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## Effect of foliar application of nano urea on growth, yield and profitability of summer pearl millet (*Pennisetum glaucum* L.)

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### Abstract

An experiment was carried out during the summer season of the year 2023 at Junagadh Agricultural University, Junagadh (Gujarat) on Effect of foliar application of nano urea on growth, yield and profitability of summer pearl millet (*Pennisetum glaucum* L.). The experiment was laid out in Randomized Block Design. The results of experiment revealed that application of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS recorded significantly the highest value for plant height, SPAD meter reading and numbers of tillers per plant. Similar treatment enhanced yield attributes viz., effective tillers per plant, length and girth of ear head, grain yield (4323 kg/ha), fodder yield (9803 kg/ha). The highest gross and net return of 117878 ₹/ha and 72374 ₹/ha of obtained with treatment of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS.

**Keywords:** Pearl millet, nano urea, foliar spray, growth, yield

### Introduction

Pearl millet (*Pennisetum glaucum* L.) is one of the important millet crops of India. It is commonly known as bajra or bajri, which is belong to *Poaceae* family. It is the most widely grown staple food of majority of poor and small land holders in Asia and Africa. It is consumed as both feed and fodder for livestock. It is a C<sub>4</sub> plant with high photosynthetic efficiency and high dry matter production capacity. It is well adapted to grow under most adverse agro-climatic conditions characterized by drought, low soil fertility and high temperatures. Pearl millet grain contains about 11.6% protein, 5% fat, 67% carbohydrates and 2.7% minerals (Gill, 1991) [5]. Pearl millet is considered as more efficient in utilization of soil moisture and has a higher level of heat tolerance than sorghum and maize. It has the maximum potential of all the millets and is mainly grown in drought prone areas and marginal soils. Because of its tolerance to difficult growing conditions such as drought, low soil fertility and high temperature, it can be grown in areas where other cereal crops would not survive (Asodariya *et al.*, 2021) [1].

Urea contributes about 82% of the total fertilizer consumption in India and about 55% of the total fertilizer nitrogen consumed in the world. Around 30-40% of nitrogen from urea is utilized by plants and the rest gets wasted due to quick chemical transformation as a result of leaching, volatilization, denitrification and run off, thereby low use efficiency. Whereas, nano urea has high nitrogen use efficiency and also it is environment friendly. This fertilizer is popularly known as “smart fertilizer” because it reduces the emission of nitrous oxide which is primarily responsible for contaminating soil, air and water bodies and also helps in reduction of global warming. These properties make it a promising alternative over conventional urea (Kanno *et al.*, 2022) [7]. Nano urea particles are easily available to crops due to their small size and high surface area to volume ratio. It increased chlorophyll and photosynthesis in leaves, as well as an increase in root biomass and the number of effective tillers/branches, result in higher crop yields. Nano urea makes the use of bulk nitrogen fertilizers like urea more efficient. It is environment friendly. Required in small quantities compared to bulky nitrogenous fertilizers like urea, it is easy to store and transport. Farmers can easily carry bottles of nano urea over bulkier

urea bags, which have a substantial influence on relative logistics and warehousing costs (Meena and Verma, 2022) <sup>[9]</sup>.

## Materials and Methods

The experiment was laid at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during summer season of the year 2023 to study the Effect of foliar application of nano urea on growth, yield and profitability of summer pearl millet (*Pennisetum glaucum* L.). The experimental area was situated in South Saurashtra Agro-climatic zone of Gujarat state. The variety chosen for this experiment was GHB 1231, with a seed rate of 4 kg/ha sown at a spacing of 60 cm x 10 cm. The experiment was comprising of 10 treatments Control (T<sub>1</sub>), 100% RDN + Water spray at 25 and 45 DAS (T<sub>2</sub>), 75% RDN + Foliar spray of 1% urea at 25 and 45 DAS (T<sub>3</sub>), 75% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS (T<sub>4</sub>), 75% RDN + Foliar spray of 2% urea at 25 and 45 DAS (T<sub>5</sub>), 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), 50% RDN + Foliar spray of 1% urea at 25 and 45 DAS (T<sub>7</sub>), 50% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS (T<sub>8</sub>), 50% RDN + Foliar spray of 2% urea at 25 and 45 DAS (T<sub>9</sub>) and 50% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>10</sub>) in Randomized Block Design with three replications. The recommended dose of fertilizers 120:60:00 kg/ha N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O was applied through urea, single super phosphate (SSP). In which, half dose of nitrogen and full dose of phosphorous was applied as basal and remaining dose of nitrogen was applied at 25 DAS. Depending on the treatment, a different amount of nitrogen was applied through foliar spray. 500 L/ha water is used in each spray. The data was examined using the usual approach for analysis of variance (ANOVA), as outlined by Gomez and Gomez (1984) <sup>[6]</sup>. At a 5% probability level, the crucial difference (CD) was used to test for differences in the treatment means.

## Results and Discussion

### Effect on growth parameters

#### Plant height (cm)

The data of plant height recorded at 45 DAS, 60 DAS and at harvest are furnished in Table 1. Significantly higher plant height (110.73 cm) was recorded with application of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), it remained statistically at par with T<sub>5</sub>, T<sub>2</sub>, T<sub>4</sub>, T<sub>3</sub> and T<sub>10</sub>. The lower values of plant height (84.00 cm) were recorded under the Control (T<sub>1</sub>). Significantly higher plant height (169.07 cm) was recorded with application of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>) it remains at par with all other treatment except T<sub>7</sub> and Control T<sub>1</sub>. Significantly higher plant height at harvest (209.87 cm) was recorded with application of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), it remained statistically at par with T<sub>2</sub>, T<sub>5</sub>, T<sub>4</sub> and T<sub>3</sub>. The lower values of plant height (156.27 cm) were recorded under the Control (T<sub>1</sub>). This is due to foliar application of nano urea enhance protein synthesis and supply adequate nitrogen which plays an important role in accelerated the activity of enzyme, cell division and plant growth. The chief function of nitrogen is multiplication, cell elongation and tissue differentiation that ultimately enhanced vegetative growth of plant. Similar findings have been reported by Rajesh *et al.* (2021) <sup>[12]</sup>, Bhargavi and Sundari (2022) <sup>[2]</sup>, Samanta *et al.* (2022) <sup>[15]</sup>, Samui *et al.* (2022) <sup>[16]</sup>, Sharma *et al.* (2022) <sup>[17]</sup>, Ojha *et al.* (2023) <sup>[10]</sup>, Pal *et al.* (2023) <sup>[11]</sup>, Srivastava and Singh (2023) <sup>[18]</sup> and Udupudi *et al.* (2023) <sup>[19]</sup>.

#### SPAD value at 45 and 50 DAS

The measurement with SPAD is an indicative of greenness of

the plant, which indicates the chlorophyll content of plant. A glance of data (Table 1.) indicated that different treatments imparted their significant influence on SPAD meter reading at 45 and 50 DAS. Significantly the highest SPAD meter reading 45 DAS (47.65) and 50 DAS (51.94) was obtained under the treatment of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), which was statistically at par with T<sub>2</sub>, T<sub>5</sub>, T<sub>4</sub>, T<sub>3</sub>, T<sub>10</sub> and T<sub>9</sub>. Applying nano nitrogen not only increases the amount of nitrogen present but also increases the amount of chlorophyll and promotes the synthesis of essential elements including proteins, amino acids, and protoplasm. The increase in SPAD value was attributed to absorption and utilization of nutrients such as nitrogen by nano-fertilizers compound. Similar reports were given by Rajesh *et al.* (2021) <sup>[12]</sup> and Sharma *et al.* (2022) <sup>[17]</sup>.

Among all the treatments, treatment of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>) recorded significantly higher number of total tillers per plant (5.20), which was statistically at par with T<sub>2</sub>, T<sub>5</sub>, T<sub>4</sub>, T<sub>3</sub> and T<sub>10</sub>. In contrast, lowest number of tillers found in Control (T<sub>1</sub>) (3.80). The application of nano urea, known for its higher absorption rate and utilization efficacy, further enhanced the growth of tillers.

### Effect on yield attributes

#### Number of effective tillers

Among different treatments, significantly the highest number of effective tillers per plant (3.27) was registered with the application of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), which was statistically at par with T<sub>2</sub> and 75% RDN + Foliar spray of 2% urea at 25 and 45 DAS (T<sub>5</sub>). On the contrary, significantly the lowest effective tillers per plant (2.07) was registered under the Control (T<sub>1</sub>).

#### Ear head length (cm)

A perusal of data indicated that different treatments exhibited their significant influence on length of ear head. Significantly the highest ear head length of 26.93 cm found under the treatment of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), it remained statistically at par with 75% RDN + Foliar spray of 1% urea at 25 and 45 DAS (T<sub>3</sub>), 75% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS (T<sub>4</sub>) and 100% RDN + Water spray at 25 and 45 DAS (T<sub>2</sub>). In contrast, the Control (T<sub>1</sub>) recorded lower values of ear head length (20.00 cm).

#### Ear head girth (mm)

An appraisal of data revealed that different treatments caused their significant influence on ear head girth. Significantly the highest ear head girth (87.67 mm) was noted under the 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>) followed by 100% RDN + Water spray at 25 and 45 DAS (T<sub>2</sub>), 75% RDN + Foliar spray of 2% urea at 25 and 45 DAS (T<sub>5</sub>), 75% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS (T<sub>4</sub>) and 75% RDN + Foliar spray of 1% urea at 25 and 45 DAS (T<sub>3</sub>). Whereas, the Control (T<sub>1</sub>) recorded lower ear head girth (68.67 mm).

#### Test weight (g)

The data regarding the test weight recorded after harvest are furnished in Table 2. A perusal of the data revealed that different treatments exercised did not show any significant influence on test weight. The increase in yield attributes due to nano fertilizer used alongside conventional fertilizer, enhance plant cells capacity for nutrient absorption. This promotes optimal growth of various plant components and vital metabolic processes like photosynthesis, leading to an accumulation of higher levels of

photosynthates. Subsequently, the translocation of these photosynthates to economically vital plant parts results in a notable improvement in yield attributing parameters. These results are in conformity with the findings of Rajesh *et al.* (2021) [12], Bhargavi and Sundari (2022) [2], Ranjan *et al.* (2022) [13], Samanta *et al.* (2022) [15], Karanjikar *et al.* (2023) [8], Ojha *et al.* (2023) [10], Pal *et al.* (2023) [11] and Udupudi *et al.* (2023) [19].

### Effect on yield

#### Grain yield (kg/ha)

Scrutiny of data (Table 2.) revealed that different treatments exerted their significant influence on grain yield. Significantly the highest grain yield (4323 kg/ha) was produced with an application of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), which was statistically at par with 100% RDN + Water spray at 25 and 45 DAS (T<sub>2</sub>), 75% RDN + Foliar spray of 2% urea at 25 and 45 DAS (T<sub>5</sub>) and 75% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS (T<sub>4</sub>). However, significantly lower grain yield (3003 kg/ha) was obtained under Control (T<sub>1</sub>).

#### Dry fodder yield (kg/ha)

An appraisal of data (Table 2.) indicated that the significantly the highest dry fodder yield (9803 kg/ha) was obtained with 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), which was statistically at par with 100% RDN + Water spray at 25 and 45 DAS (T<sub>2</sub>), 75% RDN + Foliar spray of 2% urea at 25 and 45 DAS (T<sub>5</sub>), 75% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS (T<sub>4</sub>), 75% RDN + Foliar spray of 1% urea at 25 and 45 DAS (T<sub>3</sub>) and 50% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>10</sub>). Conversely, significantly lower dry fodder yield (7292 kg/ha) were recorded under Control (T<sub>1</sub>). Crop yield is the complex function of biochemical activities and physiological processes which modify plant anatomy and morphology of the growing plants. Nitrogen is an essential element of all the amino acids in plant structures which are the building blocks of plant proteins, important in the growth and development of vital plant tissues and cells like the cell membranes and chlorophyll. Thus, plants with sufficient nitrogen will experience high rates of photosynthesis and typically exhibit vigorous plant growth and development resulted increase yield. The present findings are in close agreement with the results obtained by Rajesh *et al.* (2021) [12], Bhargavi and Sundari (2022) [2], Ranjan *et al.* (2022) [13], Sahu *et al.* (2022) [14], Samanta *et al.* (2022) [15], Samui *et al.* (2022) [16], Chavan *et al.* (2023) [3], Chinnappa *et al.* (2023) [4], Karanjikar *et al.* (2023) [8], Ojha *et al.* (2023) [10], Pal *et al.* (2023) [11], Srivastava and Singh (2023) [18], Udupudi *et al.* (2023) [19] and

Upadhyay *et al.* (2023) [20].

### Harvest index

An examination of data (Table 2.) revealed that different treatments did not showed significant influence on harvest index.

### Effect on economics

For calculating gross return, grain and fodder yields and their market prices were considered, which are given in Table 3.

#### Gross return (₹/ha)

The data regarding gross return was furnished in Table 3. which revealed that the maximum gross return (117878 ₹/ha) was obtained with the treatment of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), followed by 100% RDN + Water spray at 25 and 45 DAS (T<sub>2</sub>) with mean gross return of 115024 ₹/ha. However, the minimum gross return (82375 ₹/ha) was achieved with the treatment T<sub>1</sub> (Control).

#### Cost of cultivation (₹/ha)

The highest cultivation cost (45504 ₹/ha) was incurred with the treatment of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), followed by the treatment T<sub>10</sub> (50% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS) with mean cost of 39302 ₹/ha. However, the lowest cultivation cost (41359 ₹/ha) was observed with the treatment T<sub>1</sub> (Control).

#### Net return (₹/ha)

The maximum net return (72374 ₹/ha) was accrued with the treatment of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), followed by the treatment 100% RDN + Water spray at 25 and 45 DAS (T<sub>2</sub>) with mean net return of 71112 ₹/ha. Whereas, the lower net return (41016 ₹/ha) was observed with the treatment T<sub>1</sub> (Control).

#### B:C ratio

The highest B:C ratio (2.62) was obtained under the treatment T<sub>2</sub> (100% RDN + Water spray at 25 and 45 DAS), followed by 75% RDN + Foliar spray of 2% urea at 25 and 45 DAS (T<sub>5</sub>) and 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS (T<sub>6</sub>), with an average B:C ratio of 2.60 and 2.59, respectively. The Control (T<sub>1</sub>) recorded the lowest B:C ratio (1.99). These in findings are vicinity with those reported by Rajesh *et al.* (2021) [12], Ranjan *et al.* (2022) [13], Chinnappa *et al.* (2023) [4], Karanjikar *et al.* (2023) [8], and Udupudi *et al.* (2023) [19] and Upadhyay *et al.* (2023) [20].

**Table 1:** Effect of various treatments on growth parameters of summer pearl millet

Treatment	Plant height at 45 DAS	Plant height at 60 DAS	Plant height at harvest (cm)	SPAD value at 45 DAS	SPAD value at 50 DAS	Total tillers per plant
T <sub>1</sub> Control	84.00	133.87	156.27	38.20	41.23	3.80
T <sub>2</sub> 100% RDN + Water spray at 25 and 45 DAS	105.93	165.73	197.87	47.65	51.67	5.13
T <sub>3</sub> 75% RDN + Foliar spray of 1% urea at 25 and 45 DAS	99.07	157.93	195.27	43.79	47.76	4.67
T <sub>4</sub> 75% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS	102.33	160.13	196.47	45.59	49.75	4.80
T <sub>5</sub> 75% RDN + Foliar spray of 2% urea at 25 and 45 DAS	107.93	165.33	197.07	46.07	50.15	4.93
T <sub>6</sub> 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS	110.73	169.07	209.87	47.60	51.94	5.20
T <sub>7</sub> 50% RDN + Foliar spray of 1% urea at 25 and 45 DAS	90.40	142.33	170.33	40.83	44.11	3.87
T <sub>8</sub> 50% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS	92.00	148.07	177.13	40.55	44.52	4.00
T <sub>9</sub> 50% RDN + Foliar spray of 2% urea at 25 and 45 DAS	93.27	149.93	179.60	42.11	45.79	4.07
T <sub>10</sub> 50% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS	97.00	152.60	183.07	42.83	46.68	4.87
S.Em.±	5.07	7.16	8.85	2.02	2.24	0.21
C.D. at 5%	15.08	21.28	26.00	5.99	6.66	0.63
C.V.%	8.94	8.03	8.23	8.03	8.20	8.13



**Table 2:** Effect of various treatments on yield attributes and yield of summer pearl millet

Treatment	Effective tillers per plant	Ear head length (cm)	Ear head girth (mm)	Test weight (g)	Grain yield (kg/ha)	Dry fodder yield (kg/ha)	Harvest index (%)
T <sub>1</sub> Control	2.07	20.00	68.67	8.50	3003	7292	29.09
T <sub>2</sub> 100% RDN + Water spray at 25 and 45 DAS	3.20	23.60	85.97	9.05	4219	9549	30.66
T <sub>3</sub> 75% RDN + Foliar spray of 1% urea at 25 and 45 DAS	2.53	24.27	80.00	8.91	3543	9200	27.85
T <sub>4</sub> 75% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS	2.53	24.27	83.37	8.82	3854	9376	29.12
T <sub>5</sub> 75% RDN + Foliar spray of 2% urea at 25 and 45 DAS	2.93	22.47	85.33	8.93	4080	9502	30.12
T <sub>6</sub> 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS	3.27	26.93	87.67	9.13	4323	9803	30.60
T <sub>7</sub> 50% RDN + Foliar spray of 1% urea at 25 and 45 DAS	2.13	22.13	71.43	8.54	3194	7726	29.28
T <sub>8</sub> 50% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS	2.20	22.80	74.20	8.63	3264	7899	29.34
T <sub>9</sub> 50% RDN + Foliar spray of 2% urea at 25 and 45 DAS	2.20	22.87	71.47	8.57	3368	8160	29.49
T <sub>10</sub> 50% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS	2.67	22.67	74.13	8.82	3542	8681	29.10
S.Em.±	0.17	1.13	4.31	0.21	228	545	1.77
C.D. at 5%	0.50	3.37	12.80	NS	677	1620	NS
C.V.%	11.26	8.46	9.54	4.05	10.85	10.83	10.40

**Table 3:** Effect of various treatments on economics of summer pearl millet

Treatment	Gross return (₹/ha)	Cost of cultivation (₹/ha)	Net return (₹/ha)	B:C ratio
T <sub>1</sub> Control	82375	41359	41016	1.99
T <sub>2</sub> 100% RDN + Water spray at 25 and 45 DAS	115024	43902	71112	2.62
T <sub>3</sub> 75% RDN + Foliar spray of 1% urea at 25 and 45 DAS	97783	43532	54251	2.25
T <sub>4</sub> 75% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS	105735	44484	61251	2.38
T <sub>5</sub> 75% RDN + Foliar spray of 2% urea at 25 and 45 DAS	111502	42805	68697	2.60
T <sub>6</sub> 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS	117878	45504	72374	2.59
T <sub>7</sub> 50% RDN + Foliar spray of 1% urea at 25 and 45 DAS	87584	43094	44490	2.03
T <sub>8</sub> 50% RDN + Foliar spray of 0.2% nano urea at 25 and 45 DAS	89499	44047	45452	2.03
T <sub>9</sub> 50% RDN + Foliar spray of 2% urea at 25 and 45 DAS	92360	43161	49199	2.14
T <sub>10</sub> 50% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS	97222	45066	52156	2.16

### Conclusion

On the basis of the results of a field experimentation, it is concluded that application of 75% RDN + Foliar spray of 0.4% nano urea at 25 and 45 DAS or 100% RDN in summer pearl millet grown under South Saurashtra Agro-climatic zone is beneficial as it provided significantly highest growth parameters viz., plant height, SPAD meter value, numbers of tillers per plant, yield attributes viz., effective tillers per plant, ear head length and girth and grain and dry fodder yield along with more net returns.

### Author's contribution

Vegda Shraddha formulated the theory and conducted the calculations. Vegda Shraddha validated the analytical techniques under the guidance of Dr. H.M. Bhuva. The results were collectively deliberated by all authors, and each played a role making final manuscript.

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