Enhancing Forage Quality of Maize through Nano Urea and Urea Foliar Application: A Research Investigation

Abstract

Nano-technology based nutrient management practices in fodder crops are still in their nascent stage of growth. Fodder crops require more nitrogen and meeting this demand through nano-urea raises questions about its suitability for long-term fodder production. Therefore, a field trail on "Enhancing Forage Quality of Maize through Nano Urea and Urea Foliar Application: A Research Investigation"was conducted at ZARS, V. C. Farm, Mandya,during *kharif* season of 2022. The experiment was laid out in RCBD with eleven treatments replicated thrice. Treatments include combinations of basal application of urea at 50, 75 and 100% recommended dose of N with varied levels of nano urea and urea spray at 20 and 40 DAS, which were compared with RDF and control (RDF without N). The results indicated that application of 100% RDN (150 kg N ha^{-1}) along with urea @ 2% spray led to significantly enhanced the fodder quality like crude protein, crude fibre, crude fat and carbohydrate and was on par with 100% recommended dose of N + Nano urea @ 0.4% spray.

Key words: Fodder maize, Nano urea, Crude protein, Crude fibre, Crude fat and Carbohydrates

1. Introduction

Agriculture and animal husbandry are interwoven to each other. Livestock sector acts as cushion for the rural economy and contributes 6.2% to total GVA in 2020-21 (Anonymous, 2022a). India ranks first in the world with a huge livestock population of 536.76 million and also ranks first in milk production (Anonymous, 2022b). In order to sustain a large livestock population, a continuous supply of both green and dry fodder is essential.

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Among the various fodder crops, fodder maize is the most preferred due to its high productivity and being free from anti-nutritional factors. The fodder maize mines high nutrients from the soil for its increased productivity, specifically requiring higher amounts of nitrogenous fertilizer along with other nutrients. Nitrogen occupies an important place in plant metabolic system and is an essential constituent of protein and chlorophyll present in many major portions of the plant body. It plays a crucial role in various physiological processes (Leghari *et al.*, 2016) and helps in quantitative as well as qualitative improvement in forage crops by increasing leaf: stem ratio, chlorophyll content, succulent, better palatability and finally green fodder yield. Foliar application of nano urea and urea at critical crop growth stages of a plant effectively fulfils its nitrogen requirement and leads to higher crop productivity and quality.However, applied nitrogen fertilizers are subjected to various kind of losses and the efficacy of applied fertilizer ranges between 30.2-53.2% (Anas*et al.*, 2020).

On the other hand, nano-technology based nutrient management practices are gaining importance due to their higher efficiency, which reduced the doze of fertilizer from kilograms to milligrams. Recently, the Indian government gave approval for its use in agriculture, making nano-urea as first nano-technology based fertilizer for commercial use. The product has been included in schedule VII of the fertilizer control order 1985. Nano urea (liquid) contains 4.0% of total N (w/v) evenly dispersed in water. The size of the particles varies between 20-50 nm(Kumar*et al.*, 2020). Henceforth, the research has been conducted on high nitrogen-demanding fodder crops, specifically maize to obtain valid results. Fodder maize responds to both upper and lower levels of nitrogen. This research was focused on using nano-urea in fodder maize to enhance the fodderquality.

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2. Material and Methods

2.1 Site details

A field trial was conducted at the Zonal Agricultural Research Station (ZARS), V. C. Farm, Mandya, University of Agricultural Sciences, Bengaluru (Karnataka) during 2022. Geographically, the experimental site situated at 12º 45' and 30º 57' North latitude and 76º 45' and 78 º 24' East longitudeand at an altitude of 695m above MSL (Mean sea level).

2.2 Soil status

The soil of experimental site was neutral in pH (7.02), sandy loam in texture, medium in organic carbon (0.62%), low in available N (206.97 kg ha^{-1}) and medium in available P (42.31 kg ha^{-1}) and K (241.24 kg ha^{-1}).

2.3 Treatments description

The experiment was laid out in Randomized Complete Block Design (RCBD) consistingeleven treatment and replicated thrice. The treatments include Control (RDF without N) (T_1), RDF (N: P: K @ 150:75:40 kg ha^{-1}) (T_2), 100% recommended dose of N + Nano urea @ 0.2% spray (T_3), 75% recommended dose of N + Nano urea @ 0.2% spray (T_4), 50% recommended dose of N + Nano urea @ 0.2% spray (T_5), 100% recommended dose of N + Nano urea @ 0.4% spray (T_6), 75% recommended dose of N + Nano urea @ 0.4% spray (T_7), 50% recommended dose of N + Nano urea @ 0.4% spray (T_8), 100% recommended dose of N + Urea @ 2% spray (T_9), 75% recommended dose of N + Urea @ 2% spray (T_{10}) and 50% recommended dose of N + Urea @ 2% spray (T_{11}). Nitrogen was applied in two splits (50% N as basal and 50% N at 30 DAS). Nano urea and urea was sprayed at 20 and 40 days after sowing. The recommended dose of phosphorus and potassium was applied as basal for all treatments.The fodder maize (African tall) was sown with seed rate of 100 kg ha^{-1} with a spacing of 30 × 10 cm.

2.4 Biometric data observations

Plant samples from each treatment were collected at harvest, oven dried, powdered and used for the analysis of quality parameters. All the oven dried samples were powdered in willey mill using 2 mm sieve for crude protein, carbohydrate, fat and ash content, while 1 mm sieve for crude fibre analysis. Quality parameters are analysed and calculated according to the equations adopted by Iqbal*et al.* (2013).

2.5 Statistical analysis

Experimental data obtained on various parameters were subjected to statistical analysis by adopting Fisher's method of analysis of variance (ANOVA) as described by Gomez and Gomez (1984).The level of significance used in "F" was P = 0.05. Critical difference (CD) values were calculated for the P = 0.05 whenever "F" test was found significant, if 'F' test was found non- significant, then the symbol 'NS' was used.

3. Results and Discussion

3.1 Crude protein content and yield

Data in respect of crude protein content and crude protein yield at harvest of fodder maize as influenced by varied levels of recommended dose of nitrogen with different foliarconcentrations of nano urea and urea are presented in Fig. 1.

The crude protein content found significantly influenced by different levels of N with foliar spray treatments. The application of 100% recommended dose of N + Urea @ 2% spray (T_9) showed significantly higher crude protein content (10.44%) and however the application of100% recommended dose of N + Nanourea @ 0.4% spray (T_6= 10.31%), 100% recommended dose of N + Nanourea @ 0.2% spray (T_3= 9.68%), RDF (N:P:K @150:75:40 kg ha^{-1}) (T_2= 9.56%) and 75% recommended dose of N + Urea @ 2%pray (T_7= 9.38%) were found on par in respect to the protein content. Significantly it was obtained lower (7.63 %) by the treatment control (T_1) where no nitrogen applied during the period of investigation.

Comment [DU3]: crude protein

The crude protein yield was found significantly influenced by different levels of N with foliar spray treatments. The application of 100% recommended dose of N + Urea @ 2% spray (T_9) showed significantly higher crude protein yield (9.59 q ha^{-1}) and which was found on par with 100% recommended dose of N + Nanourea @ 0.4% spray (T_6: 9.40 q ha^{-1}). Whereas lower crude protein yield of 2.81 q ha^{-1} was observed in control treatment (T_1).

Increasing levels of recommended of N along with foliar spray of urea or nano urea has performed effectively in increasing the protein content and yield of yield of fodder maize crop. As a component of amino acids, nitrogen transmits genetic information, controls the metabolism of amino acids and proteins that serve as structural building blocks in cells and acts as a biological catalyst for the phosphorylation of chemicals involved in energy conversions. It is a significant structural component of the cell and cell wall, enhancing the protein content and raising the quality of the feed. Because the crude protein content is computed by dividing the plant's nitrogen content by 6.25, an increase in nitrogen supply will increase the crude protein content. Application of higher levels of recommended of N (100%) with foliar application 2% urea recorded higher crude protein yield followed by T_6 (100% recommended dose of N + nano urea @ 0.4% spray) due to accumulation of more dry matter and protein content of plant, which in turn increased the crude protein yield. Similar results are also reported by Amrutkar*et al*. (1985), Almodares*et al*. (2009), Shekara*et al*. (2015) and Meena*et al*. (2021).

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3.2 Crude fibre content and yield

The crude fibre content was not significantly influenced by different foliar nutrient management treatments (Table 1). However, numerically the application of treatment control (T_1) showed significantly highest crude fibre content (30.12%).

The crude fibre yield was found significantly influenced by different foliar spray treatments. The application of 100% recommended dose of N + Urea @ 2% spray (T_9) showed significantly higher crude fibre yield (23.46q ha^{-1}) and which was found on par with 100% recommended dose of N + Nanourea @ 0.4% spray (T_6: 23.39q ha^{-1}) and 100% recommended dose of N + Nano-urea @ 0.2% spray (T_3: 21.26 q ha^{-1}). Whereas, lower crude fibre yield of 11.10q ha^{-1} was observed in control (T_1).

This might be due to increased fertiliser treatment to fodder maize delays maturity, particularly through nitrogen, the crude fibre content decreased as nutrient input increased. Contrarily, a lower fertiliser dose results in forced maturity within a short period of time, which may be controlling the process of fibre synthesis. Therefore, the application of a 2% foliar urea spray coupled with the 100% required dose of N showed the lowest crude fibre concentration. Similar to that, crude fibre yield was calculated by multiplying dry matter yield by the crude fibre content of fodder maize. Similar results in agreement with those were reported byTiwana*et al*. (2009), Pathan*et al*. (2012) and Singh*et al.* (2012).

3.3 Carbohydrate (CHO) content and yield

Carbohydrate content was not significantly influenced by varied levels of recommended dose of nitrogen with different foliar concentrations of nano urea and urea (Table 2). However, application of 100% recommended dose of N + Urea @ 2% spray (T_9) recorded numerically higher carbohydrate content (43.70%) over control (42.86%).The totalCHO yield was significantly influenced by different foliar nutrient management treatments. The application of 100% recommended dose of N + Urea @ 2% spray showed significantly higherCHO yield (74.60 q ha^{-1}) followed by T_6. Higher levels of nitrogen correspondingly increased meristematic activity due to which absorption of mineral salts increases leading to rapid respiration process and conversion of most of the carbohydrates into fat. Apart from that nitrogen plays a major role in protein synthesis, the nitrogen free extract is a part of carbohydrate (Harikesh*et al.* (2017)). This is evidenced by lower CHO yield in control.

3.4 Crude fat content and yield

Data in respect of fatcontent and yieldat harvest of fodder maize as influenced by varied levels of recommended dose of nitrogen with different foliar concentrations of nano urea and urea arepresented in Fig. 2.

The fat content found significantly influenced by different foliar nutrient management treatments. The application of 100% recommended dose of N + Urea @ 2% spray (T_9) showed significantly higherfat content (2.90%)and was on par with the application of100% recommended dose of N + Nano-urea @ 0.4% spray (T_6: 2.75%). Significantly, lower obtained (1.98%) in treatment control (T_1) during the period of investigation. However, crude fat yield was found significantly influenced by different foliar spray treatments. The application of 100% recommended dose of N + Urea @ 2% spray (T_9) showed significantly higher crude fat yield (2.67 q ha^{-1}) and which was found on par with 100% recommended dose of N + Nanourea @ 0.4% spray (T_6: 2.51 q ha^{-1}) and 100% recommended dose of N + Nano-urea @ 0.2% spray (T_3: 2.15 q ha^{-1}). Whereas, lower crude fibre yield of 0.73 q ha^{-1} was observed in control (T_1).

Nitrogen has failed to help plants develop cellulose and lignin, which are fibroid components. Higher nitrogen levels consequentlyboosted meristematic activity, which enhances mineral salt absorption and speeds up the respiration process, turning the majority of the carbs into fat. The increased nitrogen application by foliar and external supplies is the cause of the higher fat and ash content. This is in conformity with findings of Ibrahim *et al.*(2006),Ahmad *et al*. (2017) and Harikesh*et al*. (2017).

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3.5 Ash, dry matter and moisture content

The data on the ash, dry matter and moisture content offodder maize as influenced by varied levels of recommended dose of nitrogen with different foliar concentrations of nano urea and urea are presented in Table 3.

Ash content was not significantly influenced by varied levels of recommended dose of nitrogen with different foliar concentrations of nano urea and urea. However, numerically higher (5.5%) was observed with application of 100% recommended dose of N + Urea @ 2% spray (T_9) over the remaining treatments (5.36 to 4.4%).

At harvest, dry matter and moisture content was not significantly influenced by varied levels of recommended dose of nitrogen with different foliar concentrations of nano urea and urea. However, numerically higher dry matter and moisture content (21.40% and 13.67%) was observed in T_9 and T_5, respectively.

4. Conclusion

The fodder maize responded positively for higher levels of N through conventional N (100% RDN) and urea spray (2%) or higher concentration of nano-urea (4 ml l^{-1}) at 20 and 40 days after sowing with respective green fodder quality. Among the interactions,100% dose of conventional N, coupled with the inclusion of urea or nano-urea, led to a significant increasing quality parameter in green fodder.

6. References

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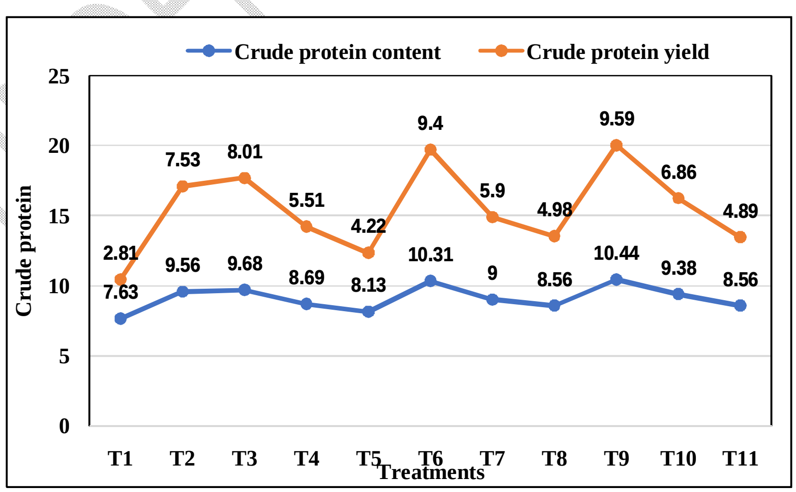

Fig.1:Effect of foliar application of nanourea and urea on crude protein content (%) and crude protein yield (q ha^{-1}) of fodder maize at harvest

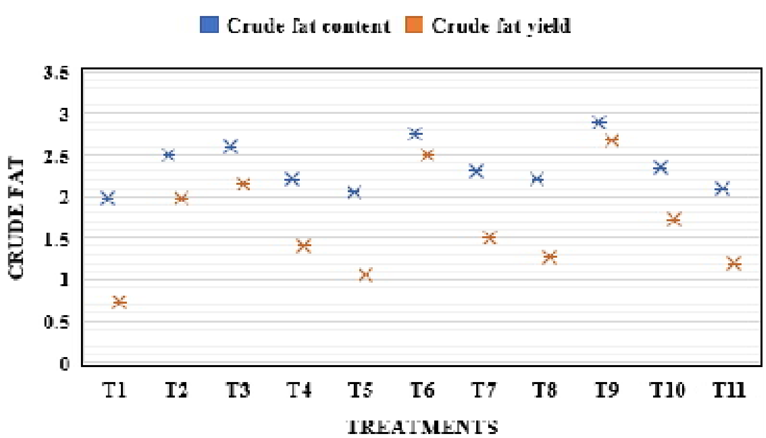

Fig. 2: Effect of foliar application of nanourea and urea on crude fatcontent (%) and crude fat yield (q ha^{-1}) of fodder maize at harvest

Table 1: Effect of foliar application of nanourea and urea on crude fibrecontent and crude fibre yield of fodder maize at harvest

Treatments	Crude fibrecontent (%)	Crude fibre yield (q ha^{-1})
T_1: Control (RDF without N)	30.12	11.10
T_2: RDF (N: P: K @ 150:75:40 kg ha^{-1})	26.51	20.70
T_3: 100% recommended dose of N + Nanourea @ 0.2% spray	26.31	21.26
T_4: 75% recommended dose of N + Nanourea @ 0.2% spray	27.37	17.35
T_5: 50% recommended dose of N + Nanourea @ 0.2% spray	28.43	14.75
T_6: 100% recommended dose of N + Nanourea @ 0.4% spray	25.95	23.39
T_7: 75% recommended dose of N + Nanourea @ 0.4% spray	27.07	17.76
T_8: 50% recommended dose of N + Nanourea @ 0.4% spray	27.82	16.19
T_9: 100% recommended dose of N + Urea @ 2% spray	25.52	23.46
T_{10}: 75% recommended dose of N + Urea @ 2% spray	26.87	19.67
T_{11}: 50% recommended dose of N + Urea @ 2% spray	28.09	16.03
S.Em.±	**1.34**	**0.84**
CD(P=0.05)	**NS**	**2.46**

Table 2: Effect of foliar application of nanourea and urea on Carbohydrate content and Carbohydrate yield of fodder maize at harvest

Treatments	Carbohydrate content (%)	Carbohydrate yield (q ha^{-1})
T_1: Control (RDF without N)	42.86	15.79
T_2: RDF (N: P: K @ 150:75:40 kg ha^{-1})	43.28	33.79
T_3: 100% recommended dose of N + Nanourea @ 0.2% spray	42.96	34.71
T_4: 75% recommended dose of N + Nanourea @ 0.2% spray	43.64	27.66
T_5: 50% recommended dose of N + Nanourea @ 0.2% spray	42.92	22.27
T_6: 100% recommended dose of N + Nanourea @ 0.4% spray	43.10	38.84
T_7: 75% recommended dose of N + Nanourea @ 0.4% spray	42.92	28.16
T_8: 50% recommended dose of N + Nanourea @ 0.4% spray	42.97	25.01
T_9: 100% recommended dose of N + Urea @ 2% spray	43.70	40.17
T_{10}: 75% recommended dose of N + Urea @ 2% spray	42.72	31.28
T_{11}: 50% recommended dose of N + Urea @ 2% spray	43.15	24.63
S.Em.±	**2.07**	**2.66**
CD(P=0.05)	**NS**	**7.81**

Table 3: Effect of foliar application of nanourea and urea on ash, moisture and dry matter content of fodder maize at harvest

Treatments	Ash content (%)	Moisture content (%)	Dry matter content (%)
T_1: Control (RDF without N)	4.40	13.01	18.14
T_2: RDF (N: P: K @ 150:75:40 kg ha^{-1})	5.30	12.85	20.93
T_3: 100% recommended dose of N + Nanourea @ 0.2% spray	5.36	13.09	20.80
T_4: 75% recommended dose of N + Nanourea @ 0.2% spray	5.04	13.05	19.92
T_5: 50% recommended dose of N + Nanourea @ 0.2% spray	4.80	13.67	18.87
T_6: 100% recommended dose of N + Nanourea @ 0.4% spray	5.38	12.51	21.29
T_7: 75% recommended dose of N + Nanourea @ 0.4% spray	5.12	13.59	20.17
T_8: 50% recommended dose of N + Nanourea @ 0.4% spray	5.00	13.45	19.80
T_9: 100% recommended dose of N + Urea @ 2% spray	5.50	11.94	21.40
T_{10}: 75% recommended dose of N + Urea @ 2% spray	5.12	13.56	20.50
T_{11}: 50% recommended dose of N + Urea @ 2% spray	5.00	13.10	19.23
S.Em.±	**0.24**	**0.63**	**0.73**
CD(P=0.05)	**NS**	**NS**	**NS**