MRS Journal of Multidisciplinary Research and Studies
*Abbreviate Title- MRS J Mul Res Stud*
ISSN *(Online) 3049-1398*
Vol-2, Iss-3(March-2025)

# A Review on Comparative Analysis of Vermicompost and Conventional Fertilizers on Growth and Yield of *Capsicum annuum* Plants

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**Article History**

Received: 02 / 03 / 2025

Accepted: 19 / 03 / 2025

Published: 21 / 03 / 2025

Abstract: The growth and production of Capsicum annuum are examined in this review in relation to the impacts of vermicompost and conventional fertilizers. Vermicompost enhances soil structure, soil nutrient availability and soil microbial health, resulting in improved plant growth and productivity. In contrast, conventional fertilizers, while providing immediate nutrients, can degrade soil quality and pose environmental risks. Findings indicate that vermicompost promotes better growth parameters, higher fruit yield, and improved nutritional quality. The review underscores the potential of vermicomposting as a sustainable alternative to conventional methods, encouraging further research and adoption in agricultural practices.

Keywords: *Capsicum annuum, Vermicompost, Conventional fertilizers, Plant growth, Sustainable agriculture.*

**Cite this article:** Alone, R., Singh, D., Pant, M., (2025**.** A Review on Comparative Analysis of Vermicompost and Conventional Fertilizers on Growth and Yield of *Capsicum annuum* Plants. *MRS Journal of Multidisciplinary Research and Studies, 2 (3),49-53.*

## Introduction

*Capsicum annuum* L. is classified under the Solanaceae family. This plant is an annual herb or shrub, featuring a densely branched, bushy structure (Basu & De 2003; Rylski 2019; Gangadhar *et al.* 2020). In modern agriculture, the search for sustainable farming methods has attracted a lot of attention, especially when it comes to managing soil fertility (National Research Council, Division 2010; Gomiero *et al.* 2011; Nongbet *et al.* 2022). Increased agricultural yields are required due to the growing world population, which has led scientists and agronomists to look at non-synthetic ways of promoting plant development (Mishra *et al.* 2017; South *et al.* 2019; Fischer 2020). The most effective organic amendment among these substitutes is vermicompost, which is said to enhance soil nutrient profiles while also enhancing soil structure and microbial diversity (Lim et al. 2015; Kumar et al. 2018). The purpose of this study is to methodically examine how conventional fertilizers and vermicompost compare in terms of their impact on the development and production of *Capsicum annuum*, a plant that has considerable economic significance (Naser 2020; Sini *et al.* 2024). This analysis aims to clarify the benefits and drawbacks of each fertilization technique by combining the body of research and empirical studies already in existence (Janssen & Van Ittersum 2007; Duru 2015). In the process, it will further our comprehension of the ways in which these techniques affect crop production efficiency and sustainable agricultural practices (Gomiero *et al.* 2011; Kassie 2013). In the field of horticulture, *Capsicum annuum* is a significant crop. Its nutritional advantages—including vitamins A and C and other antioxidants—combine with its culinary applications to give it significance. Different fertilization techniques may be used to produce the accurate nutrient balance needed for cultivation (Franczuk et al. 2023). This review aims to analyze and compare the impacts of vermicompost and conventional fertilizers on the growth, yield, and overall health of *Capsicum annuum* plants. Higher applications of vermicompost significantly improve crop yields and economic returns compared to both lower vermicompost levels and chemical fertilizers. The **20 ton vermicompost ha-1** treatment is the most effective, emphasizing the need for careful management of application rates to avoid diminishing returns. Integrating vermicompost into agricultural practices offers a sustainable and economically viable alternative to conventional fertilizers, enhancing both environmental sustainability and crop performance.

Incorporating vermicompost along with chemical fertilizers into field crops may be an effective strategy for ensuring nutrient availability and sustaining soil fertility and productivity (Zaman *et al.* 2018).

### Vermicompost: An Overview

Vermicomposting is the process of processing organic waste into a nutrient-rich soil amendment by using earthworms (Kaur 2020; Edwards & Arancon 2022). The high concentration of macro and micronutrients, advantageous microorganisms, and enhanced soil structure of this organic fertilizer are widely recognized (Itelima *et al.* 2018). In addition to increasing nutrient availability, vermicompost also helps the soil maintain water and breathe. The use of vermicompost has the potential to boost disease resistance, yield, and plant development (Kaur 2020).

**Conventional Fertilizers: An Overview**

Conventional fertilizers, which are often synthetic, provide nutrients like K, P and N in a fast-releasing form (Shahena *et al.* 2021). These fertilizers have the potential to produce large yields and quick growth, but they also carry certain dangers, such as nutrient loss, degraded soil, and detrimental effects on the microbial populations in the soil (Baweja *et al.* 2020). Concerns about sustainability and environmental health are raised by the use of conventional fertilizers, which has sparked interest in alternative strategies such organic additives like vermicompost (Oyege & Balaji Bhaskar 2023).

**Comparative Effects on Growth Parameters**

- **Plant Height and Biomass** Vermicompost procedures have been shown in several studies to greatly improve the growth characteristics of *Capsicum annuum*, such as biomass and plant height (Aslam *et al.* 2022). Vermicompost-treated plants, for example, grow taller and produce more biomass than plants treated using conventional fertilizers, according to study. The slow release of nutrients from vermicompost over time is considered to be responsible for of this effect (Arancon 2001).
- **Leaf Area and Photosynthetic Activity** One of the most important factors affecting photosynthesis and, by extension, yield is the leaf area index (Malone *et al.* 2002). Research shows that vermicompost is a more effective way than traditional fertilizers to increase the growth of the leaf area. Higher photosynthetic rates are a result of the expanded leaf area, which enhances growth and yield (Joshi, 2015). Vermicompost's organic matter promotes a more robust microbial population in the rhizosphere, which improves nutrient absorption even more.
- **Root Development** Water and nutrient absorption depend critically on root growth. Studies have shown that plants cultivated using vermicompost establish a wider root system than those treated with traditional fertilizers (Ievinsh 2020). The improved root development enhances the plant's capacity to take up water and nutrients, resulting in increased general well-being and yield.

**Yield Parameters**

- **Fruit Weight and Size** A crucial parameter for assessing fertilization techniques is the yield of *Capsicum annuum*, which includes fruit weight and size (Castellanos *et al.* 2017). Relative to plants nourished with conventional goods, studies show that plants treated with vermicompost often yield bigger and heavier fruits (Singh 2014). This rise in production is partly due to the vermicompost's balanced nutritional profile and the presence of materials that encourage growth.
- **Total Yield** An additional crucial factor is the total fruit output per plant. Vermicompost, as opposed to traditional fertilizers, has been shown in several field studies to provide greater overall yields. This might be explained by more nutrient availability, healthier soil, and increased plant resistance to external challenges (Lim *et al.* 2015).

The treatment with a 20ton VC ha-1 yield had the greatest benefit-cost ratio (12.40), according to an economic study of the yield of capsicum fruits. With solely NPK fertilizers applied, the treatment N40P15K25 kg ha-1 had the next-highest benefit-to-cost ratio (10.24). Similarly, the control group, which only received a baseline dosage of NPK and no additional vermicompost, had the lowest benefit-cost ratio (5.00). Given the greatest benefit-cost ratios at roof top farming systems, treatment 20ton VC ha-1 may thus without a doubt be advised for the successful development and output of capsicum (Alam *et al.* 2023).

**Nutrient Content**

- **Soil Nutrient Availability** Vermicompost increases the availability of important nutrients including N, P, and K by having a favorable impact on the dynamics of soil nutrients Yadav & Gupta 2017). Vermicompost offers a more balanced supply of nutrients than conventional fertilizers, which may cause nutritional imbalances. This is essential for *Capsicum annuum* to develop as best it can (Ahirwar Hussain 2015).
- **Fruit Nutritional Quality** The nutritional value of the harvested fruit is crucial, even above growth and production. Research indicates that fruits from plants treated with vermicompost often have more vitamins and antioxidants than fruits from plants treated with traditional fertilizer (AMINIFARD *et al.* 2013). This improves the produce's overall nutritional profile and increases its consumer benefits.

**Environmental Impact**

- **Soil Health** Applying conventional fertilizers over an extended period of time may cause nutrient leaching, microbial diversity to decline, and soil deterioration (Pahalvi *et al.* 2021). On the other hand, vermicompost gradually improves soil health by enhancing soil structure, encouraging microbial activity, and raising the amount of organic matter in the soil Oyege & Balaji Bhaskar 2023).
- **Sustainability** Using vermicompost is consistent with sustainable farming methods. In addition to supporting ecological balance, it minimizes the need for synthetic fertilizers and reduces the risk of chemical runoff into water systems (McClintock 2004). Vermicompost is thus an appealing alternative for *Capsicum annuum* farming that is sustainable.

**Challenges and Considerations**

- **Application Rates and Methods** Application techniques and rates determine how effective vermicompost is. To maximize effects, it is crucial to determine the proper amount and frequency of treatment. For vermicompost to be successfully included into fertilization programs, farmers would need assistance (Mupambwa *et al.* 2020).
- **Quality Variability** Based on the kind of organic material utilized and the composting procedure, vermicompost might have varying qualities. Reliable outcomes in *Capsicum annuum* cultivation depend on maintaining a constant quality of vermicompost (Castellanos *et al.* 2017; Chatterjee *et al.* 2021.
- **Economic Factors** Although vermicomposting has many advantages, some farmers may be put off by the initial

time and infrastructure costs. Nevertheless, these expenses may be compensated for over time by the savings on synthetic fertilizers and better soil health (McClintock 2004; Singh & Sinha 2022).

## Conclusion

Vermicompost offers a number of benefits over conventional fertilizers when it comes to the development and production of *Capsicum annuum* plants, according to a comparison study. It leads to better soil health and sustainability in addition to improving growth metrics and production. Even while conventional fertilizers could work quickly but vermicompost has several long-term advantages for sustainable and ecologically friendly farming methods. Following that, studies need to concentrate on improving the methods of application, understanding particular intake requirements of *Capsicum annuum*, and promoting farmers to widely use vermicomposting methods.

**Future perspectives**

In the future, using vermicompost, blended vermicompost, and conventional fertilizers interchangeably for *Capsicum annuum* is a step toward more ecologically friendly farming practices. This agricultural method improves efficiency by improving fertilizer management. Microbial interactions in vermicomposted soil may be investigated, and the findings may be useful to plant and soil health. Economic analysis will assess cost-effectiveness and promote widespread adoption. Expanding research to include other crops may discover further applications, and the expanding demand for organic food may influence farmers' practices. Finally, they may direct innovation and policy toward more productive and sustainable agriculture systems.

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