ of paddy at 30, 60, 90, 120 DAS and at harvest as influenced by different treatments

Treatments		Dry matter accumulation $plant^{-1}$ at different growth stages (cm)				
		30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T_1	Control - 100% RDN through urea two split – 50% at sowing- basal + 25% at 25 to 30 DAS and 25% at 60 DAS (booting stage) (top dressing)	4.0	15.5	22.8	25.6	27.3
T_2	75% RDN through urea two split – 50% at sowing – basal + 50% at 25 to 30 DAS (topdressing) + one foliar application of 2% urea at 45 DAS	3.8	13.4	19.7	22.2	23.4
T_3	75% RDN through urea two splits – 50% at sowing – basal + 50% at 25 to 30 DAS (top dressing) + two foliar application of 2% urea at 45 DAS and 60 DAS	3.5	13.0	19.4	21.3	22.1
T_4	100% RDN through nano-urea (two splits foliar application at 15 and 45 DAS)	2.8	15.5	23.4	26.3	28.3
T_5	75% RDN through nano-urea (two splits foliar application at 15 and 45 DAS)	2.7	13.8	19.7	22.6	25.2
T_6	75% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS)	2.9	15.1	22.0	25.2	27.2
T_7	50% RDN through nano-urea (two splits foliar application at 15 and 45 DAS)	2.4	13.3	18.6	20.1	21.3
T_8	50% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS)	2.1	12.2	17.3	19.9	19.7
	SE (m) ±	0.5	0.5	1.0	1.1	1.2
	CD at 5%	N.S.	1.4	3.1	3.5	3.6

Conclusion

Growth parameters *viz*., plant height, number of tillers m^{-1} row length and dry matter accumulation $plant^{-1}$ was significantly influenced by foliar application of nano-urea at all growth stages except at 30 DAS as treatment imposition was not done at 30 DAS. Plant population remained non-significant with application of different treatments.

Nutrient management treatment was not showing any significant influence at 30 DAS. However, at 60, 90, 120 and at harvest among all the treatment combinations application of 100% RDN through nano urea (two splits foliar application at 15 and 45 DAS) (T_4) had shown significantly higher plant height (118.5 cm), number of tillers m^{-1} row length (98.2) and dry matter accumulation $plant^{-1}$ (28.3 g) compared to all the other treatments and was statistically at par with Control - 100% RDN through urea two split – 50% at sowing- basal + 25% at 25 to 30 DAS and 25% at 60 DAS (booting stage) (top dressing) (T_1) and 75% RDN through nano-urea (three splits foliar application at 15, 45 and 75 DAS) (T_6) treatments.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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