1. Original Research Article

**Cost-Benefit Analysis of Various Treatments for White Brinjal (*Solanum melongena* L.) cv. Hybrid Snow Ball in the Bundelkhand Region**

## ABSTRACT

The present experiment was conducted during the Rabi season of 2022–2023 in the Bundelkhand region to evaluate the economic performance of different organic nutrient management practices in the cultivation of White Brinjal (Solanum melongena L.), specifically the Hybrid Snow Ball (White) variety. The study was designed using a Randomized Block Design (RBD) with three replications and eight treatments. The treatments included: T0 – Control (water spray only), T1 – 100% Farmyard Manure (FYM) + Jeevamrit, T2 – 100% Vermicompost (VC) + Jeevamrit, T3 – 100% Poultry Manure (PM) + Jeevamrit, T4 – 50% FYM + 50% VC + Jeevamrit, T5 – 50% FYM + 50% PM + Jeevamrit, T6 – 50% PM + 50% VC + Jeevamrit, and T7 – 33% FYM + 33% PM + 33% VC + Jeevamrit. The crop was cultivated at a spacing of 60 cm × 45 cm (row × plant), with each net plot measuring 2.7 meters in length and 3.0 meters in width. The experimental field had a total net area of 24.3 meters × 9.0 meters and included an irrigation channel size of 50 cm and bunds of 30 cm width. The economic evaluation of the treatments was based on four major parameters: cost of cultivation, gross return, net return, and the benefit-cost (B:C) ratio. The highest cost of cultivation was recorded in Treatment T2 (100% Vermicompost + Jeevamrit) at ₹178,150 per hectare, while the lowest was observed in Treatment T1 (100% FYM + Jeevamrit) at ₹106,150 per hectare. Gross returns were highest in Treatment T7 (33% FYM + 33% PM + 33% VC + Jeevamrit) at ₹570,000 per hectare, whereas Treatment T1 recorded the lowest gross return at ₹390,000 per hectare. Similarly, net returns followed the same pattern, with the highest return of ₹427,900 per hectare in Treatment T7 and the lowest of ₹283,850 per hectare in Treatment T1. The benefit-cost ratio was also found to be most favorable in Treatment T7, which recorded a ratio of 3.01, followed by Treatment T3 (100% Poultry Manure + Jeevamrit) at 2.87. The lowest benefit-cost ratio was observed in the control treatment (T0) at 1.78. In conclusion, the study clearly demonstrates that integrated nutrient management, particularly the combination of FYM, Poultry Manure, and Vermicompost along with Jeevamrit as applied in Treatment T7, significantly enhances the economic viability and profitability of White Brinjal cultivation under the agro-climatic conditions of the Bundelkhand region.

**Keywords:**Brinjal, Hybrid, Jeevamrit, Morphological,Organic and Snow Ball.

**INTRODUCTION**

Brinjal, or Solanum melongena L., is a member of the Solanaceae family, which includes other well-known plants like tomatoes, potatoes, and peppers as per the botanical classification [2]. While typically grown as an annual crop, it is technically a herbaceous perennial[6]. The plant blooms striking, star-shaped flowers, ranging in color from white to lavender or purple, with a yellow center, and clusters at the branch tips. Its chromosomal number is 2n = 24, indicating it has 24 paired chromosomes per somatic cell, a typical feature of many cultivated plants [4]. Brinjal is low in calories and fats, making it suitable for weight management [8]. It's a good source of dietary fiber that aids digestion and promotes satiety [5,7].Additionally, it contains essential vitamins, such as vitamin C for immune health and collagen production, and vitamin K for blood clotting and bone strength[3]. High in potassium, brinjal helps maintain fluid balance and supports heart health [1,3]. Rich in antioxidants like anthocyanins and chlorogenic acid, it protects the body from oxidative stress and inflammation [6,8]. Including brinjal in one's diet can significantly support overall well-being.

White brinjal, a variety of Solanum melongena L., offers the same health benefits as its purple counterpart [10]. It is low in calories and fat, making it a great choice for weight management. White brinjal also supports digestive health with its high fiber content, regulates blood sugar levels, and maintains heart health through its potassium content [13]. In 2023, India’s brinjal production was estimated at 12.61 million metric tons, with major cultivation regions including Andhra Pradesh, Bihar, Karnataka, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh, and West Bengal. Brinjal accounts for approximately 8.14% of India's vegetable area and 9% of the total vegetable production. Globally, major producers include India, China, Egypt, Turkey, Iran, Indonesia, Iraq, Japan, Italy, the Philippines, and parts of Africa, with Asia dominating production, led by China (53%), India (28%), and Turkey[12].

Farmyard manure (FYM), a valuable organic fertilizer, consists of animal dung, urine, bedding, and leftover feed, rich in nitrogen (0.5-1.5%), phosphorus (0.2-0.4%), potassium (0.5-1.0%), calcium, magnesium, and sulfur[13]. Poultry manure, depending on the type of poultry and its feed, contains about 1-2% nitrogen, 0.5-1% phosphorus, and 0.5-1% potassium. Vermicomposting, an efficient method of composting organic materials, produces high-quality compost faster than traditional methods and is odorless and pest-free [14,15]. Jeevamrut, an organic liquid manure made from cow dung, cow urine, jaggery, and gram flour, is fermented for 5-7 days and serves as a nutrient-rich supplement for plants [17,19] Organic farming presents multiple benefits, emphasizing sustainable practices by eliminating synthetic fertilizers, pesticides, and GMOs [15]. It relies on methods such as crop rotation, composting, and biological pest control, reducing chemical pollution and improving soil fertility. Organic farming promotes soil health by nurturing beneficial organisms like bacteria, fungi, and earthworms, ensuring better nutrient availability and water retention[12]. It also enhances biodiversity by conserving natural habitats and encouraging diverse crop planting. These practices also benefit pollinators and natural pest controllers [] Additionally, organic farming offers health benefits by reducing chemical residues in food, providing a safer and more natural option for consumers[11]. From an economic standpoint, organic farming can be financially rewarding, as organic products often fetch higher prices, and farmers can achieve self-sufficiency by utilizing natural pest control methods, composting, and diverse seed cultivation.

**MATERIAL AND METHODS**

The study was conducted at the Organic Research Farm, Karguanji, Bundelkhand University, Jhansi (U.P.) from November 2022 to April 2023. Located at 25.45°N latitude, 78.61°E longitude, and 285 meters above sea level, the site has a sub-tropical climate and focuses on evaluating vegetative growth and yield parameters.

Jhansi has a semi-arid climate with hot summers (35°C to 45°C) and cool winters (5°C to 10°C). The monsoon lasts from July to September, with an average annual rainfall of 800 mm. Humidity is low year-round, and dust storms occur occasionally in summer.

Jhansi’s soil is significant for crop growth, with its unique properties influencing agricultural productivity. The soil's characteristics are essential in determining the success of various vegetation types in the region.The region is primarily covered by red soil, rich in iron oxide and aluminum, but has low fertility. Alluvial soils are also present along the Betwa and Dhasan river banks.The soil texture in Jhansi is mostly sandy loam to sandy clay loam, with good water retention. However, due to low organic matter, it can dry out quickly and lose fertility. The study was laid out in a Randomized Block Design (RBD) with three replications and eight treatment combinations, as follows: T0 – Control (water spray only), T1 – 100% Farmyard Manure (FYM) + Jeevamrit, T2 – 100% Vermicompost (VC) + Jeevamrit, T3 – 100% Poultry Manure (PM) + Jeevamrit, T4 – 50% FYM + 50% VC + Jeevamrit, T5 – 50% FYM + 50% PM + Jeevamrit, T6 – 50% PM + 50% VC + Jeevamrit, and T7 – 33% FYM + 33% PM + 33% VC + Jeevamrit. The crop was planted with a spacing of 60 cm × 45 cm (row × plant), and each net plot measured 2.7 m in length and 3.0 m in width. The experimental field included irrigation channels 50 cm wide and bunds 30 cm wide, covering a total net area of 24.3 m × 9.0 m. The layout and treatments were designed to ensure uniformity and optimize the accuracy of observations across replications.

* Cost of Cultivation = Sum of all input costs *viz.,* (labor, manure, irrigation)
* Gross Return = Yield (kg/ha) × Market price (Rs/kg)
* Net Return = Gross Return – Cost of Cultivation
* Benefit-Cost Ratio (B:C) = Gross Return / Cost of Cultivation

**RESULTS AND DISCUSSION**

Economics of all treatments were calculated according to the expenditure incurred from nursery raising till harvesting of fruits, *viz.,* cost of cultivation, gross return, net return, and benefit-cost ratio have been worked out and presented in Table 1. The maximum cost of cultivation was recorded in treatment T2 (100% Vermicompost + Jeevamrit) with Rs. 1,78,150 ha⁻¹, while the minimum (Rs. 1,06,150 ha⁻¹) was recorded in treatment T1 (100% Farmyard Manure + Jeevamrit), followed by T0 (control) with Rs. 80,650 ha⁻¹. Similar results have been reported by [5,6]. The maximum gross return was recorded in treatment T7 (33% FYM + 33% P.M. + 33% V.C. + Jeevamrit) with Rs. 5,70,000 ha⁻¹, and the minimum (Rs. 3,90,000 ha⁻¹) was recorded in treatment T1 (100% Farmyard Manure + Jeevamrit), followed by T0 (control) with Rs. 2,25,000 ha⁻¹. The present results are consistent with the findings of [6,8,12]. The maximum net return was recorded in treatment T7 (33% FYM + 33% P.M. + 33% V.C. + Jeevamrit) with Rs. 4,27,900 ha⁻¹, and the minimum (Rs. 2,83,850 ha⁻¹) was recorded in treatment T1 (100% Farmyard Manure + Jeevamrit), followed by T0 (control) with Rs. 1,44,350 ha⁻¹. The present results have been corroborated by [7,10]. The maximum benefit-cost ratio was recorded in treatment T7 (33% FYM + 33% P.M. + 33% V.C. + Jeevamrit) with 3.01, followed by T3 (100% Poultry Manure + Jeevamrit) with 2.87, while the minimum (1.78) was recorded in treatment T0 (control). The present results are in agreement with the findings of [13,17]. The present study demonstrates that integrated nutrient management, particularly the combination of farmyard manure, poultry manure, and vermicompost with Jeevamrit (treatment T7), significantly enhances economic returns in White Brinjal cultivation under Bundelkhand conditions. These findings align with previous research indicating that organic amendments improve soil fertility and crop productivity, ultimately leading to higher gross and net returns [5,7]. The improved benefit-cost ratio observed in T7 underscores the potential for sustainable farming practices to reduce dependency on chemical fertilizers while maintaining profitability. However, variability in manure quality and availability may pose challenges for widespread adoption, warranting further investigation into region-specific organic input sourcing and cost optimization. Future research should also explore the long-term impact of these treatments on soil health and crop resilience.

**CONCLUSION**

The economic evaluation of various treatments for White Brinjal cultivation, from nursery raising to fruit harvesting, provides valuable insights into the financial outcomes of each treatment. Among the treatments analyzed, treatment T2 (100% vermicompost + jeevamrit) incurred the highest cost of cultivation (Rs 1,78,150 ha-1), while treatment T1 (100% Farmyard Manure + jeevamrit) recorded the lowest cost (Rs 1,06,150 ha-1). In terms of gross returns, treatment T7 (33% FYM + 33% P.M. + 33% V.C. + jeevamrit) yielded the highest return (Rs 5,70,000 ha-1), while T1 (100% Farmyard Manure + jeevamrit) produced the least (Rs 3,90,000 ha-1). Net returns followed a similar pattern, with T7 generating the highest net return (Rs 4,27,900 ha-1) and T1 showing the lowest net return (Rs 2,83,850 ha-1).Furthermore, the benefit-cost ratio was highest for treatment T7 (3.01), demonstrating the most favorable economic efficiency, followed by treatment T3 (100% Poultry Manure + jeevamrit) with a ratio of 2.87. In contrast, the control treatment (T0) had the lowest benefit-cost ratio (1.78). These findings indicate that integrated nutrient management, particularly the combination of FYM, poultry manure, vermicompost, and jeevamrit (T7), offers the most economically beneficial approach for White Brinjal cultivation in the Bundelkhand region. Therefore, adopting treatment T7 can lead to better profitability, making it the most viable option for farmers aiming to maximize both yield and return on investment.

**FUTURE SCOPE**

Future research could explore the long-term effects of these organic treatments on brinjal yield and soil health. Further studies could also evaluate the environmental impact of various organic fertilizers and investigate optimal combinations for different regions. Additionally, similar experiments could be conducted on other vegetable crops to assess the broader applicability of these organic practices. Exploring the economic viability and scalability of such treatments could be beneficial for promoting sustainable farming practices. The promising economic outcomes from integrated organic nutrient management suggest a viable pathway toward sustainable agriculture in the Bundelkhand region. Adoption of these practices can reduce input costs over time by improving soil health and fertility, decreasing the need for chemical fertilizers. Additionally, increasing consumer preference for organic produce offers market incentives for farmers. Future studies should assess long-term cost-benefit analyses and develop extension programs to facilitate farmer adoption, thereby promoting eco-friendly and economically viable farming systems.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators not have been used during the writing or editing of this manuscript.

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**Table 1: Cost of cultivation of brinjal (fixed cost for all the treatment) per hectare**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sr No. | Particulars | Unit | Unit rate(Rs.) | Cost of cultivation (Rs.) |
| **A.** | **Land preparation** |  |  |  |
|  | Ploughing and harrowing | 6 hours | 850/ hour | 5,100 |
|  | Layout preparation | 8 labors | 350/labor | 2,800 |
|  | Planting | 12 labors | 350/labor | 4,200 |
|  | Gap filling | 4 labors | 350/labor | 1,400 |
|  | Manure application | 15 labors | 350/labor | 5,250 |
| **B.** | **Seed** |  |  |  |
|  | Cost of seed | 300 g | 3.5/g | 1,050 |
| **C.** | **Intercultural operations** |  |  |  |
|  | Weeding | 12 labors | 350/labor | 4,200 |
|  | Spraying | 5 labors | 350/labor | 1,750 |
|  | Insecticide and pesticide | 6 liter | 650/liter | 3,900 |
| **D.** | **Irrigation** |  |  |  |
|  | Irrigation | 15 irrigation | 300/irrigation | 4,500 |
|  | Tube well charge |  |  | 3,000 |
| **E.** | **Harvesting** | 32 labor | 350/ labor | 11,200 |
|  | Transportation |  |  | 10,000 |
|  | Supervision charge |  |  | 12,600 |
|  | Rental value | 4 months | 1800/month | 7,200 |
|  | Miscellaneous |  |  | 2,500 |
|  | **Total** |  |  | **80,650** |

**Table 2: Variable costs of different treatments of brinjal.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Treatments | Amount required (hac-1) | Costing per material (Rs.) | Total variable (Rs.) | Fixed cost (Rs.) | Total cost (Rs.) |
| T1 | 100% farmyard manure + jeevamrit | 24 t. + 500 l. | 24000 + 1500 | 25,500 | 80,650 | 1,06150 |
| T2 | 100% vermicompost + jeevamrit | 6 t. + 500 l. | 96000 + 1500 | 97,500 | 80,650 | 1,78,150 |
| T3 | 100% poultry manure + jeevamrit | 4 t. + 500 l. | 60000 + 1500 | 65,500 | 80,650 | 1,46,150 |
| T4 | 50% FYM + 50% V.C.+ jeevamrit | 12 t. + 3 t. + 500 l. | 12000 + 48000 + 1500 | 61,500 | 80,650 | 1,42,150 |
| T5 | 50% FYM + 50% P.M. + jeevamrit | 12 t. + 2 t. + 500 l. | 12000 + 30000 + 1500 | 43,500 | 80,650 | 1,24,150 |
| T6 | 50% P.M. + 50% V.C. + jeevamrit | 2 t. + 3 t. + 500 l. | 30000 + 48000 + 1500 | 79,500 | 80,650 | 1,60,150 |
| T7 | 33% FYM + 33% V.C. + 33% P.M. + jeevamrit | 8 t. + 2 t. + 1.33 t. + 500 l. | 8000 + 32000 + 19950 + 1500 | 61,450 | 80,650 | 1,42,100 |
| T0 | Control | …… | 00 | 00 | 80,650 | 80,650 |

Cost of farmyard manure : Rs. 1000/t.

Cost of poultry manure : Rs. 15000/t.

Cost of vermi compost : Rs. 16000/t.

Cost of jeevamrit making : Rs. 1500/500 l.

**Table-3. Benefit cost ratio different treatments of brinjal.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment | Fruit yield (q/ha) | Gross return (Rs.) | Net return (Rs.) | B:C Ratio |
| T1 | 100% farmyard manure + jeevamrit | 260 | 39,0000 | 2,83,850 | 2.67 |
| T2 | 100% vermicompost + jeevamrit | 340 | 51,0000 | 3,31,850 | 1.86 |
| T3 | 100% poultry manure + jeevamrit | 378 | 5,67,000 |  4,20,850 | 2.87 |
| T4 | 50% FYM + 50% V.C.+ jeevamrit | 320 | 4,80,000 | 3,37,850 | 2.37 |
| T5 | 50% FYM + 50% P.M. + jeevamrit | 315 | 4,72,500 | 3,48,350 | 2.80 |
| T6 | 50% P.M. + 50% V.C. + jeevamrit | 360 | 5,40000 | 3,79,850 | 2.37 |
| T7 | 33% FYM + 33% V.C. + 33% P.M. + jeevamrit | 380 | 5,70000 | 4,27,900 | 3.01 |
| T0 | Control | 150 | 22,5000 | 1,44,350 | 1.78 |

Rate of per kg white brinjal : Rs. 15