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Comparative Analysis of Yield and Economic Benefits of Using Different Organic Manure in Broccoli Cultivation

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted during *Rabi* 2020-21 at Research farm of Department of Horticulture, R.A.K. College of Agriculture, Sehore (Madhya Pradesh) to investigate the effects of different organic manures on growth and yield of Broccoli (*Brassica oleracea var. italica*). The tan treatments were carried out including control (Recommended dose), different concentrations of organic manure, FYM (100% and 50%), Vermicompost (100% and 50%), Neem cake (100% and 50%), and Poultry manure (100% and 50%). All of the organic manures were applied at the time the Broccoli

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was transplanted into the plot, according to the doses that should be given there. It could be evinced from the data that maximum curd yield of 15.30 t/ha and net income of Rs. 236321 per ha and benefit cost ratio of 4.39 was achieved in Broccoli in the T_{10} (Recommended dose) while the minimum benefit cost ratio 3.15 in the T_2 and minimum net income Rs.139820 per ha in the T_1 with the 3.23 benefit cost ratio. Hence it could be concluded that Broccoli is a remunerative labour intensive crop.

Keywords: Broccoli; benefit cost ratio; organic manure neem cake; poultry manure.

1. INTRODUCTION

Broccoli (*Brassica oleracea* var. italica) is a popular and valuable vegetable with green flower heads, thick stems, and thin leaves. The name "broccoli" comes from the Italian word "broccolo", meaning " the flowering crest of a cabbage". It is a member of the Brassicaceae family and is native to the Mediterranean region. It was recently introduced to India and is gaining popularity, especially among affluent consumers, due to its nutritional value. Broccoli is low in fat and calories, and rich in vitamin C, vitamin A, vitamin B2, and calcium (Sanwal and Yadav, 2006). In fact, it contains more vitamin A than cabbage. Broccoli also contains important phytochemicals such as beta-carotene and indole-3-carbinol, which may help prevent cancer and lung disease. The nutritional value of sprouted broccoli per 100 grams is as follows: water (89.3%), protein (3.6%), fat (0.2%), carbohydrates (5.5%), fiber (1.2%), vitamin A (900). International Units). (1.3 mg), phosphorus (0.79 mg) and sulfur (1.26 mg).

The global demand for broccoli is increasing due to its health benefits, including its high content of vitamins, minerals, fiber, and antioxidants. More importantly, broccoli is a good source of vitamin C and vitamin K, and many phytonutrients, such as sulforaphane, have known anti-cancer potential [1]. Awareness of these health benefits increases consumer interest in broccoli, thereby increasing its market value and commercial importance.

Despite the economic potential of broccoli cultivation, there are still some challenges, especially when it comes to soil fertility and permaculture practices. Traditional reliance on chemical fertilizers to increase production has led to environmental damage such as land degradation and pollution [2]. In response to these concerns, there have been significant changes in organic farming. Organic fertilizers provide all the necessary macro and micro nutrients in usable form, thereby improving the physical and biological strength of the soil [3]. Organic fertilizers such as farmyard manure (FYM), vermicompost, neem cake and poultry manure are increasingly being used as alternatives to synthetic pesticides. These organic materials not only provide the necessary nutrients but also improve soil structure, water retention and microbial activity, resulting in healthy soil and long-term sustainability [2]. The aim of this study was to investigate the economics of broccoli cultivation, focusing on the cost-effectiveness and market potential of different organic fertilizers. This study aims to provide a better understanding of the market potential of organic broccoli cultivation by analyzing the results of these organic treatments in terms of profit, productivity and market value.

2. MATERIALS AND METHODS

The experiments were carried out at Horticulture Research farm of Department of Horticulture, R.A.K., College of Agriculture, Sehore (Madhya Pradesh), during the *Rabi* season of 2020-21. The study area is situated in the western part of M.P. It is situated at 230.10° north latitude, 760.64° east longitude and 501.5 m above sea level. The present study aims to evaluate the economic impact of various organic fertilizers on broccoli (*Brassica oleracea var. italica*). The soil of the experimental area is medium black clay (Vertisols), has static surface and good drainage capacity. The experiment was adapted to a randomized block design and repeated three times. There are tanning treatment packages containing various combinations of organic fertilizers. Prepare a bed approximately 5-6 meters long, 1 meter wide and 15 cm high. To protect the seedlings from harsh weather conditions, the seedbeds are covered with compost and mulch and then shaded with frames and polythene sheets. Thirty days after sowing, the seedlings are ready for transplanting. Select healthy crops of good shape and size to transplant to the prepared area. Before flowering, five plants from each row were randomly selected and labeled to collect information on specific characteristics.

Table 1. Treatment details

Symbols	Treatments
T_1	100% FYM
T_2	100% Vermicompost
T_3	100% Neem cake
T_4	100% Poultry manure
T_5	50% FYM +50% Vermicompost
T_6	50% Neem cake +50% Poultry manure
T_7	50% Vermicompost +50% Neem cake
T_8	50% FYM +50% Neem cake
T_9	50% Vermicompost +50% Poultry manure
T_{10}	Recommended dose (80, 100, 100 kg NPK/ ha.)

Table 2. Effect of different organic manures on economics of different treatment

Treatment	Common Expenditure (Rs/ha)	Curd yield (t/ha)	Treatment cost (Rs.)	Total cost of cultivation (Rs./ha)	Gross income (Rs.)	Net income (Rs./ha)	B:C Ratio
T_1	52580	10.12	10000	62580	202400	139820	3.23
T_2	52580	13.01	30000	82580	260200	177620	3.15
T_3	52580	12.32	7050	59630	246400	186770	4.13
T_4	52580	12.99	12000	64580	259800	195220	4.02
T_5	52580	14.62	20000	72580	292400	219820	4.03
T_6	52580	13.11	9525	62105	262200	200095	4.22
T_7	52580	12.76	23025	75605	255200	179595	3.37
T_8	52580	12.52	13025	65605	250400	184795	3.81
T_9	52580	14.42	16500	69080	288400	219320	4.17
T_{10}	52580	15.30	17099	69679	306000	236321	4.39

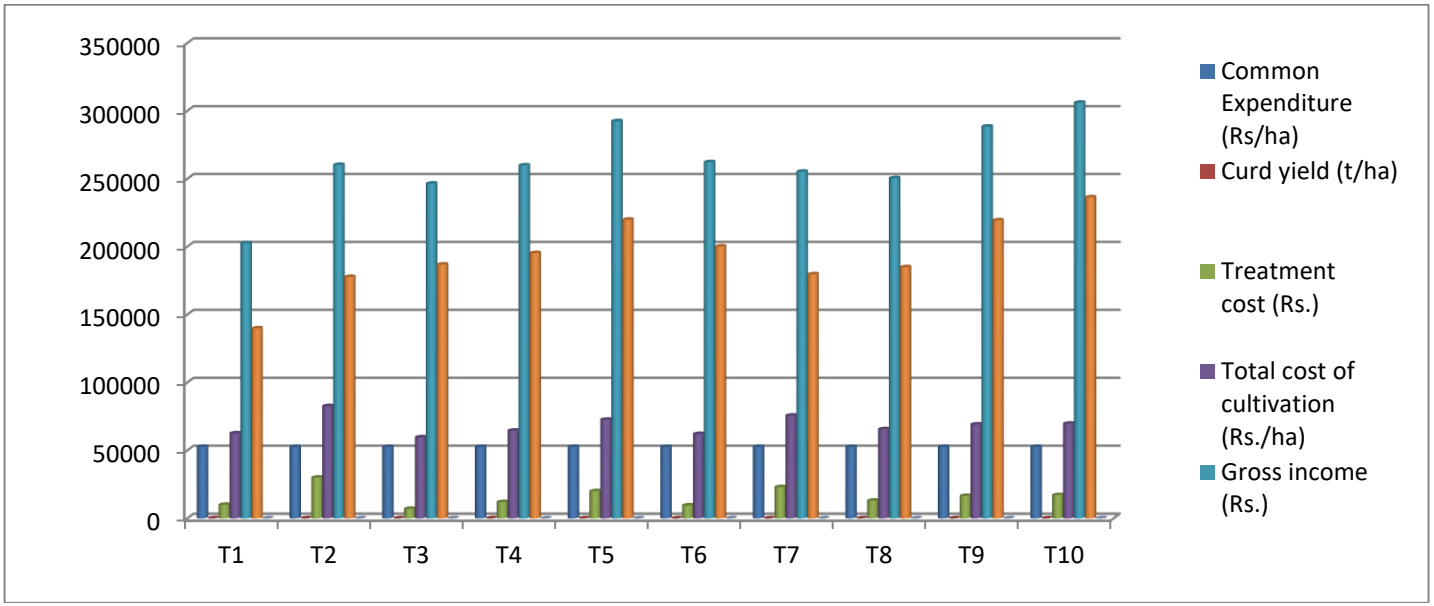

Fig. 1. Effect of different organic manures on Common Expenditure (Rs.), Treatment cost (Rs.), Total cost of cultivation (Rs./ha), Gross income, Net income (Rs./ha) and B:C Ratio

2.1 Economics from Different Treatments

2.1.1 Cost of cultivation

The cost of cultivation for each treatment was calculated based on the market prices of all inputs used to grow the crop on a per hectare basis. This included both the cost of common inputs and practices used across all treatments, as well as the cost of variable inputs specific to each treatment. These costs were then combined to determine the total cost of cultivation for each particular treatment.

2.1.2 Gross monetary return

The gross monetary return for each treatment was calculated based on the current market price of the produce, expressed on a per hectare basis. This Fig. 1. represents the total revenue generated from the crop produced under each treatment.

2.1.3 Net monetary return

The Net Monetary Return (NMR) per hectare under each treatment was determined by subtracting the cost of cultivation of a particular treatment from the GMR of the same treatment.

> Net Monetary Return = Gross Monetary Return - Cost of Cultivation

This calculation provided the profit or loss for each treatment after accounting for the cost of inputs.

2.1.4 Benefit-cost ratio

To estimate the benefits obtained under different treatments for each rupee of expenditure incurred, B: C ratio of each treatments was calculated as below:-

> B:C ratio = Gross monetary returns / Total cost of cultivation

3. RESULTS AND DISCUSSION

3.1 Cost of Cultivation

The provided data on the cost of cultivation shows a baseline expenditure of Rs. 52,580 across all treatments, with additional costs varying significantly depending on the organic material used. The treatment using 100% poultry manure (T_3) fetched the lowest additional cost at Rs. 3,000 resulting in a total cost of Rs. 55,580 and yielded 10.12 t/ha. Conversely, the treatment with 100% vermicompost (T_2) had the highest additional cost of Rs. 30,000 bringing the total to Rs. 82,580 with a yield of 13.01 t/ha. This is followed by treatments T_7 and T_5 with a total cost of Rs. 73,580 and Rs. 72,580 yielding 12.32 t/ha and 12.99 t/ha, respectively. These results match historical findings that suggest that vermicompost increases crop yield over time. For example, Singh et al. [4] reported similar increases in yield when using vermicompost, where cauliflower yield increased by about 20-25% compared to conventional manure. Similarly, Chandra et al. [5] observed a higher yield response with vermicompost, although at a higher cost, which is reflected in the current study. On the other hand, poultry manure is recognized for its economic efficiency. The yield from poultry manure treatment in this study (10.12 tonnes per hectare) is slightly lower than the yield found in similar field trials by Singh et al. [4], where poultry manure contributed to a yield of up to 11.0 tonnes per hectare. However, the relatively lower cost of Rs 55,580 with poultry manure compared to vermicompost makes it an economically attractive option. The findings emphasize the balance between immediate economic efficiency, as seen in the case of poultry manure, and the long-term benefits of vermicomposting, which, despite higher costs, improves soil fertility and increases yields over time [6,5].

3.2 Net Monetary Return

The results of the analysis show that the highest profit came from treatment T_{10}, which followed the recommended fertilizer dose, bringing in Rs. 236,321 per hectare. Close behind was treatment T_5 a combination of 50% FYM and 50% vermicompost, with a profit of Rs. 219,820 per hectare. Both of these treatments stood out for delivering the best financial returns. The high profits were largely due to the strong curd yields: 15.30 tonnes per hectare for T_{10} and 12.99 tonnes per hectare for T_5. In comparison, treatment T_1, which used only FYM, had the lowest return of Rs. 139,820 per hectare, along with a more modest yield of 10.12 tonnes per hectare. Looking at earlier research, these findings align well with past studies showing that combining organic and inorganic inputs, also known as integrated nutrient management (INM), tends to bring in better economic benefits compared to using only organic sources like FYM. For instance, research by Reddy et al. [7]

and Kumawat & Sharma [8] demonstrated that combining organic materials such as FYM with fertilizers boosted crop yields and financial returns. In this study, treatment T_5's impressive yield of 12.99 tonnes per hectare and profit of Rs. 219,820 highlight the advantages of mixing FYM with vermicompost, which echoes similar findings by Patel et al. [9]m who observed that vermicompost combined with other organic materials improved both the quantity and quality of crops. The success of treatments like T_{10} and T_5 can be linked to the balanced nutrients they provide, which improve both soil health and crop performance. Earlier studies by Singh et al. [10] and Chatterjee et al. [11] also found that using both organic and inorganic nutrient sources led to better crop yields and higher quality vegetables. In line with their research, the strong yields from T_{10} (15.30 tonnes per hectare) and T_5 (12.99 tonnes per hectare) further prove the value of integrated nutrient management in maximizing both profitability and agricultural success.

3.3 Benefit-Cost Ratio

The study shows that the highest benefit-cost B:C ratio of 4.39 was achieved with treatment T_{10} (recommended dose), indicating its better economic efficiency compared to other treatments. This high B:C ratio can be attributed to the excellent curd yield of 15.30 tonnes per hectare, which gave strong returns, making T_{10} the most economically viable option. In contrast, the lowest B:C ratio of 3.15 was observed with treatment T_2 (100% earthworm compost), which yielded 13.01 tonnes per hectare, indicating relatively low profitability despite a good yield. Patel et al. [12] also observed that recommended fertilizer doses resulted in higher B:C ratios compared to organic amendments such as earthworm compost. Similar studies conducted by Singh and Sharma [13] confirmed these findings, stating that while organic treatments including vermicompost contribute positively to soil health and long-term sustainability, their short-term economic benefits often lag behind conventional or recommended practices. In this study, the yield of T_2 at 13.01 tonnes/ha supports this, as it lags behind the more robust 15.30 tonnes/ha yield of T_{10}, resulting in a lower B:C ratio despite the environmental benefits of organic amendments. These results are in line with those of Choudhary et al. [14], Narayan et al. [15], Srichandan et al. [16], Choudhary and Paliwal [17], Negi et al.[18], Prashad et al. [19], Atal et al. [20], Lodhi et al. (2020), who consistently show that integrated nutrient management (such as T_{10}) generally results in higher B:C ratios than treatments relying solely on organic inputs (such as T_2) [21,22]. The better performance of integrated treatments can be attributed to the balanced and adequate nutrient supply, which not only increases crop productivity, as seen with T_{10} yield of 15.30 tonnes per hectare, but also increases economic benefits in a more immediate time frame [23-25].

4. CONCLUSION

Among the data showed that a significant maximum yield of 15.30 t/ha and net income of Rs. 236321) per ha and benefit cost ratio of 4.39 was achieved in broccoli in the T_{10}. However, shows the minimum benefit cost ratio 3.23 and lowest net income 139820 Rs/ha and minimum curd yield of 10.12 t/ha was obtained in Treatment T_1-(control).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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