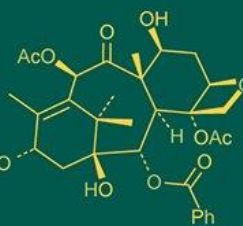
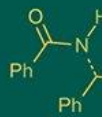


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Impact of organic manure combinations on growth and yield of broccoli (*Brassica oleracea* var. *italica*) under protected conditions

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Abstract

The present investigation entitled “Effect of Different Organic Manures on Growth and Yield of Broccoli (*Brassica oleracea* var. *italica*) under Protected Conditions” was conducted during the Rabi season of 2025-26 at the Instructional-cum-Research Farm, Department of Horticulture, College of Agriculture, Dharashiv, Maharashtra. The experiment was laid out in a Randomized Block Design (RBD) comprising ten treatments and three replications. The treatments consisted of different organic manure sources, namely vermicompost, farmyard manure (FYM), poultry manure, neem cake and their various combinations. The objective of the study was to evaluate the effect of different organic manures on growth, yield, quality and soil fertility parameters of broccoli under protected cultivation.

The results revealed significant differences among the treatments for all the characters studied. Application of vermicompost @ 5 t ha⁻¹ (T₁) recorded the maximum plant height (25.42 cm), number of leaves per plant (17.42), leaf length (38.42 cm), stem diameter (2.28 cm) and minimum days required for curd initiation (57.84 days). Among the yield attributes, the combined application of vermicompost (50%) and poultry manure (50%) (T₈) produced the maximum curd weight (468.72 g), curd diameter (19.24 cm), curd yield per plot (8.84 kg) and total curd yield (40.93 t ha⁻¹).

The study indicated that vermicompost was most effective in enhancing vegetative growth and quality attributes, whereas the combined application of vermicompost and poultry manure proved superior for yield. Therefore, integrated application of vermicompost and poultry manure can be recommended as an effective nutrient management strategy for broccoli cultivation under protected conditions.

Keywords: Broccoli, vermicompost, poultry manure, organic manures, protected cultivation, growth attributes, yield, quality parameters, soil fertility, economics

Introduction

Broccoli (*Brassica oleracea* var. *italica*) is an important cole crop belonging to the family Brassicaceae and is widely recognized for its exceptional nutritional and medicinal value. It is believed to have originated from the Mediterranean region and has gained worldwide popularity due to its rich composition of vitamins, minerals, dietary fiber, and health-promoting phytochemicals (Schery, 1972; Gómez-Campo, 1999) [22, 6]. Among cruciferous vegetables, broccoli is considered one of the most nutritious owing to its high content of vitamins A, C, K, carotenoids, glucosinolates, and antioxidant compounds that contribute to human health and disease prevention (Thamburaj and Singh, 2001; Zhao *et al.*, 2007) [27, 33].

The crop has attracted considerable attention in recent years because regular consumption of broccoli and other cruciferous vegetables has been associated with a reduced risk of several forms of cancer and other chronic diseases (Cohen *et al.*, 2000; Kirsh *et al.*, 2007) [4, 10]. Broccoli contains glucoraphanin, a precursor of sulforaphane, which possesses strong antioxidant, antimicrobial, and anticancer properties. Owing to these health benefits, consumer demand for broccoli is increasing rapidly, particularly in urban markets, hotels, restaurants, and organized retail sectors.

Broccoli is a cool-season vegetable crop that performs best under moderate temperatures and fertile soils with adequate nutrient availability. Achieving high productivity and superior curd quality requires balanced nutrient management.

In recent decades, intensive vegetable production has relied heavily on chemical fertilizers to maximize yields. However, continuous and indiscriminate use of inorganic fertilizers has resulted in deterioration of soil health, nutrient imbalance, environmental pollution, and reduced sustainability of production systems. Consequently, there is increasing emphasis on organic nutrient management practices that improve soil fertility while maintaining crop productivity.

Organic manures such as farmyard manure (FYM), vermicompost, poultry manure, and neem cake are recognized as valuable sources of plant nutrients and organic matter. These organic inputs improve soil physical, chemical, and biological properties by enhancing soil structure, water-holding capacity, microbial activity, and nutrient availability. Vermicompost is considered an excellent source of readily available nutrients and beneficial microorganisms, while poultry manure supplies substantial amounts of nitrogen, phosphorus, potassium, and organic carbon. Neem cake contributes essential nutrients and also acts as a natural nitrification inhibitor and biopesticide. Similarly, FYM improves soil aeration, root development, and overall soil fertility.

Several researchers have reported positive effects of organic nutrient sources on broccoli growth and yield. Sharma *et al.* (2018) [23] observed improved growth, yield, and quality of broccoli through integrated nutrient management involving vermicompost. Atal *et al.* (2019) [2] reported significant enhancement in growth and yield attributes with the application of biofertilizers in combination with organic manures. Dubey *et al.* (2021) demonstrated that vermicompost application improved growth and yield characteristics of broccoli. Likewise, Al-Jumaili and Mahmood (2023) found that poultry manure significantly increased plant growth, curd development, and productivity. Recent studies by Meem *et al.* (2024) and Dushyant *et al.* (2024) further confirmed the beneficial effects of organic nutrient sources on broccoli performance.

Although individual organic manures have shown promising results, comparative information regarding the effectiveness of different organic manures and their combinations under protected cultivation is limited. Since nutrient composition, mineralization rate, and soil-improving effects vary among organic sources, their influence on broccoli growth and yield may differ substantially. Therefore, evaluation of various organic manures and their combinations is essential to identify the most efficient and sustainable nutrient management strategy for broccoli production.

Materials and Methods

The present investigation entitled “Effect of Different Organic Manures on Growth and Yield of Broccoli (*Brassica oleracea* var. *italica*) under Protected Conditions” was conducted during the Rabi season of 2025-26 at the Instructional-cum-Research Farm, Department of Horticulture, College of Agriculture, Dharashiv, Maharashtra, India. The experimental site is situated at an altitude of approximately 650 m above mean sea level and falls under the semi-arid tropical climatic zone.

The experiment was laid out in a Randomized Block Design (RBD) comprising ten treatments and three replications. The broccoli variety ‘Ganesh Broccoli’ was used for the study. Healthy and uniform seedlings raised under protected conditions were transplanted at a spacing of 45 cm × 30 cm in plots measuring 1.8 m × 1.2 m.

The treatments consisted of different organic manure sources and their combinations: T₁-Vermicompost (5 t ha⁻¹), T₂-FYM (25 t ha⁻¹), T₃-Poultry manure (5 t ha⁻¹), T₄-Neem cake (2 t ha⁻¹), T₅-FYM (50%) + Vermicompost (50%), T₆-FYM (50%) + Poultry manure (50%), T₇-FYM (50%) + Neem cake (50%), T₈-Vermicompost (50%) + Poultry manure (50%), T₉-Vermicompost (50%) + Neem cake (50%), and T₁₀-Poultry manure (50%) + Neem cake (50%). Recommended cultural practices were followed uniformly for all treatments throughout the crop growth period. Irrigation, weeding and plant protection measures were carried out as per the recommended package of practices for broccoli cultivation.

Five randomly selected plants from each experimental plot were tagged for recording observations. Growth parameters such as plant height, leaf length, stem diameter and number of leaves per plant were recorded at different growth stages. Days to curd initiation, curd weight and curd diameter were recorded at harvest.

Yield parameters including curd yield per plot, total curd yield per hectare and benefit-cost ratio were computed using standard procedures. Quality parameters *viz.*, total soluble solids (TSS), reducing sugars, non-reducing sugars, total sugars, ascorbic acid content, chlorophyll content and shelf life were analyzed using standard laboratory methods. Soil samples collected before and after crop harvest were analyzed for pH, electrical conductivity, organic carbon, available nitrogen, available phosphorus and available potassium following standard analytical procedures.

The experimental data obtained for various characters were subjected to analysis of variance (ANOVA) appropriate for Randomized Block Design as described by Panse and Sukhatme (1967) [19]. Treatment means were compared using the Critical Difference (CD) test at 5 per cent level of significance.

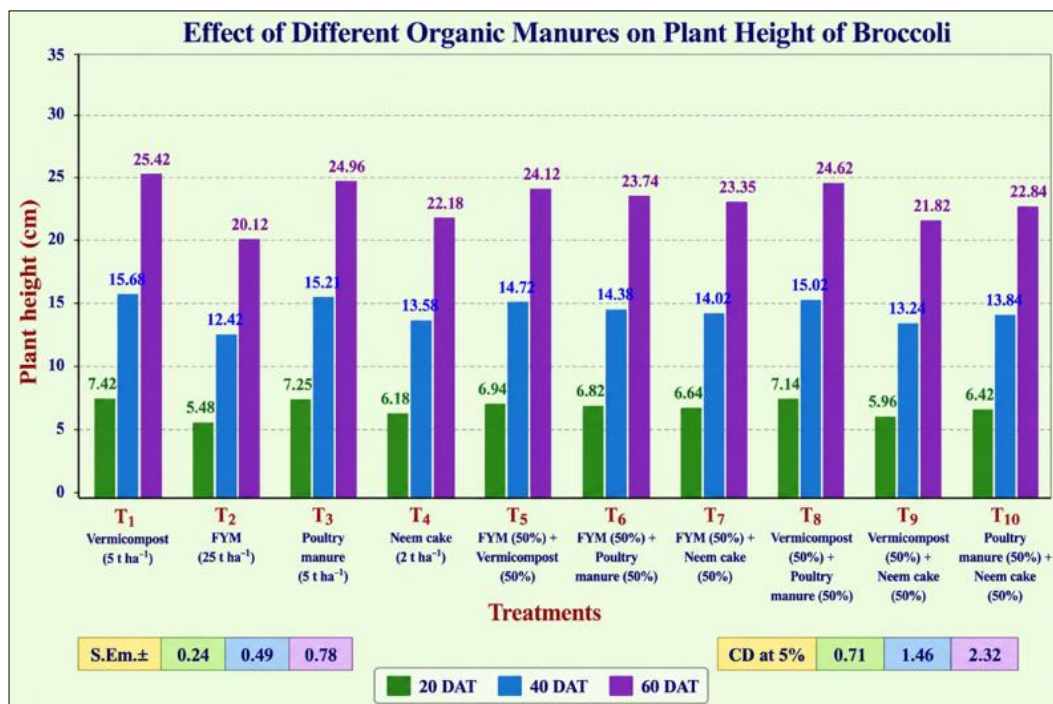
Results and Discussion

Growth Parameters

The application of different organic manures significantly influenced the vegetative growth of broccoli under protected conditions. Growth attributes such as plant height, number of leaves per plant, leaf length, stem diameter and days required for curd initiation varied significantly among treatments. Among the various organic nutrient sources evaluated, vermicompost (T₁) consistently recorded superior growth performance throughout the crop growth period. At 60 DAT, the highest plant height (25.42 cm), number of leaves per plant (17.42), leaf length (38.42 cm) and stem diameter (2.28 cm) were recorded under vermicompost application, whereas the lowest values were observed under FYM alone (T₂). In addition, vermicompost significantly reduced the days required for curd initiation (57.84 days), indicating its positive effect on crop earliness.

Table 1: Effect of different organic manures on plant height (cm) of broccoli

S.N.	Treatments	20 DAT	40 DAT	60 DAT
T ₁	Vermicompost (5 t ha ⁻¹)	7.42	15.68	25.42
T ₂	FYM (25 t ha ⁻¹)	5.48	12.42	20.12
T ₃	Poultry manure (5 t ha ⁻¹)	7.25	15.21	24.96
T ₄	Neem cake (2 t ha ⁻¹)	6.18	13.58	22.18
T ₅	FYM (50%) + Vermicompost (50%)	6.94	14.72	24.12
T ₆	FYM (50%) + Poultry manure (50%)	6.82	14.38	23.74
T ₇	FYM (50%) + Neem cake (50%)	6.64	14.02	23.35
T ₈	Vermicompost (50%) + Poultry manure (50%)	7.14	15.02	24.62
T ₉	Vermicompost (50%) + Neem cake (50%)	5.96	13.24	21.82
T ₁₀	Poultry manure (50%) + Neem cake (50%)	6.42	13.84	22.84
	S.E.m.±	0.24	0.49	0.78
	CD at 5%	0.71	1.46	2.32

**Graph 1:** Effect of different organic manures on plant height (cm) of broccoli

The superior vegetative growth under vermicompost may be attributed to the continuous and balanced supply of macro- and micronutrients coupled with the presence of beneficial microorganisms. Vermicompost is known to contain readily available forms of nitrogen, phosphorus, potassium, calcium, magnesium and several trace elements essential for plant growth. Furthermore, vermicompost contains biologically active substances such as auxins, gibberellins and cytokinins, which stimulate cell division, cell elongation and overall plant development. Enhanced microbial activity under vermicompost application improves nutrient mineralization and availability, resulting in better root growth and nutrient uptake.

The increased number of leaves and greater leaf length observed under vermicompost treatment could have contributed to a larger photosynthetic surface area, leading to greater production of photosynthates and improved crop growth. Improved stem diameter under vermicompost application indicates stronger plant architecture and efficient translocation of water and nutrients from roots to aerial plant parts. Similar beneficial effects of vermicompost on broccoli growth have been reported by Choudhary *et al.* (2012) [3], Mal *et al.* (2015) [13], Kumar and Biradar (2017)

[11], Sharma *et al.* (2018) [23], Mohanta *et al.* (2018) [15], Atal *et al.* (2019) [2] and Kabir *et al.* (2020) [9].

The early curd initiation recorded under vermicompost application may be attributed to improved nutritional status and accelerated physiological processes. Balanced nutrient availability throughout the growth period promotes rapid vegetative development and facilitates earlier transition from vegetative to reproductive phase. Similar findings were reported by Meena *et al.* (2017) [14], Mouriya *et al.* (2018) [16] and Sharma *et al.* (2018) [23], who observed earlier curd initiation in broccoli under organic nutrient management practices.

Yield Attributes and Yield

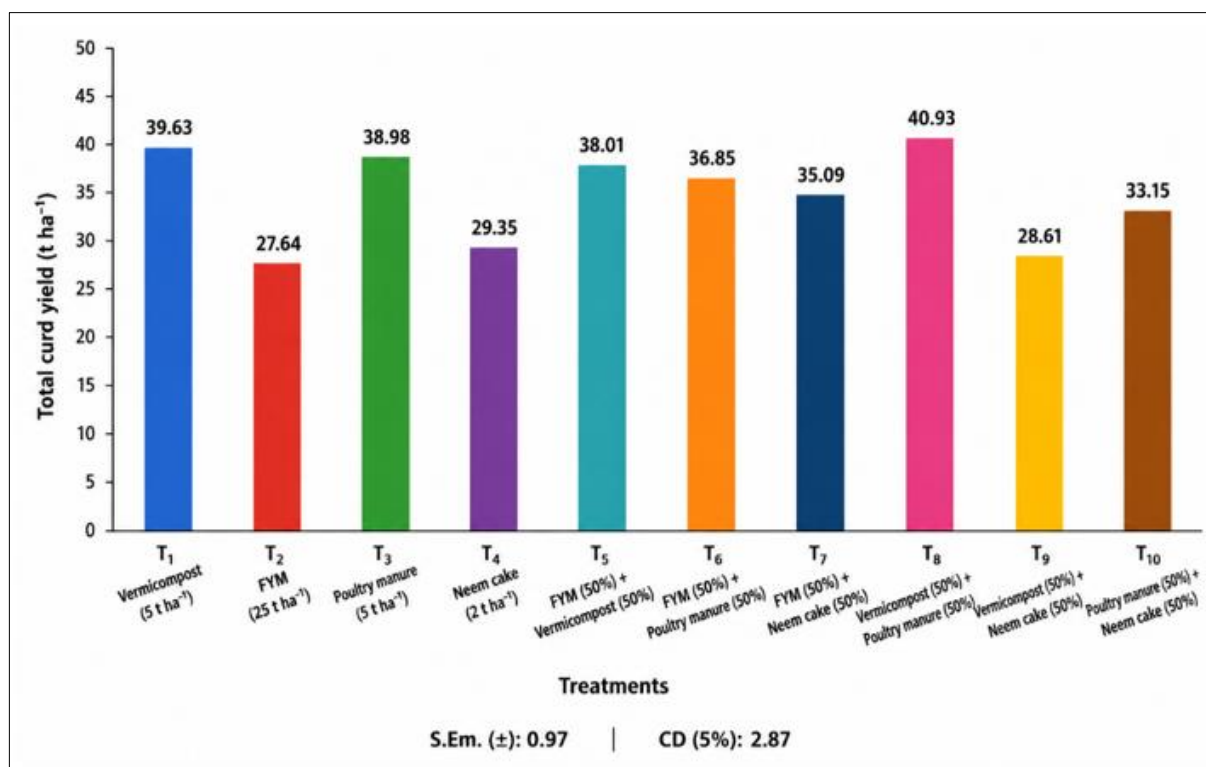
Yield attributes are important determinants of crop productivity and market value. The results revealed significant variation in total curd yield due to different organic manure treatments. The combined application of vermicompost (50%) and poultry manure (50%) (T₈) recorded the highest total curd yield (40.93 t ha⁻¹), followed by vermicompost alone (T₁) (39.63 t ha⁻¹), poultry manure alone (T₃) (38.98 t ha⁻¹) and FYM (50%) + vermicompost (50%) (T₅) (38.01 t ha⁻¹).

The superior performance of T₈ may be attributed to the complementary effect of both nutrient sources. Poultry manure provides readily available nutrients, especially nitrogen and phosphorus, which support rapid plant growth, whereas vermicompost improves soil structure, microbial activity and nutrient retention. The combined application

ensured both immediate and sustained nutrient availability throughout the crop growth cycle. Enhanced nutrient uptake, improved photosynthetic efficiency and better assimilate partitioning towards developing curds ultimately resulted in larger and heavier curds.

Table 2: Effect of different organic manures on total curd yield (t ha⁻¹) of broccoli

S. No.	Treatments	Total curd yield (t ha ⁻¹)
T ₁	Vermicompost (5 t ha ⁻¹)	39.63
T ₂	FYM (25 t ha ⁻¹)	27.64
T ₃	Poultry manure (5 t ha ⁻¹)	38.98
T ₄	Neem cake (2 t ha ⁻¹)	29.35
T ₅	FYM (50%) + Vermicompost (50%)	38.01
T ₆	FYM (50%) + Poultry manure (50%)	36.85
T ₇	FYM (50%) + Neem cake (50%)	35.09
T ₈	Vermicompost (50%) + Poultry manure (50%)	40.93
T ₉	Vermicompost (50%) + Neem cake (50%)	28.61
T ₁₀	Poultry manure (50%) + Neem cake (50%)	33.15
	S.Em. ±	0.97
	CD at 5%	2.87



Graph 2: Total Curd yield variation for treatment

The highest total curd yield (40.93 t ha⁻¹) was obtained under T₈. Increased yield under this treatment may be attributed to improved vegetative growth, enhanced nutrient availability, greater photosynthetic efficiency and efficient translocation of assimilates towards curd development. The synergistic effect of vermicompost and poultry manure ensured both immediate and sustained nutrient supply, resulting in higher productivity.

Conclusion

Organic manure treatments significantly influenced the growth, quality and yield of broccoli under protected conditions. Vermicompost @ 5 t ha⁻¹ recorded superior vegetative growth, whereas the combined application of vermicompost (50%) and poultry manure (50%) produced

the highest total curd yield (40.93 t ha⁻¹). The synergistic effect of vermicompost and poultry manure improved nutrient availability, photosynthetic efficiency and curd development, resulting in higher productivity. Therefore, the combined application of vermicompost and poultry manure can be recommended as an efficient and sustainable organic nutrient management strategy for broccoli cultivation under protected conditions.

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