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Influence of Neem Coated Urea and Nano Urea on the Agronomic Traits of Finger Millet (*Eleusine coracana* L. *Gaertn*) under Irrigated Conditions

Santhosh Anto Kumar R.[1], Sharmili K.[2*], Isaac Manuel R.[3] and Balaganesh B.[4]

[1]M.Sc. Scholar, Department of Agronomy,
Karunya Institute of Technology and Sciences, Coimbatore (Tamil Nadu), India.
[2]Assistant Professor, Department of Agronomy,
Karunya Institute of Technology and Sciences, Coimbatore (Tamil Nadu), India.
[3]Associate Professor, Department of Agronomy,
Karunya Institute of Technology and Sciences, Coimbatore,
[4]Assistant Professor, Department of Soil Science and Agricultural Chemistry,
Karunya Institute of Technology and Sciences, Coimbatore (Tamil Nadu), India.

(Corresponding author: K. Sharmili)*
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ABSTRACT: To reduce losses due to ammonia volatilization, nitrate leaching, denitrification, and improving nitrogen efficiency, furthermore to evaluate the impact of different nitrogen sources on finger millet production, a field experiment was laid out with Randomised Block Design having seven treatments which is replicated thrice. Treatments followed were T_1: Control, T_2: P and K only, T_3: 100% Neem coated urea + P and K, T_4: 75% Neem coated urea + 25% Nano urea + P and K, T_5: 50% Neem coated urea + 50% Nano urea + P and K, T_6: 25% Neem coated urea + 75% Nano urea + P and K and T_7: 100% Nano urea + P and K. The results revealed that the treatment combining 50% Neem coated urea (NCU) + 50% Nano urea (NU) + P and K (T_5) performed exceptionally well compared to the other treatments. This particular treatment exhibited notable outcomes, including increased plant height (93.7 cm), a higher total number of ear heads per hill (8.58), greater total dry matter production (6443 kg/ha), improved grain yield (4350 kg/ha), higher straw yield (5829 kg/ha), enhanced net return (Rs. 88,247/ha), and a benefit-cost ratio of (2.60).

Keywords: Finger millet, Neem-coated urea, Nano urea, Nitrogen, Yield, Economics.

INTRODUCTION

In India Finger millet (*Eleusine coracana* L. Gaertn), was commonly known as *Ragi*. Itis an ancient grain believed to have originated in East Africa. It was introduced to India around 3000 B.C. by sea traders (Hilu *et al*., 1979). The name "*ragi*" stems from the Sanskrit word "*raga*", meaning "red". This millet is often referred to as the "dancing grain" or "*Nrutya Kondaka*" in Sanskrit literature. Finger millet is primarily cultivated in India for mankind consumption addition to that it is widely seen in various arid and semi-arid regions world. It exhibits adaptability to diverse soil and climatic conditions, thriving in almost all soil types. This grain possesses remarkable characteristics as a subsistence food crop and is commonly regarded as the "poor man's food" due to its ability to sustain individuals for extended periods.

In terms of worldwide millet cultivation, after pearl millet (*Pennisetum glaucum* L.) and foxtail millet (*Setariaitalica*) the finger millet stands as the third most extensively cultivated millet. The cultivation is predominantly observed in semi-arid tropical and subtropical regions. Notably, in India, finger millet covers a substantial cultivation area of 1159 ha whereas Karnataka holds the first position which is followed by Tamil Nadu, Andhra Pradesh, Odisha, Jharkhand, together with Uttarakhand, Maharashtra, and Gujarat. The recorded production rate in 2021-22 amounted to 1998 tonnes/ha, yielding an overall average of approximately 1724 kg/ha. Among the various states, Tamil Nadu exhibited the highest productivity with (4.14 tonnes/ha) followed by Karnataka (1.54 tonnes/ha), and Telangana with (1.34 tonnes/ha) (DES, 2021).

Nitrogen (N) is a crucial nutrient element for plants, ranking along carbon (C), hydrogen (H), and oxygen (O_2). Its significance lies in its pivotal role in the synthesis of chlorophyll, which forms the foundation of the photosynthesis process (Sinfield *et al*., 2010). In order to achieve optimal growth plants, require nitrogen nutrient, to substantiate this, plants primarily absorb it in the form of ammonium (NH_4+) and nitrate (NO_3-) from the soil (Taiz and Zeiger 2010). At certain conditions, nitrogen supply in soil is frequently limited, that prevails the farmers to increase the application of mineral-based nitrogen fertilizers to obtain higher crop yields. Rubio-Covarrubias *et al*. (2009). Mentioned that

this practice can indirectly lead to overdosage of nitrogen, which hampers optimal plant productivity. Plants are incapable of absorbing excess nitrogen fertilizer, thereby negating its potential benefits.

Nano urea. Encapsulating or creating plant nutrients in nano forms and delivering them as nano-sized emulsions is how nanotechnology-based fertilizers are created. The importance of nano-fertilizers is increased nutrient use efficiency, improved yield, and decreased soil contamination. Nanostructured formulations of fertilizers with altered physicochemical properties can be a probable solution to the current problems of environmental pollution (Baboo, 2021). Nano urea is a revolutionary agricultural innovation that reduces the reliance on conventional urea by at least half, if not more. Notably, it offers substantial benefits by enhancing crop production, promoting soil health, and improving the nutritional quality of agricultural output, all without compromising soil productivity. The nitrogen particles in nano urea possess a size ranging from 20 to 50 nm and it contains approximately 4.0% nitrogen. When applied as a foliar spray, this specialized formulation of urea allows for easy penetration through stomata and other openings on the leaves. As a result, the nano urea is efficiently assimilated by the plant cells, facilitating its rapid utilization by the plants.

Neem coated urea. The findings of Ahmad *et al*. (2008) reports that the direct incorporation of chemical fertilizers into the field results in significant nutrient losses. When it comes to nitrogen (N) fertilizers, losses due to leaching and volatilization are substantial, with crops utilizing only 30 to 40 percent of the added N fertilizers. To address this crisis, in 2015 the Government of India mandated that all domestically manufactured or imported urea fertilizers must be subjected to neem oil coating at a rate of 0.5 kg per tonne. As suggested by Schmutterer (1990) the neem oil used for coating the urea granules must possess nitrification inhibition properties, which can improve the efficiency of nitrogen utilization in crops. Considering these factors, a recent investigation was made to estimate the impact of neem-coated and nano urea in the growth, yield, and economic aspects of finger millet cultivation under tropical conditions.

MATERIALS AND METHODS

The field experiment was performed at Karunya Institute of Technology and Sciences in Coimbatore during the rabi season of 2022-23. The experimental site is situated in the western agro-climatic zone of Tamil Nadu, with approximate geographical coordinates of 10°56'N latitude and 76°44'E longitude at an elevation of 474 meters above mean sea level. Throughout the cropping period, the minimum and maximum temperatures ranged from 18.4°C to 26.2°C, respectively. The total rainfall recorded during the cropping period in 2022-2023 amounted to 436.80 mm. The average relative humidity (RH) varied between 76% and 90%. The soil at the experimental site was classified as clay loam, with a pH value of 7.0, an electrical conductivity (EC) of 0.16 dS m^{-1}, organic carbon (OC) content of 1.38%, nitrogen content of 182 kg/ha, phosphorus content of 17.2 kg/ha, and potassium content of 495 kg/ha.

The experiment was carried out in a Randomized Block Design having seven treatments and three replications. Finger millet variety CO13 with a duration of 95 - 100 days was selected for this experiment. The recommended fertilizer dosage of N: P_2O_5:K_2O at 60:30:30 kg/ha was applied using urea, single super phosphate, and muriate of potash. The treatments followed during the experiment were T_1: Control, T_2: P and K only, T_3: 100% Neem coated urea + P and K, T_4: 75% Neem coated urea + 25% Nano urea + P and K, T_5: 50% Neem coated urea + 50% Nano urea + P and K, T_6: 25% Neem coated urea + 75% Nano urea+ P and K and T_7: 100% Nano urea + P and K. Nitrogen and Phosphorus levels were maintained according to the treatment combinations. All yield and growth parameters were computed from implying established protocols.

RESULTS AND DISCUSSION

Effect of neem coated urea and nano urea on plant growth and yield parameters of finger millet. The data presented in Table 1 demonstrated that at different stages of finger millet growth, there is a substantial variation in plant height between the treatments. The treatment T_5 -50% Neem coated urea + 50% Nano urea + P and K recorded the higher plant height (93.7 cm) among all the treatments, which is statistically at par with T_4 - 75% Neem coated urea + 25% Nano urea + P and K (89.0 cm) and T_6 - 25% Neem coated urea + 75% Nano urea + P and K (89.4cm) treatments. The significant variations in plant height over the treatments can be assigned with the improved nitrogen availability, that is vital for protein synthesis, plant growth, and cell division, as documented by Ullasa *et al*. (2016); Reddy *et al*. (2018).

The higher DMP (6443 kg/ha) was recorded in the T_5 (50% Neem coated urea + 50% Nano urea + P and K) which is statistically at par with the treatment T_4 (75% Neem coated urea + 25% Nano urea + P and K)(6231 kg/ha). Balanced nutrition resulted in enhanced root growth and tillering, leading to an increased capacity to intercept photosynthetically active radiation and facilitate greater crop growth (Vasanthi and Meena 2021).

The most important factor attributing to yield improvement was the contribution of yield components, especially the number of ear head per hill. The treatment T_5 (50% Neem coated urea + 50% Nano urea + P and K) exhibited the highest number of ears per head (8.58), which, in comparison to the other treatments, was significantly improved. The number of earheads has increased as a result of the improved fertilizer use efficiency, which is probably attributed to the plants' timely consumption of nutrients, causing them easier for their physiological processes to be improved.

Effect of neem coated urea and nano urea on yield parameters of finger millet. The treatment T_5 (50% Neem coated urea + 50% Nano urea + P and K)

produced an increased grain yield (4350 kg/ha) of finger millet compared with any of the prior treatments. Application of slow-release fertilizers, comprising 50% Neem coated urea and 50% Nano urea, resulted in a remarkable improvement in growth and yield characteristics, resulting in significant increases in grain and straw yield. The observed effect could be attributed to the decreased nitrogen loss and improved nutrient supply, resulting from the continuous and adequate intake of nitrogen throughout various development and growth stages of a crop. The increase in productivity, primarily attributed through the contribution of yield factors, is reported by the findings of Tadesse *et al*. (2013); Singh *et al*. (2013). The improved utilization of nitrogen, leading to enhanced yield attributing characteristics, played a crucial role in the substantial increase in finger millet grain yield (Samanta *et al*., 2022). In green gram, these findings align with the research. conducted by Das and Jana (2015); Gokul and Kumar (2019).

The treatment T_5(50% Neem coated urea + 50% Nano urea + P and K), achieved a significantly higher straw yield (5829 kg/ha) which is on par with T_4 (75% Neem coated urea + 25% Nano urea + P and K) (5798kg/ha). The factors contributing to the increased straw yield are consistent and gradual availability of nitrogen during both the early and later growth stages, as well as the presence of phosphorus in the root zone. The findings of Gavade (2010); Mendhe *et al*. (2006), align in this observation.

The timing of the nitrogen application had little impact on the finger millet harvest index. However, quantitatively, the highest finger millet harvest index (44.34%) was recorded with the treatment T_1 (Control) and followed by treatment T_2 (P and K alone) with a harvest index of about 44.08%, while the minimum harvest index (42.25%) was observed under the treatment T_3 (100% Neem coated urea + P and K). The increased nutrient use efficiency, enhanced grain yield potential, and promotion of early growth attributes have been noted as an effect of the optimal availability as phosphorus (P) (Hegde *et al*., 2006; Sakarvadia *et al.*, 2012; Patel, 2014).

Table 1: Effect of nitrogenous fertilizers on growth and yield of finger millet.

Treatments	Plant height(cm)	Number of earhead hill^{-1}	Dry matter production (kg ha^{-1})	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
T_1– Control	83.2	7.40	4574	3958	4967	44.34
T_2 - P and K alone	84.5	7.52	4645	3985	5054	44.08
T_3 - 100% Neem coated urea + P and K	87.7	7.95	5645	4157	5680	42.25
T_4 - 75% Neem coated urea + 25% Nano urea + P and K	89.0	8.23	6231	4325	5798	42.72
T_5 - 50% Neem coated urea + 50% Nano urea + P and K	93.7	8.58	6443	4350	5829	42.73
T_6 - 25% Neem coated urea + 75% Nano urea + P and K	89.4	8.19	5446	4280	5687	42.94
T_7 - 100% Nano urea + P and K	86.1	7.65	4821	4058	5254	43.57
Mean	**87.6**	**7.93**	**5401**	**4159**	**5467**	-
SEd	**2.09**	**0.18**	**102**	**67.1**	**131.1**	-
CD (*p*=0.05)	**4.38**	**0.37**	**213**	**140.2**	**273.8**	-

Table 2. Effect of nitrogenous fertilizers on economics of finger millet.

Treatments	Net return (Rs. ha^{-1})	B:C ratio
T_1– Control	74870	2.25
T_2 - P and K alone	71868	2.32
T_3 - 100% Neem coated urea + P and K	78904	2.43
T_4 - 75% Neem coated urea + 25% Nano urea + P and K	85040	2.54
T_5 - 50% Neem coated urea + 50% Nano urea + P and K	88247	2.60
T_6 - 25% Neem coated urea + 75% Nano urea + P and K	83956	2.52
T_7 - 100% Nano urea + P and K	74463	2.35

Economics: The net return exhibited a gradual increase as nitrogen and phosphorus levels were incremented, indicating a positive correlation between higher grain yield, straw yield, and the economic aspects of finger millet cultivation. Application of 50% Neem coated urea + 50% Nano urea + P and K(T_5) recorded maximum net return (Rs. 88247 Rs/ha). This was followed by 75% Neem coated urea + 25% Nano urea + P and K (T_4) (Rs. 85040 Rs/ha). The minimum net return was recorded with P and K (T_2) (Rs. 71868Rs/ha). The application of 50% Neem coated urea + 50% Nano urea + P and K (T_5) showed a higher Benefit Cost ratio of (2.60), indicating a favorable economic outcome in comparison to the other treatments. The higher net return and Benefit Cost ratio can be attributed to the superior grain and straw yield achieved in finger millet compared to the other treatments., as reported by Saravanakumar (2018); Raghunatha Reddy *et al*. (2020).

CONCLUSIONS

According to the findings of a field research, finger millet is increasing in Coimbatore's southern region with the application of T_5 (50% Neem coated urea + 50 % Nano urea and P and K) produced a significantly higher yield of both grain and straw. Hence it can be recommended as a better treatment for the farmers. Also, the application of (75% Neem coated urea + 25% Nano urea + P and K) can be considered as a second

option for obtaining higher yield and economics of growing finger millet.

FUTURE SCOPE

A comparative study can be conducted to evaluate the effectiveness of neem coated urea and nano urea on crops by combining them with other inputs such as organic fertilizers and growth enhancers. This would provide farmers with information on how to best integrate these alternatives into their overall crop management strategy.

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Conflict of Interest. None.

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