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Effect of Sugarcane Bagasse-Based Vermicompost on Growth Performance of Paddy (*Oryza sativa*) and Chilli (*Capsicum annuum*)

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Abstract

This study evaluates the effectiveness of vermicompost derived from sugarcane bagasse on the growth performance of paddy (*Oryza sativa*) and chilli (*Capsicum annuum*). Vermicomposting was carried out using a mixture of sugarcane bagasse and cow dung (1:1 ratio) inoculated with earthworms under controlled conditions. The prepared vermicompost was applied to experimental plants, while control groups were maintained without fertilizer. Growth parameters including plant height, fresh weight, and dry weight were recorded at regular intervals. Results showed significant improvement in both crops treated with vermicompost. Paddy exhibited increases of 44.71% in height, 31.90% in fresh weight, and 88.04% in dry weight, while chilli showed increases of 37.74%, 43.09%, and 71.20%, respectively. The findings confirm that sugarcane bagasse-based vermicompost is an effective, eco-friendly alternative to chemical fertilizers, enhancing plant growth and supporting sustainable agriculture.

1. Introduction

Sustainable agriculture emphasizes the adoption of environmentally friendly practices such as the use of organic fertilizers to improve soil health and crop productivity. Organic fertilizers derived from natural sources enhance soil structure, increase microbial activity, and improve nutrient cycling while minimizing environmental pollution (Gupta & Masto, 2017). In contrast, excessive use of chemical fertilizers leads to soil degradation, nutrient imbalance, and water contamination, thereby threatening long-term agricultural sustainability (Gomiero et al., 2011).

Vermicomposting, a biological process involving earthworms, converts organic waste into nutrient-rich compost and has emerged as an efficient and sustainable waste management strategy. The resulting vermicompost is rich in essential nutrients, including nitrogen, phosphorus, potassium, and micronutrients, and improves soil aeration, water retention, and microbial diversity (Edwards & Arancon, 2004; Suthar, 2009). Unlike chemical fertilizers, vermicompost provides a slow and steady release of nutrients, thereby enhancing nutrient use efficiency and reducing environmental risks (Lal, 2004).

Sugarcane bagasse, a major agro-industrial by-product, poses a significant disposal challenge due to its large-scale generation. However, its high cellulose and lignin content make it a suitable substrate for vermicomposting (Suthar & Singh, 2011). The conversion of bagasse into vermicompost not only helps in waste recycling but also produces a valuable organic fertilizer that enhances soil fertility and plant growth (Bhagat et al., 2019). This approach aligns with sustainable agricultural practices by reducing waste accumulation and minimizing dependence on synthetic fertilizers.

Paddy (*Oryza sativa*) and chilli (*Capsicum annuum*) are economically important crops with distinct agronomic requirements. Previous studies have demonstrated that vermicompost application significantly improves growth parameters, yield, and soil health in both crops (Rao et al., 2015; Khan & Ahmed, 2016). Therefore, evaluating the effectiveness of sugarcane bagasse-based vermicompost on these crops is essential for promoting sustainable agricultural practices.

2. Materials and Methods

2.1 Collection of Materials

Earthworms were collected from the college campus. Cow dung was obtained from a local dairy farm and air-dried for 10 days. Sugarcane bagasse was collected locally and dried for 12 days before use.

2.2 Vermicomposting Process

A plastic bin (45 × 13 cm) was prepared with a sand base layer (1 inch). A mixture of cow dung and sugarcane bagasse (1:1 ratio) was added, and 67 earthworms were introduced. Moisture was maintained by regular watering, and aeration was ensured by periodic mixing. Composting was carried out for 30 days.

2.3 Experimental Design

Four pots were used:

- Control: Paddy and chilli without fertilizer
- Experimental: Paddy and chilli with vermicompost

Seeds were planted and maintained under regular watering conditions.

2.4 Data Collection

Plant height was measured at 7, 14, 21, and 28 days. Fresh and dry weights were recorded on day 28.

2.5 Statistical Analysis

Mean and standard deviation were calculated to analyze variability.

3. Results and Discussion

The vermicomposting process demonstrated a successful outcome, as indicated by the increase in earthworm population from 67 individuals at the beginning of the experiment to approximately 150 by the end. This increase suggests that the environmental conditions, including substrate quality, moisture, and aeration, were optimal for earthworm growth and activity. Similar findings have been reported, where suitable organic substrates significantly enhance earthworm reproduction and composting efficiency (Edwards, 1998; Garg et al., 2006). The increase in earthworm population also reflects efficient decomposition and stabilization of organic matter.

The application of vermicompost significantly enhanced the growth performance of paddy plants compared to the control group. The observed increase in plant height, fresh weight, and dry weight indicates improved vegetative growth and biomass accumulation. These improvements can be attributed to the availability of essential nutrients such as nitrogen, phosphorus, and potassium, along with enhanced microbial activity in the soil (Suthar, 2009). Similar results were reported by Rao et al. (2015) and Sreenivasan et al. (2017), who observed increased plant height and yield in paddy following vermicompost application. The improvement in dry weight suggests enhanced nutrient assimilation and efficient physiological functioning in the plants.

Chilli plants also exhibited significant growth enhancement under vermicompost treatment. The increase in plant height, fresh weight, and dry weight indicates that vermicompost provides a balanced nutrient supply and improves soil conditions suitable for plant growth. These findings are consistent with previous studies, which reported that vermicompost improves vegetative growth, root development, and yield in chilli plants (Khan & Ahmed, 2016; Rajeswari & Narayanan, 2018). The slow-release nature of nutrients in vermicompost ensures continuous nutrient availability, which is particularly beneficial for chilli plants that are sensitive to nutrient fluctuations.

A comparative analysis between paddy and chilli plants revealed that both crops responded positively to vermicompost application, although variations were observed in growth parameters. Paddy showed a higher increase in dry weight, whereas chilli demonstrated greater improvement in fresh biomass. These differences may be attributed to species-specific growth characteristics and nutrient requirements. Similar crop-specific responses to organic amendments have been reported in earlier studies (Sharma & Rani, 2019).

The beneficial effects observed in this study can be linked to the physicochemical properties of vermicompost derived from sugarcane bagasse. The decomposition of lignocellulosic material by earthworms results in the formation of humic substances and the release of essential nutrients, which improve soil fertility and structure (Suthar & Singh, 2011). Additionally, vermicompost enhances microbial diversity and enzymatic activity in the soil, leading to improved nutrient cycling and plant growth (Awasthi & Sharma, 2019).

Furthermore, vermicompost contributes to sustainable agriculture by reducing reliance on chemical fertilizers and promoting environmentally friendly practices. The gradual release of nutrients minimizes nutrient loss through leaching and improves nutrient use efficiency (Lal, 2004). These findings are in agreement with previous studies, which highlight the long-term benefits of vermicompost in improving soil health, crop productivity, and environmental sustainability (Gomiero et al., 2011).

Overall, the results clearly indicate that sugarcane bagasse-based vermicompost is an effective organic amendment for enhancing plant growth and can serve as a sustainable alternative to synthetic fertilizers.

Growth Parameters of Paddy and Chilli Plants:

i. Effect of Vermicompost on Paddy Plants:

Parameter	Control (No Fertilizer)	Vermicompost	Percentage Increase (Vermicompost vs Control)
Plant Height (cm)	24.46± 2.99	35.4 ± 8.34	44.71 %
Fresh Weight (g/plant)	4.776	6.300	31.90 %
Dry Weight (g/plant)	1.196	2.248	88.04 %

ii. Effect of Vermicompost on Chilli Plants:

Parameter	Control (No Fertilizer)	Vermicompost	Percentage Increase (Vermicompost vs Control)
Plant Height (cm)	31± 2.3	42.7 ± 2.1	37.74 %
Fresh Weight (g/plant)	11.51	16.469	43.09 %
Dry Weight (g/plant)	2.166	3.708	71.20 %

iii. Overall Comparison of Vermicompost Effectiveness:

Parameter	Paddy (Vermicompost)	Chilli (Vermicompost)
Plant Height	35.4 ± 8.34	42.7 ± 2.1
Fresh Weight	6.300	16.469
Dry Weight	2.248	3.708

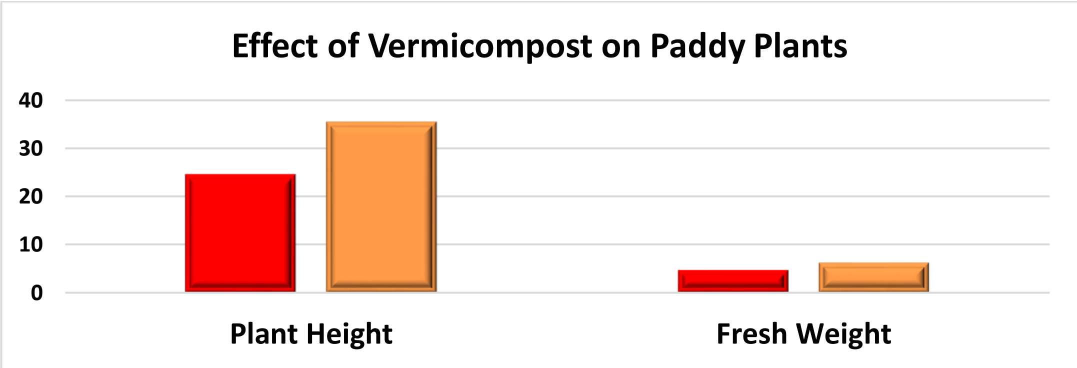

Figure 4.1. Effect of Vermicompost on Paddy Plants Height and Weight

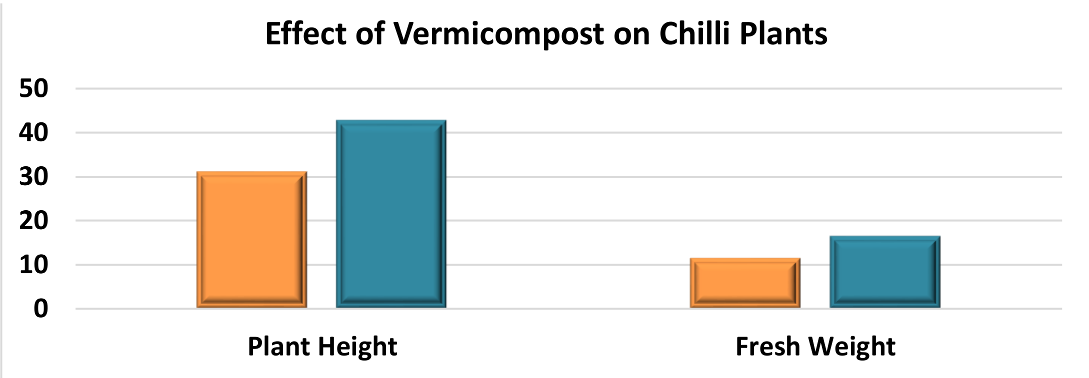

Figure 4.2. Effect of Vermicompost on Chilli Plants Height and Weight

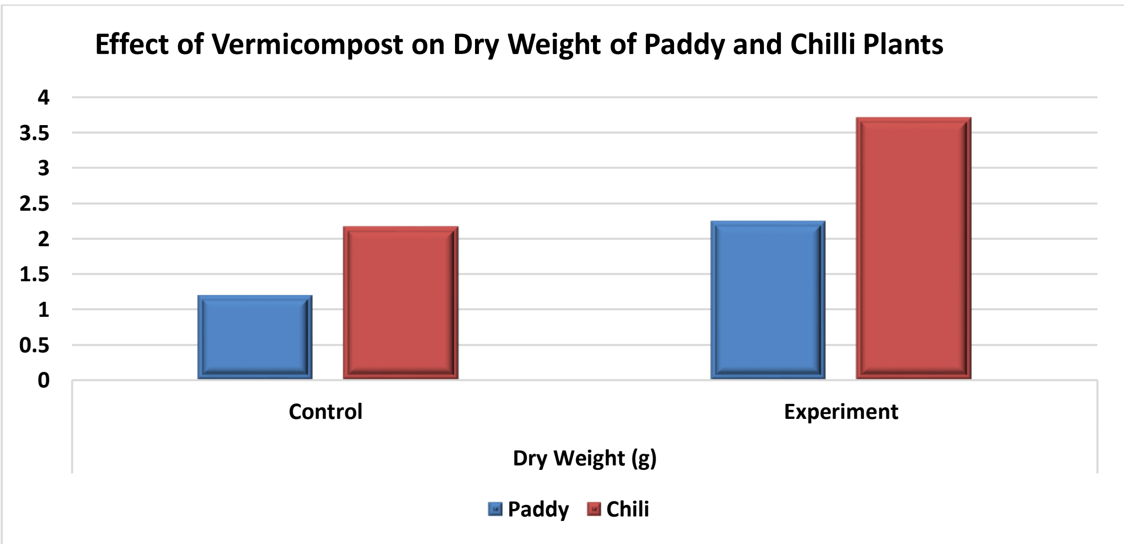

Figure 4.3. Effect of Vermicompost on Dry Weight of Paddy and Chilli Plants

4. Conclusion

The study demonstrates that vermicompost derived from sugarcane bagasse significantly improves the growth of paddy and chilli plants. The results highlight its potential as a sustainable alternative to chemical fertilizers. Additionally, the use of agricultural waste for compost production contributes to environmental conservation and resource recycling

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