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Research Communication

Different nitrogen levels with nano and prilled urea spray on productivity and profitability of maize (*Zea mays*) in alfisols of Jharkhand

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ABSTRACT

A ground-breaking and enduring way to significantly reduce the use of conventional nitrogen fertilizer is to use nano-urea as a nitrogen supplement. The combination of nano and prilled urea was investigated in this study to address this issue and allow for a 25% reduction in the recommended urea dosage. Research on rainfed maize during *kharif* season 2022-23 was conducted at ICAR-IARI Jharkhand. Twelve different combinations of conventional prilled urea, nano and prilled urea spray were investigated in the study. In the fields, the experiment used a randomized block design. Different treatments included applying prilled urea as a 2% solution in 150 liters of water per hectare and nano-urea at a rate of 1250 ml/acre applied twice through foliar application. Results showed that applying two additional applications of nano-urea along with 75% of the recommended dose of prilled-urea was the most successful fertilization strategy. This performed statistically equal with both the 100% recommended dose and the 100% recommended dose with two prilled urea spray applications in terms of yield, and cost-to-benefit ratio. The study's findings show that nano-urea can potentially replace at least 25% of the dosage of prilled urea *i.e.* recommended, providing a more profitable and environmentally friendly method of cultivation.

***Key words*:** B:C, Conventional urea, Maize, Nano-urea, Nitrogen and Productivity

In the world (comma) maize is cultivated on over 197 million hectares giving 1,137 million tonnes with 5.8 tonnes per hectare productivity (FAO Stat, 2021). In India, maize covers around 9.86 million hectares and produces 28.5 million tones with 2.89 t/ha productivity. Nitrogen plays a vital role in crucial plant processes like photosynthesis and protein synthesis and aiding nutrient transport. Nano-fertilizers show potential by enhancing nutrient efficiency and penetrating cell walls. They could reduce nutrient losses by synchronizing nutrient release with plant uptake (Lv *et al.*, 2019). Urea-based nanoparticles are now recommended for agricultural nitrogen supplementation (Kiran and Chandra, 2021). Recently, in India, IFFCO has developed nano-urea, which has been tested at the field research scale to provide essential nitrogen and enhance the effectiveness of various crops, including maize (Upadhyay *et al.,* 2023a). However, limited research has been conducted on studying the interaction effects of different levels of recommended dose of nitrogen (RDN) with nano-urea in maize. The standardization of nano-urea for higher productivity, profitability and economics in maize, especially under acid soil of Jharkhand in rainfed maize needs to be investigated. Validation of nano-urea in rainfed maize under various field conditions is crucial and further research is required to evaluate how well it can be integrated with other nitrogen sources is a new field of inquiry.

The research was conducted at the ICAR-Indian Agricultural Research Institute (IARI) farm in Jharkhand, situated at latitude 24°16' N, longitude 85°21' E and an elevation of 413 meters above sea level. The region experiences a semi-arid, sub-tropical climate with hot and dry summers from May to June and mildly chilly winters from November to January. The average annual rainfall and temperature were recorded at 714 mm and 25°C, respectively. The soil at the experimental site is sandy loam, slightly acidic, with organic carbon, available nitrogen, phosphorus, and potassium levels measured at 0.27%, 147 kg/ha, 8.2 kg/ha and

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136 kg/ha, respectively. A randomized block design (RBD) was used for the experiment with 12 different treatments that were replicated thrice. The treatments were T_1, control i.e. No-Nitrogen(N); T_2, 50% of recommended N; T_3, 75% of recommended N; T_4, 100% of recommended N; T_5, No-N + 2 Sprays of nano-N (NUS), T_6, 50% of recommended N + 2 NUS; T_7, 75% of recommended N + 2 NUS; T_8, 100% of recommended N + 2 NUS; T_9, No-N + 2% prilled urea spray (PUS); T_{10}, 50% of recommended N + 2% PUS, T_{11}, 75% of recommended N + 2% PUS; T_{12}, 100% of recommended N + 2% PUS. The hybrid variety 'DHM-121' was planted on 19 July 2022, and harvested on 6 November 2022. The planting was done with row spacing of 60cm and 20cm distance between plants. Soil preparation involved using a tractor-drawn mould-board plough, cultivator and rotavator, followed by the creation of ridge-furrows using a ridge maker. The field was divided according to the layout plan, including irrigation channels. The recommended dose of fertilizer applied was 150 kg of nitrogen, 75 kg of P_2O_5, and 50 kg of K_2O per hectare. Nano-urea was used at a rate of 500 ml/acre or 4 ml/liter of water. During sowing, the complete doses of phosphorus and potassium, along with one-third of the nitrogen, were applied. The remaining nitrogen was divided into 2-equal portions and applied at 32 and 50 days after sowing (DAS). With the first (32 DAS) and second (50 DAS) split of prilled urea top dressing, nano-urea and prilled urea spray were applied simultaneously. Keeping T_4 as base where RDF was applied, the added cost was ₹521, ₹1,070 and ₹1,500 with nano-urea spray and 50%, 75% and 100% RDN, respectively. Similarly, the added cost over RDF with prilled urea spray and 50%, 75% and 100% RDN was ₹-46, ₹503 and ₹933 respectively.

Different nitrogen levels had a significant effect on cob length (cm), cob girth (cm), number of rows/cobs, grains/row, number of grains/cobs, 1,000-grain weight (gm) and cob yield without husk of maize (Table 1). The highest cob length (cm), cob girth (cm), number of rows/cobs, grains/row, number of grains/cobs and 1,000-grain weight (g) under 100% of recommended N + 2 NUS recorded highest among other treatments.

The highest cob yield without husk was recorded in 100% of recommended N + 2 NUS followed by 100% of recommended N + 2% PUS. and 100% of recommended N The same results were found by Samui *et al*., 2022. The grain yield recorded significantly higher in 100% of recommended N + 2 NUS (6.89 t/ha) compared to 100% of recommended N + 2% PUS rest of the treatments (Fig. 1). An increase of 9.43 % in yield was recorded with the application of 100% of recommended N + 2 NUS over 100% of recommended N. 75% of recommended N + 2 NUS recorded at par grain yield over the treatment 100% of recommended N (Sarkar *et al.,* 2023). 100% of recommended N + 2 NUS recorded 66.18, 65.6 and 69.23% increase in grain yield over No N, No-N + 2 NUS and No N + 2% PUS respectively. The need-based nitrogen release from nano-urea enhanced the photosynthesis by ensuring an adequate supply of chlorophyll-protein complexes which

Table 1. Effect of variable nitrogen sources and doses on yield attributes of maize

Treatment	Cob length (cm)	Cob girth (cm)	Number of rows/ cobs	Grains/ row	Number of grains/ cobs	Cob yield without husk (kg/ha)	1000-grain weight (gm)	Harvest index (%)
T_1	11.07	10.59	9.08	23	208.9	3,843	249.69	29.49
T_2	14.64	11.89	11.30	26	294.4	5,405	275.29	32.83
T_3	17.99	15.04	12.45	28	346.6	7,154	292.46	35.28
T_4	19.12	15.28	12.95	30	388.8	8,616	308.21	37.52
T_5	12.64	13.69	9.37	23	215.3	3,867	266.23	29.90
T_6	15.83	14.84	11.48	27	310.5	5,464	280.54	33.70
T_7	19.39	16.00	12.56	29	364.2	7,455	299.70	35.99
T_8	19.67	16.86	13.16	31	407.1	8,867	316.25	38.12
T_9	12.14	13.22	9.28	23	213.0	3,554	262.29	28.72
T_{10}	15.16	14.26	11.43	26	295.8	5,426	274.65	33.18
T_{11}	18.57	16.01	12.49	29	361.3	7,320	295.75	35.46
T_{12}	19.52	16.23	12.97	31	402.6	8,678	311.21	38.13
SEm±	0.84	0.96	0.82	1.52	14.82	393.08	14.0	1.95
CpD (P=0.05)	2.46	2.8	2.4	4.45	43.48	1152.9	41.0	5.72

RDN, Recommended Dose of Nitrogen; NUS, Nano-urea Spray; PUS, Prilled Urea Spray; T_1, No-Nitrogen(N); T_2, 50% of recommended N; T_3, 75% of recommended N; T_4, 100% of recommended N; T_5, No-N+2 Sprays of nano-N (NUS); T_6, 50% of recommended N+2 NUS; T_7, 75% of recommended N+2 NUS; T_8, 100% of recommended N+2 NUS; T_9, No-N+2% prilled urea spray (PUS); T_{10}, 50% of recommended N+2% PUS; T_{11}, 75% of recommended N+2% PUS; T_{12}, 100% of recommended N+2% PUS

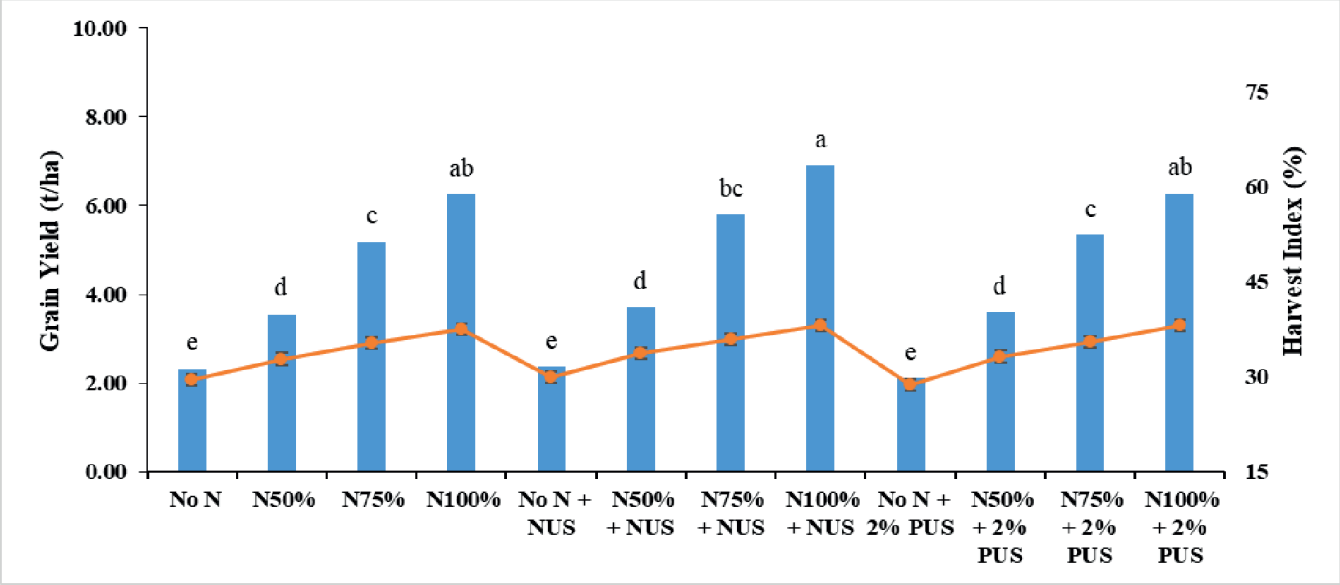

Fig. 1. Effect of variable nitrogen sources and doses on grain yield and harvest index of maize. (Symbol a, b, c, d, e denotes the 5% significant level of difference).

saves from adversity in the crops finally results in improved growth, enhances yield and physiological efficiency (Babu *et al.,* 2022).

The harvest index (HI) is an important metric that expresses how efficiently dry matter was converted into the crop's economic component. The harvest index of the maize crop differed significantly depending on the level of nitrogen management. 100% of recommended N + 2 NUS and 100% of recommended N + 2% PUS had a significantly higher harvest index (38.1%) than all other nitrogen management practices. No-N + 2% PUS had a lower harvest index (28.7%), which was statistically similar to No-N, 50% of recommended N, No-N + 2 NUS, 50% of recommended N + 2 NUS, 50% of recommended N + 2% PUS. These findings are consistent with those reported by Upadhyay *et al.* (2023b).

In terms of net returns and B: C which influenced significantly by different doses of recommended N with nano-urea and prilled urea spray. 100% of recommended N + 2 NUS recorded significantly higher over rest of the treatments and it remained at par with 100% of recommended N and 100% of recommended N + 2% PUS (Fig. 2). 75%

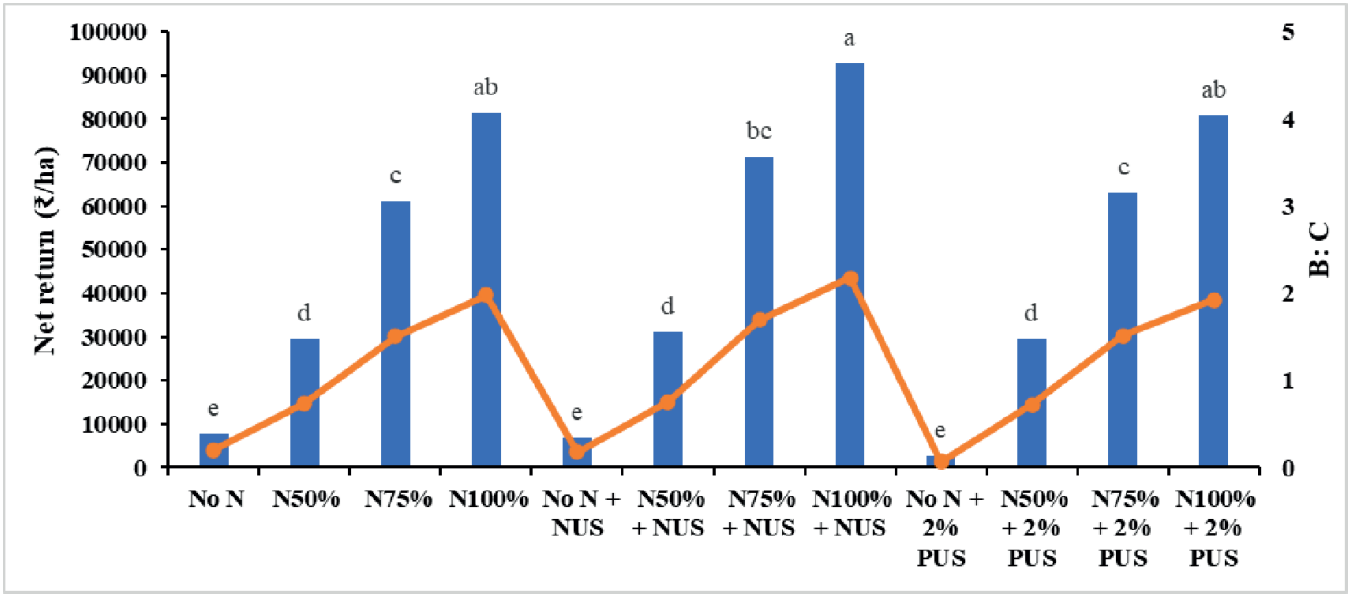

Fig. 2. Effect of variable nitrogen sources and doses on net return and B: C of maize. (Symbol a, b, c, d, e denotes the 5% significant level of difference).

of recommended N + 2 NUS recorded at par net returns and B: C over the treatment 100% of recommended N. The results are in accordance with Upadhyay *et al*. (2023b).

Based on these results, it can be concluded that the possibility of increasing productivity and profitability in maize with use of 2 nano-urea Sprays over and above of 100% recommended dose of conventional urea with full dose of P_2O_5 and K_2O application. The at par results between grain yields and economics in 100% RDN and 75% RDN + 2 NUS suggested further, there is a chance for a curtailing of 25% recommended conventional urea with use of 75% recommended dose of nitrogen through conventional urea with 2 nano-urea spray at 32 and 50 DAS in maize.

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