



# Effect of Inorganic Fertilizers, Organic Manures and Biofertilizers on Growth and Yield in Brinjal (*Solanum melongena* L.) cv. Swarna Pratibha

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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

The present study determines the effect of Inorganic Fertilizers, Organic Manures and Biofertilizers on Growth and Yield in Brinjal (*Solanum melongena* L.) cv. Swarna Pratibha. The experiment was conducted during 2020-21 at the Vegetable Research Farm of the Department of Horticulture, Birsa Agricultural University, Kanke, Ranchi. It employed a randomized block design with eleven treatments, each replicated thrice, to evaluate their impact on various growth, flowering, and yield

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parameters in Brinjal. The treatments included combinations of inorganic fertilizers (NPK), organic manures (such as vermicompost and Karanj cake), and bio-fertilizers (Azotobacter, Phosphorus Solubilizing Bacteria (PSB), *Trichoderma*, and *Pseudomonas fluorescens*). The control treatment received no additional inputs. Key findings from the study highlighted treatment T<sub>10</sub>, which comprised 100% recommended dose of fertilizers (RDF) along with *Trichoderma* and *Pseudomonas fluorescens*, as particularly effective. This treatment exhibited the highest number of flowers per cluster (4.67), the shortest days to first picking (60.75 days), the maximum number of fruits per plant (16.99), the longest fruit length (16.86 cm), and the highest fruit yield per plant (2.23 kg/plant). The results indicated that the combined application of inorganic fertilizers, organic manures, and bio-fertilizers significantly enhanced the growth, flowering, and yield attributes of Brinjal. Moreover, this integrated approach also improved nutrient content in the fruit and soil compared to the control. Specifically, the use of *Trichoderma*-enriched compost with *Pseudomonas fluorescens* was noted to enhance soil fertility and promote beneficial microbial activity in the rhizosphere. The uptake of nitrogen by brinjal fruits was significantly influenced by various treatments. The maximum N uptake (26.88 g/plant) in fruits was recorded in the treatment T<sub>10</sub> (100% RDF + *Trichoderma* + *Pseudomonas fluorescens* while minimum was found in treatment T<sub>11</sub> (15.48 g/plant) uptake of P in brinjal fruits. This synergy contributed to higher yield and increased mineral concentrations in the Brinjal fruits. This study concluded that *Trichoderma*-enriched biofertilizer has the potential to reduce dependency on chemical fertilizers, thereby, supporting sustainable agricultural practices. Overall, the findings underscored the importance of integrated nutrient management systems in optimizing Brinjal production while minimizing environmental impacts.

**Keywords:** *Azotobacter*; *brinjal*; *swarna pratibha*; *trichoderma*; *vermicompost*.

## 1. INTRODUCTION

Improvements in crop yields and reducing negative impacts, abiotic stress, plant pest, and diseases of food production, at the same time have been essential to solve the problems. In many situations, enhanced agricultural productivity or pest-disease control depend on the application of synthetic fertilizers and pesticides that are often unaffordable to many farmers and can have negative effects on humans, wildlife, the environment, ecological diversity, and others. Thus, it is imperative to investigate and implement sustainable methods that enhance agricultural food production in a manner that is more harmonious with the environment. Advancements in sustainable crop improvement, coupled with the adoption of eco-friendly agricultural practices, represent a transformative approach for modern farming systems which integrate several environmentally friendly techniques using natural resources (Thepbandit & Athinuwat, 2024). Brinjal, scientifically known as *Solanum melongena* L., originated from the warmer regions of India, China and belongs to the Solanaceae family (Lawande, 1998). It is also recognized globally under various names such as Eggplant, Aubergine, Baigan, or Vankaya. This warm-weather crop thrives predominantly in tropical and subtropical climates, showcasing a diverse

array of fruits in terms of shapes, sizes, and colours (Salunkhe and Desai, 1984; Kashyap et al., 2003; Jose et al., 2016). Nutritionally, Brinjal is a valuable source of dietary fiber, sugars and proteins, making it versatile for culinary use in dishes ranging from spiced rice and curry to pickles, bharta, and various stuffed preparations including meats and dry fish. It offers essential vitamins such as A and C, along with minerals like potassium, calcium, magnesium, phosphorus, and iron, each contributing to its overall nutritional profile.

In India, Brinjal cultivation is widespread, particularly in states like Bihar, Uttar Pradesh, Chhattisgarh, Madhya Pradesh, Odisha, Punjab, Telangana, Assam, Tripura, and Jharkhand. According to data from 2019-2020, the country boasts extensive cultivation across approximately 736,000 hectares, yielding about 12,777,000 metric tons annually (NHB, 2019). Integrated Nutrient Management (INM) is a strategic approach that optimizes the use of organic, inorganic, and biological nutrient sources in crop rotations or systems. It aims to achieve and sustain maximum yield without compromising soil health and ecosystem balance (Kaushal, 2002). The chemical and biological processes within the rhizosphere play a pivotal role in nutrient mobilization, microbial dynamics and nutrient use efficiency by crops, thereby

influencing the productivity and sustainability of cropping systems (Zhang et al., 2014).

Bio-fertilizers being cheap input, provide high economic assurance, eco-friendly environment, sustain soil health and plant growth by adding organic contents as well as supplementing 25-40% of chemical fertilizers N and P requirement in terms of urea and DAP. It is becoming difficult to meet the nutrient need of farming through chemical fertilizers alone and due to its higher costs the concept of Integrated Plant Nutrient Supply System is gaining ground (Padhiary & Dubey, 2020). The application of chemical fertilizers, pesticides and herbicides has traditionally boosted production levels, yet concerns over their detrimental effects on human health, soil fertility, and environmental quality are growing (Sharma et al., 2012). Integrated management practices, like INM, are increasingly advocated to enhance the productivity and quality of vegetables while minimizing ecological impacts (Kiran et al., 2010). By balancing the application of inorganic fertilizers, organic manures, and bio-fertilizers, INM offers a promising solution to meet crop nutrient demands effectively compared to single-source applications.

Ultimately, Integrated Nutrient Management holds considerable promise in addressing the intensifying nutrient requirements of crops, achieving optimal yields, and ensuring sustained productivity over the long term, thereby supporting both ecological and environmental sustainability in agriculture.

## 2. MATERIALS AND METHODS

The experiment conducted during the summer season of 2020-21 at the Vegetable Research Farm of the Department of Horticulture, Birsa Agricultural University, Kanke Ranchi, aimed to evaluate the effects of various nutrient

management strategies on Brinjal (*Solanum melongena* L.). The experimental field was located at 23° 17' N latitude and 85° 10' E longitude, with an altitude of 625 meters above sea level. The study employed a randomized block design with three replications, featuring eleven distinct treatments to assess their impact on the growth, flowering, and yield parameters of Brinjal. These treatments included variations in NPK levels (25%, 50%, 75%, and 100% of recommended dose), organic manures (Karanj cake and vermicompost), combinations of bio-fertilizers (Azotobacter and Phosphorus Solubilizing Bacteria), and a bio-control agent (*Trichoderma* and *Pseudomonas fluorescens*). Additionally, there was a control treatment that received no additional inputs. The standard recommended dose of fertilizers comprised 100 kg/ha of nitrogen, 50 kg/ha of phosphorus, and 50 kg/ha of potassium. Data collection involved recording various parameters from five randomly selected plants per treatment within each replication. The study aimed to assess the influence of these treatments on parameters such as plant growth, flowering characteristics like number of flowers per cluster and yield attributes including days to first picking, number of fruits per plant, fruit length, and yield per plant. Overall, the experimental setup and design allowed for a comprehensive evaluation of different nutrient management strategies in Brinjal cultivation, aiming to optimize yield while minimizing environmental impact and promoting sustainable agricultural practices.

## 3. RESULTS AND DISCUSSION

The results for the flowering parameters revealed that the plant flowering parameters like days to first flowering and number of flowers per cluster were significantly improved by the application of inorganic fertilizers, organic manures and biofertilizers over control.

**Table 1. Treatment details**

Sl. No.	Annotation	Treatments
1.	T <sub>1</sub>	RDF (NPK)
2.	T <sub>2</sub>	75% RDF + 25% Vermicompost
3.	T <sub>3</sub>	50% RDF + 50% Vermicompost
4.	T <sub>4</sub>	75% RDF + 25% Karanj Cake
5.	T <sub>5</sub>	50% RDF + 50% Karanj Cake
6.	T <sub>6</sub>	75% RDF + Azotobacter + PSB
7.	T <sub>7</sub>	50% RDF + Azotobacter + PSB
8.	T <sub>8</sub>	75% RDF + <i>Trichoderma</i> + <i>Pseudomonas fluorescens</i>
9.	T <sub>9</sub>	50% RDF + <i>Trichoderma</i> + <i>Pseudomonas fluorescens</i>
10.	T <sub>10</sub>	100% RDF + <i>Trichoderma</i> + <i>Pseudomonas fluorescens</i>
11.	T <sub>11</sub>	Absolute control

**Table 2. Effect of inorganic fertilizers, organic manures and biofertilizers on different vegetative and reproductive parameters of Brinjal**

Sl. No.	Treatment	Branches/ Plant	Plant height (cm)	Leaves/ plant	Days to first flowering	No of flowers/ cluster	Number of fruits/ plant	Yield (kg/plant)	Av. Fruit weight (g)	Fruit girth/ diameter (cm)	Fruit length (cm)
T1	RDF (NPK+ FYM)	14.75	62.24	71.03	54.07	4.22	15.41	1.90	124.70	5.92	16.43
T2	75% RDF + 25% Vermicompost	11.41	56.00	67.42	53.87	3.87	13.98	1.67	119.76	5.82	15.33
T3	50% RDF + 50% Vermicompost	9.37	55.65	53.71	53.73	2.26	12.64	1.48	117.37	5.23	14.37
T4	75% RDF + 25% Karanj Cake	10.06	55.14	56.35	52.80	3.83	14.97	1.61	110.89	5.76	15.13
T5	50% RDF + 50% Karanj Cake	10.74	54.28	66.32	52.80	2.42	12.51	1.49	107.78	5.51	14.26
T6	75% RDF + <i>Azotobacter</i> + PSB	13.72	57.60	70.47	52.87	3.97	15.30	1.77	115.22	5.84	15.33
T7	50% RDF + <i>Azotobacter</i> +PSB	10.28	56.13	67.42	54.27	3.37	13.75	1.55	112.80	5.58	14.37
T8	75% RDF + <i>Trichoderma</i> + <i>Pseudomonas fluorescens</i>	14.83	61.00	72.13	52.73	4.30	16.54	2.08	125.44	6.04	16.43
T9	50% RDF + <i>Trichoderma</i> + <i>Pseudomonas fluorescens</i>	10.34	60.17	63.87	52.80	3.83	13.26	1.56	118.00	5.58	14.76
T10	100% RDF + <i>Trichoderma</i> + <i>Pseudomonas fluorescens</i>	14.90	60.80	73.07	52.67	4.46	16.99	2.23	125.95	6.14	16.86
T11	Absolute Control	9.35	51.67	52.25	54.60	1.87	10.73	1.04	100.25	5.06	13.80
S.E.m±		0.38	1.37	1.23	0.66	0.33	0.89	0.12	4.36	0.29	0.37
CD (5%)		1.17	4.13	3.72	N/A	1.00	2.64	0.35	12.97	N/A	1.12
CV (%)		8.12	10.91	10.34	2.07	16.91	10.87	12.47	6.51	8.92	7.82

The maximum number of flowers per cluster (4.46) was recorded with the treatment T<sub>10</sub> (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*) as compared to the absolute control (1.87). The numbers of flower and siliqua were significantly boosted up by the supplementation of N fertilizer with *Trichoderma*-enriched biofertilizers, the number of flower cluster in tomatoes. Similar finding was reported by Lo and Lin (2002) in cucumber, luffa and bitter gourd and Vinale et al. (2008) in pepper and tomato.

The results for the yield parameters revealed that the yield parameters like days to first picking, number of fruits per plant, fruit yield per plant (kg) and fruit length (cm) were significantly improved by the application of inorganic fertilizers, organic manures and biofertilizers over control.

The minimum days required for first picking was recorded with treatment T<sub>10</sub> (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*) i.e., 60.75 days, while maximum days (67.18 days) taken for first picking was found in treatment T<sub>11</sub> (absolute control). Thus, nitrogen treatments decreased the days to first flowering and treated plants flowered earlier than control plants. When the plants have an increased number of leaves (food factory) this results in vigorous growth of plants. Hence, nutrition is responsible for the vigorous growth of plants (vegetative) and results in more leaves, which gives more fruits per plant.

Fruit yield per plant was recorded as maximum (1.92 kg/plant) with the treatment T<sub>10</sub> (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*). The probable reason for enhanced fruit yield may be due to the cumulative effects of nutrients (macro and micro) on vegetative growth which ultimately led to more photosynthetic activities while, the application of nutrient levels enhanced carbohydrate and nitrogen metabolism of pectic substances, as well as improved the water metabolism and water relation in the plants.

Maximum fruit length (16.86 cm) was recorded under treatment T<sub>10</sub> (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*) while minimum (13.80) was observed in treatment T<sub>11</sub> (absolute control). Higher vegetative growth might have helped in the synthesis of a greater amount of food material which was later translocated into developing fruits resulting in increased fruit length (Chumyani et al., 2012) in tomatoes and (Vimera et al., 2012).

The uptake of nitrogen by brinjal fruits was significantly influenced by various treatments. The maximum N uptake (26.88 g/plant) in fruits was recorded in treatment T<sub>10</sub> (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*) while the minimum was found in treatment T<sub>11</sub> (15.48 g/plant) uptake of P in brinjal fruits.

The availabilities of P was found higher with bacterial fertilizers (N-fixers), since the build-up of available P in the soil could be due to the organic acids which were released during microbial decomposition of native soil organic fractions increasing the available P and K in soil (Choudhury et al., 2005) in brinjal.

The data regarding P uptake by the brinjal crop with a combination of organic and inorganic fertilizers showed the highest uptake of K. This might be due to the availabilities of P was found higher with bacterial fertilizers (N-fixers), since the build-up of available K in the soil could be due to the organic acids which were released during microbial decomposition of native soil organic fractions increasing the available K in soil (Choudhury et al., 2005) in brinjal plant.

The increase in the nitrogen content of the post-harvest soil sample treated with biofertilizer might be due to the release of more nitrogenous substances in the soil. Similar results were found by Latha et al. (2014) and Thingujam et al. (2016) in the brinjal crop.

The availabilities of P were found higher with all those plots which were treated with either PSB along with inorganic fertilizer or *Trichoderma* + *Pseudomonas fluorescens* along with inorganic fertilizer. PSB is phosphorus solubilizing bacteria which solubilize available phosphorus and makes it more available for plants. *Pseudomonas fluorescens* is also a type of phosphorus-solubilizing bacteria.

The highest pH status was 6.30 (T<sub>5</sub>) when the plot was treated with (50% RDF + 50% karanj cake) fertilizers which was non-significantly higher than all the other treatments. This indicated that the combination of inorganic fertilizers and organic manures reduced the pH of soil. This might be due to increased microbial activities in the root zone which decomposed organic acids and fixed unavailable forms of mineral nutrients into available forms in soil thereby substantiating crop requirements and improving organic carbon levels and stabilising soil pH.

The highest pH status was 0.45 (T<sub>3</sub>) when plot was treated with (50% RDF + 50% vermicompost) fertilizers which was non-significantly higher than all the other treatments. This might be due to increased microbial activities in the root zone which decomposed organic acid and fixed unavailable forms of mineral nutrients into available forms in soil by thereby substantiating crop requirements and improving organic carbon levels.

#### 4. CONCLUSION

The high efficiency of *Trichoderma* enriched compost might be the result of its potential of nutrient solubilization and harboring soil microorganisms. Collectively, *Trichoderma* enriched compost increased soil fertility and favoured growth of microbes in the rhizosphere which ultimately contributed to higher yield, antioxidant, and mineral concentrations. Thus, *Trichoderma*-enriched biofertilizer may reduce the application of chemical fertilizers and therefore, can be considered as a noble practice in sustainable agriculture. Exclusive use of *Trichoderma*-enriched biofertilizer increased not only the plant growth and yield but also increased the antioxidant compounds (e.g., ascorbic acid, β-carotene and lycopene) and minerals in roots, shoots and fruits. Moreover, *Trichoderma* enriched compost increased soil fertility and stimulated microbial growth in the rhizosphere. Thus, *trichoderma*-enriched compost may reduce the application of chemical fertilizers and therefore can be considered a noble practice in sustainable agriculture.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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