

Nitrogen and Phosphorus Combination Effect on Growth and Yields of Pearl Millet (*Pennisetum glaucum* L.)

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ABSTRACT

Pearl millet (*Pennisetum glaucum* L.) is a vital cereal crop in India, especially in arid and semi-arid regions, due to its resilience to drought and low soil fertility. This study investigates the combined effects of nitrogen (N) and phosphorus (P) fertilization on the growth and yield of pearl millet. A field experiment was conducted at the Research Farm of Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, during the *kharij* season of 2024, employing a Randomized Block Design with ten fertilizer treatments replicated three times. The treatments included varying levels of nitrogen (50, 75, and 100 kg/ha) and phosphorus (50, 75, and 100 kg/ha), while potassium (100 kg/ha) was held constant. The results demonstrated that increasing levels of nitrogen and phosphorus significantly improved plant height, leaf count, SPAD value, dry weight, panicle length, and grain yield. The highest

yield (1,800 kg/ha) and straw yield (5,111 kg/ha) were recorded in the $N_{100}+P_{100}+K_{100}$ treatment, while the lowest yield was observed in the control (1,199 kg/ha). These findings highlight the importance of balanced N and P fertilization in optimizing pearl millet productivity. The study offers valuable input in nutrient management strategies for increasing millet yield and sustainability in Punjab's agroecological conditions.

Keywords Pearl millet, Nitrogen, Phosphorus, Fertilizer response, Yield, Punjab.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.) ranks as the fourth most important food crop in India, after rice (*Oryza sativa* L.), wheat (*Triticum aestivum* L.), and sorghum (*Sorghum bicolor* L.). It is highly resilient, thriving in conditions of drought, low soil fertility, and acidic soils. At world level, pearl millet is cultivated in 30 countries across Asia and Africa, covering near about 26 million hectares, with Asia accounting for 46% of this area. India solely represents 42% of the total global area under pearl millet cultivation (Muhammad *et al.* 2019). It is a vital millet crop commonly referred to as a “poor man’s food.” India is the largest producer of pearl millet in the world, which contribute 42% of the global production. In India, pearl millet is grown on approximately 6.93 million hectares, which constitutes a significant share

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of the global area under pearl millet cultivation. It contributes notably to the country's cereal production, with an annual production of 8.61 million tonnes and an average productivity of 1,243 kg/ha (AICPMIP 2024).

Given its cultivation on marginal lands, improving the productivity of pearl millet requires sustainable and efficient nutrient management strategies. Studies on other major cereal crops like wheat have shown that integrated nutrient management (INM) significantly enhances both growth and yield parameters. For instance, (Singh *et al.* 2022) reported that the application of INM under irrigated conditions improved wheat growth and productivity, highlighting its potential for boosting yield through balanced nutrient supply. Such findings underscore the possible benefits of adopting similar INM approaches in pearl millet cultivation, especially under low-input systems prevalent in arid and semi-arid regions. Under the Sub-Mission on National Food Security Mission (NFSM)-Nutri-Cereals, the Indian government has started a number of programs to encourage the production and consumption of millets, particularly pearl millet. Through training and demonstrations, these programs aim to raise farmers' awareness. In order to increase consumption, the government is also promoting R&D and helping entrepreneurs and start-ups develop recipes and value-added millet products. Eight pearl millet (bajra) hybrids or bio-fortified types were made available for cultivation between 2018 and February 2022.

The Agricultural and Processed Food Products Export Development Authority (APEDA), the Ministry of Commerce and Industry's agricultural export promotion body, has developed a comprehensive plan to promote Indian millet exports worldwide beginning in December 2022 in order to increase the export of nutri-cereals. In support of this, the government has created 30 e-catalogues aimed at different nations, including information about Indian millets, value-added goods that may be exported, and a list of current exporters, start-ups, importers, retail chains, and hypermarkets. These catalogues are intended for distribution to Indian embassies abroad, as well as to stakeholders, exporters, and importers (Munirathnam and Gautam 2002).

India produced 15.92 million metric tons (MMT) of millet in 2021–2022, a 27% increase over the previous year. As per the 4th Advance Estimate for 2021-22, pearl millet makes up 60% of the overall millet production, with sorghum coming in second at 27%, finger millet at 11%, and small millets at 2%. Among essential nutrients, nitrogen and phosphorus are critical for enhancing crop yield. Nitrogen, in particular, plays a key role in both the quantity and quality of crop production. It is a core component of proteins and chlorophyll (Khinchi *et al.* 2017), giving plants a dark green coloration and promoting vigorous vegetative growth and improved herbage quality, which are crucial for higher fodder yield and dry matter production (Monika *et al.* 2018).

MATERIALS AND METHODS

The present study was carried out during the *kharif* seasons of 2024 at the Research Farm of Guru Kashi University, Talwandi Sabo Bathinda, Punjab. The pearl millet (Kesariya) was sown @ 5 kg/ha on 17th July by driving about 3 cm deep in furrows. Chemical fertilizers were applied below the seed in furrows before sowing. Then seed was covered with soil to level the opened furrows, keeping row-to-row (30 cm) and plant-to-plant distance (10 cm). The experiment consisted of nine treatments which were replicated three times in a Randomized Block Design.

The details of the experiment are as follows: Control (no application), N₅₀+P₅₀+K₁₀₀ (50 kg +22 kg+30 kg/ha), N₅₀+P₇₅+K₁₀₀ (50 kg + 33 kg+30 kg/ha), N₅₀+P₁₀₀+K₁₀₀ (50 kg+44 kg+30 kg/ha), N₇₅+P₅₀+K₁₀₀ (66 kg +22 kg+30 kg/ha), N₇₅+P₇₅+K₁₀₀ (66 kg +33 kg+30 kg/ha), N₇₅+P₁₀₀+K₁₀₀ (66 kg+44 kg+30 kg/ha), N₁₀₀+P₅₀+K₁₀₀ (83 kg +22 kg+30 kg/ha), N₁₀₀+P₇₅+K₁₀₀ (83 kg +33 kg+30 kg/ha), N₁₀₀+P₁₀₀+K₁₀₀ (83 kg +44 kg+30 kg/ha). On the other hand, 50% N was applied at sowing and the remaining 50% N was applied at 25 days after sowing. The basal dose of fertilizer was applied in the furrow and then seedlings were started three irrigations were given during the entire crop growth period. Rainfall received during the crop growth period was 350 mm.

To control weeds, Pendimethalin @ 3ml/liter of water was sprayed on 4th day after sowing. Obser-

vations on growth, yield and yield attributes were recorded and subjected to statistical analysis (Raval *et al.* 2015).

RESULTS AND DISCUSSION

The highest plant height was observed in (T₁₀) N₁₀₀+P₁₀₀+K₁₀₀ 210 cm, those are at par with (T₉) treatment N₁₀₀+P₇₅+K₁₀₀ 185.4 cm, followed by (T₇) N₇₅+P₁₀₀+K₁₀₀ 188.4 cm, (T₆) N₇₅+P₇₅+K₁₀₀ 170.5 cm, minimum plant height was observed in (T₁) control 123.7 cm among all the treatment as given in Table 1.

According to the data (Table 1) at harvesting, the effect of nitrogen and phosphorus combination on plant leaves was found to be significant at all growth periods of the crop. The highest plant leaves were observed in (T₁₀). High nitrogen high phosphorus 22.45 which is at par with (T₉) treatment N₁₀₀+P₇₅+K₁₀₀ 21.02, the minimum plant leaves were observed in (T₁) control 11.20 among all the treatments.

After reviewing Table 1, the same trend was observed at harvesting effect of the Nitrogen and phosphorus combination on SPAD value was found to be significant at all growth periods of the crop. The highest SPAD Value was observed in (T₁₀). High nitrogen high phosphorus 30.54, those are at par with (T₉) treatment N₁₀₀+P₇₅+K₁₀₀ 29.70, followed by (T₇)

N₇₅+P₁₀₀+K₁₀₀ 28.30, (T₆) N₇₅+P₇₅+K₁₀₀ 26.80, (T₈) N₁₀₀+P₅₀+K₁₀₀ 24.56, while lowest SPAD value was observed in (T₅) N₇₅+P₅₀+K₁₀₀ 23.40, followed by (T₄) N₅₀+P₁₀₀+K₁₀₀ 21.4, (T₃) N₅₀+P₇₅+K₁₀₀ 18.89, (T₂) N₅₀+P₅₀+K₁₀₀ 16.80, the minimum SPAD value was observed in (T₁) control 15.50 among all the treatments (Reddy *et al.* 2016).

From the experiment result at the end of the stage effect of nitrogen and phosphorus combination on plant dry weight was found to be significant at all growth periods of the crop. The highest plant dry weight was observed in (T₁₀) N₁₀₀+P₁₀₀+K₁₀₀ 114.57, those are at par with (T₉) treatment N₁₀₀+P₇₅+K₁₀₀ 110.76, followed by (T₇) N₇₅+P₁₀₀+K₁₀₀ 106.10, (T₆) N₇₅+P₇₅+K₁₀₀ 101.22, (T₈) N₁₀₀+P₅₀+K₁₀₀ 98.18, while lowest plant dry weight was observed in (T₅) N₇₅+P₅₀+K₁₀₀ 95.20, followed by (T₄) N₅₀+P₁₀₀+K₁₀₀ 93.89, (T₃) N₅₀+P₇₅+K₁₀₀ 84.77, (T₂) N₅₀+P₅₀+K₁₀₀ 78.12, the minimum plant dry weight was observed in (T₁) control 76.89 among all the treatments (Roy and Khandaker 2010) as given in Table 1.

According to the findings (Table 2) effect of nitrogen and phosphorus combination on panicle length was found to be significant at all growth periods of the crop. The highest panicle length was observed in (T₁₀). High nitrogen high phosphorus 29.4 cm, those are at par with (T₉) treatment N₁₀₀+P₇₅+K₁₀₀ 28.7 cm, followed by (T₇) N₇₅+P₁₀₀+K₁₀₀ 27.8 cm, (T₆) N₇₅+P₇₅+K₁₀₀ 27.0 cm, (T₈) N₁₀₀+P₅₀+K₁₀₀ 26.5 cm, while lowest panicle length was observed in (T₅) N₇₅+P₅₀+K₁₀₀ 24.2 cm, followed by (T₄) N₅₀+P₁₀₀+K₁₀₀ 22.5 cm, (T₃) N₅₀+P₇₅+K₁₀₀ 20.5 cm, (T₂) N₅₀+P₅₀+K₁₀₀ 19.7 cm, the minimum panicle length was observed in (T₁) control 18.7 cm among all the treatments (Sharma *et al.* 2012).

After critical reviewing Table 2, it observed that the effect of nitrogen and phosphorus combination on grain yield was found to be significant at the final stage crop. The highest grain yield was observed in (T₁₀) N₁₀₀+P₁₀₀+K₁₀₀ 1,800 kg, those are at par with (T₉) treatment N₁₀₀+P₇₅+K₁₀₀ 1,777 kg, followed by (T₇) N₇₅+P₁₀₀+K₁₀₀ 1,666 kg, (T₆) N₇₅+P₇₅+K₁₀₀ 1,655 kg, (T₈) N₁₀₀+P₅₀+K₁₀₀ 1,600 kg, while lowest grain yield was observed in (T₅) N₇₅+P₅₀+K₁₀₀ 1,533. 3 kg, followed by (T₄) N₅₀+P₁₀₀+K₁₀₀ 1,411 kg, (T₃)

Table 1. Nitrogen and phosphorus combination effect on growth parameters.

Sl. No.	Treatment combination	Plant height (cm)	Plant leaves (No.)	SPAD %	Plant dry weight gm/per plant
T ₁	Control	123.7	11.20	15.50	76.89
T ₂	N ₅₀ +P ₅₀ +K ₁₀₀	131.0	13.50	16.80	78.12
T ₃	N ₅₀ +P ₇₅ +K ₁₀₀	142.6	15.70	18.89	84.77
T ₄	N ₅₀ +P ₁₀₀ +K ₁₀₀	150.8	16.20	21.4	93.89
T ₅	N ₇₅ +P ₅₀ +K ₁₀₀	165.5	16.90	23.40	95.20
T ₆	N ₇₅ +P ₇₅ +K ₁₀₀	170.5	17.80	26.80	101.22
T ₇	N ₇₅ +P ₁₀₀ +K ₁₀₀	188.4	19.85	28.30	106.10
T ₈	N ₁₀₀ +P ₅₀ +K ₁₀₀	201.2	17.50	24.56	98.18
T ₉	N ₁₀₀ +P ₇₅ +K ₁₀₀	185.4	21.02	29.70	110.76
T ₁₀	N ₁₀₀ +P ₁₀₀ +K ₁₀₀	210.0	22.45	30.54	114.57
	CD	6.1	0.84	0.90	4.24
	SE (m)	2.0	0.28	0.30	1.41
	SE (d)	2.9	0.39	0.42	2.00
	CV	2.1	2.84	2.20	2.47

Table 2. Nitrogen and phosphorus combination effect on yield attributes.

Sl. No.	Treatment combination	Panicle length cm	Yield per ha grain (kg)	Straw yield per ha (kg)
1	Control	18.7	1,199.7	3,000
2	N ₅₀ +P ₃₀ +K ₁₀₀	19.7	1,222.3	3,100
3	N ₅₀ +P ₇₅ +K ₁₀₀	20.5	1,278.0	3,111
4	N ₅₀ +P ₁₀₀ +K ₁₀₀	22.5	1,411.0	3,444
5	N ₇₅ +P ₅₀ +K ₁₀₀	24.2	1,533.3	3,611
6	N ₇₅ +P ₇₅ +K ₁₀₀	27.0	1,655.3	4,444
7	N ₇₅ +P ₁₀₀ +K ₁₀₀	27.8	1,666.7	4,678
8	N ₁₀₀ +P ₅₀ +K ₁₀₀	26.5	1,600.0	4,422
9	N ₁₀₀ +P ₇₅ +K ₁₀₀	28.7	1,777.7	4,911
10	N ₁₀₀ +P ₁₀₀ +K ₁₀₀	29.4	1,800.0	5,111
	CD	1.0	56.3	141
	SE (m)	0.3	18.8	47
	SE (d)	0.5	26.6	67
	CV	2.4	2.2	2

N₅₀+P₇₅+K₁₀₀ 1,278 kg, (T₂) N₅₀+P₅₀+K₁₀₀ 1,222 kg, the minimum grain yield was observed in (T₁) control 1,199 kg among all the treatments (Singh *et al.* 2010).

In the prospect of straw yield per ha effect of Nitrogen and phosphorus combination on straw yield was found to be significant at the final stage crop. The highest Straw yield was observed in (T₁₀) N₁₀₀+P₁₀₀+K₁₀₀ 5,111 kg, those are at par with (T₉) treatment N₁₀₀+P₇₅+K₁₀₀ 4,911 kg, followed by (T₇) N₇₅+P₁₀₀+K₁₀₀ 4,678 kg, (T₆) N₇₅+P₇₅+K₁₀₀ 4,444 kg, (T₈) N₁₀₀+P₅₀+K₁₀₀ 4,422 kg, while lowest straw yield was observed in (T₅) N₇₅+P₅₀+K₁₀₀ 3,611 kg, followed by (T₄) N₅₀+P₁₀₀+K₁₀₀ 3,444 kg, (T₃) N₅₀+P₇₅+K₁₀₀ 3,111 kg, (T₂) N₅₀+P₅₀+K₁₀₀ 3,100 kg, the minimum Straw yield was observed in (T₁) control 3,000 kg among all the treatments as given in Table 2.

CONCLUSION

The present study clearly demonstrates that the combined application of nitrogen and phosphorus significantly influences the growth and yield attributes of pearl millet. Among all treatment combinations, T₁₀ (N₁₀₀+P₁₀₀+K₁₀₀) consistently recorded the highest values across various parameters including plant height, number of leaves, SPAD value, dry weight, panicle length, grain yield, and straw yield. This was closely followed by T₉ (N₁₀₀+P₇₅+K₁₀₀) and T₇ (N₇₅+P₁₀₀+K₁₀₀),

indicating the positive synergistic effect of balanced and adequate nitrogen and phosphorus application. On the other hand, the control treatment (T₁) showed the lowest performance in all parameters, reaffirming the essential role of nutrient supplementation. These results suggest that an optimal combination of nitrogen and phosphorus, particularly T₁₀, can substantially enhance the productivity of pearl millet and could be recommended for sustainable crop production under similar agro-climatic conditions.

REFERENCES

- AICPMIP. (2024). All India Coordinated Pearl Millet Improvement Project: About Us. Indian Council of Agricultural Research. Retrieved from <https://www.aicpmip.res.in/aboutus.html>
- Khinchi, V., Kumawat, S. M., Dotaniya, C. K., & Rakesh, S. (2017). Effect of nitrogen and zinc levels on yield and economics of fodder pearl millet (*Pennisetum glaucum* L.). *International Journal of Pure and Applied Bioscience*, 5(3), 426–430.
- Monika, Sheoran, R. S., Singh, K., & Satpal. (2018). Effect of cutting management and phosphorus levels on growth, forage and seed yield of multicut oat (*Avena sativa* L.). *Forage Research*, 44(1), 8–13.
- Muhammad, F., Muhammad, B., Hussain, P., Ahmed, R., Khan, F. U., & Xue, H., *et al.* (2019). Response of fodder millet (*Pennisetum americanum* L.) to different levels of nitrogen and phosphorus. *European Academic Research*, 6(11), 6272–6281.
- Munirathnam, P., & Gautam, R. C. (2002). Response of promising pearl millet (*Pennisetum glaucum*) cultivars to levels and time of nitrogen application under rainfed conditions. *Indian Journal of Agronomy*, 47(1), 77–80.
- Raval, C. H., Patel, A. M., Bhatt, P. K., Vyas, K. G., Bedse, R. D., & Patel, C. S., & Patel, S. J. (2015). Response of multicut summer forage pearl millet (*Pennisetum glaucum* L.) to varying levels of irrigation and nitrogen under semi-arid condition of North Gujarat. *Forage Research*, 41(1), 34–39.
- Reddy, B. P. S., Madhuri, K. V., Venkaiah, K., & Prathima, T. (2016). Effect of nitrogen and potassium on yield and quality of pearl millet (*Pennisetum glaucum* L.). *International Journal of Agricultural Innovations and Research*, 4(4), ISSN: 2319-1473.
- Roy, P. R. S., & Khandaker, Z. H. (2010). Effect of phosphorus fertilizer on yield and nutritional value of sorghum (*Sorghum bicolor* L.) fodder at three cuttings. *Bangladesh Journal of Animal Science*, 39(1–2), 106–115.
- Sharma, P. K., Kumar, S., & Chaudhary, G. R. (2012). Effect of organic manure and nutrient management on productivity and soil fertility status in pearl millet (*Pennisetum glaucum*). *Research on Crops*, 13, 503–506.
- Singh, B., Kaur, V., & Saini, S. P. (2022). Influence of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.) under irrigated conditions. *Journal of Soil and*

Water Conservation, 21(3), 326-330.
Singh, R. K., Chakraborty, D., Garg, R. N., Sharma, P. K., & Sharma, U. C. (2010). Effect of different water regimes and

nitrogen application on growth, yield, water use and nitrogen uptake by pearl millet (*Pennisetum glaucum*). *Indian Journal of Agricultural Sciences*, 80(3), 213-216.