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

**ABSTRACT**

The experiment entitled "Effect of Inorganic Fertilizers, Organic Manures, and Bio-Fertilizers on Growth and Yield in Brinjal (*Solanum melongena* L.) cv. Swarna Pratibha" 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 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 T10, 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 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. 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:** *Azotobactor*, Brinjal, Swarna Pratibha, Trichoderma, Vermicompost

**Introduction**

Brinjal, scientifically known as *Solanum melongena* L., originated from the warmer regions of India, China and belongs to the Solanaceae family. 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. 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. 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 productivity and sustainability of cropping systems (Zhang *et al*., 2014).

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 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.

**Material 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 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.

**Table-1: Treatment Details**

|  |  |  |
| --- | --- | --- |
| **Sl. No.** | **Annotation** | **Treatments** |
| 1. | T1 | RDF (NPK) |
| 2. | T2 | 75% RDF + 25% Vermicompost |
| 3. | T3 | 50% RDF + 50% Vermicompost |
| 4. | T4 | 75% RDF + 25% Karanj Cake |
| 5. | T5 | 50% RDF + 50% Karanj Cake |
| 6. | T6 | 75% RDF + *Azotobactor* + PSB |
| 7. | T7 | 50% RDF + *Azotobactor* + PSB |
| 8. | T8 | 75% RDF + *Trichoderma* + *Pseudomonas fluorescens* |
| 9. | T9 | 50% RDF + *Trichoderma* + *Pseudomonas fluorescens* |
| 10. | T10 | 100% RDF + *Trichoderm*a *+ Pseudomonas fluorescens* |
| 11. | T11 | Absolute control |

**Result 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.

The maximum number of flowers per clusters (4.46) was recorded with the treatment T10 (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*) as compared to absolute control (1.87). The numbers of flower and siliqua were significantly boosted up by supplementation of N fertilizer with *Trichodemra*-enriched biofertilizers, number of flower cluster in tomato. 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 T10 (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*) i.e., 60.75 days, while maximum days (67.18 days) taken for first picking was found in treatment T11 (absolute control). Thus, nitrogen treatments decreased the days to first flowering and treated plants flowered earlier than control plants. When the plants have 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 resulted in more number of leaves, which gives more number of fruits per plant.

Fruit yield per plant was recorded maximum (1.92 kg/plant) with the treatment T10 (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*). The probable reason for enhanced fruit yield may be due to cumulative effects of nutrients (macro and micro) on vegetative growth which ultimately led to more photosynthetic activities while, 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 T10 (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*) while minimum (13.80) was observed in treatment T11 (absolute control). Higher vegetative growth might have helped in synthesis of greater amount of food material which were later translocated into developing fruits resulting in increased fruit length (Chumyani *et al.*, 2012) in tomato 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 the treatment T10 (100% RDF + *Trichoderma* + *Pseudomonas fluorescens*while minimum was found in treatment T11 (15.48 g/plant) uptake of P in brinjal fruits.

The availabilities of P 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 was 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 combination of organic and inorganic fertilizers showed the highest uptake of K. This might be due 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 was 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 of nitrogenous substance in the soil. Similar results were found by Ladha *et al*. (2014) and Thingujam *et al*. (2016) in brinjal crop.

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

The highest pH status was 6.30 (T5) when plot was treated with (50% RDF + 50% karanj cake) fertilizers which was non- significantly higher than all the other treatments. This indicated

**Table-2: Effect of inorganic fertilizers, organic manures and biofrtilizers 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 + *Azotobactor* + PSB | 13.72 | 57.60 | 70.47 | 52.87 | 3.97 | 15.30 | 1.77 | 115.22 | 5.84 | 15.33 |
| T7 | 50% RDF *+ Azotobactor*+PSB | 10.28 | 56.13 | 67.42 | 54.27 | 3.37 | 13.75 | 1.55 | 112.80 | 5.58 | 14.37 |
| T8 | 75% RDF + *Trichoderma* + *Pseudomonas fluorescens* | 14.83 | 61.00 | 72.13 | 52.73 | 4.30 | 16.54 | 2.08 | 125.44 | 6.04 | 16.43 |
| T9 | 50% RDF + *Trichoderma* + *Pseudomonas fluorescens* | 10.34 | 60.17 | 63.87 | 52.80 | 3.83 | 13.26 | 1.56 | 118.00 | 5.58 | 14.76 |
| T10 | 100% RDF + *Trichoderma* + *Pseudomonas fluorescens* | 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 |

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 form of mineral nutrients into available forms in soil thereby substantiated crop requirements and improved organic carbon levels and stabilized soil pH.

The highest pH status was 0.45 (T3) 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 form of mineral nutrients into available form in soil by thereby substantiated crop requirements and improved organic carbon level.

**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 favored growth of microbes in the rhizosphere which ultimately contributed to higher yield, antioxidant, and mineral concentrations. Thus, Trichoderma-enriched biofertilizer may reduce application of chemical fertilizers and therefore, can be considered as a noble practice in sustainable agriculture. Exclusive use of *Trichoderm*a-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 application of chemical fertilizers and therefore can be considered as a noble practice in sustainable agriculture.

**References**

Akladious, S. A. and Abbas, M. A. (2012).Application of Trichoderma harziunum T22 as a biofertilizer supporting maize growth. *African Journal of Biotechnology*, **11**(35): 8672-8683.

Akladious, S. A. and Abbas, S. M. (2014).Application of *Trichoderma harzianum* T22 as a biofertilizer potential in maize growth. *Journal of Plant Nutrition*, **37** (1), 30-49.

Black, C. A. (1965).Bulk Density. In “Method of Soil Analysis” Part I. Agronomy Monograph. *American Society of Agronomy*. Madison, Wisconsin, U.S.A., **37** (9).

Bouyoucos, G. J. (1962).Hydrometer method improved for making particle size analysis of soils. *Agronomy Journal,* **54**: 464-465.

Bray, R. H. and Kurtz, L. T. (1945).Determination of total organic and available forms of phosphate in soil. *Soil Science,* 59-39.

Cai, F, Chen, W., Wei, Z., Pang, G., Li, R., Ran, W. and Shen, Q. (2015). Colonization of *Trichoderma harzianum* strain SQR-T037 on tomato roots and its relationship to growth, nutrient availability and soil microflora. *Plant and Soil,* **388**:337–350.

Casati, L., Pagani, F., Braga, P. C., Scalzo, R. L. and Sibilia, V. (2016).Nasunin, a new player in the field of osteoblast protection against oxidative stress. *Journal of Functional Foods*, **23**:474-484.

Chumyani, K. S. P., Singh, A. K. and Singh, V. B. (2012). Effect of integrated nutrient management on growth, yield and quality of tomato (*Lycopersicon esculentum* mill.). *Journal of Soil and Crops*, **22**: 5-9.

Dickman, S. R. and Bray, H. R. (1940).Colorimetric Determination of Phosphate. *Industrial & Engineering Chemistry Analytical Edition*, **12**: 665-668.

Doni, F., Isahak, A., CheMohd Zain, C. R. and Wan Yusoff, W. M. (2014). Physiological and growth response of rice plants (*Oryza sativa* L.) to *Trichoderma spp.* Inoculants, **4**: 45.

Gogoi, D., Kotoky, U. and Hazarika, S. (2004).Effect of biofertilizers on productivity and soil characteristics in banana. *Indian Journal of Horticultural Sciences*, **61** (4): 354-356.

Gupta, A. K. and Samnotra, R. K. (2004). Effect of biofertilizers and nitrogen on growth quality and yield of cabbage cv. Golden acre. *Environment and Ecology,* **22**: 551-553.

Han, H. S. and Lee, K. D. (2005).Phosphate and Potassium Solubilizing Bacteria Effect on Mineral Uptake, Soil Availability and Growth of Eggplant, *Research Journal of Agriculture and Biological Sciences*, **1** (2): 176-180.

Islam, M. M., Akter, S., Majid, M. N., Ferdous, J. and Alam. S. M. (2013).Integrated nutrient management for potato (*Salonum tuberosum*) in grey terrace soil. *Australian Journal of Crop Science*, **7**(9): 1235-1241.

Jackson, M. I. (1973).Soil Chemical Analysis. *Prentice Hall Pvt. Ltd.,* New Delhi.

Jaishwal, A., Mauriya, S. K., Pal, A. K. and Pal, S. K. (2019). Influence of integrated nutrient management on brinjal (*Solanum melogena* L.) cv. Kashi Sandesh. *International Journal of Chemical Studies*, **6**: 438-442.

Kiran, J., Vyakaranahal, B. S., Ravikumar, G. H. and Deshpande, V. K. (2010).Seed yield and quality of brinjal as influenced by crop nutrition Department of Seed Science and Technology. *Indian Journal Agricultural Research*, **44** (1): 1-7.

Kumar, S. and Sharma, S. K. (2006). Response of tomato seed to different bio- inoculants at different levels of nitrogen, phosphorus, potassium. *Environment and Ecology,* **245** (2): 327-330.

Latha, P., Jeyaraman, S. and Prabakaran, R. (2014). Study Effects of Microbial and Chemical Fertilizer on Yield Components in Brinjal (*Solanum melongena* L.) cv. CO-2. *International Journal of Current Microbiology and Applied Sciences*, **3** (8): 817-822.

Lo, C. T. and C. Y. Lin. (2002). Screening strains of *Trichoderma spp* for plant growth enhancement in Taiwan. *Plant Pathology Bulletin,* **11**: 215-220.

Moraditochaee, M., Bozorgi, H. R. and Halajisani N. (2011).“Effects of vermicompost applictaion and nitrogen fertilizer rates on fruit yield and several attributes of eggplant (*Solanum melongena* L.) in Iran,” *World Applied Sciences Journal*, **15** (2): 174-178.

Narayanamma, M., Chiranjeevi, C. H., Reddy, I. P. and Riazuddin, S. A. (2005). Integrated nutrient management in cauliflower (*Brassica oleracea var. botrytis* L*.). Vegetable Science*, **32** (1): 62-64.

NHB, (2019), http:// nhb.gov.in/

Noor, S. Shil, N. C. Uddin, M. M. and Alam, M. K. (2011).Integrated nutrient management for tomato-okra-Indian spinach cropping pattern. *Bangladesh Journal of Agricultural Research*, **36**: 595-603.

Okoth, S. A., Otadoh, J. A. and Ochanda, J. O. (2011).improved seedling emergence and growth of maize and beans by *Trichoderma harziunum* Tropical and Subtropical Agroecosystems, **13**: 65–71.

Padhiary, G. G. and Dubey, A. K. (2020).Effect of Bio-Fertilizers on Growth, Yield and Yield Attributing Characters of Brinjal. *International Journal of Current Microbiology and Applied Sciences*, **9** (3): 1643-1647.

Ray, R., Patra, S. K., Ghosh, K. K. and Shahoo, S. K. (2005).Integrated nutrient management in okra in a river basin. *Indian Journal of Horticultural Sciences*, **62** (3): 260-264.

Suryanto, A., Hamid, A. and Damaiyanti, D. R. R. (2017).Effectiveness of Biofertilizer on Growth and Productivity of Eggplant (*Solanum melongena* L.), *Journal of Advanced Agricultural Technologies*, **4** (4).

Salunkhe, D. K. and Desai, B. B. (1984).Postharvest Biotechnology of Vegetables. CRC Press, Boca Raton, Florida. **2**: 39–47.

Sundararasu, K. and Jeyasankar, A. (2014).Effect of vermiwash on growth and yield of brinjal, *solanum melongena* (eggplant or aubergine) *Asian Journal of Science and Technology*. **5** (3): 171-173.

Takahashi, H., Nakaho, K., Ishihara, T., Ando, S., Wada, T., Kanayama, Y., Asano, S., Yoshida, S., Tsushima, S. and Hyakumachi, M. (2014).Transcriptional profile of tomato roots exhibiting *Bacillus thuringiensis*-induced resistance to *Ralstonia Solanacearum*. *Plant Cell Rep.,* **33**: 99-110.

Vimera, K., Kanaujia, S. P., Singh V. B. and Singh, P. K. (2012). Effect of integrated nutrient management on growth and yield of king chilli under foothill condition of Nagaland. *Journal of the Indian Society of Soil Science,* **60**: 45-49.

Vinale, F., Sivasithamparam, K., Ghisalberti, E. L., Marra, R., Woo, S. L. and Lorito, M. (2008).*Trichoderma*-plant-pathogen interactions. *Soil Biological Biochemistry,* **40** (1): 1-10.

Waskel, S., Kumar, J. and Singh, S. S. (2019).Effect of Integrated Nutrient Management on Growth and Yield attributes of Brinjal. *International Journal of Current Microbiology and Applied Sciences*, **8** (11): 1849- 1853.

Yedidia, I., Srivastva, A. K., Kapulnik, Y. and Chet, I. (2001).Effect of *Trichoderma harzianum* on microelement concentrations and increased growth of cucumber plants. *Plant Soil,* 235–242.

Yousefi, A. A., Khavazi, K., Moezi, A. A., Rejali, F. and Nadian, H. A. (2011).Phosphate solubilizing bacteria and Arbuscular mycorrhizal fungi impacts on inorganic phosphorus. *World Applied Sciences Journal*, **15** (9):1310-1318.

Zhang, Y. Hu, Z. Chu, G.Huang, C. Tian, S. Zhao, Z. and Chen, G. (2014). Anthocyanin accumulation and molecular analysis of anthocyanin biosynthesis-associated genes in eggplant *(Solanum melongena* L*.)*. *Journal of Agricultural and Food Chemistry,* **62**:2906-2912.