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Effect of Nano Urea on Growth, Yield and Nutrient uptake of Finger Millet (*Eleusine coracana* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The foliar application of nano urea is aimed at reducing the soil application of conventional urea. Nano fertilizers enhance crop growth and yield while enhancing nutrient uptake and reducing costs. They provide precise nutrient management, match crop growth stages, and offer an increased surface area for metabolic reactions. This boosts photosynthesis, leading to higher dry matter production and crop yield. Foliar application of nano urea (liquid) at tillering and booting stages in finger millet fulfills the nitrogen requirement and reflects higher crop productivity. Higher productivity of crops in a sustainable manner could be achieved by applying an appropriate combination of conventional fertilizers and nano fertilizers.
Study Design: The experiment was laid out in split design with three replications.
Place and Duration of Study: A field experiment was conducted in deep black soils at Agricultural Research Station, Siruguppa, during kharif 2022.
Methodology: There were sixteen treatment combinations, consisting of different doses of nitrogen (no nitrogen, 50% RDN, 75% RDN and 100% RDN) with different concentrations of nano urea and conventional urea sprayed at tillering and booting stages for HR-13 variety of finger millet.
Results: Application of 100% RDN has recorded significantly higher plant height, tillers plant^{-1}, total dry matter accumulation, grain yield and straw yield (129.82 cm, 10.10, 36.17 g plant^{-1}, 36.87 q ha^{-1} and 71.72 q ha^{-1}, respectively) in comparison to no nitrogen and 50% RDN. However, 75% RDN (123.04 cm, 9.61, 34.02 g plant^{-1}, 34.84 q ha^{-1} and 68.01 q ha^{-1}, respectively) found *on par* with 100% RDN. Among foliar nitrogen, spray of nano urea @ 4 ml L^{-1} recorded significantly higher plant height (121.59 cm), tillers plant^{-1} (9.37), total dry matter accumulation (33.16 g plant^{-1}), grain yield (31.97 q ha^{-1}) and straw yield (65.52 q ha^{-1}) compared to 0.5% and 1% conventional urea. However, nano urea @ 2 ml L^{-1} was *on par* with 4 ml L^{-1} nano urea and 1% conventional urea. Similar trend was recorded with regard to nutrient uptake by finger millet.
Conclusion: Foliar application of nano urea reduced the dosage of conventional urea by 25 per cent.

Keywords: Nitrogen; foliar application; nano urea; finger millet.

1. INTRODUCTION

Finger millet (*Eleusine coracana* L.) is one of the most important small seeded crop with superior nutritional qualities grown in low rainfall areas of semi-arid tropics of the world and ranks third in importance among millets in India after sorghum and pearl millet. In India, finger millet is grown in an area of 1.19 million hectares with production of 1.98 million tonnes and an average productivity of 1661 kg per hectare Sakamma et al., [1] and it is cultivated in Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, Jharkhand, Maharashtra and Gujarat states.

Nitrogen (N) is a key nutrient source for food, biomass and fiber production in agriculture. It is considered as most important element in terms of the energy required for its synthesis, tonnage used and monetary value. However, compared with amounts of N applied to soil, the nitrogen use efficiency (NUE) by crops is very low in conventional fertilizers. Excessive and improper usage of N fertilizer causes problems to human and environment. It is essential for a suitable alternative source of N with reduced harm on the environment. Nano-N fertilizers are alternative to conventional fertilizers with slow and control release of N [2].

Nano urea as foliar spray helps in easy absorption of nitrogen through stomata, improves crop growth, yield and reduce production costs. Higher productivity of crops in sustainable manner could be achieved applying appropriate combination of conventional fertilizer and nano fertilizers. By foliar application of nano urea, can reduce the application of conventional urea. Combined application of conventional urea and foliar application of nano urea helps in obtaining higher yield, net returns and found economically feasible.

2. MATERIALS AND METHODS

A field experiment was conducted during *kharif* 2022-23 at Agricultural Research Station, Siruguppa, UAS, Raichur, Karnataka (15º38´N, 76º54´ E, altitude 380 m). The soil of the experimental site was deep black with clayey in texture and had moderately alkaline pH (8.10), low in organic carbon content (4.41 g kg^{-1}) and

low in nitrogen (195.8 kg ha^{-1}) and was high in phosphorus (68.7) and potassium (385 kg ha^{-1}). The experiment was laid out in split plot design with three replications.

The treatments consisting of four levels of soil nitrogen in the main plots (no nitrogen, 50%, 75% and 100% RDN), two doses of nano urea (2 ml L^{-1} and 4 ml L^{-1}) and two doses of conventional urea (0.5% and 1%) as foliar nitrogen at tillering and booting stages in the sub plots. Recommended dose of P (30 kg ha^{-1}) & K (30 kg ha^{-1}) was common for all the treatments except absolute control. The finger millet variety HR-13 was selected for the study. Two seeds per hole were hand dibbled at 10 cm distance and 30 cm row spacing in furrows was maintained. At harvest, from randomly tagged five plants, plant height was measured individually from ground level to the base of fully opened top leaf. Biometric observations were recorded at 30 days interval. The observation on grain and straw yield was recorded at harvest. Nutrient uptake for all the major nutrients was calculated by the formula mentioned below.

Nutrient uptake (kg ha^{-1}) = Nutrient concentration (%) × Biomass (kg ha^{-1}) / 100

Data analysis and interpretation was done using Fisher's method of analysis and variance technique as given by Gomez and Gomez [3]. The level of significance used in 'F' was P = 0.05. Critical Difference (CD) values were calculated wherever the 'F' test was found significant.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

Among main plots, application of 100% RDN recorded significantly higher plant height (129.82 cm), tillers $plant^{-1}$ (10.10) and total dry matter accumulation (36.17 g $plant^{-1}$) in comparison to no nitrogen and 50% RDN. However, 75% RDN (123.04 cm, 9.61 and 34.02 g $plant^{-1}$, respectively) found *on par* with 100% RDN. Among the sub plots, foliar spray of nano urea @ 4 ml L^{-1} recorded significantly higher plant height (121.59 cm), tillers $plant^{-1}$ (9.37) and total dry matter accumulation (33.16 g $plant^{-1}$) compared to 0.5% and 1% conventional urea. However, nano urea @ 2 ml L^{-1} was *on par* with 4 ml L^{-1} nano urea and 1% conventional urea. There is a non-significant interaction was observed between nitrogen levels and foliar spray of nitrogen and in control, lower plant height at harvest, number of tiller $plant^{-1}$ and dry matter accumulation $plant^{-1}$ was observed as compared to nitrogen levels and foliar spray. (Table 1). Plant height, number of tillers per $plant^{-1}$ and total dry matter accumulation increased with increasing N levels. It was probably due to increased supply of nitrogen to plants, which intern accelerated the activity of enzymes involved in photosynthesis, carbohydrates metabolism, protein synthesis, cell division and cell elongation. These findings are in line with the work of Beeresha [5] and Uma et al. [4]. It was observed that foliar spray of nano urea increased the growth attributes due to enhanced availability of nutrients through easy penetration of nano urea through stomata of leaves via gas uptake [6].

3.2 Yield Attributes

Among different levels of N application, significantly higher number of ear heads $plant^{-1}$ (3.60), length of ear head (6.54 cm), weight of ear head (8.49 g), grain weight $plant^{-1}$ (12.29 g), grain yield (36.87 q ha^{-1}) and straw yield (71.72 q ha^{-1}) were recorded with 100% RDN in comparison to no nitrogen and 50% RDN. However, application of 75 % RDN recorded 3.43, 6.26 cm, 8 g, 11.83 g, 34.84 q ha^{-1} and 68.01 q ha^{-1}, number of ear heads $plant^{-1}$, length of ear head, weight of ear head, grain weight $plant^{-1}$, grain yield and straw yield, respectively) which found *on par* with 100% RDN (Table 2).

Among the foliar applications, foliar spray of nano urea @ 4 ml L^{-1} recorded significantly higher number of ear heads $plant^{-1}$ (3.25), length of ear head (6.21 cm), weight of ear head (7.94 g), grain weight $plant^{-1}$ (11.66 g), grain yield (31.97 q ha^{-1}) and straw yield (65.52 q ha^{-1}) compared to 0.5% and 1% conventional urea. However, nano urea @ 2 ml L^{-1} was *on par* with 4 ml L^{-1} nano urea and 1% conventional urea (Table 2).

Yield attributes *Viz*., number of ear heads $plant^{-1}$, length of ear head, weight of ear head and grain weight $plant^{-1}$ are the main contributors to the variation in finger millet production. All these parameters increased with the levels of N which may be attributed to the sufficient supply and availability of nitrogen and their transfer to the sink. Application of nano urea resulted in higher growth and yield parameters over the conventional urea application mainly due to foliar application of nano urea supplied the nutrients directly to plant by increasing the availability as compare to conventional urea and also due to

size of nano particles resulted in increased availability to plants. But non-significant interaction effect was observed among the soil and foliar application. Similar findings were made by Maitra et al. [7], who noted greater values of yield contributing characteristics with application of N by chemical fertilizer. In case of foliar nitrogen, 4 ml L^{-1} of nano urea recorded significantly higher number of ear heads $plant^{-1}$, length of ear head, weight of ear head and grain weight $plant^{-1}$ as compared to 0.5% and 1% conventional urea. This might be due to the smaller size and larger effective surface area of nano particles which could have easily penetrated into the plant and lead to better uptake of N.

3.3 Nutrient uptake and Available Nutrients in Soil at Harvest

Significantly higher uptake of nitrogen (103.75 kg ha^{-1}), phosphorus (47.93 kg ha^{-1}) and potassium (129.58 kg ha^{-1}) was recorded by application of 100% RDN in comparison to no nitrogen and 50% RDN. However, 75% RDN (94.43 kg ha^{-1}, 42.91 kg ha^{-1} and 117.40 kg ha^{-1}, respectively) found *on par* with 100% RDN among main plots. Among sub plot treatments, significantly higher nitrogen (88.74 kg ha^{-1}), phosphorus (40.34 kg ha^{-1}) and potassium uptake (112.73 kg ha^{-1}) was recorded by treatment with foliar spray of 4 ml L^{-1} nano urea compared to 0.5% and 1% conventional urea. However, nano urea @ 2 ml L^{-1} was *on par* with 4 ml L^{-1} nano urea and 1% conventional urea (Table 3). Application of nano urea recorded higher nutrient uptake compared to other treatments mainly due to higher availability of nutrients and also due to its nano size particles, which increased plant metabolism resulted in higher biomass yield and nutrient concentration in plant system which reflected in higher uptake mechanism. The nutrient uptake of plant was significantly increased owing to the combined application of nitrogen fertilizer and nano fertilizers. Similar results were found by Fan et al*.* [8], Manikandan and Subramanian [9].

Table 1. Plant height (cm), number of tillers $plant^{-1}$ and total dry matter accumulation at harvest of finger millet as influenced by soil nitrogen levels and foliar nitrogen

Treatment	Plant height at Harvest (cm)	No. of tillers $plant^{-1}$	Total dry matter accumulation (g $plant^{-1}$)
Main plot: Soil nitrogen management			
M_1: no nitrogen	95.86	7.56	24.34
M_2: 50% RDN	109.59	8.47	28.97
M_3: 75% RDN	123.04	9.61	34.02
M_4: 100% RDN	129.82	10.10	36.17
S. Em.±	**2.08**	**0.17**	**0.74**
C.D. at 5 %	**7.18**	**0.58**	**2.58**
Sub plot: Foliar spray of nitrogen			
N_1: nano urea @ 2 ml L^{-1}	117.76	9.15	32.05
N_2: nano urea @ 4 ml L^{-1}	121.59	9.37	33.16
N_3: 0.5% urea	106.42	8.40	28.01
N_4: 1% urea	112.55	8.82	30.27
S. Em.±	**1.99**	**0.11**	**0.63**
C.D. at 5 %	**5.80**	**0.36**	**1.84**
Interaction			
M×N	**NS**	**NS**	**NS**
Control vs Rest			
Control	78.03	3.14	18.67
S. Em.±	**3.57**	**0.37**	**1.27**
C.D. at 5 %	**10.29**	**1.08**	**3.66**

Table 2. Yield attributes of finger millet as influenced by soil nitrogen levels and foliar nitrogen

Treatment	No. of ear heads plant^{-1}	Length of ear head (cm)	Weight of ear head (g)	Grain Weight (g plant^{-1})	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Main plot: Soil nitrogen management						
M_1: no nitrogen	2.32	5.28	6.03	9.70	19.20	46.57
M_2: 50% RDN	2.78	5.68	7.00	10.75	25.83	60.92
M_3: 75% RDN	3.43	6.26	8.00	11.83	34.84	68.01
M_4: 100% RDN	3.60	6.54	8.49	12.29	36.87	71.72
S. Em.±	**0.06**	**0.10**	**0.16**	**0.14**	**0.74**	**1.11**
C.D. at 5 %	**0.21**	**0.36**	**0.55**	**0.49**	**2.57**	**3.84**
Sub plot: Foliar spray of nitrogen						
N_1: nano urea @ 2 ml L^{-1}	3.16	6.08	7.68	11.43	29.93	63.86
N_2: nano urea @ 4 ml L^{-1}	3.25	6.21	7.94	11.66	31.97	65.52
N_3: 0.5% urea	2.74	5.60	6.70	10.45	26.02	56.99
N_4: 1% urea	2.98	5.88	7.21	11.03	28.82	60.84
S. Em.±	**0.08**	**0.09**	**0.16**	**0.16**	**0.74**	**1.10**
C.D. at 5 %	**0.23**	**0.26**	**0.48**	**0.48**	**2.15**	**3.20**
Interaction						
M×N	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Control vs Rest						
Control	1.35	4.25	3.58	6.18	14.43	37.82
S. Em.±	**0.15**	**0.21**	**0.31**	**0.32**	**1.44**	**2.16**
C.D. at 5 %	**0.42**	**0.60**	**0.91**	**0.92**	**4.15**	**6.22**

Table 3. Uptake of nutrients by finger millet and available nutrients in soil as influenced by soil nitrogen levels and foliar nitrogen

Treatment	Uptake of nutrients (kg ha^{-1})			Available nutrients (kg ha^{-1})		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
Main plot: Soil nitrogen management						
M_1: no nitrogen	48.32	21.88	65.24	143.39	38.49	329.47
M_2: 50% RDN	70.38	31.80	92.06	156.99	45.27	342.80
M_3: 75% RDN	94.43	42.91	117.40	175.31	51.85	356.38
M_4: 100% RDN	103.75	47.93	129.58	182.06	55.52	361.89
S. Em.±	**2.71**	**1.77**	**4.34**	**2.51**	**1.11**	**1.81**
C.D. at 5 %	**9.39**	**6.12**	**15.03**	**8.70**	**3.84**	**6.28**
Sub plot: Foliar spray of nitrogen						
N_1: nano urea @ 2 ml L^{-1}	82.22	37.84	105.94	167.42	49.04	350.32
N_2: nano urea @ 4 ml L^{-1}	88.74	40.34	112.73	170.85	51.23	352.97
N_3: 0.5% urea	69.73	31.75	89.56	156.54	44.12	341.08
N_4: 1% urea	76.19	34.57	96.03	162.94	46.74	346.17
S. Em.±	**2.19**	**1.37**	**4.50**	**2.07**	**0.87**	**1.54**
C.D. at 5 %	**6.40**	**4.01**	**13.13**	**6.03**	**2.59**	**4.52**
Interaction						
M×N	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Control vs Rest						
Control	32.85	14.82	47.59	129.10	29.19	315.25
S. Em.±	**4.49**	**2.83**	**8.67**	**5.76**	**1.15**	**2.54**
C.D. at 5 %	**12.92**	**8.15**	**24.98**	**16.61**	**3.32**	**7.33**

Similarly, significantly higher available nitrogen (182.06 kg ha^{-1}), phosphorus (55.52 kg ha^{-1}) and potassium (361.89 kg ha^{-1}) was recorded by application of 100% RDN in comparison to no nitrogen and 50% RDN. However, 75% RDN (175.31 kg ha^{-1}, 51.85 kg ha^{-1} and 356.38 kg ha^{-1}, respectively) found *on par* with 100% RDN among main plots. Among sub plot treatments, significantly higher available nitrogen (170.85 kg ha^{-1}), phosphorous (51.23 kg ha^{-1}) and potassium (352.97 kg ha^{-1}) was recorded by treatment with foliar spray of 4 ml L^{-1} nano urea compared to 0.5% and 1% conventional urea. However, nano urea @ 2 ml L^{-1} was *on par* with 4 ml L^{-1} nano urea and 1% conventional urea (Table 3). Higher available soil nitrogen, phosphorus and potassium were noticed in 100% RDN treatment as compared to others. Nano urea applied treatments were recorded higher soil nutrient status after crop harvest due to nutrient demand by crop was met by foliar application of nano particles itself but utilization of nutrients from soil was may be less which resulted in higher nutrients status after crop harvest as compared to other treatments. Nutrient availability increases as fertilization levels are raises *i.e.,* 75% to 100%. Similar results were obtained by Thimmareddy et al. [10], who observed elevated NPK availability (kg ha^{-1}) in soil during harvest with increasing NPK levels.

4. CONCLUSION

From the results of the present study, it is concluded that there was significant response of 100 per cent of recommended dose of nitrogen along with foliar application of nano urea @ 4 ml L^{-1} cent nano nitrogen at tillering and booting stages which recorded higher growth attributes, yield parameters and nutrient uptake by the plants.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

I declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sakamma S, Umesh KB, Girish MR, Ravi, SC, Satishkumar M, Veerabhadrappa, B., 2018, Finger millet (*Eleusine coracana* L.) production system: status, potential, constraints and implications for improving small farmer's welfare. J. Agric. Sci. 2018; 10(1):162-163.
2. Sharma SK, Sharma PK, Mandeewal RL, Sharma V, Chaudhary R, Pandey R, Gupta S. Effect of foliar application of nano-urea under different nitrogen levels on growth and nutrient content of pearl millet (*Pennisetum glaucu*m L.). International Journal of Plant & Soil Science. 2022 ;10;34(20):149-55.
3. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd *Ed. John Wiley Sons,* New York; 1984.
4. Uma V, Jayadev HM, Rehaman AHM., Kadalli GG, Umashankar N. Influence of nano- zinc oxide (ZnO) particles on growth and yield of maize (*Zea mays* L.). Mysore J. Agric. Sci. 2019; 53(4):44-48.
5. Beeresha KJ. Studies on the effect of nano potassium on growth and yield of maize (*Zea mays* L.). *Ph.D. Agri. Thesis*, Univ. Agric. Sci., Bengaluru, Karnataka (India); 2018.
6. Rajasekar M, Nandhini DU, Suganthi S. Supplementation of mineral nutrients through foliar spray-A Review. Int. J. Curr. Microbiol. Appl. Sci. 2017;6:2504-2513.
7. Maitra S, Ghosh DC, Sounda G, Jana PK. Performance of intercropping legumes in finger millet (*Eleusine coracana*) at varying fertility levels. Indian J. Agron. 2001;46(1): 38 -44.
8. Fan L, Wang Y, Shao X, Geng Y, Wang Z, Liu J. Effects of combined nitrogen fertilizer and nano-carbon application on yield and nitrogen use of rice grown on saline-alkali soil. J. Food Agric. Environ. 2012;10(1): 558-562.
9. Manikandan A, Subramanian KS. Evaluation of zeolite-based nitrogen nano fertilizers on maize growth, yield and quality on Inceptisols and Alfisols. Int. J. Plant Soil Sci. 2016;9(4): 1-9.

10. Thimmareddy K, Desai BK, Vinodkumar, S. N., 2013, Seed cotton yield, uptake of NPK and economics of *Bt* cotton (*Gossypium hirsutum* L.) as influenced by different bio-fertilizers in-situ green manuring under irrigation. Trends Biosci. 2013;6(6): 838-841.

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