Eco. Env. & Cons. 29 (October Suppl. Issue) : 2023; pp. (S203-S206)

ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i05s.035

Comparative assessment of urea and nano urea for growth and yield of pearl millet

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(Received 27 March, 2023; Accepted 28 May, 2023)

ABSTRACT

The field experiment was conducted on loamy sand soil of medium nitrogen, medium phosphorus and high potassium content with pH 8.1 at Research Farm, ICAR-AICRP on Pearl Millet, Agricultural Research Station, Mandor, Agriculture University, Jodhpur during *Kharif* 2022 in randomized block design with four replications. The treatments comprised of 50% RDN in two split doses as urea top dressing at 25-30 and 35-40 DAS (T_1), 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_2), Two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_3), 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of water (600 litre ha^{-1}) at 35-40 and 45-50 DAS (T_4) and Two foliar spray of water (600 litre ha^{-1}) at 35-40 and 45-50 DAS (T_5). Results revealed that effective tillers $plant^{-1}$ (1.7), grain yield (3793 kg ha^{-1}), fodder yield (7578 kg ha^{-1}), gross return (111868 Rs.ha^{-1}), net return (80829 Rs ha^{-1}) and BC ratio (5.3) were recorded higher under 50% RDN given as urea top dressing (T_1) being at par with 25% RDN given as urea top dressing + two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_2).

Key words *Economics, Growth, Nano urea, Pearl millet, Urea and Yield*

Introduction

Millets are known as 'nutri-cereals' and climate resilient crops because of their ability to withstand under unfavourable consequences of climate change facilitating food and nutritional security for rapidly developing population, especially in resource-poor and rainfed areas (Brahmachari *et al.*, 2019). Pearlmillet [*Penisetum glaucum* (L.)] R. Br. Emend Stuntz] belong to Poaceae family is one of the important cereal crops of arid and semi-arid regions. It is a good source of carbohydrate, energy, dry matter (92.5%), fat (5-7%), ash (2.1%), dietary fibre (1.2 g 100^{-1} g), crude protein (13.6%), quality protein (8-19%), starch (63.2%), α-amylase activity, minerals (2.3 mg 100^{-1} g), vitamin A and B, antioxidants, essential amino acids. It is rich in unsaturated fatty acids (75%) that are useful in lowering cholesterol and reducing cancer risk. Being gluten-free, it is extremely useful for people suffering from celiac diseases (ICDPMSSLS-2023). Pearl millet embodies a good productivity potential particularly in areas encountering extreme environmental stress situations on account of drought. It grows well on poor sandy soils as well as its drought escaping character has made it a popular crop of drought prone areas. India is the largest producer of pearl millet with 10.86 million tonnes production from an area of 7.57 million ha with a productivity of 1436 kg ha^{-1} (ARDB, 2022). Major pearl millet growing States in

India are Rajasthan, Uttar Pradesh, Haryana, Gujarat, Madhya Pradesh, Maharashtra and Karnataka which contribute more than 90 per cent of total acreage and production of the country. Though Rajasthan has largest area under pearl millet in the country, its productivity (1049 kg ha^{-1}) is low as compared to the country (ARDB, 2022). Pearl millet cultivation in Rajasthan is mainly confined to the arid and semi-arid regions and its lower productivity in these regions are due to erratic nature of climate, poor soil physical conditions, less availability and poor quality of irrigation water and imbalance fertilization with deficiencies of some macro and micro nutrients. Besides these, soils are course texture and have poor organic matter content, low water receptivity, excessive permeability and sharp increase in soil strength upon drying are also important factors associated with low production. Among nutrients, nitrogen (N) is the first and most important nutrient required for crop growth and development. As a constituent of chlorophyll, it greatly supports the photosynthesis process (Rathnayaka *et al*., 2018). In addition, N contributes for biosynthesis of many growth-promoting enzymes and proteins and, thus, plays a crucial role in regulating plant growth especially during the vegetative phase. Among the different commercial fertilizers, urea is the most widely used, mainly due to its high nitrogen content (46% N), in addition to its compatibility with other nutrients (Elemike *et al*., 2019). However, around 75% of urea applied to the soil is lost (Chhowalla, 2017; Khalifa and Hasaneen, 2018). Nitrogen fertilizer loss primarily occurs through nitrate leaching, that contaminates ground water and volatilization that increases greenhouse gasses (i.e., nitrous oxides), contributing to the global warming. Nonetheless, the nitrogenous fertiliser use efficiency in the modern farming systems is reported to be only 45-50% (Iqbal *et al.,* 2019). The high N loss coupled with its low use efficiency forced the farmers to increase the amounts of applied N fertilizers in order to achieve better crop production (Rathnayaka *et al.,* 2018), which resulted in rising the costs of the farming practice, meanwhile, increasing the consequent environmental implications (Chhowalla, 2017; Marchiol, 2019). Therefore, there is a pressing need to improve the N availability for plants, while reducing its harmful effects to the environment. Nanotechnology can reduce the rate of fertilizer nutrients loss through leaching and increase their availability to plants which ultimately leads to reduced water and soil pollution. Present day's nano fertilizers are emerging as an alternative to conventional fertilizers (Veronica *et al*., 2015) and they are said to be an important tool in agriculture to improve crop growth, yield and quality parameters, reduce wastage of fertilizers and cost of cultivation. However, there was lack of research on comparative assessment of urea and nano urea in pearl millet crop for supporting its application part in the field. Therefore, keeping above facts in view an experiment entitled "Comparative assessment of urea and nano urea on growth and yield of pearl millet" was conducted during *Kharif* season of 2022 at Research Farm, PC Unit, ICAR-AICRP on Pearl Millet, Agricultural Research Station, Mandor, Agriculture University, Jodhpur.

Materials and Methods

The field experiment was carried out during *Kharif* season of 2022 at Research Farm of ICAR-AICRP on Pearl Millet, PC Unit, Agricultural Research Station, Mandor, Agriculture University, Jodhpur. The experimental area was located in 26.35'05° N latitude, 73.04'45° E longitude at an altitude of 150 m above the mean sea level under Agroclimatic Zone Arid Western Plains (IA) of Rajasthan. The initial soil of the experimental area was loamy sand in texture, neutral to slight saline in reaction (pH 8.1) having low in organic carbon (1.3 g kg^{-1}), medium in available nitrogen (174.0 kg ha^{-1}), medium in available phosphorus (24.2 kg ha^{-1}) and high availability of potassium (325.0 kg ha^{-1}). The experiment was laid out in randomized block design (RBD) with four replications five treatments and consisting 50% RDN in two split doses as urea top dressing at 25-30 and 35-40 DAS (T_1), 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_2), Two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_3), 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of water (600 litre ha^{-1}) at 35-40 and 45-50 DAS (T_4) and Two foliar spray of water (600 litre ha^{-1}) at 35-40 and 45-50 DAS (T_5). The hybrid MPMH 17 was sown with a seed rate of 4 kg ha^{-1} at a spacing of 45 cm x 10 cm. Recommended dose of nutrients, *i.e.* 60 kg N and 30 kg P_2O_5 per hectare applied through urea and single super phosphate. Half of recommended dose of nitrogen and full dose of phosphorus were applied as a basal application, while the remaining dose of nitrogen was top dressed as per treatments. Foliar application of IFFCO nano urea was applied at 35-40 and 45-50 DAS. All the recommended package of practices of the zone were followed for growing the crop except nutrient management. There was sufficient rains received (674 mm) during *Kharif* 2022 in total 35 rainy days. Comprehensive statistical analysis (treatment mean, standard error mean, critical difference and range of variation) and test of significance test (F-test) were carried out for each trait. For this, entire biometric data recorded during the course of investigation were compiled in proper tables and statistically analyzed by using the standard procedures of statistical analysis for randomized block design as suggested by Gomez and Gomez (1984).

Results and Discussion

The results revealed that the pearl millet crop responded to foliar application of nano urea (Table 1). The significantly higher plant height (198 cm), spike length (23.6 cm), spike diameter (2.93 cm) and test weight (7.81 g) were recorded under 50% RDN in two split doses as urea top dressing at 25-30 and 35-40 DAS (T_1) being statistically at par with 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_2) over control (T_5). Similar trend was found in terms of effective tillers plant^{-1} (1.7), grain yield (3793 kg ha^{-1}), fodder yield (7578 kg ha^{-1}), gross return (Rs.111868 ha^{-1}), net return (Rs.80829 ha^{-1}) and BC ratio (5.3). The maximum increase (55%) was recorded in number of tillers plant^{-1} due to application of 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_2) over control (T_5). Plant height (cm), spike length (cm), spike diameter (cm), grain yield (kg ha^{-1}) and fodder yield (kg ha^{-1}) were increased by 10, 16, 10, 25 and 22%, respectively over control (T_5) due to application of 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_2). Economic analysis of the data revealed that the cost of cultivation was increased by 9% over control (T_5) due to application of 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_2), however, increase in gross return and net return were comparatively higher by 25 and 30% due to T_2 over T_5. Overall, the effect of alone 25% RDN as urea top dressing at 25-30 DAS (T_4) was comparatively higher than alone two foliar spray of nano urea (2 ml l^{-1} of water) at 35-40 and 45-50 DAS (T_3) with respect to growth, yield and economics of rainfed pearl millet. The response of pearl millet to foliar application of nano urea was found when one top dressing of urea was given at 25-30 DAS. It is well known fact that adequate fertilization to crops is known to improve various physiological and metabolic processes

Table 1. Effect of urea and nano urea on growth, yield and economics of pearl millet (*Pennisetum glaucum* L.) under rainfed condition.

Treatments	Plant height (cm)	Effective (tillers/ plant)	Spike length (cm)	Spike diameter (cm)	Test weight (g)	Grain yield (kg/ha)	Fodder yield (kg/ha)	Gross return (Rs./ha)	Cost of cultivation (Rs./ha)	Net return (Rs./ha)	BC ratio
T_1	198	1.7	23.6	2.93	7.81	3793	7578	111868	20935	80829	5.3
T_2	197	1.7	23.5	2.89	7.80	3791	7576	111808	22519	79368	5.0
T_3	190	1.4	22.3	2.87	7.68	3560	7148	105096	22412	73497	4.7
T_4	192	1.5	22.4	2.88	7.70	3665	7480	108578	21367	77520	5.1
T_5	179	1.1	20.2	2.62	7.66	3022	6209	89654	20731	61265	4.3
SEm±	9.6	0.07	1.12	0.12	0.8	176	344				
CD (*P=0.05*)	NS	0.21	NS	NS	NS	541	1058				
CV (%)	10.1	9.2	10.0	8.3	2.1	9.9	9.5				

Treatments details*

T_1: 50% RDN in two split doses as urea top dressing at 25-30 and 35-40 DAS

T_2: 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of nano urea (2 ml/l of water) at 35-40 and 45-50 DAS

T_3: Two foliar spray of nano urea (2 ml/l of water) at 35-40 and 45-50 DAS

T_4: 25% RDN as urea top dressing (25-30 DAS) + two foliar spray of water (600 litre/ha) at 35-40 and 45-50 DAS

T_5: Two foliar spray of water (600 litre/ha) at 35-40 and 45-50 DAS

*50% RDN as basal was common to all treatments in the plant system. Nitrogen played a key role in carbohydrates and protein metabolism; hence, it is essential in plant growth and development. The chief function of nitrogen is cell multiplication and cell elongation and tissue differentiation that ultimately enhanced vegetative growth attributes. The increase in the growth character described above under application of nitrogen may be due to the synergistic effect of nitrogen on chlorophyll content, cell division, photosynthetic rate and root activities of plants, resulting higher removal of nutrient and thereby increasing the growth attributes. Thus, with adequate supply of nitrogen, the plants grow tall, produce more LAI and ultimately greater production of total dry matter accumulation (Rajput *et al*., 2022).

Acknowledgement

Financial support by ICAR-AICRP on pearl millet to conduct the experiment is gratefully acknowledged. Authors are thankful to Dr. C. Tara Satyavathi, Project Coordinator, ICAR-AICRP on pearl millet for providing all essential facilities to conduct this experiment.

Conclusion

From the present study it was clear that nano urea was effective to enhance yield of pearl millet when it was applied through foliar spray 10 days after one top dressing of urea at 25-30 DAS. The findings can be used to optimize dose of urea and foliar spray of IFFCO nano-urea in pearl millet under rainfed condition.

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