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Effect of integrated organic and inorganic nutrient management on growth, yield, quality and economics of grafted brinjal (*Solanum melongena* L.) cv. VNR 212

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Abstract

A field investigation was conducted during the *Kharif* season of 2025 at the Horticultural Research Farm, GH Rasoni University, Saikheda, Madhya Pradesh, to evaluate the effect of integrated application of organic manure and inorganic fertilizer on grafted brinjal (*Solanum melongena* L.) cv. VNR-212. The experiment was laid out in a Randomized Block Design (RBD) comprising 14 treatment combinations replicated three times. The treatments involved varying proportions of inorganic fertilizers integrated with organic sources such as Vermicompost (VC), Neem Cake (NC), and Poultry Manure (PM) on a nitrogen-equivalent basis. The results revealed that treatment combinations significantly influenced the growth, yield, and quality attributes of the grafted crop. Among the evaluated modules, treatment T₁₀ (75% RDN through inorganic fertilizers + 25% N through poultry manure) demonstrated superior performance, recording the maximum number of fruits per plant (16.87), fruit weight (2144.97 g/plant), and the highest marketable fruit yield of 321.75 q ha⁻¹. This was statistically at par with treatment T₉ (50% Inorganic + 50% Poultry Manure), which recorded a yield of 316.26 q ha⁻¹ and the highest Total Soluble Solids (TSS) content of 5.40 °Brix. In contrast, the unfertilized control (T₁) recorded the lowest yield of 63.52 q ha⁻¹. Economic analysis further established T₁₀ as the most commercially viable strategy, securing the maximum Net Return of ₹6,33,570 ha⁻¹ with a Benefit-Cost (B:C) ratio of 2.91. Consequently, the integration of 75% inorganic fertilizers with 25% poultry manure is recommended to maximize the productivity and profitability of grafted brinjal in the Pandhurna district of Madhya Pradesh, India.

Keywords: *Solanum torvum*, INM, poultry manure, vermicompost, fruit yield, B:C ratio

Introduction

Eggplant (*Solanum melongena* L.), or brinjal, is a vital tropical vegetable in India (Pramila *et al.*, 2015) [15]. Its diverse regional names include Baingan (Hindi), Venkaya (Telugu), and Kathiri (Tamil). Globally, it is known as eggplant due to its egg-shaped white varieties, and as aubergine in Europe (Pramila *et al.*, 2015) [15]. It is widely consumed across all social strata, making it a highly valued crop (Patel and Sarnaik, 2003) [14].

Vegetable grafting involves fusing a scion (shoot) with a rootstock to grow as one plant. The practice began in 1920s Japan by grafting watermelon onto marrow rootstocks, expanding commercially to *Lagenaria* stocks by the 1930s (Lee, 1994) [8]. Eggplant grafting started in the 1950s using *Solanum integrifolium*, followed by tomatoes in the 1960s (Oda, 1995) [13]. Today, it is highly popular in Asia, Europe, and the Mediterranean (Lee and Oda, 2003; Traka-Mavrona *et al.*, 2000) [1, 20]. For instance, southern Greece utilizes grafted plants for 90–100% of early watermelons, though the practice remains rare in the north (Traka-Mavrona *et al.*, 2000) [20].

Grafting commercial cultivars (like the high-yielding VNR 212 hybrid) onto resilient or wild *Solanum* rootstocks combats soil-borne diseases such as Fusarium and bacterial wilts [King *et al.*, 2010; Kumar *et al.*, 2021] [6, 7]. This technique serves as a rapid alternative to slow traditional

breeding programs (Bahadur *et al.*, 2015) [1]. The rootstock alters the scion's phenotype, offering an eco-friendly replacement for chemical soil sterilants. Grafted plants show enhanced physiological traits-such as higher antioxidant content, cell membrane selectivity, and adventitious root growth-which buffer crops against climate change and abiotic stresses.

Brinjal productivity in Maharashtra is below the national average, leaving substantial room for improvement through wild rootstock grafting and optimized field management. Achieving ideal plant density through precise row and plant spacing maximizes yield. Because grafted brinjals have longer productive lifespans, they require optimized spacing and a sustained nutrient supply to maintain high yields and fruit quality.

Balanced plant nutrition is vital to unlock the potential of grafted crops. While synthetic fertilizers boost immediate yields, continuous use degrades soil health (Subbiah *et al.*, 2019) [18]. Conversely, organic manures improve soil structure but release nutrients slowly (Bairwa *et al.*, 2018) [2]. Integrating both sources ensures sustainable productivity (Ramesh *et al.*, 2020) [16].

Historically, chemical fertilizers have sustained global populations by feeding nearly half the planet (Erisman *et al.*, 2008) [4]. To complement this, vermicompost provides a stable, granulated organic source rich in C, H, O, and

essential macro- and micronutrients (such as NO_3 , PO_4 , Ca, K, and Mg) (Singh *et al.*, 2008) ^[8]. It improves soil aeration, releases nutrients steadily in bioavailable forms, and provides organic carbon advantages absent in synthetics (Nagavallema *et al.*, 2004) ^[12]. Finally, shifting from traditional fertilizer broadcasting to drip fertigation applies nutrients directly to the root zone, significantly increasing fertilizer-use efficiency (Hebbbar *et al.*, 2004) ^[5].

Materials and Methods

A field experiment was conducted at the University Research Farm, Department of Horticulture, School of Agricultural Sciences, GH Rasoni University, Saikheda, located in the southern region of Pandhurna District, Madhya Pradesh, with geographically from 21°36' North latitude to 78°32' East longitude. Climatologically, the region is characterized by a Tropical wet and dry climate (savanna type), with an average annual rainfall ranging from 837 mm to 1,100 mm, which is heavily concentrated during the southwest monsoon months (June to September). The region experiences distinct seasonal variations, transitioning from a scorching summer (March to May) with maximum temperatures peaking near 41.4°C (106.5°F), to a humid monsoon season with an average relative humidity of 60–70%, followed by a dry winter (October to February) where minimum temperatures routinely drop to between 10°C and 12.2°C. The field experiment comprised 14 treatment combinations replicated three times in a Randomized Block Design (RBD). The nutrient treatments were formulated based on the recommended dose of fertilizer (RDF) of 180:70:70 kg/ha N:P₂O₅:K₂O. Individual plots measured 5.4 m × 3.6 m (Gross Area: 19.44 m²) with a crop spacing of 90 cm × 60 cm, establishing a population of 36 plants per plot. To eliminate border effects, data collection was restricted to the net plot area of 8.64 m² (16 plants). The treatments evaluated were viz. T₁: Local control, T₂: 25% RDN through Inorganic + 75% N through Vermicompost, T₃: 50% RDN through inorganic + 50% N through Vermicompost, T₄: 75% RDN through inorganic + 25% N through Vermicompost, T₅: 25% RDN through inorganic + 75% N through neem cake, T₆: 50% RDN through inorganic + 50% N through Neem cake, T₇: 75% RDN through inorganic + 25% N through Neem cake, T₈: 25% RDN through inorganic + 75% N through Poultry manure, T₉: 50% RDN through inorganic + 50% N through Poultry manure, T₁₀: 75% RDN through inorganic + 25% N through Poultry manure, T₁₁: 50% N through Vermicompost + 50% N through Neem cake, T₁₂: 50% N through Poultry manure + 50% N through Vermicompost, T₁₃: 50% N through Neem cake + 50% N through Poultry manure, T₁₄: 100% NPK (RDF). The standardized RDF for the grafted brinjal VNR 212 was fixed at 180:70:70 kg NPK ha⁻¹ (Pradhan., *et al.*, (2022)). The Organic manure components—vermicompost, poultry manure, and neem cake—were applied entirely as a single basal soil amendment 10 to 15 days prior to transplanting based on their tested nitrogen concentrations to strictly satisfy the designated treatment RDN allocations. These manures were broadcast uniformly across their respective treatment plots and incorporated into the top 15 cm of the soil profile to facilitate microbial decomposition.

The treatment combinations integrated inorganic fertilizers—Urea (46% N), Single Superphosphate (16% P₂O₅), and

Muriate of Potash (60% K₂O)—with three organic sources applied on a nitrogen-equivalent basis: vermicompost, neem cake, and poultry manure. The control treatment (T₁) received no amendments. The absolute mineral reference (T₁₄) received 100% RDF via chemical fertilizers, requiring 761 g Urea, 850 g SSP, and 227 g MOP per plot. Organic-inorganic substitution treatments (T₂ to T₁₀) replaced the required nitrogen component at ratios of 25%, 50%, or 75% using the respective organic manures while maintaining blanket phosphorus and potassium levels. Pure organic combinations (T₁₁ to T₁₃) substituted the total nitrogen requirements using combinations of two organic manures without synthetic nitrogen inputs.

Although several studies have reported the beneficial effects of integrated nutrient management in brinjal, limited information is available regarding nutrient management in grafted brinjal cultivated on *Solanum torvum* rootstock under the agro-climatic conditions of central India. Therefore, the present investigation was undertaken to identify the most suitable combination of organic and inorganic nutrient sources for improving productivity, fruit quality and profitability.

Results and Discussion

Data recorded during the experiment were subjected to analysis of variance (ANOVA) following the Randomized Block Design as described by Gomez and Gomez (1984). Treatment means were compared using the Critical Difference (CD) test at the 5% level of significance. The treatment T₁₀ (75% RDN inorganic + 25% N via poultry manure) recorded the maximum number of fruits per plant (16.87) and the highest individual plant yield (2144.97 g). This performance was found to be statistically at par with treatment T₉ (50% Inorganic + 50% Poultry Manure), which registered 15.73 fruits and 2108.39 g per plant, respectively. Both poultry manure-integrated treatments proved significantly superior to the absolute control (T₁), which registered the lowest reproductive output of 9.00 fruits and 423.48 g per plant, remaining statistically comparable to the organic-only treatment T₁₃ (503.74 g/plant). The superiority of T₁₀ and T₉ is attributed to the balanced nutritional profile of poultry manure, which accelerates vegetative vigor and enhances photosynthate translocation to the sink. Dauda *et al.*, (2008) ^[3] and Suge *et al.*, (2011) ^[19] reported that poultry manure minimizes flower abortion and increases fruit set retention. These findings align with recent studies by Mishra *et al.*, (2018) ^[9] and Mohanty *et al.*, (2020) ^[10], who confirmed that integrating inorganic nitrogen with organic sources optimizes source-sink relationships in *Solanaceous* crops.

The highest marketable fruit yield was realized in T₁₀ (321.75 q ha⁻¹), closely followed by T₉ (316.26 q ha⁻¹). The integrated treatment T₁₀ outperformed the standard 100% chemical practice (T₁₄: 191.28 q ha⁻¹) by approximately 68%. Among other organic sources, vermicompost treatments (T₃) performed moderately well (251.49 q ha⁻¹), whereas the neem cake combinations (T₅–T₇) ranged between 130.40 and 172.98 q ha⁻¹. The unfertilized control (T₁) recorded the minimum yield of 63.52 q ha⁻¹, which was statistically on par with T₁₃ (75.56 q ha⁻¹). The robust yield in T₁₀ highlights the synergistic advantage of INM, where poultry manure improves soil physical properties and sustains microbial

continuity, preventing the "nutrient starvation" typical of chemical-only plots during late maturity (Ullah *et al.*, 2008) [21]. The sustained release of nutrients likely extended the harvesting window, a mechanism corroborated by Ramesh *et al.*, (2020) [16] and Mohapatra *et al.*, (2025) [11], who observed that integrated nutrient applications significantly enhance nutrient use efficiency and final economic yield in brinjal. The maximum quality index value (5.40) was recorded in treatment T₉ (50% RDN inorganic + 50% poultry manure), which was found to be significantly superior to all other treatments. This was followed by treatment T₁₀, which recorded a value of 5.26. The standard inorganic fertilizer treatment (T₁₄) recorded a moderate quality value of 4.53, whereas the lowest values were observed in the unfertilized control T₁ (3.23) and the organic-only combination T₁₃ (3.38). The significant improvement in quality traits under poultry manure-enriched treatments can be attributed to the balanced supply of macro- and micronutrients, which enhances the photosynthetic efficiency and the subsequent accumulation of carbohydrates and Total Soluble Solids (TSS) in the fruit. These findings are in agreement with Ramesh *et al.*, (2020) [16] and Mohapatra *et al.*, (2025) [11]. The economic viability of the various nutrient management protocols was evaluated to identify the most commercially remunerative strategy for grafted brinjal cultivation (Table 2)

The analysis was based on a plant population of 18,518 plants ha⁻¹ (90cm x 60 cm spacing) and prevailing market rates. The economic data revealed that monetary returns were directly proportional to the marketable fruit yield. The maximum gross return of ₹9,65,250 ha⁻¹ and net return of ₹6,33,570 ha⁻¹ were accrued under treatment T₁₀ (75% RDN inorganic + 25% N via poultry manure). This was closely followed by the 50:50 poultry manure combination (T₉), which generated a net return of ₹6,15,600 ha⁻¹. The superior profitability in these treatments is attributed to the significant yield increment (approximately 68% over the standard inorganic practice), which effectively offset the additional treatment costs.

Consequently, the Benefit-Cost (B:C) ratio was highest in T₁₀ (2.91), implying that for every rupee invested, a net return of ₹1.91 was gained. Treatments T₉ (2.85) and T₃ (2.24) also demonstrated excellent commercial feasibility. In contrast, the unfertilized control (T₁) and specific organic combinations like T₁₃ resulted in negative net returns and B:C ratios below 1.0. This highlights a critical economic reality: the high initial investment of grafted planting material (approx. ₹2.03 Lakh/ha for seedlings) cannot be recovered without a robust nutrient management regime that ensures yields exceed the break-even point.

Table 1: Effect of combination of organic manures and inorganic fertilizers on grafted brinjal for yield, quality and economics parameter

Treatments	Number of fruits per plant	Fruit yield per plant (g plant ⁻¹)	Fruit yield per plot (kg/plot)	Fruit yield (q ha ⁻¹)	Quality (°Brix)	Treatment Cost (₹)	Total Cost (₹)	Yield (q ha ⁻¹)	Gross Return (₹)	Net Return (₹)	B:C Ratio
T ₁	9.00	423.48	3.81	63.52	3.23	0	3,15,180	63.52	1,90,560	-1,24,620	0.60
T ₂	13.20	1211.99	10.91	181.80	4.13	27,000	3,42,180	181.8	5,45,400	2,03,220	1.59
T ₃	14.00	1676.58	15.09	251.49	4.93	21,000	3,36,180	251.49	7,54,470	4,18,290	2.24
T ₄	14.87	1523.96	13.72	228.59	4.70	15,000	3,30,180	228.59	6,85,770	3,55,590	2.08
T ₅	13.00	869.35	7.82	130.40	3.83	41,250	3,56,430	130.4	3,91,200	34,770	1.10
T ₆	12.87	1065.87	9.59	159.88	4.10	31,500	3,46,680	159.88	4,79,640	1,32,960	1.38
T ₇	13.20	1153.19	10.38	172.98	4.23	21,750	3,36,930	172.98	5,18,940	1,82,010	1.54
T ₈	13.47	1304.13	11.74	195.62	4.66	19,500	3,34,680	195.62	5,86,860	2,52,180	1.75
T ₉	15.73	2108.39	18.98	316.26	5.40	18,000	3,33,180	316.26	9,48,780	6,15,600	2.85
T ₁₀	16.87	2144.97	19.3	321.75	5.26	16,500	3,31,680	321.75	9,65,250	6,33,570	2.91
T ₁₁	11.27	627.03	5.64	94.05	3.60	33,000	3,48,180	94.05	2,82,150	-66,030	0.81
T ₁₂	12.87	741.55	6.67	111.23	3.76	15,000	3,30,180	111.23	3,33,690	3,510	1.01
T ₁₃	9.87	503.74	4.53	75.56	3.38	25,500	3,40,680	75.56	2,26,680	-1,14,000	0.67
T ₁₄	13.47	1275.22	11.48	191.28	4.53	18,000	3,33,180	191.28	5,73,840	2,40,660	1.72
S. Em±	0.33	67.24	0.6052	10.09	0.019						
CD (5%)	0.97	195.48	1.7593	29.32	0.057						

Common Cost (₹) 3,15,180

Conclusion

Based on the results of the present investigation, it is concluded that the combined application of organic manure and inorganic fertilizers significantly outperformed the sole application of chemical fertilizers or organic manures in grafted brinjal production. Among the evaluated modules, treatment T₁₀, comprising 75% RDN through inorganic fertilizers + 25% N through poultry manure, proved to be the most superior treatment. It recorded the maximum plant growth, yield attributes, and a commercial fruit yield of 321.75 q ha⁻¹. Furthermore, this treatment emerged as the most economically viable option, securing the highest net return (₹6,33,570 ha⁻¹) and Benefit-Cost ratio (2.91). Therefore, the integration of inorganic fertilizers with poultry manure is recommended for maximizing the productivity and

profitability of grafted brinjal in the Pandhurna district of Madhya Pradesh.

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