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INFLUENCE OF FOLIAR APPLICATION OF NANO-UREA ON CHEMICAL, BIOCHEMICAL, YIELD AND YIELD PARAMETERS IN RICE (*Oryza sativa* L.)

M. N. Dhawne[1], G. R. Shamkuwar[2], P. S. Kalpande[3], Vaibhavi P. Madavi[4], Shirin F. Khan[5] and Samruddhi R. Madavi[6]

ABSTRACT

A field experiment was conducted during *kharif* 2022-23 at research farm of Agriculture Research Station, Sakoli, district-Bhandara, Maharashtra, to study the influence of foliar application of nano urea on biochemical, yield and yield attributing parameters of rice. The experiment was laid out in randomized block design with three replications and eleven treatments at research farm of Agriculture Research Station, Sakoli. Treatments included in the experiment were (T_1) control, (T_2) Recommended Dose of Fertilizer, and (T_3) to (T_{11}) were of basal dose with different doses of foliar application of nano-urea on rice. Observations about chemical, biochemical parameters such as nitrogen content in flag leaf, nitrogen content in de husked grains and protein content in de husked grains, total chlorophyll content in flag leaf were estimated, while yield and yield contributing characters *viz.,* total number of grains panicle^{-1}, length of panicle, number of filled grains panicle^{-1}, number of unfilled grains panicle^{-1}, weight of grains panicle^{-1}, number of panicles meter^{-2}, 1000 grain weight, grain yield plant^{-1}, grain yield ha^{-1} were recorded and harvest index was calculated. It is inferred that foliar application of 50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20 and 40 DAT could be considered as most suitable treatment to enhance chemical, biochemical, yield and yield contributing parameters in rice significantly except 1000 grain weight.

(Key words: Nano urea, rice, foliar application, chemical, biochemical and yield parameters)

INTRODUCTION

Rice (*Oryza sativa* L.) has a renowned relationship with the human since ages. It is the world's most important staple food crop, rice is among the world's important and second most produced crop worldwide. About 90% of the world's rice is grown in China, India, Pakistan, Japan, Korea, Southeast Asia and other adjacent area. Rice is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of the planets human population (Purane *et al.,* 2021).

It is the premier food grain crops of the India. There has been a phenomenal increase in their production after mid-sixties with the introduction of high yielding varieties. Due to inadequate and imbalance fertilizer application, farmers are not able to harness the full yield potential of rice crop (Naskar and Mallick, 2023). As the population of India grows, the necessity for food to survive will increase. Because of this reason, agriculture fields face further and extra problems with the amount of yield and economical condition of farmers (Jadhav *et al.,* 2023). Nano engineering is an important field of study and research that focuses on the design and manipulation of material at the nano scale. This field has the potential to revolutionize many industries and technologies by providing novel solutions to current challenges (Verma *et al.,* 2018).

MATERIALS AND METHODS

In the *kharif* season of 2022-23, an investigation was carried out at research farm of Agriculture Research Station, Sakoli, Bhandara district, Maharashtra while biochemical estimations were undertaken at section of Agricultural Botany section, College of Agriculture, Nagpur. The research was laid out in RBD with three replications and eleven treatments comprising different doses of nano urea. 4% Nano urea was procured from IFFCO in liquid form. The treatments tested were, T_1: No fertilizer (Control), T_2: 100:50:50 NPK kg ha^{-1} (RDF), T_3: 50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 2ml l^{-1} of water at 20 and 40 DAT, T_4: 50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20, 40 and 60 DAT, T_5: 50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20, 40, 60 and 80 DAT, T_6: 50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20 and 40 DAT, T_7: 50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20, 40 and 60 DAT, T_8: 50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20, 40, 60 and 80 DAT, T_9: 50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20 and 40 DAT, T_{10}: 50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20, 40 and 60 DAT, T_{11}:

1,3, 4,5 & 6. P. G. Students, College of Agriculture Nagpur, Maharashtra, India
2. Professor of Agril. Botany (CAS), ARS, Sindewahi, Maharashtra, India

50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20, 40, 60 and 80 DAT. The rice variety PDKV-Sadhana was sown on June 29, 2022, while transplanting was done on July 29,2022 at spacing of 20 cm X 15 cm on plot with gross size 4.0 m X 2.0 m and net size 3.40 m X 1.60 m. Five plants from each plot were selected randomly and data for chemical and biochemical characters were estimated at 65, 85 DAT and at harvest. Total chlorophyll content of oven dried leaves was estimated by colorimetric method as suggested by Bruinsma (1982). Nitrogen content in leaves was estimated by micro kjeldhal's method as given by Anonymous (1990). For protein content in seed initially nitrogen content in seed was estimated and it was converted to crude protein by multiplying N percentage with the factor 5.95. Total number of grains $panicle^{-1}$, length of panicle, number of filled grains $panicle^{-1}$, number of unfilled grains $panicle^{-1}$, weight of grains $panicle^{-1}$, number of panicles $meter^{-2}$, 1000 grain weight, grain yield $plant^{-1}$, grain yield ha^{-1}, harvest index were recorded and calculated after harvest. The data were analysed statistically as per method suggested by Panse and Sukhathme (1954).

RESULTS AND DISCUSSION

Chemical and biochemical parameters

It is obvious from the data presented in Table 1 that nitrogen content in flag leaf at 65 and 85 DAT while protein content in de husked grain at harvest was significantly improved with the treatment of 50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20 and 40 DAT (T_6) which was at par with rest of the treatments except control, while nitrogen content in de husked grain at harvest was significantly improved with the treatment of 50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20 and 40 DAT (T_6) which was at par with treatment T_2 (100:50:50 NPK kg ha^{-1}) and treatment T_{11} (50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20, 40, 60 and 80 DAT). Total chlorophyll content in flag leaf was significantly improved with treatment of 50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20 and 40 DAT (T_6) which was at par with the treatment T_2 (100:50:50 NPK kg ha^{-1}) and treatment T_9 (50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20 and 40 DAT) at 65 and 85 DAT and treatment T_7 (50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20, 40 and 60 DAT) at 85 DAT).

Increase in nitrogen content in de husked grains might be the result of higher N concentrations from N fertilisation in the grain and plant tissue of rice plants. The increased nitrogen content and protein in the treated plants may be related to beneficial effect of nitrogen on a number of critical physiological functions. Increase in chlorophyll may be due to large surface area and minute particle size of nano urea which is less than leaves and root pore size, this may cause higher penetration of nutrient into the plant (Sahu *et al.,* 2022).

Benzon *et al.* (2015) reported that the full recommended rate of conventional and nano fertilizer (FRR-CF+FRR-NF) enhanced the chlorophyll content by 2.72% over the full recommended rate of conventional fertilizer (FRR-CF). Chaudhary *et al.* (2022) reported that nutrient content and uptake were significantly improved under the treatment N_3 (50 % Conventional urea + 50 % of Nano urea fertilizer).

Yield and yield contributing characters

Yield and yield contributing characters *viz.,* length of panicle, weight of grains $panicle^{-1}$, grain yield $plant^{-1}$, grain yield ha^{-1} and harvest index were significantly improved with the treatment of 50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20 and 40 DAT (T_6) which was at par with rest of the treatments except control (T_1). Total number of grains $panicle^{-1}$ was significantly improved with treatment T_6 which was at par with rest of the treatments except T_1 (control), T_4 (50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20, 40 and 60 DAT) and T_5 (50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20, 40, 60 and 80 DAT). Number of filled grains $panicle^{-1}$ was significantly improved by treatment T_6 which was at par with treatment T_2 (100:50:50 NPK kg ha^{-1}),T_7 (50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20, 40 and 60 DAT) and T_9 (50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20 and 40 DAT). While number of panicles m^{-2} was significantly improved by treatment T_6 which was at par with rest of the treatments except treatment T_5 (50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20, 40, 60 and 80 DAT) and control (T_1). However, 1000 grain weight was non-significant. As test weight being a genetical character, it was not significantly influenced by the foliar application of nano fertilizers (Dhamankar, 2022).

Foliar application of nano urea at their critical stage may lead to supply sufficient amount of nitrogen. Nitrogen enhances the cell elongation, activity of merismatic cells, enzymatic activity and also increase grain formation causing increase in length of panicle, total number of grains $panicle^{-1}$, number of filled grains $panicle^{-1}$ (Sahu *et al.,* 2022). It improves the ability of plants to absorb and translocate nutrients and created a hospitable environment for the crop. This increased cell division, meristematic activity and stimulation of cell elongation in plants ultimately led to a higher number of panicles per m^{-2} (Meenakshi *et al*., 2022). Increase in nutrient uptake by the plant resulted in optimal growth of plant parts and metabolic processes like photosynthesis, which maximises the accumulation and translocation of photosynthates to the economic parts of plants, resulted in higher grain yield.

Benzon *et al.* (2015) reported that the full recommended rate of conventional and nano fertilizer (FRR-CF+FRR-NF) enhanced the number panicles, panicle weight, total grain weight (unpolished and polished) with the magnitudes of increase over the full recommended rate of

Table 1. Chemical and biochemical parameters influenced by treatments in rice

	Treatments	Nitrogen content in flag leaf (%)		Nitrogen content (%) in de husked grain	Protein content (%) in de husked grain	Total chlorophyll content in flag leaf (mg g^{-1})	
		65 DAT	85 DAT			65 DAT	85 DAT
T_1	Control	2.79	2.27	1.09	6.48	1.83	1.24
T_2	RDF (100:50:50 NPK kg ha^{-1})	3.19	2.56	1.24	7.36	2.60	1.66
T_3	50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20 and 40 DAT	3.11	2.50	1.19	7.07	2.38	1.47
T_4	50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20, 40 and 60 DAT	3.10	2.48	1.17	6.97	2.37	1.43
T_5	50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20, 40, 60 and 80 DAT	3.09	2.46	1.17	6.97	2.25	1.41
T_6	50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20 and 40 DAT	3.23	2.59	1.25	7.46	2.77	1.72
T_7	50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20, 40 and 60 DAT	3.15	2.56	1.22	7.27	2.57	1.64
T_8	50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20, 40, 60 and 80 DAT	3.12	2.54	1.21	7.17	2.45	1.50
T_9	50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20 and 40 DAT	3.17	2.58	1.22	7.36	2.64	1.70
T_{10}	50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20, 40 and 60 DAT	3.15	2.56	1.22	7.27	2.55	1.55
T_{11}	50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20, 40, 60 and 80 DAT	3.14	2.56	1.24	7.27	2.34	1.42
	Mean	3.11	2.51	1.20	7.15	2.43	1.52
	SE (m) ±	0.07	0.06	0.06	0.18	0.06	0.04
	CD at 5%	0.21	0.17	0.18	0.53	0.17	0.11

Table 2. Yield and yield contributing characters influenced by treatments in rice

	Treatments	Total number of grains panicle^{-1}	Length of panicle (cm)	Number of filled grains panicle^{-1}	Weight of grains panicle^{-1} (g)	Number of panicles m^{-2}	1000 grain weight (g)	Grain yield plant^{-1} (g)	Grain yield ha^{-1} (kg)	Harvest index (%)
T_1	Control	103.92	20.99	69.05	1.74	182.00	24.97	10.28	3426	36.16
T_2	RDF (100:50:50 NPK kg ha^{-1})	126.63	27.70	88.43	2.28	228.33	25.35	13.09	4362	46.86
T_3	50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20 and 40 DAT	118.53	26.67	80.00	2.23	219.00	25.13	12.67	4223	43.84
T_4	50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20, 40 and 60 DAT	113.50	26.40	73.67	2.22	209.00	25.03	12.61	4203	42.47
T_5	50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 2 ml l^{-1} of water at 20, 40, 60 and 80 DAT	110.03	26.10	69.93	2.16	200.67	25.00	12.46	4152	41.51
T_6	50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20 and 40 DAT	130.57	27.90	98.60	2.31	234.67	25.50	13.78	4593	47.46
T_7	50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20, 40 and 60 DAT	128.04	27.33	85.87	2.26	227.00	25.22	13.24	4415	44.96
T_8	50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 3 ml l^{-1} of water at 20, 40, 60 and 80 DAT	126.53	26.83	84.00	2.24	220.67	25.10	12.91	4303	43.88
T_9	50:50:50 NPK kg ha^{-1} as basal dose + 2 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20 and 40 DAT	126.33	27.83	89.00	2.25	231.67	25.28	13.23	4411	47.11
T_{10}	50:50:50 NPK kg ha^{-1} as basal dose + 3 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20, 40 and 60 DAT	119.96	26.93	79.53	2.20	221.67	25.18	13.18	4395	44.87
T_{11}	50:50:50 NPK kg ha^{-1} as basal dose + 4 foliar sprays of nano urea @ 4 ml l^{-1} of water at 20, 40, 60 and 80 DAT	115.64	26.10	72.87	2.16	210.33	25.14	13.05	4351	43.24
	Mean	119.97	26.44	81.00	2.19	216.82	25.17	12.77	4258	43.85
	SE (m) ±	5.55	1.24	4.36	0.10	10.11	0.59	0.59	196.62	2.08
	CD at 5%	16.36	3.66	12.86	0.30	29.83	-	1.74	580.02	6.13

conventional fertilizer (FRR-CF) by 9.10%, 17.4%, 17.5% and 20.7% respectively. Dhamankar (2022) and Rakesh (2022) reported non-significant influence of nano urea on 1000 grain weight. Sahu *et al.* (2022) reported that yield attributing characters *viz.,* number of effective tillers m^{-2}, panicle length (cm), total number of grains $panicle^{-1}$ and number of filled grains $panicle^{-1}$ were significantly higher under treatment T_6 (50% RDN as basal + foliar spray of nano urea at tillering stage + foliar spray of nano urea at the panicle initiation stage), while test weight was non-significant.

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