Effect of Nitrogen and Foliar Spray of Urea and Nano Urea on Yield and Economics of *rabi* Maize (*Zea mays* L.)

ABSTRACT:

A field experiment was conducted during *Rabi* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) on the topic "Effect of nitrogen and foliar spray of urea and nano urea on yield and economics of rabi maize (*Zea mays* L.)", to study treatments consisting of three levels of Nitrogen *viz.* 50% RDN, 75% RDN and 100% RDN and three Foliar sprays of nano urea *viz*. 2000 ppm (2ml/L), 4000ppm (4ml/L), and foliar spray of urea *viz.*, 20000ppm (2%). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28 %), available N (225 kg/ha), available P (19.50 kg/ha) and available K (92 kg/ha). There were 10 treatments each being replicated thrice and laid out in Randomized Block Design. The results revealed that higher number of cobs per plant (1.60), number of grains per cob (249.67), Seed index (23.55 g), Grain yield (6.41 t/ha), Stover yield (8.65 t/ha), Harvest Index (42.58 %), Maximum gross return (INR 1,28,266.67), net return (INR 81,682.75) and B:C ratio (1.75) as compared to other treatments.

Keywords: *Nitrogen, foliar spray, urea, nano urea, yield, economics.*

INTRODUCTION

Maize (*Zea mays* L.) is considered as one of the most important food grains in India after the main cereals rice and wheat. India ranks fifth in the area and third in production and productivity over other cereal crops and members of the Gramineae family. It is the third most important crop in Uttar Pradesh and is also regarded as the "Queen of Cereals". It has great potential to meet the food demands of living beings which collectively include both humans and animals. Nutrient composition of maize includes crude protein 7.6%, crude fiber2.3%, crude fat 3.6%, and starch 63.8%, and Total sugar 1.7%, Gross energy3840kcal/kg. In India maize is cultivated over an area of 8.49 million hectares with the production of 21.28 million tones and productivity of 2057 kg/ha. With maize world's

average yield production of 27.8 q/ha, considering Uttar Pradesh has reported 8.33% of the total maize area and 9.65% of total maize production in the country. It almost contributes 9% in national food basket. Mostly maize is cultivated throughout the year in every state for different requirements like grains, fodder, green cobs, baby corn, sweet corn, popcorn in different areas. The highest maize growing states which produce more than 80% of total maize produced in the country include Andhra Pradesh (21%), Karnataka (17%), Rajasthan (10%), Bihar (9%), Maharashtra (8%), Uttar Pradesh (7%), Madhya Pradesh (6%) and Himachal Pradesh (4.4%). Some contribution is also done by Jammu Kashmir and few North-East states. Besides, human consumption and animal feed it can also be used in certain industries like corn starch industries, corn oil production, baby corn, etc. Starch extracted from corn is considered one of the major ingredients in every home of India. From maize starch, many bi-products like corn syrups and also alcoholic beverages include beer, whiskey, etc. In India, about 28% of maize produced is used for food purposes, about 11% as livestock feed, 48%for poultry feed, 12% in the milling industry, and 1% for seeds purpose. Due to many multiple uses of maize as food, feed and fodder improves its demand and had a very great shot over low demand situation. These kind of characteristics of maize accounts for improving farmer's income and standard 65-75% acreage of maize hybrids and most of it is used as a feed for animals, also for industrial purpose where food grade maize is cultivated using traditional cultivars. Farmers are slowly replacing traditional cultivars with new high yielding hybrids now a days.

Balanced use of nitrogen (N), phosphorus (P) and potassium (K) fertilizers could play a pivotal role in increasing the yields of cereals under moisture stress condition. Among the limiting factors; proper level and ratio of NPK are of prime importance **(Asghar *et al*.2010).** Foliar application of NPK could increase crop productivity many fold under moisture stress condition. Foliar spray not only provides the nutrients but can also provide a significant amount of water in the time of water stress. In addition to supplying a nutrient for plant growth, N application could enhance drought tolerance of plant to increase yield under water deficit **(Li *et al.* 2007).** Research shows that N-application during grain filling could enhance the remobilization from stored carbohydrates in vegetative organs to grain under moderate water stress (WS), which might benefit starch synthesis and grain yield formation under post-anthesis drought. Foliar-applied N can be up to seven times more efficient than soil applied N **(Dixon *et al.* 2003)**. Other benefits of foliar applied N include lower application rates (higher efficiency), plus the relative ease of obtaining timely, uniform applications. A combination of

soil-applied and foliar applied N is the best management practice to reduce the efficient alternative for feeding N to plants.

Nano Urea is a nanotechnology based revolutionary Agri-input which provides nitrogen to plants. Nano Urea is a sustainable option for farmers towards smart agriculture and combat climate change. These fulfill the plant nutrient requirement as a fertilizer. In addition to this, Nano urea helps in minimizing the environmental footprint by reducing the loss of nutrients from agriculture fields in the form of leaching and gaseous emissions which used to cause environmental pollution and climate change.

MATERIALS AND METHODS

A field trial was conducted during *Rabi,* 2022 at Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (U.P.), India which is located at 25.40˚ N latitude, 81.85 ˚ E longitude, and 98 m altitude above the mean sea level (MSL). Nutrient sources were Urea, Single Super Phosphate, Murate of Potash and Nano urea to fulfil the requirement of Nitrogen, Phosphorus, and Potassium. The experiment was laid out in Randomized Block Design (RBD) with ten treatments replicated thrice. The treatments were 1. 50% RDN + 2000 PPM (2 ml/L) spray of Nano Urea, 2. 50% RDN + 4000 PPM (4 ml/L) spray of Nano Urea, 3. 50% RDN + 20000 PPM (2%) spray of Urea , 4.75% RDN + 2000 PPM (2 ml/L) spray of Nano Urea, 5. 75% RDN + 4000 PPM (4 ml/L) spray of Nano Urea, 6. 75% RDN + 20000 PPM (2%) spray of Urea, 7. 100% RDN + 2000 PPM (2 ml/L) spray of Nano Urea, 8. 100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea, 9. 100% RDN + 20000 PPM (2%) spray of Urea, 10. Control Plot (RDF N: P: K-120:60:60 kg/ha). The yield parameters of the plants were recorded after harvest. These parameters were statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design.

RESULTS AND DISCUSSION

YIELD

Grain yield (t/ha):

Treatment 8 with 100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea recorded the highest grain yield (6.41 t/ha). However, treatment with 100% RDN + 2000 PPM (2 ml/L) spray of

Nano Urea was statistically at par with the treatment 100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea.

The increase in grain yield might be due to the favorable influence of nitrogen in increasing the source size and establishing an appropriated source to sink relationship, respectively. Similar findings were observed by Rathnayaka *et al*. (2018). Nano urea particles have a smaller size compared to conventional urea, which can enhance their solubility and improve nutrient availability. This increased nutrient uptake, particularly nitrogen, can contribute to improved plant growth, development, and ultimately, higher maize yields (Kumar et al., 2019; Ananth et al., 2020). Nano urea has been reported to enhance plant growth parameters such as plant height, leaf area, and chlorophyll content. Improved photosynthetic efficiency can contribute to increased biomass accumulation and grain yield in maize (Tripathi et al., 2019).

Stover yield (kg/ha):

Treatment 8 with 100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea recorded the highest stover yield (8.65 t/ha). However, treatments with 100% RDN + 2000 PPM (2 ml/L) spray of Nano Urea, 100% RDN + 20000 PPM (2%) spray of Urea, and 75% RDN + 4000 PPM (4 ml/L) spray of Nano Urea were statistically at par with the treatment 100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea.

However, increased stover yield was attributed due to enhanced morphological characters. Similar findings were observed by Alimohammadi *et al*. (2020). Nano urea formulations are often developed to improve nutrient uptake efficiency. By enhancing the availability and uptake of nutrients, including nitrogen, nano urea has the potential to promote plant growth, including stover biomass production (Kumar et al., 2019; Ananth et al., 2020).

Harvest Index (%)

Treatment 8 with 100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea recorded the highest harvest index (42.58 %) and there was significant difference among the treatments.

Similarly, improvement in harvest index was mainly attributed to allocation of photosynthates to grain filling rather accumulating in the straw. Similar findings were observed by Bhuiya *et al*. (2020) and Mohanta *et al*. (2021). Nano urea may influence the biomass allocation pattern in maize plants. By promoting greater allocation of biomass towards grain production rather than vegetative growth, nano urea can contribute to an increased harvest index (Tripathi et al., 2019).

ECONOMICS

Cost of cultivation

Cost of cultivation varied due to different levels of Nitrogen and Foliar spray of urea and nano urea. Highest cost of cultivation was seen in treatment 8 with 100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea (INR 46,583.92) and lowest was seen in the 50% RDN + 20000 PPM (2%) spray of Urea (INR 44,479.92).

Gross returns

Gross returns varied due to different levels of Nitrogen and Foliar spray of urea and nano urea on Yield and Yield components of Maize. Highest Gross returns were seen in treatment 8 with 100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea (INR 1,28,266.67) and lowest Gross returns were seen in the treatment control (INR 1,12,400.00)

Net returns

Net returns varied due to different levels of Nitrogen and Foliar spray of urea and nano urea on Yield and Yield components of Maize. Highest net returns were seen in treatment 8 with 100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea (INR 81,682.75) and lowest Gross returns were seen in the treatment control (INR 66,716.08)

Benefit Cost Ratio

Highest B: C Ratio was recorded with the treatment 8, 100% RDN + 4000 PPM (4 ml/L)

spray of Nano Urea (1.75) and lowest B: C Ratio was seen in the treatment control (1.46).

CONCLUSION

Based on my research trail, the treatment combination of 100% RDN along with 4000 ppm (4ml/L) of nano urea foliar spray recorded higher growth and yield parameters, grain yield in Maize crop.

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Table 1. Effect of Nitrogen levels and foliar spray of urea and nano urea on Yield and Yield attributes of Maize.

S No	Treatments	At Harvest		
		Grain yield (t/ha)	Stover Yield (t/ha)	Harvest Index (%)
1.	50% RDN + 2000 PPM (2 ml/L) spray of Nano Urea	5.75	8.10	41.54
2.	50% RDN + 4000 PPM (4 ml/L) spray of Nano Urea	5.77	8.11	41.59
3.	50% RDN + 20000 PPM (2%) spray of Urea	5.73	8.07	41.52
4.	75% RDN + 2000 PPM (2 ml/L) spray of Nano Urea	5.90	8.24	41.72
5.	75% RDN + 4000 PPM (4 ml/L) spray of Nano Urea	6.00	8.39	41.67
6.	75% RDN + 20000 PPM (2%) spray of Urea	5.81	8.15	41.62
7.	100% RDN + 2000 PPM (2 ml/L) spray of Nano Urea	6.21	8.55	42.08
8.	100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea	6.41	8.65	42.58
9.	100% RDN + 20000 PPM (2%) spray of Urea	6.11	8.52	41.75
10.	Control Plot (RDF N: P: K-120:60:60 kg/ha)	5.62	7.96	41.39
	F-test	S	S	NS
	SE(m)±	0.08	0.10	0.47
	CD (P=0.05)	0.22	0.29	--

Table. 2 Effect of Nitrogen levels and foliar spray of urea and nano urea on on Economics of Maize.

S No	Treatments	Total cost of cultivation (INR/ha)	Gross Returns (INR/ha)	Net Returns (INR/ha)	B:C ratio
1.	50% RDN + 2000 PPM (2 ml/L) spray of Nano Urea	44829.92	115066.67	70236.75	1.57
2.	50% RDN + 4000 PPM (4 ml/L) spray of Nano Urea	45279.92	115466.67	70186.75	1.55
3.	50% RDN + 20000 PPM (2%) spray of Urea	44479.92	114666.67	70186.75	1.58
4.	75% RDN + 2000 PPM (2 ml/L) spray of Nano Urea	45479.92	118000.00	72520.08	1.59
5.	75% RDN + 4000 PPM (4 ml/L) spray of Nano Urea	45929.92	119933.33	74003.41	1.61
6.	75% RDN + 20000 PPM (2%) spray of Urea	45089.92	116266.67	71176.75	1.58
7.	100% RDN + 2000 PPM (2 ml/L) spray of Nano Urea	46133.92	124266.67	78132.75	1.69
8.	100% RDN + 4000 PPM (4 ml/L) spray of Nano Urea	46583.92	128266.67	81682.75	1.75
9.	100% RDN + 20000 PPM (2%) spray of Urea	45743.92	122133.33	76389.41	1.67
10.	Control Plot (RDF N: P: K-120:60:60 kg/ha)	45683.92	112400.00	66716.08	1.46