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Effect of Vermicompost and Fertilizer Levels on Soil Properties, Yield, and Quality of Sugarcane in Calcareous Soil of Bihar

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ABSTRACT

The experiment was conducted over three consecutive years (2015–2017) at RPCAU, Bihar, to evaluate the effects of levels of vermicompost (0, 2.5, 5.0, and 7.5 t ha^{-1}) and 0, 50, 75, and 100% of the recommended dose of fertilizer (RDF) on soil properties, yield and quality of mid-late sugarcane variety BO 154 sugarcane grown in calcareous soils. Results showed that increasing doses of both vermicompost and fertilizers significantly enhanced the number of tillers, millable canes, and overall cane yield. The highest number of millable canes and maximum cane yield were recorded with the highest fertilizer level (100% RDF), while the maximum cane yield was observed at the highest vermicompost application rate of 7.5 t ha^{-1}. Additionally, the interaction between vermicompost and fertilizer levels significantly influenced cane yield. Juice quality parameters such as brix, sucrose content, and purity % were not significantly impacted by the treatments. However, sugar yield followed the trends observed for cane yield. Post-harvest soil analysis revealed a significant improvement in organic carbon % and availability of nitrogen (N), phosphorus (P), and potassium (K) with increasing levels of vermicompost and fertilizers. The greatest improvements in organic carbon and nutrient availability were noted at the highest vermicompost and fertilizer doses. The application of 5.0 t ha^{-1} vermicompost combined with 100% RDF proved to be the most effective treatment for enhancing both cane and sugar yields in the calcareous soils of Bihar.

KEYWORDS: Calcareous soil, fertilizer, soil properties, sugarcane, vermicompost

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1. INTRODUCTION

The prolonged use of inorganic fertilizers without the supplementation of organic inputs has led to the degradation of soil physical, chemical, and biological properties, in addition to contributing to environmental pollution. In contrast, organic manures not only provide essential nutrients and organic matter but also enhance soil biodiversity, stimulate microbial activity, and improve key soil health parameters. The soil amendment with bio-manures improves soil quality, cane productivity, and soil carbon sequestration under long-term sugarcane plant-ratoon system in the Indian sub-tropics (Srivastava et al., 2018). Sugarcane is a nutrient-intensive crop thatextracts large quantities of nutrients from the soil. To ensure high-quality production and sustainable yields, it requires a balanced supply of plant nutrients. However, excessive and unbalanced application of chemical fertilizers has resulted in declining soil health, reduced organic matter levels, and disruption of ecological balance. The diminishing organic matter content is a major concern, as it plays a crucial role in maintaining soil fertility by serving as a reservoir of nutrients and a source of metabolic energy for soil biological processes. Vermicompost, produced through the microbial breakdown of organic waste facilitated by earthworm activity, is a highly effective organic fertilizer (Li et al., 2020). It is rich in organic matter, essential nutrients, and promotes soil microbial and enzymatic activity (Keerthana et al., 2025). Vermicompost acts as a nutrient-rich soil amendment that significantly improves soil structure, aeration, and microbial activity, and boosts plant health (Oyege and Bhaskar, 2023) and improve soil water retention and physical quality indicators (Castellini et al., 2024). Venkatakrishnan and Manimaran (2020) revealed that organic manure significantly influenced the yield attributes and yield of sugarcane. In Bihar, sugarcane is cultivated over approximately 3.0 lakh hectares, with an average yield of 55 t ha^{-1}, significantly lower than the national average of 60 t ha^{-1}. This lower productivity is largely attributed to the unbalanced and inconsistent use of chemical fertilizers. The sole dependence on chemical fertilizers and pesticides has been associated with several adverse effects, including financial stress for farmers, deterioration of soil quality, risks to human health, increased greenhouse gas emissions, loss of biodiversity, and environmental contamination (Duddigan et al., 2023). Soil fertility in the region is deteriorating due to the limited addition of organic matter and the overuse of high-analysis fertilizers like N, P, and K, often applied without micronutrient supplementation. Vermicompost application enhances cation exchange capacity and water-holding capacity of the calcareous sandy loam soils of Bihar, low in organic carbon and nutrient retention (Orhan and Yuksel, 2020). The biointensive nutrient management improved soil rhizosphere environment, sugarcane quality and productivity (Tayade et al., 2019).The dominant soil type in North Bihar's "white sugar belt" is calcareous in nature, characterized by low to medium organic matter content due to the rapid rate of microbial decomposition. With the decline in traditional practices such as composting and green manuring, there is substantial scope for vermicompost to enhance soil organic carbon and improve the availability of vital nutrients. Integrating chemical fertilizers with appropriate doses of vermicompost offers a promising strategy to maintain soil fertility and enhance sugarcane productivity in the long term (Sinha et al., 2017a and Pal et al., 2021). Integrated effect of organic and inorganic fertilizers significantly enhanced the yield, quality and nutrient availability of sugarcane (Jha et al., 2018). This approach not only helps restore soil health but also reduces environmental risks and promotes profitable sugarcane production. Despite its potential, limited research exists on the optimal application rates of vermicompost and its interaction with chemical fertilizers. Therefore, the present study was undertaken to evaluate the effects of different levels of vermicompost and chemical fertilizers on soil properties, yield, and quality of sugarcane grown in the calcareous soils of Bihar.

2. MATERIALS AND METHODS

A field experiment was carried out at Pusa Farm, RPCAU, Bihar, during spring season from February, 2015 to March, 2017 period to evaluate the effects of varying levels of chemical fertilizers and vermicompost on soil properties, cane yield, and juice quality of sugarcane grown in the calcareous soils of Bihar. The experimental site is located in a subtropical climate zone, receiving an average annual rainfall of approximately 1200 mm. The soil at the site was classified as sandy loam, calcareous in nature (32.2% $CaCO_3$), with a pH of 8.30 and electrical conductivity (EC) of 0.28 dS m^{-1}. The experimental soil revealed low levels of organic carbon (0.48%) and available nitrogen (191.2 kg ha^{-1}), phosphorus (14.0 kg ha^{-1}), and potassium (92.1 kg ha^{-1}). Vermicompost (VC) was applied at four levels: 0, 2.5, 5.0, and 7.5 t ha^{-1}. The recommended dose of fertilizers (RDF) was applied at four levels: 0, 50, 75, and 100% of the standard recommendation. The treatments were arranged in a split-plot design, with fertilizer levels assigned to the main plots and vermicompost levels to the subplots. The sugarcane variety used was BO 154, a mid-late maturing type. The RDF consisted of 150 kg N, 85 kg P_2O_5, and 60 kg K_2O ha^{-1}. The fertilizers used were urea (46% N), di-ammonium phosphate (DAP: 18% N and 46% P_2O_5), and muriate of potash (MOP: 60% K_2O). Nitrogen was applied in three splits: 50% at planting, 25% at the first irrigation, and the remaining 25% at earthing up (coinciding with the onset of the monsoon). Sugarcane was planted in the last week of February at a row spacing of 90 cm and harvested after 12 months. The crop received four irrigations the onset of the monsoon, and standard agronomic practices were followed throughout the growing season.

Soil samples were collected at both the beginning and the end of the crop cycle. These samples were analysed for organic carbon, available nitrogen (alkaline $KMnO_4$ method), available phosphorus (0.5 M $NaHCO_3$ extraction at pH 8.5), and available potassium (NH_4 OAc extractable K), following the standard protocols. Cane juice was extracted using a power crusher, and juice quality parameters were determined. Sugar yield (tha^{-1}) was calculated using the following formula:

Sugar yield (t ha^{-1})=[(S−0.4×(B−S))×0.73×cane yield (t ha^{-1})] /100, whereas sucrose (%), and Bis brix (%) in cane juice. Whole cane samples were analysed for nutrient content (N, P, and K), and total nutrient uptake was estimated by multiplying nutrient concentrations by the respective dry matter yield. Economic analysis of treatments was performed based on prevailing market prices during the period of the experiment.

3. RESULTS AND DISCUSSION

3.1. Germination and number of tillers

The application of varying levels of vermicompost and fertilizer, as well as their interaction, had no significant effect on cane germination. However, significant differences were observed in the number of tillers at 150 days after planting (DAP) under the different fertilizer and vermicompost treatments (Table 1). Among the fertilizer treatments, the highest tiller count (137.11×10³ tillers ha^{-1}) was recorded in (F_2) with the application of 75% recommended dose of fertilizers (RDF). This was statistically comparable to the 100% RDF treatment (F_3), which produced 136.37×10³ tillers ha^{-1}. The lowest number of tillers (106.09×10³ ha^{-1}) was observed in the control treatment without fertilizer (F_0). Regarding vermicompost treatments, the highest number of tillers (139.97×10³ ha^{-1}) was recorded with the application of 7.5 t ha^{-1} vermicompost (V_3), which was statistically at par with the 5.0 t ha^{-1} treatments (V_2) that produced 134.77×10³ tillers ha^{-1}. The better soil moisture retention in vermicompost-treated plots improved microbial activity and enhanced seed-soil contact. Vermicompost enhances tiller production by improving soil structure, nutrient availability (especially nitrogen and phosphorus), and microbial activity, which together stimulate early vegetative growth (Sisodiya et al., 2025.). The interaction between fertilizer and vermicompost levels was not significant. The increase in tiller number with higher levels of NPK and vermicompost aligns with the findings of Sinha et al. (2024).

Table 1: Effect of vermicompost and fertilizer levels on cane germination and number of tillers after planting

Treatments	Germination (%)					Number of tillers (×10³ ha^{-1})				
	45 days					150 days				
	V_0	V_1	V_2	V_3	Mean	V_0	V_1	V_2	V_3	Mean
F_0	34.93	31.83	32.30	33.86	33.23	93.34	103.86	111.65	115.50	106.09
F_1	33.37	36.57	39.02	34.51	35.87	101.67	119.34	131.86	136.06	122.23
F_2	35.02	34.87	35.21	34.62	34.93	109.80	135.95	148.51	154.25	137.11
F_3	32.92	35.14	36.93	36.00	35.25	109.72	134.63	147.07	154.07	136.37
Mean	34.06	34.60	35.87	34.75		103.63	123.45	134.77	139.97	
Source	SEm±	LSD (0.05)	CV (%)			SEm±	LSD (0.05)	CV (%)		
V	0.96	NS	11.12			2.03	4.90	5.59		
F	1.57	NS				2.99	8.38	8.26		
V×F	3.11	NS				4.85	NS			

V_0: 0; V_1: 2.5; V_2: 5.0; V_3: 7.5 t ha^{-1}; F_0: 0; F_1: 0-25; F_2: 50; F_3: 75% RDF

3.1.1. Number of millable canes and cane yield

The number of millable canes (NMC) and cane yield showed significant responses to varying levels of vermicompost and fertilizer application (Table 2). The highest mean NMC (111.01×10³ ha^{-1}) was recorded in the 100% recommended dose of fertilizers (RDF) treatment (F_3), which was significantly higher than the other fertilizer treatments. Similarly, the maximum NMC (110.71×10³ ha^{-1}) among the vermicompost treatments was observed with the application of 7.5 t ha^{-1} vermicompost (V_3), which was statistically comparable to the 5.0 t ha^{-1} treatment (V_2) with 105.90×10³ ha^{-1}. The interaction between fertilizer

Table 2: Effect of vermicompost and fertilizer levels on the number of millable cane (NMC) and cane yield

Treatments	NMC ($\times 10^3$ ha^{-1})					Cane yield (t ha^{-1})				
	V_0	V_1	V_2	V_3	Mean	V_0	V_1	V_2	V_3	Mean
F_0	62.51	79.07	83.98	87.37	78.23	39..71	52.23	58.72	63.79	53.61
F_1	75.42	88.24	105.01	108.01	94.17	51.10	68.02	87.24	92.74	74.78
F_2	82.11	101.51	114.21	119.28	104.11	58.78	83.56	98.25	106.67	86.82
F_3	86.76	108.70	120.39	128.17	111.01	63.83	92.75	110.97	115.01	96.64
Mean	76.70	94.38	105.90	110.71		53.36	74.14	88.80	94.55	
Source	SEm±	LSD (0.05)	CV (%)			SEm±	LSD (0.05)	CV (%)		
V	2.65	7.44	9.49			2.09	5.87	9.30		
F	2.48	6.00	8.81			1.78	4.33	7.94		
V×F	5.31	NS				4.19	11.75			

V_0: 0; V_1: 2.5; V_2: 5.0; V_3: 7.5 t ha^{-1}; F_0: 0; F_1: 0-25; F_2: 50; F_3: 75% RDF

and vermicompost levels was not significant for NMC. The increase in NMC with higher fertilizer and vermicompost doses may be attributed to reduced plant mortality and favourable conditions that supported the conversion of tillers into millable canes. Cane yield was significantly affected by both vermicompost and fertilizer levels, and their interaction (V×F) was also statistically significant at the 5% level (Table 2). The data showed that cane yield followed a pattern similar to NMC, increasing with higher levels of both inputs. The application of 100% RDF (F_3) yielded the highest mean of 96.64 t ha^{-1}, which was significantly superior to all other fertilizer treatments. The lowest yield (53.61 t ha^{-1}) was recorded in the no-fertilizer control (F_0). This yield improvement is likely due to enhanced yield attributes such as higher NMC and single cane weight, under higher fertilizer input, which supports the observations made by Sathya et al. (2025) and Sinha et al. (2024).

The graded application of vermicompost also led to significant increases in cane yield. The highest yield (94.55 t ha^{-1}) was recorded under V_3 (7.5 t ha^{-1} vermicompost), while the lowest (53.36 t ha^{-1}) was observed in the control treatment without vermicompost (V0). These results align with the findings of Priyadarshi et al. (2021). Patel et al. (2018) also observed that organic management attained optimum performance using 50% recommended dose of nitrogen (RDN) through vermicompost and 50% RDN through cakes resulted in substantial improvements in sugarcane height, quality, and yield. The organic amendments improve nutrient availability through decomposition and mineralization, enhancing soil physical, chemical, and biological properties, and ultimately boosting crop productivity.

The interaction between vermicompost and fertilizer was significant for cane yield. The highest yield (115.01 t ha^{-1}) was achieved with the combined application of 7.5 t ha^{-1} vermicompost and 100% RDF (V_3F_3), which was statistically on par with V_3F_2 (106.67 t ha^{-1}) and V_2F_3, indicating potential savings of 2.5 t ha^{-1} vermicompost and 25% RDF without compromising yield. The lowest yield (39.71 t ha^{-1}) was recorded in the untreated control (V_0F_0). The yield enhancement can be ascribed to synergistic effects of organic and inorganic nutrient sources that improve nutrient availability and uptake, enhance soil microbial activity, and sustain crop productivity.

The highest Benefit-cost (B:C) ratio of 2.38 was recorded with the 100% recommended dose of fertilizer (F_3), significantly outperforming other fertilizer treatments (Figure 1). Among the vermicompost levels, the maximum mean B:C ratio (1.94) was achieved with 5 t ha^{-1} (V_2), which was statistically at par with 2.5 t ha^{-1} (V_1) and 7.5 t ha^{-1} (V_3). The interaction between fertilizer and vermicompost treatments had no significant effect on the B:C ratio.

3.2. *Juice quality and sugar yield*

The quality of cane juice, assessed through parameters such as Brix, sucrose content, and purity %, did not show significant variation across different levels of vermicompost and fertilizer. The sucrose content in cane juice ranged from 16.19 to 17.08%, respectively, across the

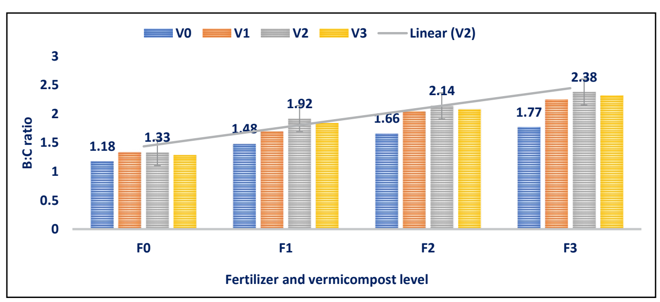

Figure 1: Effect of vermicompost and fertilizer levels on B:C ratio

treatments (Figure 2). The sugar yield at maturity exhibited significant differences in response to varying fertilizer and vermicompost levels. The highest mean sugar yield (11.55 t ha^{-1}) among fertilizer treatments was recorded with 100% RDF ($F_{3)}$. Likewise, vermicompost treatments showed significant effects, with the highest sugar yield (10.91 t ha^{-1}) observed at 7.5 t ha^{-1} (V_3), which was comparable to 5.0 t ha^{-1} (V_2) yielding 10.62 t ha^{-1}. The pattern of sugar yield followed that of cane yield, as sugar yield depends on cane yield combined with sucrose and Brix% in the juice. A similar trend was observed by Jha et al. (2017) and Bairwa et al. (2022). The interaction between vermicompost and fertilizer was not significant.

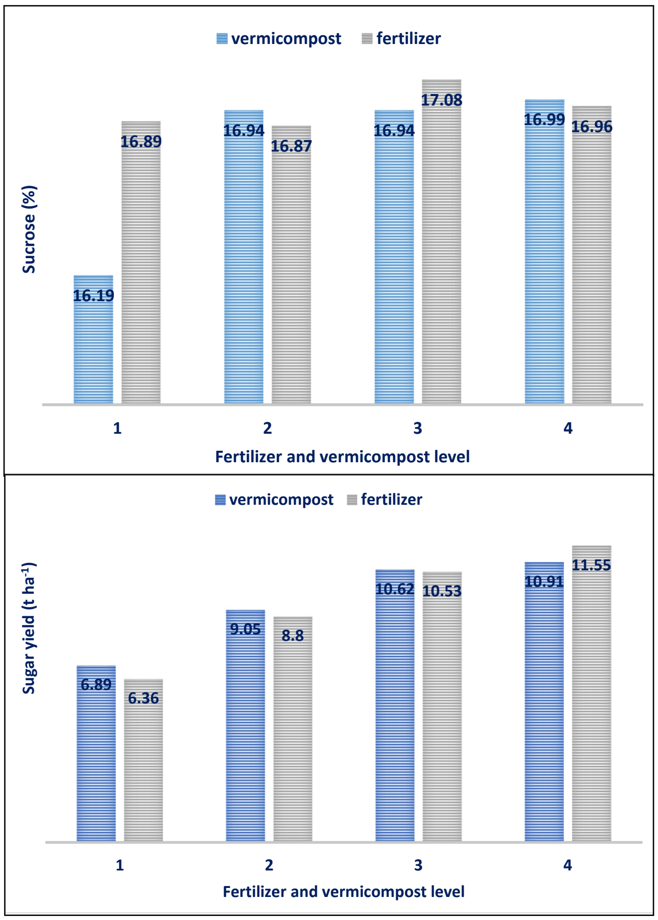

Figure 2: Effect of vermicompost and fertilizer levels on sucrose % and sugar yield

3.4. Soil properties after harvest

Soil organic carbon (SOC) content in the post-harvest soil showed a significant increase with the application of both vermicompost (V) and chemical fertilizers (F), ranging from 0.46% to 0.56% (Table 3). The main effects of vermicompost and fertilizer were significant, while their interaction was non-significant. Compared to the control, organic carbon increased by 5.1%, 10.6%, and 17.0% with fertilizer levels of 50%, 75%, and 100% NPK, respectively, and by 8.7%, 15.2% and 21.7% with vermicompost doses of 2.5, 5.0 and 7.5 t ha^{-1}, respectively. This enhancement is attributed to the direct addition of organic matter from vermicompost and improved crop growth due to fertilization, leading to significant biomass accumulation, which accounted for approximately 30% of the total sugarcane biomass. These results align with the findings of Aher et al. (2018), Sinha et al. (2016), and Shridevi et al. (2016), who showed that accumulation of organic carbon and nutrient enrichment occurred under the treatments receiving organic manures. Mthimkhulu et al. (2016) showed that the addition of organic substances increased the soil organic carbon and accelerated the microbial activities in soil. The use of chemical fertilizers alone showed a moderate increase in SOC, possibly due to increased crop biomass and root exudation promoting organic matter input. SOC, carbon pools and carbon indices improved significantly under activated trash treatments in sugarcane plant-ratoon system grown in calcareous soil of subtropics (Bairwa et al., 2023). The interaction effect between vermicompost and fertilizer on organic carbon was non-significant, consistent with a graded dose of fertilizer.

3.41. Available nutrients in post-harvest soil

The availability of nitrogen (N), phosphorus (P), and potassium (K) in the soil increased significantly with higher levels of both fertilizers and vermicompost. The 100% NPK treatment (F_3) recorded the highest available N, P, and K-273.15, 20.11, and 111.63 kg ha^{-1}, respectively-while the control (F_0) showed the lowest values of 196.24, 13.89, and 87.49 kg ha^{-1}. These findings are consistent with Shridevi et al. (2016), who observed increased nutrient availability with greater chemical fertilizer application. Similarly, graded doses of vermicompost enhanced nutrient availability in post-harvest soil, with the highest values (252.40 kg N, 19.33 kg P, and 106.00 kg K ha^{-1}) recorded at 7.5 t ha^{-1} (V_3). However, the interaction between fertilizer and vermicompost was not significant. Organic amendments improved the soil properties and created a complementary soil environment with improvement in the quality of soil (Djajadi et al., 2020). The treatment of vermicompost and biofertilizer significantly improved soil physico-chemical properties and increased availability of nutrient (Aechra et al., 2022). The improved nutrient availability is attributed to the addition of organic matter, which promotes root growth, increases plant residue, and stimulates microbial activity, thereby enhancing mineralization and nitrogen release. The integrated use of organic and inorganic sources of nutrients improved nutrient availability in calcareous soil. The increase in available phosphorus may result from organic matter decomposition, which releases carbon dioxide (CO_2) and enhances phosphorus solubilization in

Table 3: Effect of vermicompost and fertilizer levels on organic carbon and available N, P and K content of the post-harvest soil

Treatments	Organic C (%)					Available N (kg ha^{-1})				
	V_0	V_1	V_2	V_3	Mean	V_0	V_1	V_2	V_3	Mean
F_0	0.42	0.46	0.48	0.50	0.47	176.40	184.89	207.11	216.56	196.24
F_1	0.45	0.49	0.53	0.55	0.51	187.82	210.66	226.65	235.10	215.06
F_2	0.48	0.51	0..55	0.57	0.52	223.27	238.37	248.82	264.53	243.75
F_3	0.49	0.53	0.58	0.60	0.55	258.66	262.97	277.54	293.41	273.15
Mean	0.46	0.50	0.53	0.56		211.54	224.22	240.03	252.40	
Source	SEm±	LSD (0.05)	CV (%)			SEm±	LSD (0.05)	CV (%)		
V	0.006	0.017	4.22			3.44	9.66	5.14		
F	0.0075	0.018	5.09			4.688	11.34	6.99		
V×F	0.012	NS				6.89	NS			
Treatments	Available P (kg ha^{-1})					Available K (kg ha^{-1})				
	V_0	V_1	V_2	V_3	Mean	V_0	V_1	V_2	V_3	Mean
F_0	11.17	13.80	14.89	15.71	13.89	79.52	83.80	92.56	94.08	87.49
F_1	12.90	15.70	17.02	17.69	15.83	83.27	93.54	98.01	99.63	93.61
F_2	14.79	17.37	18.74	19.99	17.72	89.85	99.85	105.02	112.06	101.70
F_3	15.82	18.76	21.94	23.91	20.11	104.08	107.33	116.87	118.24	111.63
Mean	13.67	16.41	18.15	19.33		89.18	96.13	103.12	106.00	
Source	SEm±	LSD (0.05)	CV (%)			SEm±	LSD (0.05)	CV (%)		
V	0.4	1.14	8.32			2.27	6.23	8.94		
F	0.43	1.04	8.87			2.51	NS	11.65		
V×F	0.81	NS				4.44	NS			

the soil. The integration of organic and inorganic nutrient sources of fertilizer in calcareous soil to enrichment of soil fertility and yield of sugarcane. Similar and comparable results have been reported by Sinha et al. (2016).

4. CONCLUSION

The application of vermicompost and chemical fertilizers significantly improved the physical, chemical, and biological properties of calcareous soils. These improvements enhanced overall soil health and fertility, which are critical for the sustainable cultivation of sugarcane. Among the treatments evaluated, the application of vermicompost at 5.0 t ha^{-1} combined with 100% of the recommended dose of fertilizers (RDF) proved to be the most economically beneficial, resulting in higher cane and sugar yields.

5. REFERENCE

Aechra, S., Meena, R.H., Meena, S.C., Jat, H., Doodhwal, K., Shekhawat, A.S., Verma, A.K., Jat, L., 2022. Effect of biofertilizers and vermicompost on physico-chemical properties of soil under wheat (*Triticum aestivum*) crop. The Indian Journal of Agricultural Sciences 92(8), 997–995. https://doi.org/10.56093/ijas.v92i8.111479.

Aher, S.B., Lakaria, B.L., Kaleshananda, S., Singh, A.B., Ramana, S., Thakur, J.K., Biswas, A.K., Jha, P., Manna, M.C., Yashona, D.S., 2018. Soil microbial population and enzyme activities under organic, biodynamic and conventional agriculture in semi-arid tropical conditions of central India. Journal of Experimental Biology and Agricultural Sciences 6(5), 763–773. https://doi.org/10.18006/2018.6(5).763.773.

Bairwa, R., Jha, C.K., Thakur, S.K., Mamta, Roy, D.K., Brajendra, 2023. Carbon pools and indices under activated trash treatments in sugarcane plant-ratoon system grown in calcareous soil of subtropics. Sugar Tech 25, 1433–1444. https://doi.org/10.1007/s12355-023-01280-1?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle.

Bairwa, R., Jha, C.K., Thakur, S.K., Kumar, V., 2022. Soil health, cane productivity, and juice quality improvement through sugarcane trash management in the plant-ratoon system grown in calcareous soil. Biological Forum-An International Journal 14(2), 1091–1094. Available from: https://www.researchgate.net/publication/361926313.

Castellini, M., Bondi, C., Giglio, L., Iovino, M., 2024. Impact of vermicompost addition on water availability of differently textured soils. Heliyon 10(15), e35699. https://doi.org/10.1016/j.heliyon.2024.e35699.

Djajadi, D., Syaputra, R., Hidayati, S.N., Khairiyah, Y., 2020. Effect of vermicompost and nitrogen on N, K, Na uptakes and growth of sugarcane in saline soil. Agrivita Journal of Agricultural Science 42(1), 110–119. https://doi.org/10.17503/agrivita.v41i0.2364.

Duddigan, S., Shaw, L.J., Sizmur, T., Gogu, D., Hussain, Z., Jirra, K., Kaliki, H., Sanka, R., Sohail, M., Soma, R., Thallam, V., Vattikuti, H., Collins, C.D., 2023. Natural farming improves crop yield in SE India when compared to conventional or organic systems by enhancing soil quality. Agronomy for Sustainable Development 43, 31. DOI: 10.1007/s13593-023-00884-x.

Jha, C.K., Kumar, V., Thakur, S.K., 2019. Integrated effect of sugarcane trash mulch, pressmud and Zn nutrition on soil fertility and productivity of sugarcane in calcareous soil. Journal of Agri Search 6, 4–7. Available from: https://www.researchgate.net/publication/359856642.

Jha, C.K., Sinha, S.K., Thakur, S.K., 2017. Enhancing soil fertility, nutrient uptake and sugarcane productivity through integrated use of Fe and organics in a sub-tropical system. Indian Journal of Ecology 44(5), 521–525. Available from: https://www.researchgate.net/publication/356251240.

Keerthana, V., Shivakumar, K.M., Prasanna, S.M., Yogeeshappa, H., Gurumurthy, S.B., Anitha R.G., Prasad, P.S., Sachin, S.H., 2025. Influence of organic and natural farming nutrient management practices on soil microbial biomass carbon and enzymatic activity. International Journal of Plant & Soil Science 37(7), 251–258. https://doi.org/10.9734/ijpss/2025/v37i75570.

Li, Y., Yang, X., Gao, W., Qiu, J., Li, Y., 2020. Comparative study of vermicomposting of garden waste and cow dung using *Eisenia fetida*. Environmental Science and Pollution Research 27(9), 9646–9657. DOI: 10.1007/s11356-020-07667-x.

Mthimkhulu, S., Podwojewski, P., Hughes, J., Titshall, L., Antwerpen, R.V., 2016. The effect of 72 years of sugarcane residues and fertilizer management on soil physico-chemical properties. Agriculture, Ecosystems and Environment 225, 54–61. Available from: https://ui.adsabs.harvard.edu/link_gateway/2016AgEE.225...54M/doi:10.1016/j.agee.2016.04.002.

Orhan, A., Yuksel, O., 2020. Effects of vermicompost on aggregate stability, bulk density and some chemical characteristics of soils with different textures. Journal of Tekirdag Agricultural Faculty 17(1), 1–11. https://doi.org/10.33462/jotaf.598809.

Oyege, I., Bhaskar, M.S., 2023. Effects of vermicompost on soil and plant health and promoting sustainable agriculture. Soil Systems 7(4), 101. https://doi.org/10.3390/soilsystems7040101.

Pal, R., Singh, O., Sanghera, G.S., Gupta, R.K., 2021. Influence of integrated nutrient management on sugarcane productivity and soil fertility under Indo-Gangetic plain. The Indian Journal of Agricultural Sciences 91(5), 703–707. https://doi.org/10.56093/ijas.v91i5.112987.

Priyadarshi, R., Thakur, S.K., Jha, C.K., Singh, S.K., 2021. Effect of organic amendments on soil carbon stock, yield, and quality of sugarcane ratoon. International Journal of Environment and Climate Change 11(2), 12–18. https://doi.org/10.9734/ijecc/2021/v11i230355.

Sathya, S., Paulpandi, S., Muthusamy, N., Velmurugan, K., 2025. *In situ* mulching of sugarcane trash: Effective tool for soil fertility and productivity enhancement of sugarcane. Journal of Advances in Biology & Biotechnology 28(7), 508–515. https://doi.org/10.9734/jabb/2025/v28i72568.

Shridevi, B.A., Chandrashekar, C.P., Patil, S.B., 2016. Performance of sugarcane genotypes under organic, inorganic and integrated nutrient management systems. Imperial Journal of Interdisciplinary Research 2(9), 970–979. Available from: https://www.researchgate.net/publication/341488575.

Sinha, S.K., Jha, C.K., Kumar, V., Pandey, S.S., 2017b. Yield and soil organic carbon pool in relation to soil fertility of sugarcane (*Saccharumspp hybrid* complex) plant-ratoon system under integrated nutrient management. Indian Journal of Agronomy 62(1) 25–30. https://doi.org/10.59797/ija.v62i1.4269.

Sinha, S.K., Kumar, A., Kumari, A.K., Singh, 2024. The integrated effect of organic manure, biofertilizer and inorganic fertilizer on soil properties, yield, and quality in sugarcane plant-ratoon system under calcareous soil of Indo-Gangetic Plains of India. Journal of Scientific Research and Reports 30(5), 193–206. https://doi.org/10.9734/jsrr/2024/v30i51934.

Sinha, S.K., Kumar, V., Jha, C.K., 2016. Effect of integrated use of bio-compost and nitrogen on productivity and soil properties of sugarcane plant ratoon system in calcareous soil. Sugar Tech 19(5), 485–491. https://doi.org/10.1007/s12355-016-0501-7?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle.

Sisodiya, R.R., Patel, K.G., Dubey, P.K., Zinzala, V.J., Singh, N., Vasave, J.B., 2025. Effect of organic farming on growth, yield attributes and yield of sugarcane under South Gujarat condition. International Journal of Plant & Soil Science 37(6), 571–580. https://doi.org/10.9734/ijpss/2025/v37i65536.

Srivastava, T.K., Singh, K.P., Singh, P., Suman, A., Singh, S.R., Verma, R.R., Singh, V.K., Singh, R.K., 2018. Effect of bio-manures on soil quality, cane productivity and soil carbon sequestration under long-term sugarcane (*Saccharum officinarum*) plant-ratoon system in the Indian sub-tropics. Indian Journal of Agricultural Sciences 88(11), 1696–1703. https://doi.org/10.56093/ijas.v88i11.84902.

Tayade, A.S., Geetha, P., Anusha, S., Dhanapal, R., Hari, K., 2019. Bio-intensive modulation of sugarcane ratoon rhizosphere for enhanced soil health and sugarcane productivity under tropical Indian conditions. Sugar Tech 21(2), 278–288. https://doi.org/10.1007/s12355-018-0669-0.

Venkatakrishnan, D., Manimaran, S., 2020. Organic manures and industrial by-products influence the yield attributes and yield of sugarcane. Indian Journal of Agricultural Research 54(4), 541–544. DOI: 10.18805/IJARe.A-5346.