



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(8): 310-314
Received: 24-06-2026
Accepted: 28-07-2026

Arun Pandey
M.Sc. Scholar, Department of
Agronomy, Naini Agricultural
institute, Sam Higginbottom
University of Agriculture,
Technology and Sciences,
Prayagraj, Uttar Pradesh, India

Rajesh Singh
Professor, Department of
Agronomy, Naini Agricultural
institute, Sam Higginbottom
University of Agriculture,
Technology and Sciences,
Prayagraj, Uttar Pradesh, India

Kumar Raj
Ph.D. Scholar, Department of
Agronomy, Naini Agricultural
institute, Sam Higginbottom
University of Agriculture,
Technology and Sciences,
Prayagraj, Uttar Pradesh, India

Akankhya Pradhan
Ph.D. Scholar, Department of
Agronomy, Naini Agricultural
institute, Sam Higginbottom
University of Agriculture,
Technology and Sciences,
Prayagraj, Uttar Pradesh, India

Corresponding Author:
Arun Pandey
M.Sc. Scholar, Department of
Agronomy, Naini Agricultural
institute, Sam Higginbottom
University of Agriculture,
Technology and Sciences,
Prayagraj, Uttar Pradesh, India

Effect of nitrogen management on growth and yield of pearl millet (*Pennisetum glaucum* L.) varieties

Arun Pandey, Rajesh Singh, Kumar Raj and Akankhya Pradhan

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i8d.6247>

Abstract

A field experiment was conducted during *Kharif* season 2025 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (PH 7.1), low in organic carbon (0.36%), Available N (171.48 kg/ha), Available P (15.2 kg/ha) and available K (232.5 kg/ha). To determine the “Effect of Nitrogen Management on growth and yield of Pearl millet (*Pennisetum glaucum* L.) Varieties” to study the response of Nitrogen levels. The experiment was laid out in Randomized Block Design. The treatment comprised of 3 levels of Nitrogen and Biofertilizers along with different Varieties. There were 9 treatments which were replicated thrice, divided into Twenty-nine plots. The results revealed that significantly higher growth attributes of Pearl millet at 80 DAS viz., Plant height (182.31cm), number of tillers/m² (18.60) dry weight (85.10 g), higher crop growth rate (25.07 g/m²/day) and yield attributes i.e., Number of grains/head (1482.85), grain yield (3.83 t/ha) and stover yield (7.55 t/ha) were recorded in treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS) compared to other treatments.

Keywords: Biofertilizers, growth, nitrogen, pearl millet, varieties and yield

1. Introduction

Pearl millet (*Pennisetum glaucum* L.) is world's sixth and India's fourth important cereal food crop after rice, wheat and maize. Pearl millet is commonly known in India as Bajra or Bajri also known as 'cattail' and 'bullrush millet'. It is originated from tropical western Africa. It belongs to the family *Poaceae*. The cultivated species are *Pennisetum glaucum* L. (2n=14) used for grain and *Pennisetum purpureum* (2n=28) used for green and dry fodder. It is used as a staple food for human consumption and fodder for livestock sector. It is a C₄ plant with higher photosynthetic efficiency, more dry matter production with less inputs and more economic returns (Reddy *et al.* 2022) [15]. It is commonly known as pearl millet, cat tail, spiked or bulrush millet and locally known as Bajra. Pearl millet is not only a cereal having maximum potentiality of grain production in adverse conditions. The share of Pearl millet in total food grain production is to the tune of 10.7 per cent. The major growing states in India are Rajasthan, Maharashtra, Gujarat, Punjab, Haryana and Uttar Pradesh where, it is grown both in Kharif and summer season. In Maharashtra, the crop is grown in the hilly and dry areas of the central plateau on poor soils in the districts of Beed, Nasik, Dhule, Satara, Pune, Sangli, Aurangabad, Solapur, Jalgaon and Ahmednagar. Pearl millet covers an area of 1035 thousand hectares area in Maharashtra, producing 1123 thousand tones with productivity of 1086 kg/ha (Areshwar *et al.* 2018) [1]. The production of bajra in 2020-21, was 9.35 million tonnes from an area of 7.41 million ha with a productivity of 1,391 kg/ha. The major Pearl millet growing states are Rajasthan contributes nearly (45%) followed by Uttar Pradesh (19%), Haryana (9%), Gujarat (9%), Maharashtra (6%) and Tamil Nadu (2%). (Directorate of Millets Development, 2021-22; Project Coordinator Review, 2022) [5, 13].

In India, Pearl millet occupies an area of 7.8 million hectares with production of 9.25 million tones and productivity of 1270 kg/ha (GOI, 2022) [7]. Pearl millet are very important crops in the Agra region of Uttar Pradesh for their contribution to human and animal nutrition as components of cropping system and as restorers of soil fertility. Pearl millet – lentil cropping system is prefaced with no application of chemical fertilizer only to pearl millet. This crop sequence is also important as it requires low water inputs and labor in comparison to other pearl millet-based systems. Our

soils have been exhausted in respect of major and minor elements hampering the yield of crops.

Nitrogen is an essential nutrient for plant growth and development. Nitrogen is a very important constituent of cellular components. Alkaloids, amides, amino acids, proteins, DNA, RNA, enzymes, vitamins, hormones and many other cellular compounds contain Nitrogen as one of the elements. An adequate supply of Nitrogen is associated with vigorous vegetative growth and deep green color also. Judicious and appropriate use of fertilizer not only increases yield but also improves the quality of forage especially protein contents (Ayub *et al.* 2007) ^[3]. Generally, Pearl millet has been known for growing under low N management (Gascho 1995) ^[6] but, several studies showed that N application can increase millet production efficiency (Singh *et al.* 2010) ^[21]. N is the most important nutrient element, while sorghum is known to respond well to N fertilization. Several studies are reporting on the positive effect of N application on the yields of Pearl millet. (Srinivasarao *et al.*, 2013) ^[22].

Nano urea is a liquid fertilizer developed using nanotechnology, designed to provide nitrogen to plants efficiently and sustainably. It offers a more effective alternative to traditional urea by improving nitrogen use efficiency, reducing environmental impact, and potentially increasing crop yields. Conversely, nano fertilizers represent a significant source of nutrients in agriculture, enhancing crop growth, yield, and quality parameters. They improve nutrient use efficiency and reduce cultivation costs, proving highly effective in precision agriculture for precise nutrient management. Nano fertilizers offer increased surface area for various metabolic reactions plants, elevating photosynthesis rates, and consequently, enhancing dry matter production and crop yield (Qureshi *et al.*, 2018) ^[14].

Azotobacter is attributed with varied benefits viz., nitrogen fixation, stimulates the growth of plants and build up the soil matter. Ability of these bacteria to contribute to yields in crops is only partly a result of biological N₂-fixation. The mechanisms involved have a significant plant-growth promotion potential. Economic and environmental benefits can include increased income from reduced fertilizer cost, reduced leaching of Nitrate N to ground water as well as reduced emission of greenhouse gas, the global warming effect of which is 300 times more than CO₂ (Singh *et al.* 2016) ^[19].

2. Materials and Methods

An experiment was conducted during the *Kharif* season 2025. In the alluvial soil at the Crop Research Farm, Department of Agronomy, NAI, SHUATS, Prayagraj, U.P. It is situated 98 meters above mean sea level at latitude 25° 24' 42" N, longitude 81° 50' 56" E. About five kilometers from Prayagraj city, this location lies on the right bank of the Yamuna River beside Prayagraj Rewa Road. At a depth of 0–30 cm, a composite soil sample was taken. It underwent crushing, air drying, and physical and chemical testing. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), Available N (171.48 kg/ha), Available P (15.2kg/ha) and available K (232.5kg/ha). The seed were sown on 12th August 2025, with spacing 45 cm x 15 cm in line sowing. The experiment was laid out in a Randomized block design with nine treatments replicated thrice. The treatment details are as follows T₁ - MPMH21 + 100% RDN T₂ - MPMH21 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS, T₃ - MPMH21 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS, T₄ - 86 M 90 + 100% RDN + Azotobacter seed inoculation, T₅ - 86M90 + 75%

RDN + 4% Nano urea spray at 30 and 45 DAS, T₆ - 86M90 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS, T₇ - MD1722 + 100% RDN, T₈ - MD1722 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS, T₉ - MD1722 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS. To apply nutrients as a spreading method, 4-5 cm deep furrows were dug along the seed rows using a hand hoeing. Ten days after sowing, the gaps were filled by transplanting once germination took place. Whereas necessary, seeds were trimmed out to maintain 45 cm x 15 cm spacing. In order to reduce crop density, weed competition, intercultural operations were carried out between 25- and 45-days intervals. On 25th October 2025, harvesting of the crop was done. At regular intervals from germination to harvest, plant growth parameters such as plant height (cm), dry weight (g/plant), CGR and RGR were assessed. At harvest, yield metrics such as Number of Grains/ear head, seed yield (kg/ha) and straw yield (kg/ha) were measured at 20, 40, 60 and 80 DAS. Analysis of variance (ANOVA), as it relates to randomized block design, was used to statistically examine the observed data of nine treatments (Gomez and Gomez, 1984 and Mohan *et al.* 2024) ^[8].

3. Results and Discussion

3.1 Growth Attribute

3.1.1 Plant Height (cm)

At the time of harvest the maximum plant height (182.31 cm) was recorded under Treatment 5 (86M90 + 75% RDN + 4% nano urea spray at 30 and 45 DAS). However, Treatments 6 (86M90 + Azotobacter seed inoculation + 4% nano urea spray at 45 DAS) and 9 (MD1722 + Azotobacter seed inoculation + 4% nano urea spray at 45 DAS) were found to be statistically at par with Treatment 5, indicating that these treatments produced comparable plant heights at 80 DAS. The results indicate that plant height in pearl millet was significantly influenced by both hybrid selection and nitrogen management, as well as their interaction. Hybrids with vigorous growth habits exhibited greater plant height compared to less responsive ones, suggesting inherent variability in their ability to utilize available resources. Similar results were also reported by Reddy *et al.* (2021) ^[16]. Nitrogen application had a pronounced effect on plant height, with increasing nitrogen levels resulting in taller plants. This could be due to the role of nitrogen in chlorophyll synthesis, protein formation, and enhanced meristematic activity, which promotes cell division and elongation. These findings are in close with the results of Kumar *et al.* (2015) ^[11], who reported a significant increase in plant height with increasing nitrogen with an optimum dose observed that nitrogen fertilization significantly improved vegetative growth due to enhanced photosynthetic activity.

Number of tiller/m²

At 80 DAS, significantly maximum number of tiller/m² (18.60) was recorded in treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS) However, treatment 6 (86M90 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS), treatment 7 (MD1722 + 100% RDN) and treatment 8 (MD1722 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS) as found to be statistically at par with treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS).

The present findings indicate that increasing nitrogen levels significantly enhanced the vegetative growth and overall productivity of pearl millet. Higher nitrogen availability improved plant growth, resulting in an increased number of tillers

per plant. This response may be attributed to enhanced cell division, chlorophyll synthesis, photosynthetic activity, and various physiological and metabolic processes. Nitrogen also acts as a key component in enzyme activation, promoting better plant growth and development. These findings are similar to Vinod Kumar *et al.* (2018) ^[12].

Plant dry weight (g)

At 80 DAS, significantly higher plant dry weight (85.10 g) was recorded in treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS). However, treatment 4 (86M90 + 100% RDN) and treatment 9 (MD1722 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS) and was found to be statistically at par with treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS). Plant dry weight is a key indicator of vegetative growth and overall crop productivity in Pearl millet. The present findings indicate that increasing nitrogen levels significantly enhanced plant dry matter accumulation, which may be attributed to improved nitrogen availability leading to enhanced cell division, chlorophyll synthesis, and photosynthetic activity and the physiological and metabolic processes and metal activator or enzymes resulting in increased growth and development of plant. Similar results were also reported by Reddy *et al.* (2021) ^[16].

Crop growth rate (g/m/day)

The significantly higher crop growth rate (25.07 g/m/day) recorded during 60–80 DAS under Treatment 5 (86M90 + 75% RDN + 4% nano urea spray at 30 and 45 DAS) may be attributed to the synchronized supply of nitrogen during the period of maximum vegetative growth and reproductive transition in Pearl millet. Foliar application of nano urea at 30 and 45 DAS likely improved nitrogen availability during the crop's peak demand, resulting in enhanced chlorophyll content, photosynthetic efficiency, leaf area development, and dry matter accumulation Singh *et al.*, (2016) ^[19]. The improved nitrogen use efficiency of nano urea, together with 75% RDN, appears to have sustained active growth, leading to a higher crop growth rate during this critical growth phase. Similar findings were reported by Srivastava *et al.* (2023) ^[23]. Who observed that the combined application of recommended nitrogen and foliar nano urea significantly increased crop growth and biomass accumulation in Pearl millet compared with lower nitrogen treatments.

Post harvest observations

Number of grains/ear head

Significantly maximum number of grains/ear head (1482.85) was observed in treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS). However, treatment 6 (86M90 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS), treatment 7 (MD1722 + 100% RDN), and treatment 8 (MD1722 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS) were found to be statistically at par with the treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS). The improvement in grain number with higher nitrogen application may be attributed to enhanced vegetative growth and better development of

reproductive structures. Adequate nitrogen supply during critical growth stages promotes panicle development, floret initiation, and reduces floret abortion, thereby increasing the number of grains per ear head. These results are in agreement with Chouhan *et al.* (2015) ^[4], who reported that nitrogen plays a vital role in reproductive development and yield formation in cereals.

Grain Yield (t/ha)

Significantly higher grain yield (3.83 t/ha) was recorded in treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS). However, treatment 6 (86M90 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS) was found to be statistically at par with the treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS). Applying nitrogen might be applied to improve vegetative development, probably uptake and utilization of other elements fascinated by its wide root system developed by NPK imitation. The increase in grain yield with higher nitrogen levels can be attributed to enhanced vegetative growth, improved leaf area index, and higher photosynthetic activity, which ultimately led to better assimilate production and translocation towards reproductive organs. Nitrogen also plays a crucial role in the formation of yield-attributing characters such as number of effective tillers, earhead length, and grain weight. Similar findings were previously published by Sharma *et al.*, (2012) ^[18] and Singh *et al.*, (2016) ^[20].

Stover yield (t/ha)

Significantly higher stover yield (7.55 t/ha) was recorded in treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS). However, treatment 6 (86M90 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS), treatment 7 (MD1722 + 100% RDN), and treatment 8 (MD1722 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS) were found to be statistically at par with the treatment 5 (86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS).

The significantly higher stover yield recorded under Treatment 5 (86M90 + 75% RDN + 4% nano urea spray at 30 and 45 DAS) may be attributed to the improved nitrogen availability throughout the crop growth period. The enhanced nitrogen use efficiency of nano urea, coupled with a reduced basal nitrogen dose, could have contributed to greater stover production while minimizing nitrogen losses through volatilization and leaching. Similar findings have been reported by Srivastava *et al.* (2023) ^[24]. Who observed significantly higher stover yield in Pearl millet. The combined application of 75% recommended nitrogen dose (RDN) and foliar nano urea sprays at critical growth stages likely enhanced photosynthetic efficiency, chlorophyll synthesis, and vegetative growth, resulting in greater biomass accumulation. Nano urea, owing to its higher nutrient use efficiency and gradual nitrogen release, may have supplemented the crop's nitrogen requirement effectively while minimizing nitrogen losses Vasanth *et al.* (2025) ^[26]. These findings indicate that nano urea, either in combination with reduced fertilizer nitrogen or with biofertilizer inoculation, has the potential to maintain stover yield while reducing dependence on conventional nitrogen fertilizers Hemanth *et al.* (2025) ^[9].

Table 1: Effect of Nitrogen management on growth attributes of Pearl millet varieties

S. No.	Treatments	Plant height (cm)	Number of tiller/m ²	Plant dry weight (g)	Crop Growth Rate (g/m ² /day)
		80 DAS	80 DAS	80 DAS	60 – 80 DAS
1	MPMH21 + 100% RDN	159.28	15.21	47.15	12.69
2	MPMH21 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS	155.64	15.36	45.92	10.20
3	MPMH21 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS	157.29	16.40	43.71	13.20
4	86M90 + 100% RDN	178.09	16.45	84.38	18.69
5	86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS	182.31	18.60	85.10	25.07
6	86M90 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS	179.81	17.50	76.43	16.47
7	MD1722 + 100% RDN	175.26	16.56	68.10	17.48
8	MD1722 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS	174.17	18.19	74.05	11.07
9	MD1722 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS	175.37	17.65	83.03	17.07
	F-test	S	S	S	S
	SEm(±)	3.12	0.69	2.21	2.12
	CD (p=0.05)	9.29	2.06	6.64	6.35

Table 2: Effect of Nitrogen management on yield attributes of Pearl millet varieties

S. No.	Treatments	Grains/ear head (no.)	Grain yield (t/ha)	Straw yield (t/ha)
1	MPMH21 + 100% RDN	1081.74	2.39	4.79
2	MPMH21 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS	1139.65	2.24	5.18
3	MPMH21 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS	1108.55	2.75	5.52
4	86M90 + 100% RDN	1272.40	3.36	7.13
5	86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS	1482.85	3.83	7.55
6	86M90 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS	1349.40	3.71	7.24
7	MD1722 + 100% RDN	1443.78	3.38	6.89
8	MD1722 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS	1393.24	3.41	7.13
9	MD1722 + Azotobacter seed inoculation + 4% Nano urea spray at 45 DAS	1281.70	3.07	6.13
	F-test	S	S	S
	SEm(±)	24.50	0.12	0.21
	CD (P= 0.05)	71.86	0.36	0.62

4. Conclusion

It is concluded that application of 86M90 + 75% RDN + 4% Nano urea spray at 30 and 45 DAS in treatment -5 was recorded highest growth attributes and grain yield, in Pearl millet crop which performed better in terms of growth and yield.

Acknowledgement

I am grateful to my advisor Prof (Dr.) Rajesh Singh as well as all of the faculty members of Department of Agronomy, NAI, SHUATS, Prayagraj, for their unwavering support and advice throughout the entire experimental research study.

References

- Areshwar B. Status of pearl millet cultivation in Maharashtra. Maharashtra (India): Department of Agriculture, Government of Maharashtra; 2018.
- Arshad M, Ahmad R, Mahmood A, Hassan FU. Effect of nitrogen levels on growth, yield and quality of pearl millet (*Pennisetum glaucum* L.). Journal of Animal and Plant Sciences. 2016;26(2):470-476.
- Ayub M, Nadeem MA, Tanveer A, Husnain A. Effect of different levels of nitrogen and harvesting times on forage yield and quality of pearl millet. Pakistan Journal of Agricultural Sciences. 2007;44(4):592-595.
- Chouhan M, Singh P, Kumar R, Yadav R. Effect of nitrogen and phosphorus levels on growth, yield attributes and yield of pearl millet (*Pennisetum glaucum* L.). Annals of Agricultural Research. 2015;36(2):188-192.
- Directorate of Millets Development. Annual Report 2021-22. Jaipur (India): Directorate of Millets Development, Department of Agriculture & Farmers Welfare, Government of India; 2022.
- Gascho GJ. Nitrogen fertilization of pearl millet. In: Proceedings of the National Grain Pearl Millet Symposium; 1995. p. 141-148.
- Government of India. Agricultural Statistics at a Glance 2022. New Delhi (India): Ministry of Agriculture and Farmers Welfare, Government of India; 2022.
- Gomez KA, Gomez AA. Statistical procedures for agricultural research. New York: John Wiley and Sons; 1984.
- Hemanth K, Reddy PS, Kumar M, Singh V. Effect of nano urea and biofertilizers on growth, yield and nitrogen use efficiency of pearl millet (*Pennisetum glaucum* L.). International Journal of Plant and Soil Science. 2025;37(1):145-154.
- Kumar A, Bobra JS. Economics of nitrogen management in pearl millet under semi-arid conditions. Indian Journal of Agricultural Economics. 2014;69(4):522-528.
- Kumar R, Singh R, Yadav RS. Effect of nitrogen levels on growth and yield of pearl millet (*Pennisetum glaucum* L.). Indian Journal of Agronomy. 2015;60(3):449-453.
- Kumar V, Meena BS, Sharma R. Influence of nitrogen levels on growth, yield and quality of pearl millet (*Pennisetum glaucum* L.). International Journal of Chemical Studies. 2018;6(5):2788-2792.
- Project Coordinator Review. Annual Review of All India Coordinated Research Project on Pearl Millet. Jodhpur (India): Indian Council of Agricultural Research; 2022.
- Qureshi A, Singh DK, Dwivedi S. Nano-fertilizers: A novel way for enhancing nutrient use efficiency and crop productivity. International Journal of Current Microbiology and Applied Sciences. 2018;7(2):3325-3335.
- Reddy BVS, et al. Pearl millet: A climate-resilient crop for nutritional security and sustainable agriculture. Indian Journal of Agricultural Sciences. 2022;92(4):421-428.
- Reddy BVS, Sharma HC, Rao PS. Nitrogen management and

- hybrid performance for improving productivity of pearl millet under semi-arid conditions. *Indian Journal of Agricultural Sciences*. 2021;91(6):873-878.
17. Sharma RK, Singh R, Meena NL. Effect of fertility levels on growth and yield attributes of pearl millet (*Pennisetum glaucum* L.). *Forage Research*. 2008;34(3):173-176.
 18. Sharma RK, Yadav BL, Meena RS. Response of pearl millet (*Pennisetum glaucum* L.) to nitrogen fertilization under rainfed conditions. *Indian Journal of Agronomy*. 2012;57(2):178-181.
 19. Singh A, Kumar R, Sharma S. Effect of nitrogen management on growth, yield and nutrient uptake of pearl millet (*Pennisetum glaucum* L.). *International Journal of Agriculture Sciences*. 2016;8(51):2298-2302.
 20. Singh JS, Pandey VC, Singh DP. Efficient soil microorganisms: A new dimension for sustainable agriculture and environmental development. *Agriculture, Ecosystems & Environment*. 2016;140:339-353.
 21. Singh R, *et al.* Effect of nitrogen levels on growth, yield and nitrogen use efficiency of pearl millet (*Pennisetum glaucum* L.). *Indian Journal of Agronomy*. 2010;55(1):68-72.
 22. Srinivasarao C, Wani SP, Sahrawat KL, Rego TJ, Pardhasaradhi G. Integrated nutrient management for enhancing productivity and nitrogen use efficiency in pearl millet. *Indian Journal of Fertilisers*. 2013;9(4):30-40.
 23. Srivastava A, Patel P, Singh D, Verma S. Evaluation of nano urea in combination with conventional nitrogen fertilizer on growth and productivity of pearl millet (*Pennisetum glaucum* L.). *The Pharma Innovation Journal*. 2023;12(8):1345-1350.
 24. Srivastava A, Singh R, Choudhary D, Pradhan A, Roy S, Pandey S, *et al.* Effect of nitrogen rates and foliar spray of urea application and nano urea on yield and economics of rabi maize (*Zea mays* L.). *International Journal of Environment and Climate Change*. 2023.
 25. Vasanth P, Kumar G, Reddy MS, Rao N. Nano urea improves nitrogen use efficiency, biomass production and yield in pearl millet. *Journal of Plant Nutrition*. 2025;48(3):425-437.
 26. Vasanth P, Sivakumar K, Jeyajothi R, Chandrasekaran P. Foliar spray of urea and nano-urea in yield and economics of maize (*Zea mays* L.). *Journal of Applied and Natural Science*. 2025.