Influence of foliar application of nano urea and urea on productivity and nutrient status of fodder Maize during *Kharif* season

ABSTRACT

A field study entitled "Influence of foliar application of nano urea and urea on productivity and nutrient status of fodder Maize during *kharif* season" was carried out during *kharif,* 2022 at Zonal Agricultural Research Station, V. C. Farm, Mandya, Karnataka. The soil was sandy loam in texture, neutral in reaction, low in available nitrogen, and medium in organic carbon, phosphorous and potassium status. The experiment was carried out with fodder Maize in randomized block design with 11 treatments and 3 replications. The treatments include varied levels of recommended dose of N (50, 75 and 100%) along with foliar application of nano urea (0.2% and 0.4%) and urea (2%) spray at 20 and 40 DAS, in comparison with RDF alone and control (RDF without N). The application of 100% recommended dose of N + Urea @ 2% spray recorded significantly higher growth parameters such as leaf area and dry matter accumulation at harvest and was on par with 100% recommended dose of N + Nano urea @ 0.4% spray. Significantly higher green fodder yield, dry fodder yield and nutrient content in fodder maize was recorded in 100% recommended dose of N + Urea @ 2% spray and was on par with 100% recommended dose of N + Nano urea @ 0.4% spray. Higher gross returns, net returns and B:C ratio was observed with application of 100% recommended dose of N + Urea @ 2% spray over rest of the treatments.

Key words: Nano urea, Urea, Nutrient content and Fodder yield

1. INTRODUCTION

Fodder crops are the plant species that are cultivated and harvested for feeding livestock in the form of forage (cut green and fed fresh), where livestock is an important asset and livelihood option for people in rainfed areas of India. Better feeding could be achieved by ensuring the adequate supply of good quality forage from improved varieties and best management practices (BMPs).

Fodder production depends on the cropping pattern, climate and socio-economic conditions of the region. Total area under fodder crops in India is 9.58 m. ha (Indiastats, 2020) on individual crop basis. The most common cereal fodder crops cultivated in India are maize, sorghum, pearl millet, etc. Currently in India a net deficiency of 35.6% green fodder, 44% concentrate feed materials and 10.95% dry fodder existed. Maize, Sorghum, Pearl millet and Oat provide energy-rich herbage to livestock. Among the cultivated forage crops, Maize is mostly suitable for fodder as well as silage on account of its high yield potential and nutritional profile. It has highest fodder production potential, per day productivity, wider adaptability, succulent nature, excellent fodder quality with high digestibility and palatability. Hence, safely fed to animals at any stage of crop growth.

Nitrogen (N) occupies a conspicuous place in plant metabolic system and 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). Nanotechnology can reduce the rate of nutrient loss through leaching and increase their availability to plants and thus reduce water and soil pollution. It is designed to deliver nutrients in a regulated pattern in accordance to the crop demand and thereby improve nutrient use efficiency without associated ill effects (Naderi and Shahraki., 2013).

Nano urea and Urea as foliar spray in small quantities helps in easy absorption of nitrogen through stomata, improves crop growth, yield and reduce production costs. Keeping these points in view, the present experiment on "Influence of foliar application of nano urea and urea on productivity and nutrient status of fodder Maize during *Kharif* season".

2. MATERIALS AND METHODS

The field research was conducted at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya (Karnataka) located at 12º 45' and 30º 57' North latitude and 76º 45' and 78 º 24' East longitude with 695 metre above mean sea level. The research station falls under region III and Agro Climatic Zone VI (Southern Dry Zone) of Karnataka. During the field experiment, highest rainfall of 447.1 mm was recorded in the August month and highest mean maximum air temperature was recorded during September. The relative humidity varied from 88.7 per cent to 90 per cent and 66.4 per cent to 69.0 per cent during morning and afternoon hours, respectively during the growing period. The mean bright sunshine hours varied from 4.3 to 5.8 hours during August to November. The soil characteristics of the experimental site was sandy loam in texture, medium in organic carbon (0.62 %), low in available nitrogen (206.97 kg ha^{-1}), medium in available phosphorus (42.31 kg ha^{-1}) and potassium (241.24 kg ha^{-1}).

The experiment was laid out in a randomized completely block design (RCBD) with eleven treatments and replicated thrice. The treatments were, 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 observations on leaf area and dry matter accumulation were recorded at harvest stage. The crop was harvested manually after attaining milky stage i.e., at 50% flowering and during harvesting a representative plant sample was collected from each plot to estimate dry matter percentage and nutrient analysis. Nitrogen content was determined by modified Micro-Kjeldhal's method, phosphorus content in the digested plant sample was determined by vanadomolybdate phosphoric yellow colour method in nitric acid medium and the colour intensity was recorded at 660 nm wave length and potassium in the digested plant sample was determined by atomizing the diluted acid extract in a flame photometer as described by Jackson (1973). All data recorded were analysed with the help of analysis of variance (ANOVA) technique (Gomez and Gomez 1984) and least significant difference at 5% level of significance ($P<0.05$) was computed to compare the treatments.

3. RESULTS AND DISCUSSION

3.1 Growth parameters: The data on the growth parameters like leaf area and dry matter accumulation in fodder maize as influenced by varied levels of recommended dose of nitrogen along with foliar application of different concentrations of nano urea and urea are presented in Table 1.

Significantly higher leaf area (4680.72 cm^2 $plant^{-1}$) was recorded with application of 100% recommended dose of N + Urea @ 2% spray (T_9) which was significantly on par with application of 100% recommended dose of N + Nano urea @ 0.4% spray (T_6: 4552.86 cm^2 $plant^{-1}$) at harvest. However, T_6 was on par with 100% recommended dose of N + Nano urea @ 0.2% spray (T_3: 3982.08 cm^2 $plant^{-1}$). Whereas, lower leaf area of 1705.79 cm^2 $plant^{-1}$ was observed with control treatment (T_1).

As a thumb rule, with increase in the number of leaves $plant^{-1}$, the leaf area $plant^{-1}$ also increases. Higher nitrogen applications result in noticeably increased leaf area. A combination of soil application and spray, match the N requirement of crop in demand with time series and further nano N spray at 20 and 40 DAS probably sustained the N content, thereby helped to increase the cell elongation and in turn, leaf area. (Amanullah *et al*. 2009 and Rani *et al*. 2019)

At harvest, significantly higher dry matter accumulation (75.50 g $plant^{-1}$) was recorded with application of 100% recommended dose of N + Urea @ 2% spray (T_9) which was significantly on par with application of 100% recommended dose of N + Nano urea @ 0.4% spray (T_6: 70.50 g $plant^{-1}$). However, T_6 was on par with 100% recommended dose of N + Nano urea @ 0.2% spray (T_3: 68.00 g $plant^{-1}$). Whereas, lower dry matter accumulation of 37.61 g $plant^{-1}$ was observed with control treatment (T_1).

The significantly higher dry matter accumulation in treatment T_9 followed by T_6 might be attributed due to higher number of leaves, more leaf length and width at higher nitrogen levels might have offered a larger photosynthetic surface to collect more radiant energy, which might have led to a considerable increase in dry matter accumulation with increased nitrogenous foliar fertiliser. These results are in conformity to the findings of Singh *et al.* (2012), Rani *et al*. (2019) and Ajithkumar (2021).

Table 1: Growth parameters of fodder maize as influenced by foliar application of nano urea and urea at harvest

Treatments	Growth parameters	
	Leaf area (cm^2 $plant^{-1}$)	**Dry matter accumulation (g $plant^{-1}$)**
T_1	1705.79	37.61
T_2	3284.56	62.00
T_3	3982.08	68.00
T_4	2812.50	48.17
T_5	2711.94	43.17
T_6	4552.86	70.50
T_7	3089.96	55.00
T_8	2744.06	46.17
T_9	4680.72	75.50
T_{10}	3038.37	55.33
T_{11}	2685.96	42.50
S.Em.±	**123.45**	**2.10**
CD (P=0.05)	**362.08**	**6.15**

3.2 Yield parameters: The data on the yield parameters like green fodder yield, dry matter content and dry fodder yield of fodder maize are presented in Table 2.

Green fodder yield was significantly influenced by various foliar spray treatments. The application of 100% recommended dose of N + Urea @ 2% spray recorded significantly higher green fodder yield (T_9: 427.70 q ha^{-1}) and which was found on par with application of 100% recommended dose of N + Nano urea @ 0.4% spray (T_6: 422.17 q ha^{-1}). However, T_6 was on par with 100% recommended dose of N + Nano urea @ 0.2% spray (T_3: 386.40 q ha^{-1}). Whereas lower green fodder yield of 203.20 q ha^{-1} was observed in control treatment T_1.

At harvest, dry matter 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 content (21.40%) was observed with application of 100% recommended dose of N + Urea @ 2% spray (T_9) over the remaining treatments (18.14 to 21.29%). Dry fodder yield was significantly influenced by various foliar spray treatments. The application of 100% recommended dose of N + Urea @ 2% spray recorded significantly higher dry fodder yield (T_9: 91.64 q ha^{-1}), which was found on par with application of 100% recommended dose of N + Nano urea @ 0.4% spray (T_6: 89.87 q ha^{-1}). However, T_6 was on par with 100% recommended dose of N + Nano urea @ 0.2% spray (T_3: 80.48 q ha^{-1}). Whereas lower dry fodder yield of 36.85 q ha^{-1} was observed in control treatment T_1.

The treatment T_9 was recorded significantly higher green and dry fodder yield followed by T_6 this mainly because of superior performance in vegetative growth with respect to plant height, a greater number of leaves, leaf area and leaf: stem ratio result in more accumulation of dry matter as evidence in present study. Nitrogen and phosphorus application through RDF and foliar spray of urea and nano urea treatments increase plant height, stem girth, leaf: stem ratio which ultimately increase fodder yield of maize. The results are in corroborate with the finding of Tariq *et al*. (2011), Singh *et al*. (2012) and Meena *et al*. (2021). The highest forage yield obtained with nano urea foliar spray rates were in conformity with the findings of Abdel (2018).

Table 2: Yield parameters of fodder Maize as influenced by foliar application of nano urea and urea at harvest

Treatments	Green fodder yield (q ha^{-1})	Dry matter percentage	Dry fodder yield (q ha^{-1})
T_1	203.20	18.14	36.85
T_2	375.27	20.93	78.12
T_3	386.40	20.80	80.48
T_4	316.80	19.92	63.20
T_5	275.10	18.87	51.89
T_6	422.17	21.29	89.87
T_7	321.40	20.17	65.06
T_8	293.50	19.80	58.07
T_9	427.70	21.40	91.64
T_{10}	357.80	20.50	73.17
T_{11}	293.60	19.23	56.46
S.Em.±	**13.76**	**0.73**	**3.58**
CD (P=0.05)	**40.37**	**NS**	**10.50**

3.3 Nutrient status: The concentration of major nutrients in plant sample of fodder maize as influenced various foliar spray treatments recorded at different growth stages is presented in Table 3.

At harvest, supply of 100% recommended dose of N + Urea @ 2% spray recorded significantly higher N, P and K content (1.67, 0.36 and 1.32 %, respectively) and which was statistically on par with T_6 (1.62, 0.33 and 1.26 %, respectively) and significantly superior over the remaining treatments. The lower N, P and K content (1.22, 0.21 and 1.03 %, respectively) recorded with control.

The application of RDF along with foliar application of urea and nano urea increases the nutrient concentration in soil solution. It results in better extraction by roots and translocation within plant system. Similar trend was also indicated by Sheoran *et al*. (2008) and Bochare (2015). Increased uptake of phosphorus by fodder maize might be due to an increase in the amount of urea applied to the soil as nitrogen, which when nitrified produces hydrogen ions in addition to nitrate ions. Application of nano urea increased the uptake of N due to more surface area and permeability of nano urea which in turn increased the absorption of K nutrients also. The results were conformity with the findings Manjanagouda *et al*. (2017), Abdel (2018) and Upasana *et al*. (2022).

Table 3: Nutrient status of fodder Maize as influenced by foliar application of nano urea and urea at harvest

Treatments	**Nutrient content (%)**		
	Nitrogen	**Phosphorus**	**Potassium**
T_1	1.22	0.21	1.03
T_2	1.53	0.33	1.18
T_3	1.55	0.31	1.21
T_4	1.39	0.27	1.02
T_5	1.30	0.27	1.04
T_6	1.62	0.33	1.26
T_7	1.44	0.24	1.07
T_8	1.37	0.27	0.96
T_9	1.67	0.36	1.32
T_{10}	1.50	0.31	1.07
T_{11}	1.37	0.28	0.92
S.Em.±	0.06	0.01	0.05
CD (P=0.05)	0.18	0.04	0.15

3.4 Economics: Economics in terms of cost of cultivation (COC), gross returns (GR), net returns (NR) and benefit: cost ratio (BCR) varied with different treatments (Table 4). Foliar application along with varied level of RDN slightly increased the cost of cultivation. The maximum cost of cultivation of Rs. 37,713 ha^{-1} was recorded in the treatment with application of 100% recommended dose of N + Nano urea @ 0.4% spray followed by 75% recommended dose of N + Nano urea @ 0.4% spray (Rs. 37,207 ha^{-1}) and lower cost of cultivation was recorded in treatment control (Rs. 33,129 ha^{-1}) during the period of investigation.

Application of 100% recommended dose of N + Urea @ 2% spray (1,06,925, 70,945 Rs. ha^{-1} and 2.97, respectively) followed by 100% recommended dose of N + Nano urea @ 0.4% spray (1,05,543, 67,829 Rs. ha^{-1} and 2.80, respectively) recorded higher gross, net monetary returns and BCR over all the treatments and this has resulted in higher BCR as recorded in T_9. This may be attributed to lower cost of cultivation and higher net returns as reported by Yogendra *et al*. (2020), Mohammad (2021) and Ajithkumar *et al*. (2021).

Table 4: Economics of fodder maize cultivation as influenced by foliar application of nano urea and urea

Treatments	Cost of Cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Benefit: Cost ratio
T_1	33129	50800	17671	1.53
T_2	35153	93817	58664	2.67
T_3	36513	96601	60088	2.65
T_4	36007	79200	43193	2.20
T_5	35501	68776	33275	1.94
T_6	37713	105543	67829	2.80
T_7	37207	80350	43143	2.16
T_8	36701	73376	36675	2.00
T_9	35980	106925	70945	2.97
T_{10}	35474	89450	53976	2.52
T_{11}	34968	73400	38432	2.10

4. CONCLUSION

The study demonstrated that the soil and foliar application of urea and nano urea had significant effect on growth and yield parameters of fodder maize. Thus, it can be concluded that the application of RDF (150:75:40 N: P: K kg ha^{-1}) along with urea spray @ 2% or foliar spray of nano urea @ 0.4% at 20 and 40 days after sowing is promising in increasing the growth and yield parameters of fodder maize and economically viable.

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