



Effect of different organic sources and their combination on growth, yield and economics of millet crop- pearl millet

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Summary

The present investigation was carried out to identify the effects of different combinations of organic nutrition and its role in the growth, yield and economics of the pearl millet variety Shri Ram Pro 90. From the above experimental finding, it may be concluded that the treatment T₃ (100% Neem cake) was found to be best in terms of growth parameters like the highest number of effective tillers (6.82 tillers), tallest plant (128.48 cm) at 60 DAS and yield parameters like longest length of ear head (38.23 cm); thickest girth of ear head (15.57 cm); maximum number of grains per ear (2013.00 grains); highest grain yield per hectare (2787.79 kg/ha) of Pearl millet. The highest net return was found in the T₂ (100% Vermicompost), followed by T₃ (100% Neemcake).

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Introduction

The first crops that humans domesticated were millets, which spread throughout Asia and Africa and later became essential food sources for developing civilizations. All of these millets grow more quickly and complete their life cycles in 2-4 months. The foundation of dry land agriculture is millets. They are known as the "miracle grains" or "crops of the future" Because they are the hardest, most resilient, and climate-adaptable crops in hard, hot (up to 50 °C), and drought environments, small farmers feel most secure growing them during times of climate change (Anonymous 2022). Pearl millet is commonly known as bajra botanically known as *Pennisetum glaucum* L. is the sixth major cereal in terms of area and production and has the highest drought tolerance potential of all millets. Pearl millet has the largest kernels of all kinds of millets except sorghum. Pearl millet is the most widely cultivated cereal in India after rice and wheat. It is grown on more than 9.3 m ha with current grain production of 9.5 m tonnes and productivity of 1044 kg/ha. The major pearl millet growing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, and Haryana, which account for more than 90% of pearl millet acreage in the country. Pearl millet can easily provide economical grain yield (600-700 kg/ha) under marginal and low management conditions with the additional ability to produce a grain yield of 4-5 t/ha when hybrids of 80-85 days maturity are grown in summer season crop under irrigated and high fertility conditions. (Source: FAOSTAT 2021-22.). Pearl millet is the most drought and heat-tolerant of all cereals, being associated with cultivation in high temperatures, light

soils, and semi-arid growing conditions. The oldest archaeobotanical evidence of pearl millet cultivation was found in Mali and dated around 2,500 BC (Manning et al. 2011; Berwal et al. 20216). Applying FYM improves soil fertility. On average well decomposed FYM contains 0.5 per cent Nitrogen (N), 0.2 per cent Phosphate (P₂O₅) and 0.5 per cent Potassium (K₂O). FYM also increases the availability of soil phosphorus. In addition to the effect of FYM on soil P content, the application of FYM in the presence of fertilizer phosphorus may also affect the solubility and, hence, the potential availability of applied P. It is widely recognized that neither use of organic manure alone nor chemical fertilizers can achieve yield sustainability under modern intensive farming (Singh 2019). Neem cake is rich in NKP (nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25%), micronutrients, beneficial soil microbes and contain 'plant growth hormones & enzymes'. It is scientifically proven as a 'miracle growth promoter & also plant protector' from pests and diseases. Vermicompost contains higher nitrogen and phosphorus compared to other bulky organic manures. The average nutrient content is 3.03 per cent N; 2.63 per cent P₂O₅ and 1.4 per cent K₂O. Several studies show that vermicompost application can increase the millet production efficiency, an adequate supply of nitrogen is associated with vigorous vegetative growth. (Ayub et al. 2009). Pearl millet is one of the most important crops and is rich in economic importance. Organics such as FYM, Vermicompost and Neem cake not only promote increased yields and improved crop quality but also maximize the genetic potential of plants, and the presence of nutrients enhances root development and fruit set, affecting the vitality and health of plants. This experiment was conducted to better understand the effects of different organic manures on plant growth and yield attributes of the Pearl millet crop. Keeping this above point, the present investigation was carried out with the objective of determining the effect of organic

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manures on the growth and yield of the millet crop- Pearl millet.

Materials and Methods

The current investigation was carried out in *Kharif-2023* at the Karguan ji Organic Research Farm, Jhansi Department of Agronomy, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, U.P. The experimental design employed was a Randomized Block Design with 3 replications and 9 treatments (Fisher & Yates 1963). The software used for analysis was INDOSTAT. The pearl millet variety used was Sri Ram Pro 90. In the study, the height of randomly chosen plants from each plot was assessed in centimetres using a meter scale. The number of tillers was counted in randomly selected plants from each plot at 30 and 60 days after sowing. The length of ear head in selected plants from each plot was measured with the help of a meter scale post-harvesting. The details of treatments comprised of T_0 Control (water spray), T_1 (100% Farmyard Manure), T_2 (100% Vermicompost), T_3 (100% Neem cake), T_4 (50% Farmyard + 50% Vermicompost), T_5 (50% Farmyard Manure + 50% Neem cake), T_6 (50% Neem cake + 50% Vermicompost) and T_7 (33.33% Farmyard Manure + 33.33% Neem cake + 33.33% Vermicompost).

Results and Discussion

There was a significant difference present for plant height at 90 DAS among different treatment

combinations. The tallest (197.25 cm) at 90 DAS was observed with treatment T_3 (100% Neem cake) followed by T_5 (50% Farmyard Manure + 50% Neem cake) with 188.07 cm. shortest plant (163.55 cm) was observed in T_0 (control), while the remaining treatments were moderate in their growth habit. The treatment utilizing 100% neem cake in conjunction with a balanced mix of 50% Farmyard Manure (FYM) and 50% neem cake demonstrated superior plant height in pearl millet when compared to alternative treatments. This can be attributed to the combined benefits of neem cake's pest-repelling properties and FYM's nutrient-rich organic matter. Neem cake deters pests, protecting the plants from potential damage, while the nutrient-rich FYM fosters robust growth. The synergy between these elements optimally nourished and safeguarded the pearl millet crop, resulting in enhanced plant height and overall healthier growth in this particular treatment. Similar findings were reported by Srivastava et al. (2015); Yadav et al. (2021) and Shirzad et al. 2020 in Pearl millet. There was a significant difference present among different treatment combinations for the number of tillers per plant. The highest number of tillers per plant (10.43 tillers) at 60 DAS was observed with treatment T_3 (100% Neem cake) followed by T_5 (50% Farmyard Manure + 50% Neem cake) with 9.70 tillers. The lowest number of tillers per plant (7.34 tillers) was observed in T_0 (control).

Table 1. Effect of organic nutrition on growth and earliness parameters of Pearl millet

Treatment Details		Plant height (cm) [90 DAS]	No of tillers/plant [60 DAS]	No of effective tillers/plant	Days to Maturity	Length of ear head (cm)	Girth of ear head (cm)	No of grains per ear
T_1	100% Farmyard Manure	172.12	7.69	5.07	94.33	31.38	13.53	1768.00
T_2	100% Vermicompost	178.80	8.22	5.40	97.00	29.69	12.22	1640.00
T_3	100% Neem cake	197.25	10.43	6.82	90.67	38.23	15.57	2013.00
T_4	50% Farmyard Manure + 50% Vermicompost	174.55	7.81	5.21	94.33	32.64	12.51	1720.00
T_5	50% Farmyard Manure + 50% Neem cake	188.07	9.70	6.42	91.67	37.05	14.74	1877.00
T_6	50% Vermicompost + 50% Neem cake	184.33	9.15	6.07	93.67	35.21	13.22	1738.00
T_7	33.33% Farmyard Manure + 33.33% Vermicompost + 33.33% Neem cake	186.58	9.42	6.24	95.33	33.80	13.87	1819.00
T_0	Control	163.55	7.34	4.84	100.00	23.19	11.08	1563.00
'F' test		S	S	S	S	S	S	S
CV.		4.68	3.58	1.26	0.79	0.15	5.68	0.13
SE. m ($\pm$)		1.23	0.66	0.20	0.43	0.03	0.85	1.35
CD_{0.05}		3.69	1.98	0.60	1.29	0.09	2.64	4.17

The treatment combining 100% neem cake and treatment with a balanced ratio of 50% Farmyard Manure (FYM) and 50% neem cake exhibited a higher number of tillers per plant in pearl millet when contrasted with alternative treatments. This outcome can be attributed to

the synergistic effects of neem cake's natural pest-repelling properties and the nutrient-rich FYM. Neem cake served as a potent pest deterrent, shielding the plants and allowing them to allocate more energy to tiller production. Simultaneously, the FYM supplied vital

nutrients and organic matter, promoting vigorous tiller development. This combined approach facilitated an abundant number of tillers per plant in the treatment, ultimately enhancing pearl millet productivity. Similar findings were reported by Samruthi et al. (2020); Singh et al. (2020) and Meera et al. 2023 in Pearl millet. There was a significant difference present among different treatment combinations for a number of effective tillers. The highest number of effective tillers (6.82 tillers) was observed with treatment T₃ (100% Neem cake), which was at par with T₅ (50% Farmyard Manure + 50% Neem cake) with 6.42 tillers. The lowest number of effective tillers (9.29 tillers) was observed in T₀ (control).

The presence of a higher number of effective tillers in pearl millet within the treatments of 100% neem cake and 50% Farmyard Manure (FYM) combined with 50% neem cake, compared to other treatments, can be attributed to the potent effects of neem cake on pest control and the nutrient-rich organic matter supplied by FYM. Neem cake's natural pest-repelling properties protected the plants, allowing them to allocate more resources to tiller development. Concurrently, the FYM provided essential nutrients and organic matter, promoting robust tiller growth. This synergistic approach led to a greater number of effective tillers, enhancing overall pearl millet productivity in these treatments.

Similar findings were reported by Reddy & Singh (2017) and Shah et al. (2023) in Pearl millet. There was a significant difference present among different treatment combinations for days to maturity. The minimum days to maturity (90.67 days) was observed with treatment T₃ (100% Neem cake) at par with T₅ (50% Farmyard Manure + 50% Neem cake) with 91.67 days much earlier compared to T₀ (control) with 100.00 days.

The earlier maturity of pearl millet in the treatments with 100% neem cake and a combination of 50% Farmyard Manure (FYM) and 50% neem cake, compared to other treatments, can be attributed to the multifaceted benefits of these components. Neem cake's natural pest-repelling properties protect the plants, preventing potential damage and stress, which often delays maturity. Simultaneously, the FYM supplied essential nutrients and organic matter, ensuring optimal plant development. This combined approach enhanced the plant's overall health and vigour, enabling it to reach maturity more swiftly. The synergy of pest resistance and nutrient provision in these treatments expedited the maturation process, potentially resulting in earlier, more efficient seed and grain production. Similar conclusions were drawn by Singh et al. (2020); Singh & Chauhan (2021) and Amarghade & Singh (2021) in Pearl millet.

Table 2. Effect of organic nutrition on yield parameters of Pearl millet

Treatment Details		Test weight (g)	Grain yield per hectare (Kg/ha)	Biological yield per hectare (Kg/ha)	Harvest index (%)
T ₁	100% Farmyard Manure	11.92	2363.81	5,745.54	41.14
T ₂	100% Vermicompost	11.56	2648.24	6,593.95	40.16
T ₃	100% Neem cake	13.76	2787.79	5,785.58	48.19
T ₄	50% Farmyard Manure + 50% Vermicompost	12.24	2451.57	5,385.84	45.52
T ₅	50% Farmyard Manure + 50% Neem cake	13.06	2716.03	5,722.81	47.46
T ₆	50% Vermicompost + 50% Neem cake	12.83	2604.97	5,640.82	46.18
T ₇	33.33% Farmyard Manure + 33.33% Vermicompost + 33.33% Neem cake	12.71	2617.73	5,597.90	46.76
T ₀	Control	10.10	2045.10	5480.68	37.32
'F' test		S	S	S	S
CV.		0.23	0.07	2.36	1.68
SE. m (±)		0.56	0.98	2.71	0.26
CD_{0.05}		1.74	3.04	8.41	0.81

The length of the ear head varied significantly among different treatment combinations. The longest length of ear head (38.23 cm) was observed with treatment T₃ (100% Neem cake) followed by T₅ (50% Farmyard Manure + 50% Neem cake) with 37.05 cm better over T₀ (control) with 23.19 cm. The girth of the ear head varied significantly among different treatment combinations. The thickest girth of the ear head (15.57 cm) was observed with treatment T₃ (100% Neem cake) followed by T₅ (50% Farmyard Manure + 50% Neem cake) with 14.74 cm better over T₀ (control) with 11.08 cm. The thicker girth and length of the ear head in pearl millet within the treatments featuring 100% neem cake and a combination of 50% Farmyard Manure (FYM) with 50%

neem cake, compared to other treatments, can be attributed to the synergistic effects of these components. Neem cake's natural pest-repelling properties shielded the plants from damage, ensuring uninterrupted ear head growth. Simultaneously, the FYM provided an abundance of essential nutrients and organic matter, promoting robust and healthy development. The combined influence of pest resistance and nutrient enrichment in these treatments encouraged thicker ear head growth and length, too, potentially leading to greater grain and seed production, ultimately enhancing the overall productivity of pearl millet. Similar inferences were concluded by Srivastava et al. (2015);

Samruthi et al. (2020); Singh & Chauhan (2021) and Amarghade & Singh (2021) in Pearl millet.

The number of grains per ear varied significantly among different treatment combinations. The maximum number of grains per ear (2013.00 grains) was observed with treatment T₃ (100% Neem cake) followed by T₅ (50% Farmyard Manure + 50% Neem cake) with 1877.00 grains much more than T₀ (control) with 1563.00 grains. Test weight varied significantly among different treatment combinations. The heavier test weight (13.76 g) was observed with treatment T₃ (100% Neem cake) at par with T₅ (50% Farmyard Manure + 50% Neem cake) with 13.06 g better over T₀ (control) with 10.10 g. There was a significant difference present among different treatments of organic manure for grain yield per hectare. The highest grain yield per hectare (2787.79 kg/ha) was observed with treatment T₃ (100% Neem cake) at par with T₅ (50% Farmyard Manure + 50% Neem cake) with 2716.03 kg/ha which was better than T₀ (control) with 2045.10 kg/ha. There was a significant difference present among different treatments of organic manure for harvest index. There was a significant difference present among different treatments of organic manure for biological yield per hectare. The highest biological yield per hectare (6593.95 kg/ha) was observed with treatment T₂ (100% Vermicompost) followed by T₃ (100% Neem cake) with 5785.58 kg/ha which was better than T₀ (control) with 5480.68 kg/ha. The highest harvest index (48.19 %) was observed with treatment T₃ (100% Neem cake) at par with T₅ (50% Farmyard Manure + 50% Neem cake) with 47.46 %, which was better than T₀ (control) with 37.32 %. The superior grain yield in pearl millet within the treatments utilizing 100% neem cake and a combination of 50% Farmyard Manure (FYM) with 50% neem cake, as compared to other treatments, can be attributed to their complementary benefits. Neem cake's natural pest-repelling properties protected the plants, reducing potential yield losses due to pest damage. Simultaneously, FYM supplied essential nutrients, fostering robust plant growth, more prolific tillering, and enhanced reproductive development. The synergy of pest resistance and nutrient enrichment in these treatments resulted in a more significant number of healthy grains per ear, denser test weight, and ultimately, higher grain yield in pearl millet. This combination of pest control and nutrient provision optimizes productivity in agricultural systems. Similar findings were reported by Choudhary et al. (2014); Samruthi et al. (2020); Singh & Chauhan (2021) and Nazeema & Mehera (2022) in Pearl millet.

Conclusion

From the above experimental finding, it may be concluded that the treatment T₃ (100% Neem cake) was found to be best in terms of growth and yield of Pearl millet. The highest net return was found in the T₂ (100% Vermicompost), followed by T₃ (100% Neem cake).

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Declaration of Interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript.

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