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Effect of organic manure combinations on yield of chilli (*Capsicum annuum*) in Bundelkhand region

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Abstract

The experiment was conducted on chilli (*Capsicum annuum* L.) to evaluate the efficacy of eight distinct treatments: control (no manure), farmyard manure (FYM) 100% (20 t ha^{-1}), poultry manure (PM) 100% (2 t ha^{-1}), vermicompost (VM) 100% (3.33 t ha^{-1}), neem cake 100% (2 t ha^{-1}), FYM 50% (10 t ha^{-1}) + vermicompost 50% (1.66 t ha^{-1}), FYM 50% (10 t ha^{-1}) + PM 50% (1 ton ha^{-1}) and FYM 50% (10 t ha^{-1}) + neem cake 50% (1 t ha^{-1}), at the Karguwan Ji Institute of Agricultural Sciences, Bundelkhand University, during *rabi* season of 2019-2020. A randomized complete block design with three replications was employed. Applying 50% FYM (10 t ha^{-1}) + PM 50% (1 t ha^{-1}) significantly improved several plant characteristics. The results showed plant height of (56.70 cm), stem diameter (1.94 cm), 21 branches, 132 fruits/plant, fruit length of 8.63 cm, fruit diameter of 1.92 cm, average fruit weight of (1.59 g), fruit yield of (7.8 t ha$^{-1)}$, and 100g dry fruit weight 31.57g. Additionally, days to first flowering decreased to 40 days. Thus, this research offers valuable insights into optimizing organic manure usage to improve crop yield contributing farming systems overall sustainability and resilience.

Key words: Bundelkhand region, Growth, Organic manures, *Rabi* season, Yield

In arid region of Bundelkhand agriculture faces significant challenges due to persistent dry conditions, soil degradation and water scarcity (Garg *et al.,* 2020). These factors have made sustainable farming practices essencial for ensuring the viability and resilience of agricultural systems. Previous studies have consistently pointed to the need for more targeted approaches to combat the negative impacts of climate change on agriculture in arid regions, underscoring the importance of sustainable practices tailored to local environmental conditions (Baraj *et al.,* 2024; Sahoo *et al.,* 2024). Organic farming has gained traction globally, recognized for its numerous environmental benefits, including improved soil health, reduced chemical runoff and enhanced ecosystem services (Gamage *et al.,* 2023). However, despite its advantages, the adoption of organic practices in Bundelkhand, remains limited. This difficulty arises from the lack of region-specific research and a limited understanding of how various organic fertilizers can effectively improve crop yields under soil conditions of Bundelkhand (Kumar *et al.,* 2021). Thus, there has been a pressing need for region-specific research that focuses on optimizing organic inputs and addresses local farmers' concerns and challenges, such as water scarcity and soil degradation. Previous studies have demonstrated the positive effects of organic inputs on crop performance (Khaitov *et al.,* 2019).

There is a critical gap in understanding the most effective organic fertilizers for enhancing Chilli growth and yield in these arid agro-ecosystems. Still, comprehensive research focused on optimizing organic fertilizer combinations in this arid region is notably sparse (Verma *et al.*, 2020; Choudhary *et al.*, 2021). Research indicates that soil nutrient management is crucial for improving crop performance and the choice of organic inputs can significantly influence these outcomes (Rani *et al.*, 2023). However, specific needs of Bundelkhand's soil and climate remain underexplored. Therefore, evaluating the influence of various organic fertilizers on chilli yield seeks to enhance the resilience and its productivity in the region's unique agroclimatic conditions (Kumar *et al.*, 2022).

MATERIALS AND METHODS

The experiment was conducted during 2019–2020 *rabi* season at the Karguwan Ji at the Bundelkhand University Jhansi, Uttar Pradesh. Pusa Jwala variety was used in study with eight treatments organized in a randomized block design with three replications. These treatments included a control: no manure and various combinations and levels of organic manures such as 100% FYM (20 t ha^{-1}), 100% poultry manure (2 t ha^{-1}),

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100% vermicompost (3.33 t ha^{-1}), 100% neem cake (2 t ha^{-1}), 50% FYM (10 t ha^{-1}) + 50% vermicompost (1.66 t ha^{-1}), 50% FYM (10 t ha^{-1}) + 50% poultry manure (1 t ha^{-1}) and 50% FYM (10 t ha^{-1}) + 50% neem cake (1 t ha^{-1}). In November 2019, chilli transplanting was carried out with a spacing of 60 × 45 cm. During the crop growth season activities such as hoeing, weeding and irrigation were conducted at appropriate intervals to support optimal crop growth and development. Different parameters, including plant height (cm), stem diameter (cm), number of branches plant, plant diameter (cm), number of fruits per plant, fruit length (cm), fruit diameter (cm), average fruit weight (g), dry fruit weight (g) (100g fresh weight then oven dry 105^0) and fruit yield (t ha^{-1}). The data on lant height (cm), stem diameter (cm), number of branches per plant, stem diameter (cm) were recorded 30 days after transplanting. Ripe fruits were carefully chosen from each plant, and the total weight of dried fruits was calculated in grams. The yield obtained from each experimental plot was converted and expressed as tonnes per hectare to standardize the results across treatment. The net plot size 2.70 x 2.20 m^2 and 16 plant per block.

The field was characterized by sandy loam soil with a neutral reaction (pH 7.1). Initial physico-chemical analysis revealed that the soil was low in available nitrogen (142 kg ha^{-1}) and phosphorus (4.5 kg ha^{-1}), while medium in available potassium (206 kg ha^{-1}). The organic carbon content was found to be 0.52%. Organic manure treatments were applied on a nutrient-equivalent basis ten days prior to transplanting to ensure precise delivery of the recommended nitrogen dose. The nitrogen content of manures used was: farmyard manure (0.50%), vermicompost (2.01%), poultry manure (2.70%), and neem cake (5.03%)." were applied ten days before transplanting at the time of final land preparation.

Statistical analysis:

The data were subjected to Analysis of Variance (ANOVA) using [Software Name, e.g., OPSTAT] as per the procedure for a Randomized Block Design. The significance of treatment effects was tested using the 'F' test at a 5% level of significance (p=0.05). Standard Error of Mean (SEm±) and Critical Difference (CD) were computed for comparing treatment means."

RESULTS AND DISCUSSION

The application of organic manures significantly influenced the growth parameters of plants (Table 1). Among the treatments, a combination of 50% farmyard manure (10 t ha^{-1}) and 50% poultry manure (1 t ha^{-1}) led to the most notable improvements in plant height, stem diameter, number of branches and days to first flowering compared to the control. The plants treated with 50% FYM + 50% poultry manure exhibited the maximum plant height (56.70 cm) and maximum stem diameter (1.94 cm), along with highest number of branches per plant (21.33) At 120 days after transplanting and earliest days to first flowering (39.66 days). These values were significantly better when compared to the control. The significant improvement in growth parameters with the integrated use of FYM and poultry manure is in close agreement with the findings of Verma *et al.* (2024), who reported that organic manures directly supply essential macro and micronutrients during mineralization. Similarly, Singh *et al.* (2011) observed that the microbial activity stimulated by organic matter produces humic acid and phytohormones, leading to early flowering and enhanced vegetative growth. Furthermore, Meena *et al.* (2023) also reported that the application of vermicompost and poultry manure creates a significant positive response on vegetative characters, plant height, and flowering attributes of solanaceous vegetable crops. Overall, treatments with poultry manure, vermicompost and neem cake also demonstrated considerable enhancements in growth parameters throughout the plant's life cycle. These findings are strongly supported by Yadav *et al.* (2024), who emphasized that application of diverse organic inputs optimizes the growth dynamics and vegetative parameters of vegetable crops. However, combination of FYM and poultry manure consistently outperformed other treatments in promoting robust growth and early flowering in chilli plants. Additionally, synergistic effects of these organic fertilizers likely created an ideal growth environment for chilli plants, leading to superior performance compared to other treatments.

The use of different organic manures had a significant impact on yield and fruit quality (Table 2). Among sole application of organic manures, use of 100% poultry manure resulted in highest number of fruits/plant (122.33), maximum fruit length (7.73 cm) and fruit diameter (1.60 cm), highest average fruit weight (1.46 g) and maximum dry fruit weight (26.95 g), consequently yielding the highest fruit yield (6.6 t ha^{-1}). The combination of 50% farmyard manure and 50% poultry manure exhibited maximum number of fruits/plant (132.33), maximum fruit length (8.63 cm) and fruit yield (7.8 t ha^{-1}) among all treatments. The superior performance of 100% poultry manure in sole application may be attributed to its balanced nutrient composition and higher organic matter content, promoting robust plant growth and fruit development.

Table 1: Effects of application of various combinations and levels of organic manures on growth parameters of chilli

Treatment	Plant height (cm)				Stem diameter (cm)				Number of branches per plant				Days taken to 1st flowering
Days after transplanting	30	60	90	120	30	60	90	120	30	60	90	120	
Control (no manure)	13.15	19.34	31.46	40.17	0.19	0.26	0.75	1.12	1.66	4.33	7.33	11.66	53.33
100% farm yard manure (FYM)	14.48	23.46	34.29	45.60	0.26	0.43	1.10	1.40	2.00	5.66	8.66	13.00	48.33
100% poultry manure	16.33	25.86	37.82	49.46	0.42	0.74	1.29	1.70	3.00	6.66	11.33	16.33	45.00
100% vermicompost	16.40	25.42	37.73	49.33	0.32	0.47	1.23	1.53	2.33	6.66	10.66	16.00	44.66
100% neem cake	16.23	24.20	36.39	46.48	0.29	0.43	1.19	1.42	2.00	6.00	9.33	14.00	47.66
50% FYM + 50% vermicompost	16.94	26.33	38.52	50.92	0.44	0.82	1.37	1.84	3.33	8.33	13.00	17.66	43.00
50% FYM + 50% poultry manure	18.70	28.36	40.49	56.70	0.49	0.90	1.56	1.94	4.00	9.66	14.66	21.33	39.66
50% FYM + 50% neem cake	15.51	24.59	36.68	47.78	0.35	0.62	1.22	1.65	2.00	6.33	11.33	16.00	46.66
SE (m) ±	0.35	0.66	0.54	0.22	0.008	0.009	0.009	0.011	0.28	0.38	0.27	0.49	0.43
C.D. (5 %)	1.08	2.04	1.67	0.69	0.024	0.013	0.013	0.034	0.87	1.16	0.83	1.52	1.33

Table 2: Effects of application of various combinations and levels of organic manure on yield attributes of chilli

Treatment	Number of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Average Fruit weight (g)	Dry fruit weight (g)	Fruit yield (t ha^{-1}) (calculated)
Control (no manure)	102.00	5.32	1.12	1.18	23.99	4.5
100% farm yard manure (FYM)	106.33	6.30	1.37	1.23	25.52	4.9
100% poultry manure	122.33	7.73	1.60	1.46	26.95	6.6
100% vermicompost	116.66	7.30	1.55	1.27	26.82	5.5
100% neem cake	113.00	6.43	1.39	1.26	25.84	5.3
50% FYM + 50% vermicompost	127.33	8.25	1.71	1.53	27.52	7.2
50% FYM + 50% poultry manure	132.33	8.63	1.92	1.59	31.57	7.8
50% FYM + 50% neem cake	120.66	7.05	1.43	1.32	26.04	5.9
SE (m) ±	0.85	0.087	0.041	0.011	0.32	0.07
C.D. at 5 %	2.62	0.26	0.12	0.035	0.99	0.21

These observations are in close conformity with Choudhary *et al.* (2021), who also recorded significant enhancement in yield attributes and overall fruit yield of chilli through strategic application of organic manures. The synergistic effects observed with the combination of farmyard manure and poultry manure suggest a complementary nutrient profile, enhancing both plant vigour and fruit yield, potentially due to combined benefits of different organic sources enriching soil fertility and promoting nutrient availability for optimal plant uptake. Furthermore, Sharma *et al.* (2023) confirmed that such organic combinations play a vital role in maintaining soil fertility and yield sustainability of vegetable crops over time.

CONCLUSION

Thus, combined application of 10 t ha^{-1} FYM and 1 t ha^{-1} poultry manure is highly recommended for chilli cultivation in the Bundelkhand region. This strategy not only maximizes fruit productivity (7.8 t ha^{-1}) but also offers a sustainable pathway to enhance soil health and resilience against region's harsh climatic conditions.

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Data Availability Statement

Data will be available on request

Conflict of interest

The authors declare that there is no conflict of interest.

Authors' contribution:

Safik Ahamad conducting research, data recording, and analysis, J. N. Tiwari-supervising and original hypothesis of research, Harpal Singh- writing, RK Patel- review and writing, Abhilasha Pathak , Pradeep kumar editing, Devideen Yadav- writing,

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