Chemical Science Review and Letters ISSN 2278-6783
www.chesci.com
Research Article
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Effect of Vermicompost and Zinc Levels on Growth and Yield of Wheat (*Triticum aestivum* L.)

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Abstract
A field experiment was conducted during the Rabi season of 2024–25 at the Research Farm, Department of Agriculture, Vivekananda Global University, Jaipur, to evaluate the effect of vermicompost and zinc on the productivity and nutrient uptake of wheat (*Triticum aestivum* L.). The experiment was laid out in a Factorial Randomized Block Design (RBD) with three replications, comprising four levels of vermicompost (0, 5, 7.5, and 10 t/ha) and four levels of zinc (0, 2.5, 5.0, and 7.5 kg/ha), resulting in a total of sixteen treatment combinations. Observations were recorded on various growth parameters, yield attributes, yield, nutrient content and uptake, and economic returns. The results revealed that the combined application of vermicompost @ 10 t/ha and zinc @ 7.5 kg/ha (V3Zn3) significantly enhanced plant height, number of tillers, dry matter accumulation, and crop growth rate. Yield attributes such as number of spikes, seeds per spike, and test weight also showed significant improvement. The highest grain yield (4147.16 kg/ha), biological yield (9172.23 kg/ha), and net return (Rs. 67,115.66/ha) with a benefit-cost (B:C) ratio of 1.96 were recorded under the V3Zn3 treatment. It is concluded that the integrated application of vermicompost @ 10 t/ha and zinc @ 7.5 kg/ha is the most effective and economically viable strategy for improving wheat productivity and nutrient uptake in the semi-arid regions of Rajasthan.

Keywords: Wheat (*Triticum aestivum* L.), Vermicompost, Zinc, Nutrient uptake, Productivity, Grain yield

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Introduction

Wheat (*Triticum aestivum* L.) is a staple cereal crop that significantly contributes to global food security, providing about 20% of dietary calories and protein. In India, it ranks second after rice in both area and production. The importance of wheat extends beyond nutrition to include substantial industrial applications such as flour, starch, gluten, and livestock feed production [1]. Rajasthan, a major wheat-producing state, achieved a yield of 3,739 kg/ha in 2023–24 across 2.78 million hectares [2].

To meet increasing food demand while ensuring sustainability, integrated nutrient management strategies that combine organic and inorganic sources are gaining prominence. Vermicompost—a product of earthworm-mediated decomposition—is rich in macro- and micronutrients, beneficial microbes, vitamins, and enzymes [3]. Its application enhances soil structure, microbial biomass, and nutrient retention [4, 5]. Studies have confirmed its positive impact on wheat growth parameters such as plant height, tiller number, and dry matter accumulation [6–8].

Zinc, an essential micronutrient, influences several enzymatic and physiological processes including protein synthesis, auxin metabolism, and stress tolerance [9]. Its deficiency leads to chlorosis, stunted growth, reduced tillering, and poor yield [10]. Significant yield enhancements in wheat with zinc fertilization have been reported [11-13]. Therefore, combining vermicompost and zinc may synergistically improve crop performance. In this context, the present study was undertaken during the Rabi season of 2024–25 at Vivekananda Global University, Jaipur, to evaluate the integrated effect of vermicompost and zinc on growth and yield attributes of wheat.

Materials and Methods
The experiment was conducted at the Research Farm, Vivekananda Global University, Jaipur, Rajasthan (Agro-Climatic Zone III-A), during Rabi 2024–25. The soil was sandy loam in texture, slightly alkaline (pH 8.25), and low in organic carbon (0.25%), with available N (136.87 kg/ha), P_2O_5 (20.56 kg/ha), and K_2O (257.16 kg/ha).

The experiment was laid out in a Factorial Randomized Block Design (FRBD) with 16 treatment combinations replicated thrice. Treatments consisted of four vermicompost levels (0, 5, 7.5, and 10 t/ha) and four zinc levels (0, 2.5, 5.0, and 7.5 kg Zn/ha as $ZnSO_4$). The wheat variety ‘HD-2851’ was sown on 10th November 2024 at a spacing of 20 cm using the "Kera" method. The seed rate was 100 kg/ha. Vermicompost and zinc were applied as basal doses before sowing. Cultural operations like weeding and hoeing were done at 25 DAS. Six irrigations were applied uniformly across treatments.

Growth parameters such as plant height, dry matter accumulation, number of tillers, crop growth rate (CGR), and relative growth rate (RGR) were recorded at regular intervals (30, 60, 90 DAS, and harvest). Yield attributes such as number of spikes/m², number of grains/spike, spike length, test weight (1000-grain weight), and yield traits such as grain yield, straw yield, biological yield, and harvest index were measured at harvest.

Plant samples were dried and weighed for dry matter accumulation. CGR and RGR were calculated using standard formulas [12]. Yield data were recorded from the net plot area (8.8 m²). Harvest index was computed as the ratio of grain yield to biological yield. Data were statistically analyzed using ANOVA as per the procedure outlined by [14]. Critical difference (CD) at 5% was used for comparing treatment means.

Results and Discussion

During the standard meteorological weeks 42 to 10 (15 October 2024 to 11 March 2025), weather conditions showed a gradual transition from warm to cool and back to warmer temperatures. Maximum temperatures ranged from 33.4°C in mid-October to a low of 20.1°C in mid-January, followed by a rise to 32.1°C by early March. Minimum temperatures dropped to as low as -1.1°C in the first week of January (**Table 1**). Relative humidity varied between 35–69% (maximum) and 19–34% (minimum), with the highest humidity during late January (Wk 05). Except for a rainfall event of 17.0 mm in week 05, the entire period remained dry. Pan evaporation and sunshine hours showed a decreasing trend during the coldest weeks and increased again with rising temperatures. Wind speed remained moderate, ranging from 2.0 to 7.3 km/hr, with maximum sunshine (9.7 hrs/day) in week 42 and minimum (4.1 hrs/day) in week 04. These conditions reflected typical Rabi season weather with a dry, cool winter followed by a warming trend.

Table 1 Mean weekly weather parameters recorded during crop season (*rabi*, 2024-25)

Standard weeks	Period		Temperature, °C		Mean R.H. (%)		Rainfall (mm)	Pan Evap. (mm)	Wind speed (km/hr)	Sunshine hors/day
	From	To	Max.	Min.	Max.	Min.				
42	15/10/2024	21/10/2024	33.4	12.3	40	24	0	7.1	5.2	9.7
43	24/10/2024	28/10/2024	32.7	09.9	35	19	0	6.3	3.2	8.1
44	29/10/2024	04/11/2024	33.3	10.0	38	24	0	5.8	5.6	9.1
45	05/11/2024	11/11/2024	32.5	11.0	40	25	0	4.3	2.8	7.1
46	12/11/2024	18/11/2024	28.7	08.4	38	24	0	3.5	3.4	8.5
47	19/11/2024	25/11/2024	27.6	04.9	46	21	0	3.4	5.6	9.3
48	26/11/2024	02/12/2024	27.9	04.8	49	26	0	3.1	6.2	8.9
49	03/12/2024	09/12/2024	25.5	03.7	55	27	0	2.3	3.2	8.1
50	10/12/2024	16/12/2024	26.5	04.6	54	25	0	2.2	4.8	8.9
51	17/12/2024	25/12/2024	25.5	04.6	58	29	0	2.4	4.9	8.1
52	24/12/2024	31/12/2024	25.3	02.2	56	30	0	2.2	3.8	7.9
01	01/01/2025	07/01/2025	20.7	-01.1	60	33	0	02.0	6.8	07.5
02	08/01/2025	14/01/2025	24.5	04.9	55	31	0	02.7	7.3	07.3
03	15/01/2025	21/01/2025	20.1	-0.5	55	29	0	02.6	7.9	08.3
04	24/01/2025	28/01/2025	21.3	03.6	61	33	0	02.8	6.1	04.1
05	29/01/2025	04/02/2025	24.0	05.2	69	34	17.0	03.1	5.4	07.3
06	05/02/2025	11/02/2025	26.9	06.9	56	21	0	04.1	3.2	09.0
07	12/02/2025	18/02/2025	28.4	05.8	51	28	0	05.2	5.9	09.4
08	19/02/2025	25/02/2025	31.9	09.8	49	25	0	05.4	6.1	08.6
09	26/02/2025	04/03/2025	32.1	12.0	49	20	0	05.3	4.3	08.8
10	05/03/2025	11/03/2025	30.7	11.3	53	24	3.0	04.5	4.8	06.9

The application of vermicompost and zinc showed a significant and synergistic influence on various growth parameters, crop growth rate, yield attributes, and ultimately the grain and stover yield of wheat.

Growth Parameters: The results in **Table 2** indicate that the application of vermicompost significantly improved plant height, dry matter accumulation, and number of tillers per plant at all growth stages. The highest plant height was recorded with V3 (10 t ha^{-1} vermicompost) at harvest (66.30 cm), which was significantly higher than the control (62.84 cm). Similarly, dry matter accumulation showed a progressive increase with increased levels of vermicompost, with V3 again showing the maximum accumulation at all intervals. The enhanced performance may be attributed to improved soil structure, nutrient availability, and microbial activity from vermicompost application, which aligns with earlier findings by [15]. Zinc application also positively influenced plant height and biomass. At harvest, the maximum plant height (65.02 cm) was observed with Zn3 (7.5 kg Zn ha^{-1}), while the minimum was with the control (Zn0). This might be due to zinc's role in auxin synthesis and metabolic enzyme activation which promotes meristematic growth [16]. The interaction effect was also significant at harvest, indicating that combined application of vermicompost and zinc is superior to their individual applications. The number of tillers per plant, a vital yield-contributing trait, followed a similar pattern. At harvest, V3 and Zn3 treatments recorded the highest tiller counts (94.67 and 90.59, respectively). The enhancement in tiller numbers under integrated nutrient sources is supported by previous studies highlighting zinc's contribution to cell elongation and division as well as vermicompost's slow-release of macro and micronutrients [17].

Table 2 Effect of vermicompost and zinc on growth traits of wheat

Treatment Symbol	Treatment combinations	Plant height (cm)				Dry matter accumulation (cm)				Number tiller			
		30 DAS	45 DAS	60 DAS	At harvest	30 DAS	45 DAS	60 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
V0	Control	29.88	53.00	58.84	62.84	29.88	53.00	58.84	62.84	28.56	58.21	86.308	84.64
V1	5 t ha-1	29.94	53.55	59.44	63.28	29.94	53.55	59.44	63.28	29.34	59.45	86.36	84.78
V2	7.5 t ha-1	30.06	53.56	60.41	64.41	30.06	53.56	60.41	64.41	31.22	61.34	87.00	91.52
V3	10 t ha-1	30.12	53.95	62.30	66.30	30.12	53.95	62.30	66.30	31.33	62.05	88.44	94.67
	S.Em. (±)	0.43	0.53	0.92	1.15	0.43	0.53	0.92	1.15	1.59	1.83	1.61	1.15
	C.D.at 5%	NS	1.52	2.70	3.33	NS	1.52	2.70	3.33	NS	2.14	4.66	3.31
Zn0	Control	29.13	52.38	59.68	63.51	29.13	52.38	59.68	63.51	28.68	59.39	85.53	86.13
Zn1	2.5 Zn kg ha-1	29.39	53.48	59.95	63.95	29.39	53.48	59.95	63.95	33.23	60.57	85.99	88.28
Zn2	5.0 Zn kg ha-1	30.59	53.60	60.34	64.34	30.59	53.60	60.34	64.34	35.67	62.39	87.45	89.56
Zn3	7.5 Zn kg ha-1	30.89	54.60	61.02	65.02	30.89	54.60	61.02	65.02	38.22	63.57	88.92	90.59
	S.Em. (±)	0.43	0.53	0.92	1.15	0.43	0.53	0.92	1.15	1.59	1.83	1.61	1.15
	C.D.at 5%	NS	1.52	2.70	3.33	NS	1.52	2.70	3.33	NS	2.14	4.66	3.31
	V_1 x Zn_1	0.87	1.05	1.87	2.30	0.87	1.05	1.87	2.30	2.72	3.44	3.32	2.30
	CV%	5.01	5.40	5.41	6.22	5.01	5.40	5.41	6.22	8.60	5.1	6.43	5.48

Crop Growth Rate (CGR) and Relative Growth Rate (RGR)

CGR and RGR values (**Table 3**) showed non-significant differences statistically but followed an increasing trend with nutrient addition. Among vermicompost levels, V3 registered the highest CGR of 30.55 g m^{-2} day^{-1} during 30–60 DAS, while Zn3 recorded 28.33 g m^{-2} day^{-1}, highlighting the additive effect of micronutrients and organic matter on biomass production. Higher CGR and RGR can be attributed to enhanced leaf area development and photosynthetic activity under nutrient-enriched conditions [18]. Although not statistically significant, the numerical trends corroborate the positive effect of both vermicompost and zinc in boosting dry matter production efficiency over time.

Yield Attributes

Table 4 illustrates that yield attributes such as spike number, seeds per spike, and test weight were significantly enhanced by vermicompost and zinc application. The highest spike count per plant (188.03) was recorded in V3, whereas Zn3 yielded 189.91 spikes per plant. Similarly, seeds per spike improved substantially, with V3 (50.01) and Zn3 (48.35) being statistically superior to control treatments. These results may be attributed to the role of zinc in pollen viability, seed development, and translocation of photosynthates [19], whereas vermicompost enhanced soil structure and nutrient uptake leading to better flowering and seed setting [20]. Test weight, representing grain plumpness and maturity, showed significant increases under V3 (41.94 g) and Zn3 (40.93 g), demonstrating enhanced grain quality due to balanced nutrient supply. Similar increases in test weight with organic and zinc treatments have been reported by [21].

Table 3 Effect of vermicompost and zinc on Crop Growth Rate and Relative growth rate of wheat

Treatment Symbol	Treatment combinations	Crop Growth Rate (g/m²/day)			Relative growth rate (g/g/day)		
		30-60 DAS	60-90DAS	90-At harvest	30-60 DAS	60-90 DAS	90-At harvest
V0	Control	26.67	49.16	175.27	0.031	0.130	0.040
V1	5 t ha-1	27.77	50.97	175.56	0.033	0.132	0.048
V2	7.5 t ha-1	28.33	51.06	175.59	0.030	0.134	0.047
V3	10 t ha-1	30.55	51.11	175.69	0.034	0.130	0.048
	S.Em. (±)	1.14	1.43	1.14	0.0002	0.000	0.000
	C.D.at 5%	NS	NS	NS	NS	NS	NS
Zn0	Control	28.00	48.88	175.12	0.035	0.131	0.049
Zn1	2.5 Zn kg ha-1	28.13	50.60	175.19	0.032	0.133	0.047
Zn2	5.0 Zn kg ha-1	28.22	51.29	175.28	0.031	0.134	0.047
Zn3	7.5 Zn kg ha-1	28.33	51.52	175.79	0.030	0.136	0.048
	S.Em. (±)	1.14	1.43	1.14	0.0002	0000	000
	C.D.at 5%	NS	NS	NS	NS	NS	NS
	V_1 x Zn_1	2.28	2.86	2.28	0.0003	000	000
	CV%	13.91	9.83	5.24	16.19	6.50	5.57

Table 4 Effect of vermicompost and zinc on yield attributes and yields of wheat

Treatment Symbol	Treatment combinations	Spike/ plant	Seeds/ Spikes	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Biological yield	Harvest Index (%)
V0	Control	181.41	45.66	38.20	3172.74	4001.35	7174.09	44.22
V1	5 t ha-1	186.08	46.53	39.42	3414.64	4203.02	7617.66	44.82
V2	7.5 t ha-1	187.41	46.96	40.41	3564.61	4354.54	7919.15	45.01
V3	10 t ha-1	188.03	50.01	41.94	4147.16	5025.07	9172.23	45.21
	S.Em. (±)	3.11	0.66	0.51	109.22	104.65	107.22	0.34
	C.D.at 5%	8.98	1.91	1.48	315.41	302.20	297.08	NS
Zn0	Control	182.33	46.53	38.72	3311.73	4082.14	7393.87	44.79
Zn1	2.5 Zn kg ha-1	188.08	46.65	39.94	3556.88	4431.97	7988.85	44.52
Zn2	5.0 Zn kg ha-1	189.08	47.67	40.44	3656.08	4481.92	8138.00	44.92
Zn3	7.5 Zn kg ha-1	189.91	48.35	40.93	3774.45	4587.96	8362.41	45.13
	S.Em. (±)	3.11	0.66	0.51	109.22	104.65	107.22	0.34
	C.D.at 5%	8.98	1.91	1.48	315.41	302.20	297.08	NS
	V_1 x Zn_1	6.22	1.33	1.02	218.44	209.30	197.33	1.23

Yield and Harvest Index

The grain yield was significantly improved by the application of vermicompost and zinc. Among treatments, V3 (10 t ha^{-1}) recorded the highest grain yield of 4147.16 kg ha^{-1}, followed by V2 (7.5 t ha^{-1}) with 3564.61 kg ha^{-1}. In zinc treatments, Zn3 (7.5 kg Zn ha^{-1}) yielded 3774.45 kg ha^{-1}, significantly higher than the control. The combined application of V3 + Zn3 demonstrated superior performance due to enhanced growth and yield components, consistent with the findings of [22].

Stover yield and biological yield also increased significantly with higher doses of vermicompost and zinc. The highest biological yield (9172.23 kg ha^{-1}) and harvest index (45.21%) were recorded under V3, indicating improved biomass partitioning towards economic yield. Though the harvest index showed non-significant statistical variation among treatments, the trend favors integrated nutrient application for maximizing productivity [23]. The cumulative influence of vermicompost and zinc highlights the advantage of integrated nutrient management strategies. Zinc ensures efficient nutrient metabolism and enzyme activity, while vermicompost improves physical and biological soil properties. The results validate the synergy between organic and inorganic nutrient sources in optimizing wheat growth and productivity.

Conclusion

The results of this study demonstrate that application of vermicompost @ 10 t/ha and zinc @ 7.5 kg/ha significantly enhanced growth parameters, yield attributes, and yield traits in wheat. The combined application (V3Zn3) was most effective, indicating a synergistic effect. Integrated nutrient management involving organic and micronutrient inputs are a viable strategy for sustainable wheat production in semi-arid regions.

Acknowledgement

The presented results are the part of M.Sc. thesis research (Vivekananda Global University, Jaipur) of the first author. The experimental and analytical facilities extended by the Dean are duly acknowledged.

References

[1] Swaminathan MS. Wheat and Wheat Improvement. New Delhi: Indian Council of Agricultural Research; 1981.
[2] Anonymous. Grain and Feed Update – April 2024. Washington, DC: Foreign Agricultural Service, U.S. Department of Agriculture; 2024.
[3] Sinha RK, Herat S, Valani D, Chauhan DK. Earthworms vermicompost: a powerful crop nutrient over the conventional compost & protective soil conditioner against the destructive chemical fertilizers for food safety and security. Am Eurasian J Agric Environ Sci. 2009;5:1–55.
[4] Gupta G, Rani R, Chandra A. Enhanced soil fertility, plant growth promotion and microbial enzymatic activities of vermicomposted fly ash. Sci Rep. 2003;9:10455.
[5] Lourduraj AC. Vermicomposting: a sustainable approach for organic waste management. Agric Rev. 2006;27:229–232.
[6] Verma S, Sharma RA, Singh S. Effect of integrated nutrient management on growth and yield of wheat (Triticum aestivum L.) under sandy loam soil. Indian J Agron. 2014;59:270–273.
[7] Dekhane SS, Patil VS, Bhilare RL. Response of late sown wheat (Triticum aestivum L.) to organic and inorganic sources of nutrients. Bioinfolet. 2017;14:123–126.
[8] Choudhary S, Sahu RK, Jangde R. Influence of vermicompost and inorganic fertilizers on productivity and soil health in wheat. Int J Curr Microbiol Appl Sci. 2023;12:987–993.
[9] Peck AW, McDonald GK, Graham RD. Zinc nutrition influences the protein composition of flour in bread wheat (Triticum aestivum L.). J Cereal Sci. 2008;47:266–274.
[10] Disante KB, Cortina J, Vilagrosa A. Sensitivity to zinc of Mediterranean woody species important for restoration. Sci Total Environ. 2010;408:2216–2225.
[11] Tiwari R, Patel M, Sharma A, Verma S. Effect of graded levels of zinc sulphate on growth, yield and zinc content in wheat (Triticum aestivum L.) under Vindhyan Plateau of Madhya Pradesh. J Pharmacogn Phytochem. 2023;12:2310–2314.
[12] Singh B, Pal A, Sharma S, Yadav P. Zinc biofortification of wheat through agronomic practices. Indian J Fert. 2010;6:40–52.
[13] Singh R, Verma KK. Role of zinc and organic manures in crop growth and productivity. Int J Agric Sci. 2022;14:34–40.
[14] Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. 4th ed. New Delhi: Indian Council of Agricultural Research; 1985.
[15] Ghanshyam, Hooda RS, Mehta KK. Residual effect of organic manures on productivity and nutrient uptake in wheat (Triticum aestivum L.). Indian J Agron. 2010;55(2):121–124.
[16] Bairwa SK, Verma R, Meena M, Kumawat SM. Effect of zinc fertilization on growth and yield of wheat (Triticum aestivum L.) under southern Rajasthan conditions. Int J Chem Stud. 2021;9(2):1743–1746.
[17] Ali A, Hussain M, Habib HS, Kiani TT, Anees MA, Rahman MA. Foliar spray surpasses soil application of potassium for maize production under rainfed conditions. Turk J Field Crops. 2016;21(1):36–43.
[18] Tiwari R, Patel M, Sharma A, Verma S. Effect of graded levels of zinc sulphate on growth, yield and zinc content in wheat (Triticum aestivum L.) under Vindhyan Plateau of Madhya Pradesh. J Pharmacogn Phytochem. 2023;12(2):2310–2314.
[19] Bano K, Kale RD, Gajanan GN. Culturing of earthworms Eudrilus eugeniae for cast production and assessment of worm cast as bio-fertilizer. J Soil Biol Ecol. 1987;7(2):98–104.
[20] Kapoor A, Singh R, Singh VK, Serawat M, Vishwakarma DK. Effect of organic, inorganic and biofertilizers on growth and yields of mungbean \[Vigna radiatus (L.) Wilczek]. Biol Forum – Int J. 2023;15(2):929–937.
[21] Kumari P, Singh R, Jha AK, Kumar S. Interaction effect of irrigation regimes and zinc nutrition on growth and

yield of wheat (Triticum aestivum L.) under eastern Indo-Gangetic Plains. J AgriSearch. 2024;11(1):45–50.
[22] Tiwari R, Patel M, Sharma A, Verma S. Zinc fertilization enhances yield and grain zinc concentration in wheat under rainfed conditions. J Pharm Innov. 2023;12(3):1020–1026.

Publication History	
Received	30.07.2025
Revised	11.08.2025
Accepted	11.08.2025
Online	15.09.2025