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Effect of Nitrogen Management on Growth and Yield of Pearl Millet (*Pennisetum glaucum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *Zaid* season of 2023 at Crop Research Farm Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Sciences and Technology. To determine "Effect of Nitrogen Management on Growth and Yield of Pearl Millet" the result revealed that treatment 6 [25% Nitrogen through poultry manure + 75% Nitrogen through urea] recorded significantly higher plant height (183.10 cm), higher plant dry weight (64.49 g), higher ear head length (26.10 cm), maximum number of ear head/plant (2.20), higher grain yield (2.46 t/ha) and higher straw yield (6.79t/ha).

Keywords: Pearl millet; urea; vermicompost; poultry manure; nitrogen; growth and yield.

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1. INTRODUCTION

One of the major millet crops for dry and semi-arid climates is pearl millet (*Pennisetum glaucum* L.). It is a member of the Poaceae family. Due to its ability to withstand dryness, it is produced on poor, sandy soil and, in comparatively dry regions of the nation, yields staple food in a short amount of time. Pearl millet, a staple crop for millions of people living in dry regions, ranks sixth in importance among grains in India, behind rice, wheat, maize, and sorghum. It is a greater source of protein (12.1% digestibility), fat (5%), carbohydrates (69.4%), and minerals (2.3%), than many cereals. Green fodder is either made into silage, which is very helpful in arid areas, or conserved hay.

"Over an area of over 6.70 million hectares, pearl millet is produced in India, where it produces 9.62 million tonnes and has a productivity of 1.44 t/hectare. In Uttar Pradesh, there are 0.90 million hectares of pearl millet planted, with a production of 1.95 million tonnes and a yield of 2.16 t/hectare" [1].

One of the essential plant nutrients, nitrogen, is lacking in the majority of Indian soils, especially those with light textures. It is a crucial component of chlorophyll and has a role in the synthesis of proteins, nucleic acids, growth hormones, and vitamins. In dry and semi-arid regions, the biggest obstacles to agricultural productivity are low soil fertility and unpredictable rainfall. Lack of nitrogen is one of the main factors limiting agricultural productivity. The distinctive characteristics of N include its extremely low organic matter content, highly ammonia-potential soils, and soils with specific limitations on native N supply (NH3). Older leaves become orange-yellow in colour and eventually die from the tip down due to a N shortage; new leaves are slender, short, andrigid. Similarly, a deficiency of N causes a decrease in plant height and the number of tillers.

"A key factor in pearl millet's increased productivity and output is nitrogen. One of the most crucial plant nutrients for agricultural plant growth and development is nitrogen. Additionally, it is crucial for the production of amino acids and chlorophyll, which are components of protein and support plant development. Nitrogen aids in the early development of photosynthesis-capable leaf area. Pearl millet is a crop that requires a lot of energy and devours plant nutrients. Nitrogen encourages quick leaf and stem development, which raises production and quality" [2]. "The most common commercial nitrogen fertiliser used to boost agricultural yield is urea" [3].

Vermicompost is the final product of an organic waste decomposition process that employs earthworms to produce high-quality compost mostly composed of decomposed organic matter and worm cast. Animal dung, household garbage, and agricultural waste may all be turned into incredibly nutrient-dense fertilisers for soil and plants with the help of vermicomposting. Vermicompost contains 1.5% K, 1% P, and 3% N. It improves soil structure and water-holding capacity while safeguarding soil health and preventing environmental contamination. "In addition to altering the pH, solidity, and salinity of the soil and promoting the activity of microbes that help plants receive macro- and micronutrients through biological processes, it also enhances the solubility of nutrients" [4].

"An essential organic fertiliser source for raising pearl millet grain and stover output is poultry manure. Poultry manure is used by farmers who understand its benefits for improved soil and increased crop yield. Compared to cow dung, poultry manure has a greater proportion of N, P, and K" [5]. "One of the best sources of nutrients is poultry manure. The highest organic C:N ratio and the lowest organic C:N concentration were found in poultry manure. It has been discovered that poultry dung contains more nitrogen than other animal wastes. Because of its slow-release pattern, it lessens nitrogen loss" [6].

"Long-term soil fertility and consistently better levels of productivity may be maintained by using an organic and inorganic fertiliser mix wisely. It has been discovered that integrating organic manure and inorganic fertiliser has promise for stabilising crop output, preserving better crop yield, and enhancing soil physical conditions" [7].

Keeping in view of the above fact, the experiment was conducted to find out "Effect of Nitrogen Management on Growth and Yield of Pearl Millet (*Pennisetum glaucum* L.)"

2. MATERIALS AND METHODS

The experiment was conducted during *Zaid* season 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental field was sandy loam in texture, with soil (pH 7.8), low level of organic carbon (0.62%), available N (225 Kg/ha), P (38.2 kg/ha), K (240.7 kg/ha) and zinc

(2.32 mg/kg). The experiment was laid out in RBD with 09 treatments each replicated thrice. The treatment combinations are T1- 100% Nitrogen through urea, T2- 25% Nitrogen through vermicompost + 75% Nitrogen through urea, T3- 50% Nitrogen through vermicompost + 50% Nitrogen through urea, T4- 75% Nitrogen through vermicompost + 25% Nitrogen through urea, T5- 100% Nitrogen through vermicompost, T6- 25% Nitrogen through poultry manure + 75% Nitrogen through urea, T7- 50% Nitrogen through poultry manure + 50 % Nitrogen through urea, T8- 75% Nitrogen through poultry manure + 25% Nitrogen through urea, T9- 100% Nitrogen through poultry manure. Data recorded on different aspects of crop, *viz*., growth, yield attributes & yield were subjected to statistically analysed by analysis of variance method as described by Gomez and Gomez [8].

3. RESULTS AND DISSCUSSION

3.1 Growth Attributes

3.1.1 Plant height (cm)

The data revealed that significantly higher plant height (183.1 cm) was recorded in treatment 6 [25% Nitrogen through Poultry manure + 75% Nitrogen through Urea]. However, the treatment 2 [25% Nitrogen through Vermicompost + 75% Nitrogen through Urea], treatment 7 [50% Nitrogen through Poultry manure + 50% Nitrogen through Urea], treatment 3 [50% Nitrogen through Vermicompost + 50% Nitrogen through Urea], and treatment 1 [100% Nitrogen through Urea] were found to be statistically at par with treatment 6 [25% Nitrogen through Poultry manure + 75% Nitrogen through Urea]. “The significant and higher plant height was observed with application of 25% Nitrogen through poultry manure and 75% Nitrogen through urea, may be due to during initial stages of crop, nutrients are readily available through inorganic fertilizers, whereas during later stages of crop the nutrients are supplied by both inorganic as well as organic forms due to decomposition, thus making higher availability of nutrients which resulted in better root development and high photosynthetic rate, resulted higher plant height. Similar result was also reported: Amarghade and Singh, [7].

3.1.2 Plant dry weight (g)

“Results revealed that significant higher plant dry weight (64.49 g) was recorded in treatment 6 (25% Nitrogen through Poultry manure + 75% Nitrogen through Urea). However, treatment 2 (25% Nitrogen through Vermicompost + 75% Nitrogen through Urea) was found statistically at par treatment 6 (25% Nitrogen through Poultry manure + 75% Nitrogen through Urea) Significant and higher plant dry weight was observed with application of organic and inorganic, may be due to release of macro and micro nutrients with application of inorganic and organic under favourable environment might have helped in higher uptake of nutrients, this accelerated the growth of new tissues and development of new shoots that have ultimately increased plant dry weight. Similar results were reported” [9].

3.1.3 Crop Growth Rate (g/m2/day)

The data recorded during 60-80 DAS, significantly higher crop growth rate (16.91 g/m^2/ day) was recorded in treatment 6 [25% Nitrogen through poultry manure + 75% Nitrogen through urea]. However, treatment 2 [25% Nitrogen through vermicompost + 75% Nitrogen through urea], treatment 7 [50% Nitrogen through poultry manure + 50 % Nitrogen through urea], treatment 3 [50% Nitrogen through vermicompost + 50% Nitrogen through urea] were found statistically at par with treatment 6 [25% Nitrogen through poultry manure + 75% Nitrogen through urea]. Significantly higher crop growth rate was recorded with the application of Poultry manure may be due to higher nitrogen availability may have incorporatied in the soil through continuous slow release of nutrients supply resulted better crop growth rate. Similar results were reported by Ashokh et al. [10]. Further, significantly higher crop growth rate was increased with the application inorganic fertilizer might be the increased availability of nutrients to plant initially through inorganic nitrogen source. Similar results were reported by Yadav et al. [11].

3.1.4 Relative Growth Rate (g/g/day)

The data revealed that during 60-80 DAS, higher relative growth rate (0.0232 g/g/day) was recorded in treatment 5 [100% Nitrogen through vermicompost]. There was found no any significant difference among all the treatments.

3.2 Yield and Yield Parameters

3.2.1 Ear head length

The data recorded that Significant and higher ear head length (26.10 cm) was recorded in treatment 6 [25% Nitrogen through poultry manure + 75% Nitrogen through urea]. However, the treatment 2 [25% Nitrogen through

vermicompost + 75% Nitrogen through urea], treatment 7[50% Nitrogen through poultry manure + 50 % Nitrogen through urea], treatment 3[50% Nitrogen through vermicompost + 50% Nitrogen through urea] were found statically at par with treatment 6 [25% Nitrogen through poultry manure + 75% Nitrogen through urea]. Significant and higher ear head length was with the application of Poultry manure, may be due to the release of essential nutrients by the poultry manure which may have increased of nutrient availability to the plants, resulted in more nutrient uptake and its subsequent translocation to the developing spike. Similar findings were reported by Swaroop and Debbarma [6] in foxtail millet. Further, significantly higher ear head length with application of urea might be due to high nitrogen uptake by plants which may have influenced better growth characters particularly ear head length. Similar findings were reported by Devi and Debbarma [12] in rice.

3.2.2 Number of ear head / plant

The data recorded that Significant and maximum number of ear head was recorded in treatment 6 [25% Nitrogen through poultry manure + 75% Nitrogen through urea]. However, the treatment 2 [25% Nitrogen through vermicompost + 75% Nitrogen through urea], treatment 7[50% Nitrogen through poultry manure + 50 % Nitrogen through urea] were found statically at par with treatment 6 [25% Nitrogen through poultry manure + 75% Nitrogen through urea]. Significant and maximum number of ear head/ plant was with the application of Poultry manure may be due to produces more humic acid which form water soluble chelated phosphorus which helped in easy release of phosphorus to the crop which resulted in increased grain and straw yield as well as overall growth characteristics. Similar findings were reported by Ledhan et al. [13] in finger millet Further, significant and maximum number of ear head /plants was with the application of Nitrogen through urea may be due to supply of nutrient from inorganic nutrient sources and prolonged availability of nutrients to the growing plant, which results into tissue differentiation from somatic to reproductive meristematic activity resulting in higher number of ear head /plant. These results were corroborated by Patel et al. [14] in groundnut.

3.2.3 Test weight (g)

Treatment 6 [25% Nitrogen through poultry manure + 75% Nitrogen through urea], recorded higher test weight (8.50 g). There was found no any significant difference among all the treatments.

3.2.4 Grain yield (t/ha)

The data recorded Significant and higher grain yield (2.46 t/ha) was recorded in treatment 6 [25% Nitrogen through Poultry manure + 75% Nitrogen through Urea]. However, treatment 2 [25% Nitrogen through Vermicompost + 75% Nitrogen through Urea] was found statistically at par treatment 6 [25% Nitrogen through Poultry manure + 75% Nitrogen through Urea]. Significant and higher grain yield with the application of Poultry manure may be ascribed to better root growth and development, resulting in more nutrient uptake and higher dry matter accumulation per plant and its subsequent translocation to the developing panicle, and relate to the release of essential nutrient elements by the poultry litter and increase of nutrient availability. Similar findings were reported by Goud et al. [5]. Further, significant and higher seed yield with application of urea this might be due to the fact that nitrogen led to higher availability of nutrient that promoted growth and development and ultimately resulting in increasing yield attributes and yield. Similar results were reported by Chuhan et al. (2015) [2].

3.2.5 Straw yield

“Significant and higher straw yield (6.76 t/ha) was recorded in treatment 6 [25% Nitrogen through Poultry manure + 75% Nitrogen through Urea]. However, treatment 2 [25% Nitrogen through Vermicompost + 75% Nitrogen through Urea] was found statistically at par treatment 6 [25% Nitrogen through Poultry manure + 75% Nitrogen through Urea. Significant and higher straw yield was with the application of Poultry manure may be due to incorporation of organic manures increases the availability of plant nutrients and helps in formation of organic acids through decomposition process, which develops native nutrients within the soil and increases their availability to plants for better vegetative growth and leads to increase in straw yield” (Suma et al., 2023) [15]. Further, “significant and higher stover yield was with application of urea maybe it improves plant metabolic processes, leaf photosynthetic area, it ultimately results in greater nutrient uptake by the plant, increasing grain and straw yield in pearl millet. Similar results were reported” [16].

Table 1. Effect of nitrogen management on growth attributes of pearl millet

S.No.	Treatment combinations	Plant height (cm) (80 DAS)	Plant dry weight (g)	CGR ($g/m^2/day$)	RGR (g/g/day)
1	100% Nitrogen through urea	175.24	54.16	13.69	0.0207
2	25% Nitrogen through vermicompost + 75% Nitrogen through urea	180.92	62.21	15.64	0.0205
3	50% Nitrogen through vermicompost + 50% Nitrogen through urea	176.98	57.91	14.94	0.0212
4	75% Nitrogen through vermicompost + 25% Nitrogen through urea	170.42	51.09	13.22	0.0213
5	100% Nitrogen through vermicompost	167.70	48.87	13.50	0.0232
6	25% Nitrogen through poultry manure + 75% Nitrogen through urea	183.10	64.49	16.91	0.0217
7	50% Nitrogen through poultry manure + 50 % Nitrogen through urea	178.66	59.38	16.07	0.0225
8	75% Nitrogen through poultry manure + 25% Nitrogen through urea	172.76	53.62	13.60	0.0209
9	100% Nitrogen through poultry manure	168.00	49.82	13.23	0.0220
	F-test	**S**	**S**	**S**	**NS**
	SEm(±)	2.99	1.63	0.78	0.0032
	CD (P=0.05)	8.97	4.88	2.34	-

Table 2. Effect of nitrogen management on yield and yield attributes of pearl millet

S.No.	Treatment combination	Ear head length (cm)	Number of ear head/ plant	Test weight (g)	Grain Yield (t/ha)	Straw Yield (t/ha)	Harvest Index (%)
1	100% Nitrogen through urea	23.93	1.67	7.89	1.60	4.61	25.51
2	25% Nitrogen through vermicompost + 75% Nitrogen through urea	25.33	2.13	8.40	2.28	5.94	27.86
3	50% Nitrogen through vermicompost + 50% Nitrogen through urea	24.20	1.80	8.05	1.88	5.57	25.31
4	75% Nitrogen through vermicompost + 25% Nitrogen through urea	21.10	1.47	7.35	1.48	3.81	29.69
5	100% Nitrogen through vermicompost	19.00	1.33	7.12	1.34	3.64	28.36
6	25% Nitrogen through poultry manure + 75% Nitrogen through urea	26.10	2.20	8.50	2.46	6.79	26.85
7	50% Nitrogen through poultry manure + 50 % Nitrogen through urea	24.86	1.87	8.32	1.97	5.79	25.39
8	75% Nitrogen through poultry manure + 25% Nitrogen through urea	21.53	1.47	7.50	1.51	4.43	25.21
9	100% Nitrogen through poultry manure	19.76	1.40	7.20	1.45	3.75	28.90
F test		**S**	**S**	**NS**	**S**	**S**	**NS**
SEm(±)		0.69	0.12	0.39	0.14	0.55	3.76
CD (P=0.05)		2.06	0.35	_	0.42	1.63	_

3.2.6 Harvest index (%)

Treatment 4 [75% Nitrogen through vermicompost + 25% Nitrogen through urea], recorded higher harvest index (29.69%). Though there was no significant difference was found among all the treatments.

4. CONCLUSION

It is concluded that (treatment 6), application of 25% Nitrogen through poultry manure and 75% Nitrogen through urea recorded higher growth and seed yield.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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