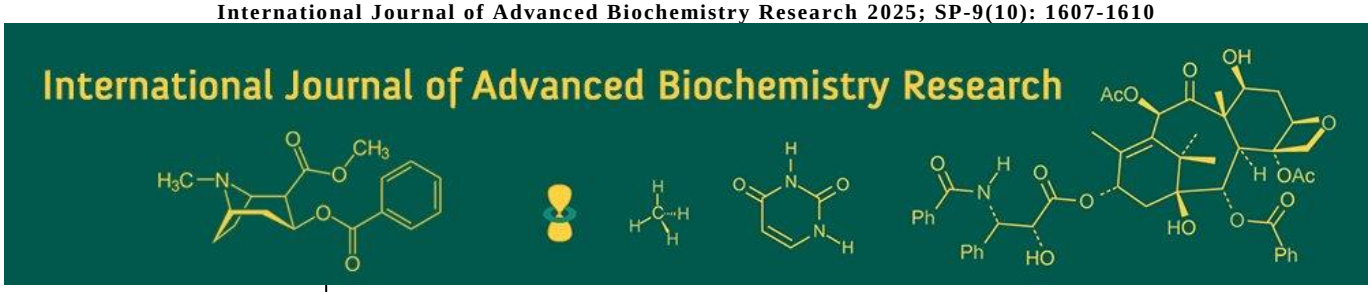

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Response of vermicompost levels and PGRs on growth and yield of cabbage (*Brassica oleracea* var. *capitata*) under sub humid South Eastern plain

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Abstract
A field experiment was conducted at Research Farm, Mewar University Gangrar, Chittorgarh (Rajasthan) during rainy season to check of organic manures and biofertilizers on growth and yield of cabbage variety "Golden Acre" was used in this study. The present investigation was conducted at Research Farm, Mewar University Gangrar, Chittorgarh (Rajasthan) during Rabi season to evaluate the effect of vermicompost and plant growth regulators (PGRs) on the growth and yield of cabbage (*Brassica oleracea* var. *capitata* L.). The study assessed different levels of vermicompost (0, 2.5, 3.5, and 5 t/ha) and PGRs (Control, NAA 50 ppm, GA_3 50 ppm, and NAA 50 ppm + GA_3 50 ppm). Results revealed that the application of vermicompost at 5 t/ha (V4) significantly enhanced plant height (28.12 cm at 60 DAT), number of leaves (8.88), plant spread (59.63 cm^2), and leaf length (24.60 cm), as compared to the control (V1). Similarly, PGR treatment P4 (NAA + GA_3) showed the best performance in most growth traits. The combination of V4P4 resulted in the earliest head initiation (34.02 days) and the highest fresh head weight (785.00 g), plot yield (22.15 kg), and yield per hectare (38.77 t/ha). The synergistic effect of vermicompost and PGRs significantly improved vegetative growth, reduced time to maturity, and maximized yield. The enhancement in yield attributes is attributed to improved nutrient availability, hormonal regulation, and efficient assimilate partitioning. These findings highlight the potential of integrating organic nutrition and hormonal treatments for sustainable cabbage production.

Keywords: Cabbage, vermicompost, PGR, yield, organic fertilizer

1. Introduction
Cabbage (*Brassica oleracea* var. *capitata* L.), a member of the family Brassicaceae (Cruciferae), is an important Cole crop cultivated globally for its high nutritional and economic value. It has a diploid chromosome number of 2n = 2x = 18 and is believed to have originated in the Western Europe and Mediterranean region. Nutritionally, cabbage is a rich source of vitamins and minerals; 100 g of green leaves contain approximately 103 KJ energy, 5.8 g carbohydrates, 36.6 mg vitamin C, and 2.5 mg dietary fiber, along with significant amounts of β-carotene and fiber, making it a valuable component of a healthy diet.

To improve yield and quality sustainably, the use of vermicompost and plant growth regulators (PGRs) has gained significant attention. Vermicompost, produced through the interaction of earthworms and microbes, is a nutrient-rich organic amendment that enhances plant growth and soil health. Its field-level production is cost-effective and environmentally friendly. According to Talashilkar *et al.* (2003) [27], vermicompost application leads to superior plant development compared to traditional composts. Sinha *et al.* (2010) [24] reported growth improvements of 50-100% over conventional compost and 30-40% over chemical fertilizers. Additionally, vermicompost has shown a positive impact on the growth and yield of cabbage (Chaudhary *et al.*, 2012) [13].

Plant growth regulators such as gibberellic acid (GA_3) and naphthalene acetic acid (NAA) also play a pivotal role in enhancing crop performance. Their effectiveness depends on both the concentration applied and the plant's physiological response. GA_3, a naturally occurring gibberellin, promotes stem elongation, fruit setting, enzyme production, and early flowering (Dhage *et al.*, 2011) [14].

On the other hand, NAA, a synthetic auxin, influences cell elongation, division, vascular differentiation, root initiation, and fruit retention, while also acting as an antifungal agent (Solaimalai *et al.*, 2001) [25].

Despite the individual benefits of vermicompost and PGRs, limited research exists on their combined effect on cabbage. Therefore, the present study was undertaken to evaluate the influence of different levels of vermicompost and plant growth regulators on the growth, development, and yield performance of cabbage under field conditions.

2. Materials and Methods

A field experiment was conducted during Rabi season of 2024-25 at research farm, Department of Agriculture (Horticulture), Faculty of Agriculture and Veterinary Sciences, Mewar University Gangrar, Chittorgarh (Rajasthan). Soil of the experimental field was sandy loam intexture, saline in reaction with a pH value of 7.6, poor in organic carbon (0.16%), deficient inavailable zinc (0.48 ppm) and iron (1.2 ppm) low in available nitrogen (176 kg/ha) and phosphorus (20.2 kg/ha) but medium in available potassium (320 kg/ha). The experiment was laid out in factorial randomized block design with three replications, Level-I:-V1-Control, V2-Vermicompost 2.5 t/ha, V3-Vermicompost 3.5 t/ha, V4-Vermicompost 5 t/ha and Level-II:-P1-Control, P2-NAA-50 ppm, P3-GA3-50 ppm and P4-NAA 50 ppm + GA3 50 ppm. There is total 16 treatment combinations and total 48 plots in research.

3. Results and Discussion

The purpose of this study was to determine the extent of performance for growth and yield parameters.

3.1 Growth parameters

3.1.1 Plant height (cm)

Vermicompost significantly affected plant height at both 30 and 60 DAT. V4 (5 t/ha) attained the greatest height (16.52 cm and 28.12 cm), followed by V3 and V2, whereas V1 (control) recorded lowest values (14.37 and 24.52 cm). Similarly, among PGR treatments, P4 (NAA + GA_3) had the highest heights (16.00 & 26.95 cm), statistically par with P3 (GA_3) at 30 DAT. The control (P1) had lowest (14.58 & 24.85 cm).

These results agree with previous work where vermicompost improved vegetative vigor in cabbage and other vegetables (Ali & Kashem, 2018; Sultana *et al.*, 2022) [8, 26]. The stimulation by PGRs is consistent with findings in cabbage and brassicas, where GA_3 and NAA enhanced cell elongation and division (Moniruzzaman *et al.*, 2019) [18].

3.1.2 Number of leaves

The increased leafiness and canopy expansion likely result from improved nutrient availability and hormonal stimulation, as reported in other vermicompost + PGR studies in vegetables (Thapa *et al.*, 2017) [28].

3.1.3 Leaf length (cm)

Leaf length peaked under V4 (24.60 cm) and was statistically similar to V3 (23.96 cm). Among PGRs, P4 (23.85 cm) slightly outperformed P3 and P2. Controls had lowest leaf lengths. This suggests that nutrient and hormonal inputs synergize to maximize leaf expansion.

3.1.4 Days taken to head initiation

The shortest duration to head initiation was recorded in V4 (34.39 days) and was statistically equivalent to V3 (35.89 days). P4 treatment also shortened initiation (34.02 days) relative to control (37.48 days). Thus, optimum vermicompost and PGR application accelerates developmental maturity.

Earlier initiation may derive from faster vegetative growth enabling earlier transition into reproductive phase, along with the influence of auxin-GA signalling. Comparable reductions in days to heading with GA_3/NAA have been seen in cabbage under controlled PGR experiments (Moniruzzaman *et al.*, 2019) [18].

3.2 Yield parameters

3.2.1 Fresh Head Weight & Diameter

Vermicompost exerted a strong positive influence on fresh head weight: V4 (5 t/ha) produced the highest head weight (747.50 g), followed by V3 (682.25 g), whereas the control (V1) had the lowest (527.50 g). PGR application also significantly affected head weight: P4 (NAA 50 + GA_3 50 ppm) led to the maximum weight (683.00 g), followed by P3 (GA_3 50 ppm, 653.75 g) and P2 (NAA 50 ppm, 638.75 g); P1 control had the lowest (610.00 g).

Head diameter increased similarly: under vermicompost, V4 yielded the greatest diameter (19.34 cm), while V1 the lowest (17.04 cm). Among PGRs, P4 (18.67 cm) was at par with P3 (18.44 cm) and P2 (18.25 cm), and P1 had the smallest (17.64 cm).

The interaction effect between vermicompost and PGR was significant: the highest fresh head weight (785.00 g) occurred under V4P4, and the lowest (480.00 g) under V1P1.

3.2.2 Yield per Plot and per Hectare

V4 produced the highest plot yield (22.15 kg) and hectare yield (36.91 t/ha), while V1 gave the lowest (15.63 kg, 26.05 t/ha). Among PGRs, P4 had the highest yield (20.24 kg, 33.73 t/ha), statistically at par with P3 (19.37 kg, 32.28 t/ha), and P1 had the lowest (18.07 kg, 30.12 t/ha). The V4P4 interaction gave the maximum yield (38.77 t/ha), and V1P1 the minimum (23.70 t/ha).

The increase in head weight, diameter, and yield with vermicompost likely arises from improved soil fertility, nutrient availability, water retention, and microbial activity, enabling stronger sink growth. PGRs (especially the combination of NAA + GA_3) enhance cell division, elongation, and assimilate partitioning toward the head. The strong interaction suggests that optimal nutrient status (via vermicompost) enhances the responsiveness of plants to hormonal regulation. These findings are consistent with prior studies in cabbage and related crops demonstrating beneficial effects of organic amendments and growth regulators on yield traits (Moniruzzaman *et al.*, 2019; Upadhyay *et al.*, 2012; Chatterjee & Jana, 2005) [18, 29, 12].

Table 1: Effect of organic manures and biofertilizers on growth attributes of cabbage

Treatments	Plant height (cm)		Leaf length (cm) at 60 DAT	Number of non-wrappers leaves per plant at 60 DAT	Days taken to initiation of head
	30 DAT	60 DAT			
Factor-I (Organic manures)					
O0-Control (No application of organic manure)	16.30	26.12	6.06	13.12	37.72
O1-FYM @ 12 t/ha	18.46	27.54	6.64	14.32	37.19
O2-Vermicompost @ 7.5 t/ha	20.22	28.67	7.14	15.13	35.89
O3-Poultry manure @ 5 t/ha	21.95	29.97	7.66	15.96	34.39
S. Em. ±	0.38	0.26	0.11	0.19	0.58
CD%	1.10	0.74	0.33	0.56	1.68
Factor-II (Biofertilizer)					
B0-Control (No application of biofertilizer)	18.31	27.51	6.66	14.12	37.48
B1-PSB	19.18	27.95	6.79	14.58	36.45
B2-VAM	19.52	28.27	6.96	14.80	35.00
B3-PSB + VAM	19.93	28.57	7.10	15.03	34.02
S. Em. ±	0.38	0.26	0.11	0.19	0.58
CD%	1.10	0.74	0.33	0.56	1.68

Table 2: Response of vermicompost and PGR on yield parameters

Treatments	Fresh weight of head (g)	Diameter of head (cm)	Yield per plot (kg)	Yield per hectare (t/ha)
Level-I (Vermicompost levels)				
V1-Control	527.50	17.04	15.63	26.05
V2-Vermicompost 2.5 t/ha	628.25	18.03	18.61	31.02
V3-Vermicompost 3.5 t/ha	682.25	18.58	20.21	33.86
V4-Vermicompost 5 t/ha	747.50	19.34	22.15	36.91
S. Em. ±	9.58	0.26	0.30	0.58
CD%	27.67	0.74	0.86	1.68
Level-II (Plant Growth Regulators)				
P1-Control	610.00	17.64	18.07	30.12
P2-NAA-50 ppm	638.75	18.25	18.93	31.71
P3-GA3-50 ppm	653.75	18.44	19.37	32.28
P4-NAA 50 ppm + GA3 50 ppm	683.00	18.67	20.24	33.73
S. Em. ±	9.58	0.26	0.30	0.58
CD%	27.67	0.74	0.86	1.68

4. Conclusion

The combined application of vermicompost (5 t/ha) and plant growth regulators (NAA 50 ppm + GA_3 50 ppm) significantly enhanced vegetative growth, hastened head initiation, and maximized yield in cabbage. This integrated approach resulted in superior plant height, leaf number, spread, and head weight, culminating in the highest yield of 38.77 t/ha under V4P4 treatment. The findings confirm that organic nutrient sources, when coupled with targeted hormonal treatments, can effectively boost productivity and promote sustainable cabbage cultivation.

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