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Research Article

Effect of Crop Specific Enriched Vermicompost on the Growth and Yield of Wheat and Pearl Millet

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Abstract

The aim of this research was to investigate the effect of crop specific enriched vermicompost on the growth and yield of wheat and pearl millet. The experiment was laid out in Randomized Block Design with 3 treatments and were replicated three times The study was conducted on wheat and Pearl millet sown in soil with Enriched vermicompost (EVC) in treatment T_1 50% EVC + 50% ,T_2 RDF through chemical fertilizer and also 100% RDF T_3 through Chemical Fertilizers. results showed that Effect of enriched vermicompost on the growth and yield parameters viz. plant height, number of tillers, leaf area index, ear heads plant^{-1},protein content, root length density at harvest (cm cm^{-3}), shoot dry weight plant^{-1} (g), shoot fresh weight plant^{-1} (g), test weight (g) ,grain yield, Straw yield, Biological yield and harvest Index of wheat and pearl millet were found at par in case of 100% EVC, 50% EVC + 50% RDF and T_3: 100% RDF. The findings of this study suggest that crop specific enriched vermicompost can partially substitute the inorganic fertilizers up to 100 percent wheat and millet crops cultivated in central plateau and hill region zone of India. without hampering the crop yields.

Keywords: Leaf area index, Root length density, Enriched vermicompost, RDF

1. Introduction

Cereals play a pivotal role to satisfy the global food demand of growing population, particularly in developing nations like India where cereal-based production system is the only predominant source of nutrition and calorie intake (Yashavanthakumar *et al.,* 2023).The greatest challenge in the coming years is to fulfil the demand for safe food, healthy soil, and a pollution-free environment for the growing populations of the world. Indiscriminate use of inorganic fertilizers and pesticides in conventional crop production is considered to be one of the prime factors for deterioration in crop productivity, degradation of soil health, and serious threats to the environment and human health that largely affect the sustainability of the agricultural production system.(Tilman *et al.,* 2002; Pingali, 2012; Gomiero *et al.,* 2011).

With increasing awareness of the ill effects of conventional farming/chemical faming, recent years have seen renewed interest in the sustainability of our food production system by revitalizing and restoring soil fertility and reviving microbial activity to make the soil lively and healthy. Consequently, awareness has been generated on recycling of available organic residues for the production of quality organic manures. Vermicompost is a nutrient-rich, microbiologically active organic amendment that is obtained in the form of castings by earthworms of ingested biomass after undergoing physical, chemical, and microbial transformation. Several research findings have established the beneficial effect of vermicompost on soil health through improvement in the physical, chemical, and biological properties and subsequently better crop growth and yield (Edwards *et al.,* 2004; Arancon *et al.,* 2006; Garg and Gupta, 2011). Microbial enrichment of vermicompost by addition of bio fertilizers and bio inoculants further enhances the microbial population of the soil, nutrient mineralization uptake, and availability of nutrients. Vermicomposting is gradually emerging as a potential technology for recycling available organic wastes as a source of quality organic manures, and vermicompost is rising as a promising organic fertilizer for maintaining good soil health and crop growth as well as reducing dependence on non-renewable resources. The present work highlights the beneficial role of vermicompost and the preparation and utilization of vermicompost with special emphasis on how vermicompost can address the emerging soil health problems for sustainability in soil health and the ecosystem.

In general, the organic manures like farm yard manure (FYM), compost, vermicompost contain on an average 0.5 to 1.5% N, 0.2 to 0.8% P_2O_5 and 0.5 - 1.2% K_2O,which is not sufficient to meet the crop demand in low dose. For supplying N at 100 kg ha^{-1}, the organic manure to be applied at 07 to 20 t ha^{-1}.These demerits of manures can be overcome to a certain extent through preparation of enriched Vermicompost by adding natural or biological-sources of nitrogen, phosphorus, potassium, sulphur and micronutrients either alone or in combination. Moreover, waste with different nutrient rich substances opening new direction of technological up gradation for improving the quality and nutrient status of vermicompost. Modification of vermicompost either by microbial enrichment or fortifying with nutrient rich rock minerals and agricultural waste may help in enriching the nutrient content.

The enrichment of vermicompost through iron refuse makes it a rich source of total and available iron (Hashemimajd and Golchin, 2009), enrichment of cow manure with rock phosphate could significantly improve the P availability, The enrichment of vermicompost with biofertilizers and beneficial microorganisms, including nitrogen-fixing and phosphorus-solubilizing bacteria, has been reported to enhance its quality and efficiency (Kaushik *et al.,* 2008; Karmegam & Rajasekar, 2012; Ashwin *et al.,* 2013). Such microbial inoculation not only accelerates the mineralization of organic matter but also improves nutrient availability, particularly nitrogen and phosphorus, to plants. Consequently, enriched vermicompost serves as a dual source of organic manure and microbial bio fertilizer, thereby improving soil fertility, crop productivity, and sustainability of the production system.

Studies on the viability of bio fertilizer microorganisms in enriched vermicompost have demonstrated that the inoculated microbes can survive for longer durations and significantly enhance nutrient availability to plants as well as improve soil fertility. Although these findings are encouraging, limited research is available on the combined effect of enriched vermicompost with specific microbial consortia under diverse agro-climatic conditions. In particular, systematic evaluation of its role in soil health restoration and crop productivity remains insufficient. Considering this research gap, the present study was undertaken with the objective of assessing the impact of bio fertilizer-enriched vermicompost on the growth and yield of wheat and Pearl millet.

2. Material and Methods

Enriched vermicompost was prepared at the animal husbandry farm, Rajamata Vijayaraje scindia Krishi Vishwavidyalaya, Gwalior district of Madhya Pradesh. Vermicompost was prepared by using (Esenia fetida) earthworm species using with different organic materials and minerals for the enrichment of the compost for N, P, K, S, Zn, Ca and Mg. The enriched vermicompost composition, given in Table 1 was used for the effect of wheat and Pearl millet production. The field experiment was conducted during Rabi and kharif season 2020-2022 in randomized block design (RBD) with three replications at Research Farm of Department of Soil Science, RVSKVV Gwalior (M.P), and India. There was total 21 plots, net size of each experimental plot was 4.0 m x3.0 m=12 m^2 and 3 treatments which were as follows: T1: 100% enriched vermicompost (100% EVC); T2: 50% enriched vermicompost +50% recommended dose of fertilizer (50%EVC+ 50%RDF); T3: 100 % recommended dose of fertilizer (100% RDF). Land preparation was done by ploughing the field twice with tractor drawn cultivator. To attain ideal tilth, a rotavator was used crosswise afterwards. Seed were sowing in lines maintaining a row spacing of 22.5 cm and 45 cm for wheat and pearl millet. During rabi season wheat sown on Rabi 1st 18.10.2020, Rabi 2nd 20.10.2021 taking seed rate of 100 kg ha^{-1} and during kharif season pearl millet sown on date kharif 1st - 23.7.2021 , kharif 2nd - 15.7.2022 taking seed rate 5 kg ha^{-1}. the wheat and pearl millet variety used in this study was HI8759 and JBV-2. The recommended dose of NPK fertilizer for wheat and Pearl millet crop was 120, 60 and 30 $kgha^{-1}$ and 80:40:20 $kgha^{-1}$, respectively. The sources of N, P and K were urea, single super phosphate, Di ammonium phosphate and muriate of potash, respectively. In both, 50 per cent of nitrogen and entire dose of P_2O_5 and K_2O was applied at the time of sowing and remaining 50 per cent of nitrogen was top dressed in the form of urea 30 days after sowing (crown root initiation and tillering stage) .In treatment 100 % NPK, P was added through DAP. As per treatment vermicompost was added @ 5 tons $ha^{-1}yr^{-1}$ before sowing of Wheat and Pearl millet crop.

The data on growth parameters like height of the plant was measured in centimeter by meter scale from ground level to the collar of the flag leaf height was measured at 30,60,90 and 120 day after sowing in different stage of crop. Numbers of tillers $plant^{-1}$ / Numbers of panicle $plant^{-1}$ was counted and Leaf area index is the ratio of leaf area over ground area. Periodically at 30, 60, 90 and 120 days interval. Yield parameters like No. of ear heads $plant^{-1}$, Shoot dry weight plant-1 (g), Shoot fresh weight plant-1 (g), 1000-grain weight (g), Protein content (%), Root length density at harvest time (cm/cm^3) were recorded at harvest. Root length density (cm cm^{-3}) was determined at harvest as the ratio of total root length to the volume of soil, following the procedure suggested by Bohm (1979). For estimation of grain and straw yield the entire produce from net plot area of 12 m^2 (4 m x 3 m) demarcated previously excluding border rows was harvested manually. After threshing grain were sun dried to bring the moisture of grain to 12% and then samples were weighed separately and obtained value was expressed in kg ha-1. Biological yield was then computed as the sum of grain yield and straw yield and expressed in kilograms per hectare (Donald, 1962; Singh and Stoskopf, 1971). The harvest index was calculated by taking the ratio of economic yield to biological yield. The digested plant samples were analysed for crude protein and nutrient content like N, P, K, Ca, Mg and micronutrient cations viz. Fe, Mn, Zn, Cu. For the analysis of crude protein, the nitrogen content in grain was multiplied by a factor of 6.25 (Jones, 1941).

The data recorded during the investigation was statistically analysed following the analysis of variance for randomized block design as suggested. Statistical significance was tested with an 'F' value at a 5 % level of probability by using Microsoft Excel.

Table 1: Chemical composition of enriched vermicompost at the end of decomposition

S.N.	Parameters	Value
1.	pH (1:2.5)	7.5
2.	EC (dSm-1)	0.43
3.	TOC (%)	33.1
4.	Total N (%)	2.60
5.	Total P (%)	1.44
6.	Total K (%)	2.2
7.	Total S (%)	0.88
8.	Total Zn (ppm)	89
9.	Total Cu (ppm)	19
10.	Total Fe (ppm)	400
11.	Total Mn (ppm)	129
12.	Total Ca (%)	0.26
13.	Total Mg (%)	0.42
14.	C:N Ratio	12.7

3. Results and Discussion

3.1. Growth and yield attributes of wheat:

The Plant height was not affected significantly by various treatments at 30 days after sowing (DAS) and 60 DAS, but, at 90 DAS and 120 DAS it was significantly higher in case of T_2 (50%EVC+ 50%RDF as compared to (100% EVC) and T_3 (100% RDF) Table 2 The numbers of tillers and leaf area index were not affected significantly by different treatments and all the treatments were at par with each other. The overall results suggest that the wheat growth was similar in all the treatments. It is evident from the Table 3 data that No. of ear heads $plant^{-1}$ was higher in case of T_2 (5.1cm) followed by 100% RDF and 100% EVC. All the three treatments were statistically at par with each other during 2020-21 and similar trend was observed during 2021-22 and also in pooled analysis. Similarly, the fresh weight, dry weight $plant^{-1}$, root length density, test weight and percent protein content in seeds were not affected significantly due to different treatments, It was found maximum in 100% EVC during both the years during 2020-21 and 2021-22, respectively). Thus, it is evident from the above findings that application of enriched vermicompost has been found equality good or slightly better in few yield attributing characters particularly after second year of application as compared to Treatment T_2 and T_3.

The results of Table 4 it is observed that, the highest grain yield, straw yield and biological yield of wheat was recorded in the treatment T_2 (50% RDF through chemical fertilizer + 50% of RDF through EVC) and lowest in case of RDF through chemical fertilizers. All these three treatments were statistically at par with each other. In case of harvest Index (%) treatment T_2 gave higher HI as compared to treatment T_1 and T_3 during 2020-21 and 2021-22, respectively.

All these three treatments were statistically at par with each other in during 2020 and 2021.On the basis of pooled analysis, the difference in HI% was found non-significant among the treatments T_1, T_2 and T_3.

Thus, it may be inferred that all the nutrient management practices tested were equally effective in influencing grain yield, straw yield biological yield and harvest index. However, the integrated approach of 50% EVC + 50% RDF consistently maintained slightly higher mean values, suggesting its potential agronomic advantage, even though the differences were not statistically significant.

These observation is in agreement with earlier reports, where vermicompost was shown to act as a rich source of macro- and micronutrients in plant-available forms and to improve nutrient uptake efficiency when combined with chemical fertilizers (Yadav *et al.,* 2024). In addition to nutrient enrichment, vermicompost also plays a significant role in improving soil physical and chemical properties such as soil organic carbon, cation exchange capacity, water holding capacity, and pH balance, which are essential for sustainable productivity (Singh *et al.,* 2024).

Similar findings have been reported by several researchers. Kang and Juo (1986) observed that the integration of organic and inorganic nutrient sources could sustain crop yields while maintaining soil fertility. Ranwa and Singh (1999) also highlighted the positive role of vermicompost in enhancing crop growth and productivity. Desai *et al.,* (1999) emphasized that the combined use of organic manures and fertilizers improved nutrient availability and crop performance. Likewise, Ismail (2005) demonstrated that vermicompost not only increased yields but also enriched soil microbial activity. Channabasanagowda *et al.* (2008) reported higher yields under integrated nutrient management compared to sole fertilizer application, and similar beneficial effects were confirmed by Ahmed *et al.* (2010).

3.2. Pearl millet crop

It is evident from the Table 5 and 6 that the plant height, number of tillers plant^{-1} and leaf area index were not affected significantly by various treatments at 30, 60, 90 and 120 DAS. In general, the maximum plant height, number of tillers plant^{-1} and leaf area index were recorded in case of treatment T_2 (50% EVC+50% RDF) followed by T_1 (100% RDF through EVC) and minimum in case of T_3 (100% RDF through chemical fertilizer) at all the growth stages.

It is evident from the result that number of panicle plant^{-1}, shoot fresh weight plant^{-1} (g), shoot dry weight plant^{-1} (g), test weight (g), along with root length density at harvest time (cm/cm^2) and The lower protein content observed under T3 (100% RDF) during the year 2020 may be attributed to the exclusive reliance on chemical fertilizers without the contribution of organic matter. The application of inorganic fertilizers alone often leads to rapid nutrient availability, but a significant portion of nitrogen is lost through leaching, volatilization, and denitrification processes, thereby reducing the effective supply to the crop. In contrast, organic sources such as enriched vermicompost not only provide a steady release of nutrients but also improve soil organic carbon, microbial activity, and cation exchange capacity, which enhance nutrient transformation and uptake. The lack of such beneficial effects in T3 likely constrained nitrogen assimilation and translocation into the grains, resulting in comparatively lower protein content in grain. While protein content were higher in case of T_2 followed by T_3 and T_1. However, these treatments were statistically at par with each other during 2020 and similar trend was observed during 2021 and also in pooled analysis. Thus, overall results suggest that root length density at harvest time (cm/cm^2) increase with the addition of enriched vermicompost application as compared to conventional

Table 2: Plant height (cm) tillers plant^{-1} and LAI at different stages of wheat growth as influenced by different treatments

Treatment	30 DAS			60 DAS			90 DAS			120 DAS		
A: Plant Height												
	2020-2021	2021-2022	Pooled	2020-2021	2021-2022	Pooled	2020-2021	2021-2022	Pooled	2020-2021	2021-2022	Pooled
T_1: 100% EVC	14.9	15.5	15.2	49.8	53.9	51.9	94.2	94.4	94.3	95.6	96.1	95.8
T_2:50%EVC+50% RDF	15.5	15.6	15.5	51.0	56.0	53.5	105.5	106.9	106.2	107.2	108.5	107.8
T_3: 100% RDF	14.2	15.4	14.8	49.9	48.7	49.3	93.2	94.3	93.7	94.4	94.2	94.3
SEm±	0.84	0.806	0.58	0.52	3.31	1.50	2.26	2.706	0.39	2.305	2.583	0.45
CD $_{(0.05\%)}$	NS	NS	NS	NS	NS	NS	6.98	8.341	1.2	7.1	7.9	1.4
B: No. of tillers												
T_1: 100% EVC	2.4	2.1	2.3	2.8	2.95	2.9	4.48	4.58	4.53	4.39	4.46	4.43
T_2: 50%EVC + 50% RDF	2.5	2.3	2.4	2.8	3.00	2.9	4.62	4.65	4.64	4.50	4.53	4.52
T_3: 100% RDF	2.3	2.2	2.3	2.6	2.91	2.8	4.45	4.56	4.51	4.39	4.46	4.43
SEm±	0.1	0.05	0.1	0.1	0.03	0.12	0.06	0.03	0.04	0.05	0.02	0.04
CD $_{(5\%)}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C: Leaf area index												
T_1: 100% EVC	2.09	2.18	2.14	5.47	5.46	5.47	5.26	6.3	5.78	2.49	2.5	2.50
T_2: 50%EVC + 50% RDF	2.25	2.32	2.29	5.60	5.62	5.61	5.12	6.5	5.81	2.54	2.6	2.57
T_3: 100% RDF	1.98	2.03	2.01	5.39	5.38	5.39	5.18	6.1	5.64	2.42	2.5	2.46
SEm±	0.12	0.119	0.10	0.07	0.08	0.09	0.21	0.213	0.20	0.096	0.100	0.02
CD $_{(0.05\%)}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Yield attributing characters of wheat as influenced by different treatments at harvesting of crop

Treatment	No. of ear heads plant^{-1}			Protein content (%)			Root length density at harvest time (cm/cm^3)		
	2020-2021	2021-2022	Pooled	2020-2021	2021-2022	Pooled	2020-2021	2021-2022	Pooled
T_1: 100% EVC	4.8	5.2	5.0	10.96	11.44	11.201	2.74	3.57	3.16
T_2: 50%EVC + 50% RDF	5.1	5.2	5.2	11.53	11.53	11.526	2.68	2.72	2.70
T_3: 100% RDF	5.0	5.0	4.9	10.76	11.28	11.02	2.60	2.60	2.60
SEm±	0.14	0.07	0.12	0.23	0.25	0.26	0.12	0.59	0.04
CD $_{(0.05\%)}$	NS	NS	NS	NS	NS	NS	NS	NS	0.12

Treatment	Shoot dry weight plant^{-1} (g)			Shoot fresh weight plant^{-1} (g)			Test weight(g)		
	2020-2021	2021-2022	Pooled	2020-2021	2021-2022	Pooled	2020-2021	2021-2022	Pooled
T_1: 100% EVC	0.23	0.25	0.24	0.62	0.69	0.66	45.89	47.73	46.81
T_2: 50%EVC + 50% RDF	0.28	0.30	0.29	0.78	0.77	0.78	46.69	46.67	46.68
T_3: 100% RDF	0.23	0.23	0.23	0.61	0.66	0.64	43.88	45.69	44.79
SEm±	0.02	0.02	0.02	0.07	0.04	0.06	1.13	0.85	0.66
CD $_{(0.05\%)}$	NS	0.06	NS	NS	NS	NS	NS	NS	NS

Table 4: Seed, straw, biological yield (kg ha^{-1}) and harvest index of wheat as influenced by different treatments.

Treatment	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})		
	2020-2021	2021-2022	Pooled	2020-2021	2021-2022	Pooled
T_1: 100% EVC	4101	4152	4126	5796	5841	5819
T_2:50%EVC+50%RDF	4194	4237	4216	5821	5872	5846
T_3: 100% RDF	3948	4020	3984	5756	5812	5784
SEm±	201	208	145	98	126	80
CD $_{(0.05\%)}$	NS	NS	NS	NS	NS	NS

Treatment	Biological yield (kg ha^{-1})			Harvest Index (%)		
	2020-2021	2021-2022	Pooled	2020-2021	2021-2022	Pooled
T_1: 100% EVC	9897	9993	9945	41.3	41.5	41.4
T_2:50%EVC+50%RDF	10015	10109	10062	41.7	41.8	41.8
T_3: 100% RDF	9705	9832	9768	40.6	40.7	40.7
SEm±	227	146	135	1.2	1.6	1.0
CD $_{(0.05\%)}$	NS	NS	NS	NS	NS	NS

Table 5: Plant height (cm), no. of tillers plant^{-1} and LAI at different days after sowing (DAS) during pearl millet growth period

Treatment	30 DAS			60 DAS			90 DAS			120 DAS		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
A: Plant height												
T_1: 100% EVC	61.7	67.5	64.3	161.8	165.0	163.4	182.5	185.4	184.0	184.9	186.0	185.4
T_2: 50%EVC + 50% RDF	65.0	67.6	66.3	164.5	166.5	165.5	184.5	185.7	185.1	186.5	186.6	186.5
T_3: 100% RDF	60.5	66.8	63.6	162.9	165.1	164	181.1	184.6	182.9	184.1	184.9	184.5
SEm±	1.713	0.380	0.87	0.95	0.520	0.54	1.19	0.61	0.67	1.01	0.70	0.61
$CD_{(0.05\%)}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
B: No. of tillers												
T_1: 100% EVC	1.8	2.2	2.0	2.8	3.1	2.9	2.8	3.1	2.9	2.8	3.3	3.0
T_2: 50%EVC + 50% RDF	1.8	2.3	2.0	3	3.2	3.1	3.1	3.2	3.1	3.2	3.4	3.3
T_3: 100% RDF	1.6	2.2	1.9	2.8	3.06	2.9	2.7	3.1	2.9	2.8	3.2	3.0
SEm±	0.143	0.063	0.07	0.172	0.072	0.16	0.09	0.05	0.054	0.141	0.077	0.14
$CD_{(0.05\%)}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C: Leaf area index												
T_1: 100% EVC	1.5	1.6	1.5	2.7	3.1	2.9	1.23	1.1	1.1	0.92	0.95	0.935
T_2: 50%EVC + 50% RDF	1.5	1.6	1.5	2.9	3.1	3.0	1.34	1.2	1.3	1.08	0.91	0.995
T_3: 100% RDF	1.4	1.5	1.4	2.5	2.9	2.7	1.22	1.1	1.1	0.92	0.87	0.895
SEm±	0.048	0.032	0.029	0.138	0.073	0.078	0.037	0.019	0.021	0.103	0.068	0.062
$CD_{(0.05\%)}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 6: Different growth, yield attribute and quality parameter of pearl millet crop

Treatment	No. of panicle plant^{-1}			Shoot fresh weight plant^{-1} (g)			Shoot dry weight plant^{-1} (g)		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
T_1: 100% EVC	1.4	1.5	1.5	476.4	486.4	481.4	287.9	301.2	294.5
T_2: 50%EVC + 50% RDF	1.5	1.7	1.6	489.3	503.9	496.6	293.9	304.1	299.0
T_3: 100% RDF	1.4	1.4	1.4	461.7	481.4	471.5	247.4	300.8	274.1
SEm±	0.20	0.21	0.14	17.5	17.7	12.4	16.2	6.8	8.7
$CD_{(5\%)}$	NS	NS	NS	NS	NS	NS	NS	NS	NS

Treatment	Test weight (g)			Root length density at harvest time (cm/cm^3)			Protein content (%)		
	2020	2021	Pooled	2020	2021	Pooled	2020	2021	Pooled
T_1: 100% EVC	7.6	7.9	7.7	3.7	3.9	3.8	10.5	11.7	11.1
T_2: 50%EVC + 50% RDF	7.9	8.0	7.9	3.8	4.3	4.0	10.7	11.9	11.3
T_3: 100% RDF	7.2	7.7	7.5	3.7	3.9	3.8	9.9	11.6	10.7
SEm±	0.24	0.11	0.13	0.21	0.12	0.16	0.21	0.10	0.44
$CD_{(0.05\%)}$	NS	NS	NS	NS	NS	NS	0.650	NS	NS

Table 7: Grain, straw, biological yield (kg ha^{-1}) and harvest index (HI%) of pearl millet as influenced by different treatments

Treatment	Grain yield			Biological yield		
	2020	2021	Pooled	2020	2021	Pooled
T1: 100% EVC	2354	2411	2383	8665	8836	8750
T2: 50%EVC+50%RDF	2427	2513	2470	8748	9013	8880
T3: 100% RDF	2334	2405	2369	8542	8814	8678
SEm±	60.1	33.4	34.4	47.3	36.1	30.0
$CD_{(0.05\%)}$	NS	103.0	NS	NS	114.2	87.8
Treatment	**Straw yield**			**Harvest Index**		
	2020	**2021**	**Pooled**	**2020**	**2021**	**Pooled**
T1: 100% EVC	6310	6425	6367	27.1	27.2	27.1
T2: 50%EVC + 50% RDF	6321	6440	6380	27.7	27.8	27.7
T3: 100% RDF	6310	6409	6308	27.3	27.2	27.2
SEm±	43.4	27.5	25.7	0.50	0.33	0.35
$CD_{(0.05\%)}$	NS	NS	NS	NS	NS	NS

treatment *i.e.,* 100% RDF through chemical fertilizers. Thus, it is evident from the above findings that application of enriched vermicompost has been found equally good or slightly better in few yield attributing characters particularly after second year of application as compared to Treatment T_2 and T_3.

From Table 7 the results it is observed that, the highest grain yield, straw yield, biological yield and harvest index (%) of pearl millet were recorded in the treatment T_2 (50% RDF through chemical fertilizer + 50% of RDF through enrich vermicompost) followed by T_1 a having 5tha^{-1} enriched vermicompost and lowest in case of RDF through chemical fertilizers. All these three treatments were statistically at par with each other. Several studies have also confirmed that the integration of vermicompost with inorganic fertilizers significantly enhances crop yield and quality. A recent systematic review reported yield increases ranging from 12–100% across crops such as wheat, rice, maize, tomato, and sunflower under combined application compared to sole use of chemical fertilizers (Kumar & Lal, 2024b). Furthermore, vermicompost exhibits slow nutrient release, which ensures residual fertility and benefits succeeding crops, thus offering long-term agronomic advantages (Mwangi *et al.,* 2023).

Similar results were also documented by Singh (2003), who reported that the integration of organic and inorganic nutrient sources enhanced crop productivity and improved soil health. Likewise, Narolia *et al.,* (2009) observed that the combined application of vermicompost with chemical fertilizers resulted in better nutrient availability, higher yields, and sustained soil fertility compared to the sole use of inorganic fertilizers.

Conclusion

The growth and yield attributing characters of wheat and pearl millet were found to be statistically at par under the treatments of 100% enriched vermicompost (T_1), 50% EVC + 50% RDF (T_2), and 100% RDF through chemical fertilizers (T_3). Similarly, grain yield of both crops was not significantly influenced by the different nutrient management practices evaluated during the study.

In addition to yield, the quality of food grains is of paramount importance for the present generation, as nutrient-rich cereals play a vital role in maintaining good health, boosting immunity, and reducing the risk of chronic diseases. Enriched vermicompost has been reported to enhance the nutritional quality of grains by improving protein content, essential amino acids, and micronutrients such as iron and zinc. These improvements contribute to better dietary intake and can help in addressing widespread nutritional deficiencies. Furthermore, nutrient-dense cereals are increasingly recognized for their role in preventing lifestyle-related disorders and diseases, including cardiovascular complications, diabetes, and even cancers. Thus, integrated nutrient management using enriched vermicompost not only sustains soil fertility and crop productivity but also contributes to producing healthier food grains that are essential for combating malnutrition and reducing disease burden in society.

Author contributions

AB, AP, SKS conducted the experiment, recorded data & prepared the manuscript; RSJ, SLY, PS conceptualized the research including plant material & finalized the manuscript; All authors read, edited, and approved the final manuscript.

Conflict of interest

The authors declare no conflict of interest.

Ethical Approval

The article doesn't contain any study involving ethical approval.

Generative AI or AI/Assisted Technologies use in Manuscript Preparation

No

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