RESEARCH ARTICLE

Effect of Inorganic and Bio-fertilizer on Growth and Yield of Brinjal in the Hilly Conditions of Srinagar Garhwal, Uttarakhand

[1]Nusrat Jahan, [2]R.S. Negi and *[3]Santosh Singh

Department of Rural Technology, HNB Garhwal University, Srinagar, Garhwal, Uttarakhand

Received: 12 Jan 2026

Revised: 26 Mar 2026

Accepted: 22 Apr 2026

ABSTRACT

The field experiment was carried out at the Demonstration Unit, Department of Rural Technology, H.N.B. Garhwal University, Srinagar Garhwal, Uttarakhand, to investigate the effects of inorganic and biofertilizers on brinjal growth and yield during the Kharif season of 2023–2024. All eight treatments involved different combinations of inorganic fertilizers (NPK), micronutrients (Borax and $ZnSO_4$), and biofertilizers (PSB and Rhizobium). The treatments consisted of T_1 (RDF), T_2 (RDF + Rhizobium), T_3 (RDF + Borax), T_4 (RDF + PSB), T_5 (RDF + $ZnSO_4$), T_6 (RDF + PSB + Rhizobium), T_7 (RDF + Borax + $ZnSO_4$ + PSB + Rhizobium) and T_8 (Control). The results revealed significant variation among treatments in growth and yield parameters. The treatment T_7 recorded maximum in terms of plant height, the highest number of primary branches, and maximum stem diameter, early flowering (36.66 days to first flowering and 40.33 days to 50% flowering), number of fruits per plant, fruit length, fruit diameter, fruit weight, fruit yield per plant, and fruit yield per plot (2.95 kg). The lowest values for most parameters were recorded in the control treatment (T_8). The study concluded that the integrated use of inorganic fertilizers, micronutrients, and biofertilizers significantly improved growth, yield attributes, and productivity of brinjal under hilly agro-climatic conditions.

Keywords: *Brinjal, Inorganic fertilizers, Bio-fertilizers, PSB, Rhizobium, Borax, Zinc sulphate, Yield attributes, Pusa Purple Cluster*

INTRODUCTION

Vegetables are those annual, biennial, and non-woody perennial plants that are used for either raw or cooked consumption of their juvenile succulent plant parts, such as their roots, rhizomes, bulbs, stems, blooms, leaves, seeds, and fruits (Singh et al., 2020; Keatinge et al., 2011; Dias, 2012). They are high in nutrients and vital components of a healthy diet. Vegetables are considered protective foods since they can help avoid various ailments. Many vegetables are important trade items so that they can play a large part in economic development (Susmitha et al., 2023; Ülger et al., 2018). Brinjal (*Solanum insanum*), which belongs to the Solanaceae family, is commonly known as Aubergine or Eggplant. Tender or semi-hardy annual vegetables are typically grown from this tropical, perennial plant (Arti et al., 2020; Demir, 2020). Conventional pharmaceutical frameworks utilize different parts of plants, such as natural products. Brinjal is commercially grown in India, Bangladesh, Pakistan, China, and the Philippines

*Corresponding author mail: **singhrawat.santosh@gmail.com**

(Sachan et al., 2021). In India, major brinjal-producing states are Odisha, Bihar, Karnataka, West Bengal, Uttar Pradesh, and Maharashtra. Nutritionally, it is an important vegetable containing vitamins (A, B, C, and K) and minerals (iron, phosphorus, and calcium) (Mirza, 2023; Ülger et al., 2018; Dias, 2023; Senthilkumar et al., 2019). It also has Ayurveda properties, hence is being used as a medicine for curing diabetes and several liver problems (Kudlu and Stone 2013). Apart from this, it is a good appetizer, aphrodisiac, and laxative as well. India is one of the leading producers of brinjal (eggplant) in the world. It ranks second after China, contributing about 21-22% of the total global production, with an annual production of around 12.8–13.0 million tonnes. Additionally, the best time to plant brinjal is the Rabi season. Some prominent kinds incorporated into local cuisines include the Pusa Purple Cluster and Round, Azad Kranti, and the elongated Pusa Purple Long, Arka Shirish, Arka Kusumkar, Arka Nidhi, and Pusa Barsat. (Singh et al., 2014)

In Uttarakhand, brinjal is an important vegetable crop grown in both plains and mid-hill regions. According to recent estimates of the Department of Agriculture and Farmers Welfare, the area under brinjal cultivation in Uttarakhand is about 2.12 thousand hectares, with an annual production of approximately 22.7 thousand tonnes (Towards Sustainable Horticulture in the Himalayas: A Development Framework from Uttarakhand 2025). The crop contributes significantly to the state's vegetable economy due to its adaptability to diverse agro-climatic conditions and its importance in the daily diet. The steady production trend indicates the growing importance of brinjal cultivation for nutritional security and income generation of farmers in the region (Harish et al., 2023; Singh et al., 2014)

Inorganic fertilizers and biofertilizers play a vital role in improving the growth, yield, and quality of brinjal crop by ensuring the balanced availability of essential plant nutrients (Kumari et al., 2025; Sumanth et al., 2024; Sachan et al., 2021; Mishra et al., 2017). Macronutrients such as nitrogen (N), phosphorus (P), and potassium (K), along with secondary nutrients like calcium (Ca), magnesium (Mg), and sulphur (S), are crucial for various metabolic processes, including photosynthesis, protein synthesis, root development, enzyme activation, and energy transfer, which ultimately enhance crop productivity. Nitrogen improves vegetative growth and chlorophyll formation, while phosphorus promotes root development and energy metabolism (ATP and ADP), and potassium enhances enzyme activity, nutrient translocation, and stress tolerance (Sumanth et al., 2024; Sathe and Raskar, 2023; Saha et al., 2023; Padhiary and Dubey, 2022). Micronutrients such as zinc (Zn), boron (B), iron (Fe), copper (Cu), manganese (Mn), molybdenum (Mo), chloride (Cl), and nickel (Ni) are required in small quantities. Still, they are essential for enzyme function, hormone regulation, reproductive development, and photosynthetic processes, thereby improving fruit quality and yield in brinjal. Biofertilizers such as Rhizobium, Azotobacter, Azospirillum, Blue-green algae, Azolla, and phosphate-solubilizing bacteria (PSB) enhance nutrient availability by fixing atmospheric nitrogen and converting insoluble phosphorus and potassium into plant-available forms (Kumar et al., 2020; Abbas et al., 2021; Sharma et al., 2024; Sachan et al., 2021; Padhiary and Dubey, 2022). They improve soil fertility, reduce dependence on chemical fertilizers, and promote sustainable agriculture by maintaining soil health and enhancing nutrient use efficiency (Suraj et al., 2025; Rathore et al., 2025; Manickam et al., 2022; Kumar et al., 2021)

Therefore, the present study aims to evaluate the Effects of Inorganic and Biofertilizers on the growth and Yield of brinjal to identify an efficient and sustainable nutrient management strategy suitable for the hilly agroclimatic conditions of Srinagar Garhwal, Uttarakhand.

MATERIALS AND METHODS

Experimental site

The experiment was conducted in the Department of Rural Technology, Demonstration unit, and Laboratory at Chauras Campus, H.N.B. Garhwal University, Srinagar (Garhwal), Uttarakhand, during the kharif crop season (monsoon period) of 2023. Geographically, Chauras is situated 4 km East of Srinagar city at 30.22°N 78.78°E, 132 kilometers from Haridwar on the Haridwar-Badrinath Dham Highway (NH-58), at 540 meters above MSL, in the mid-hill region of Uttarakhand.

Crop Variety

The present experiment was conducted during the Kharif season of 2023–24 to evaluate the effect of inorganic fertilizers and biofertilizers on the growth and yield of brinjal (*Solanum melongena L.*) variety Pusa Purple Cluster. We brought the seeds from IARI in New Delhi. The experiment used the Pusa Purple Cluster cultivar, which was released by IARI in New Delhi.

Treatments

The experiment consisted of eight treatment combinations involving inorganic macronutrients (NPK), micronutrients (Borax and $ZnSO_4$), bio-fertilizers a control treatment. The treatments included T_1 (NPK), T_2 (NPK + Rhizobium), T_3 (NPK + Borax), T_4 (NPK + PSB), T_5 (NPK + $ZnSO_4$), T_6 (NPK + PSB + Rhizobium), T_7 (NPK + Borax + $ZnSO_4$ + PSB + Rhizobium), and T_8 (Control).

Experimental Design and Layout

The experiment was laid out in a Randomized Block Design (RBD) with three replications and a total of eight treatments, each with eight plants, and each bed held 12 plants, resulting in 24 experimental plots. Each plot measured 3.0 m × 1.2 m with a spacing of 60 × 45 cm between plants. The area of each plot was 3.6 m², and the total net experimental area was 86.4 m². Transplanting of seedlings was carried out on 15 July 2023, during the Kharif season, to assess the crop's growth and yield performance under different nutrient combinations.

RESULTS AND DISCUSSION

RESULTS

The experimental results obtained from the present experiment on the effect of Inorganic and Bio-fertilizers on the growth and Yield of brinjal (*Solanum melongena L.)* cv. Pusa Purple Cluster. The observations were recorded at different growth stages and statistically analyzed using a Randomized Block Design (RBD) in Tables 1 and 2. The results are discussed under the following headings:

Growth Parameters

Plant height is considered an important growth characteristic associated with life span maturity and plant yield. The mean plant height under eight treatments was recorded at 30, 60, and 90 DAT. Plant height is an important growth parameter associated

Plate 1: Preparation of the seedbed & raising of seedlings

Plate 2: (A) Experimental site (B). Watering after transplantation (C) A View during Weeding

with plant vigor, maturity, and yield potential. The mean plant height of eight treatments was recorded at 30, 60, and 90 DAT. At all growth stages (30, 60, and 90 DAT), treatment T_7 (RDF + Borax + Zinc + PSB + Rhizobium) recorded the maximum plant height of 30.60 cm, 71.73 cm, and 84.73 cm, respectively. Similarly, treatment T_3 (RDF + Borax) remained the second-best treatment at all stages, with plant heights of 29.33 cm, 59.66 cm, and 73.73 cm at 30, 60, and 90 DAT, respectively. The minimum plant height at all stages was recorded in T_8 (Control) with 19.00 cm, 47.40 cm, and 59.20 cm, respectively, which was closely followed by T_1 (RDF) with plant height of 26.33 cm, 52.40 cm, and 62.40 cm at 30, 60, and 90 DAT, respectively. The results indicated that the combined application of RDF along with micronutrients and biofertilizers (T_7) consistently produced significantly higher plant height throughout the crop growth period.

The number of primary branches per plant is an important growth parameter that contributes to canopy development and yield potential. The mean number of primary branches per plant was recorded at 30, 60, and 90 DAT under eight treatments. At all the growth stages (30, 60, and 90 DAT), treatment T_7 (RDF + Borax + Zinc + PSB + Rhizobium) recorded the maximum number of primary branches per plant with values of 6.73, 8.60, and 11.46, respectively. Similarly, treatment T_3 (RDF + Borax) remained the second-best treatment at all stages, with 6.20, 8.20, and 10.53 primary branches per plant at 30, 60, and 90 DAT, respectively. The minimum number of primary branches per plant at all stages was recorded in T_8 (Control), with values of 2.20, 4.93, and 8.40, respectively, closely followed by T_1 (RDF) with 6.23, 7.20, and 8.60 primary branches per plant at 30, 60, and 90 DAT, respectively. The results indicated that the combined application of RDF with micronutrients and biofertilizers (T_7) consistently produced a significantly more primary branches per plant throughout the crop growth period.

Stem diameter is an important growth parameter that reflects plant vigor and structural strength. The mean stem diameter of eight treatments was recorded at 30, 60, and 90 DAT. At all growth stages (30, 60, and 90 DAT), treatment T_7 (RDF + Borax + Zinc + PSB + Rhizobium) recorded the maximum stem diameter with values of 3.20 cm, 3.93 cm, and 5.61 cm, respectively. Similarly, treatment T_3 (RDF + Borax) remained the second-best treatment at all stages, with stem diameters of 2.77 cm, 3.39 cm, and 5.12 cm at 30, 60, and 90 DAT, respectively. The minimum stem diameter at all stages was recorded in T_8 (Control) with

Table 1: Effect of inorganic and biofertilizers on Growth Parameters in Brinjal

Name of treatments	Plant height (cm)			No. of primary branches			Stem Diameter (cm)			Days to 1st flower initiation	Days to 50% Flowering
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT		
(T_1) RDF (NPK)	26.33	52.40	62.40	4.80	7.20	8.60	2.41	3.34	4.44	44.33	47.00
(T_2) RDF+Rhizobium	28	53.13	68.33	4.86	7.86	8.86	2.84	3.42	4.77	41.00	44.66
(T_3) RDF+Borax	29.33	59.66	73.73	6.20	8.20	10.53	2.77	3.39	5.12	39.00	42.66
(T_4) RDF+PSB	27.53	58.80	68.13	5.26	7.66	9.46	2.63	3.31	4.53	42.00	48.00
(T_5) RDF + ZnSO4	28.13	56.60	68.13	6.00	8.20	10.53	2.42	3,57	4.56	43.00	50.66
(T_6) RDF + PSB + Rhizobium	27.26	59.40	68.26	5.26	7.53	9.93	2.66	3.56	4.24	42.00	47.33
(T_7) RDF + Borax + Zinc + PSB + Rhizobium	30.6	71.73	84.73	6.73	8.60	11.46	3.20	3.93	5.61	36.66	40.33
(T_8) Control	19	47.40	59.20	2.20	4.93	8.40	2.06	3.16	4.04	45.33	48.66
CD	1.135	1.531	1.595	0.243	0.597	0.849	0.156	0.232	0.272	2.221	2.406
SE(m)	0.371	0.500	0.521	0.079	0.195	0.277	0.051	0.076	0.089	0.725	0.786

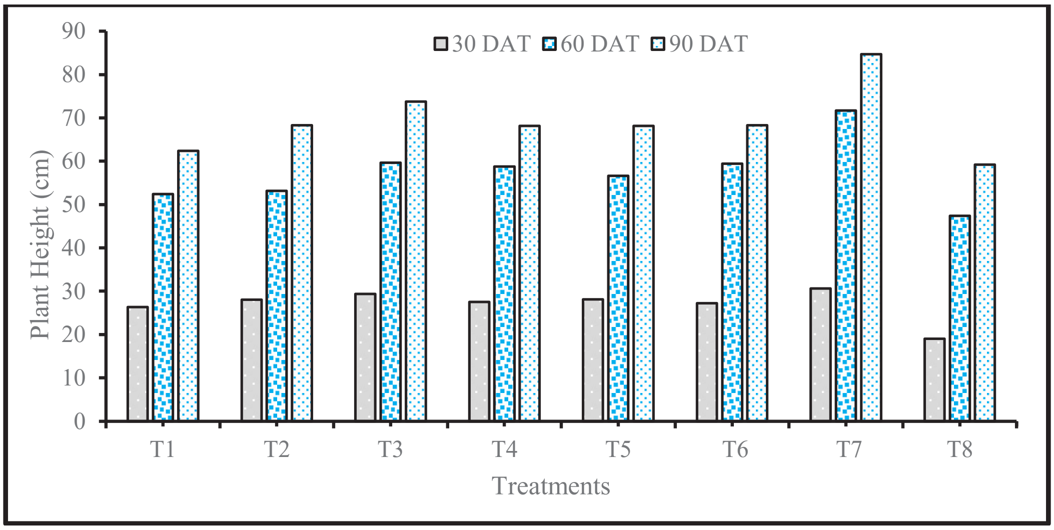

Figure 1: Influence of Different Treatments on Days to Plant Height in Brinjal

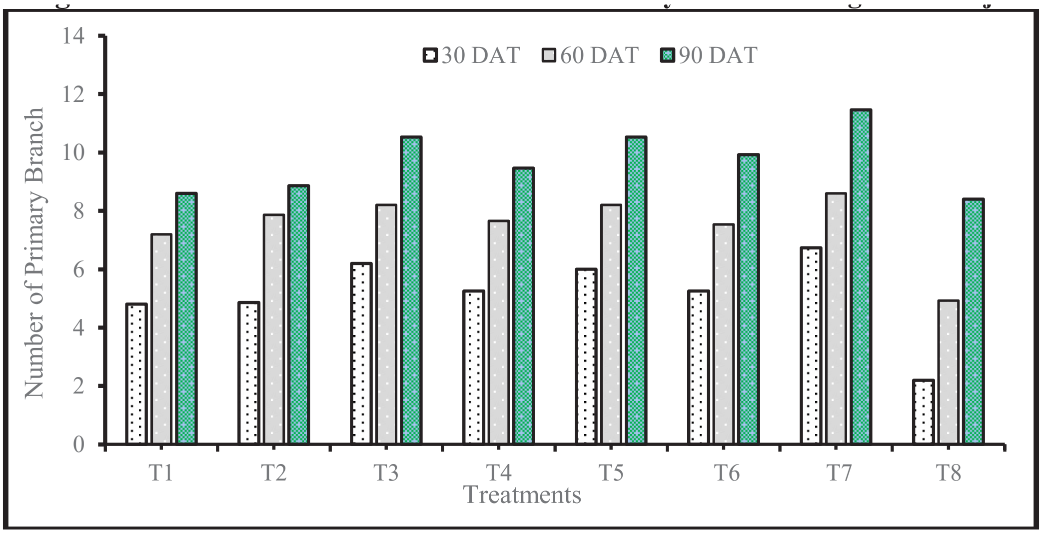

Figure 2: Influence of Different Treatments on the Number of Primary Branches in Brinjal

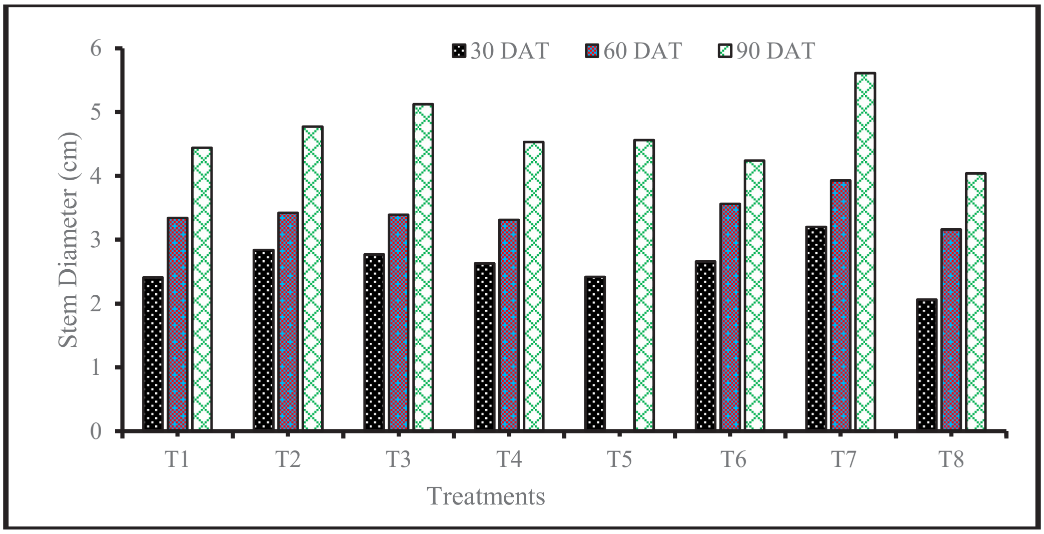

Figure 3: Influence of Different Treatments on Stem diameter Diameter in Brinjal

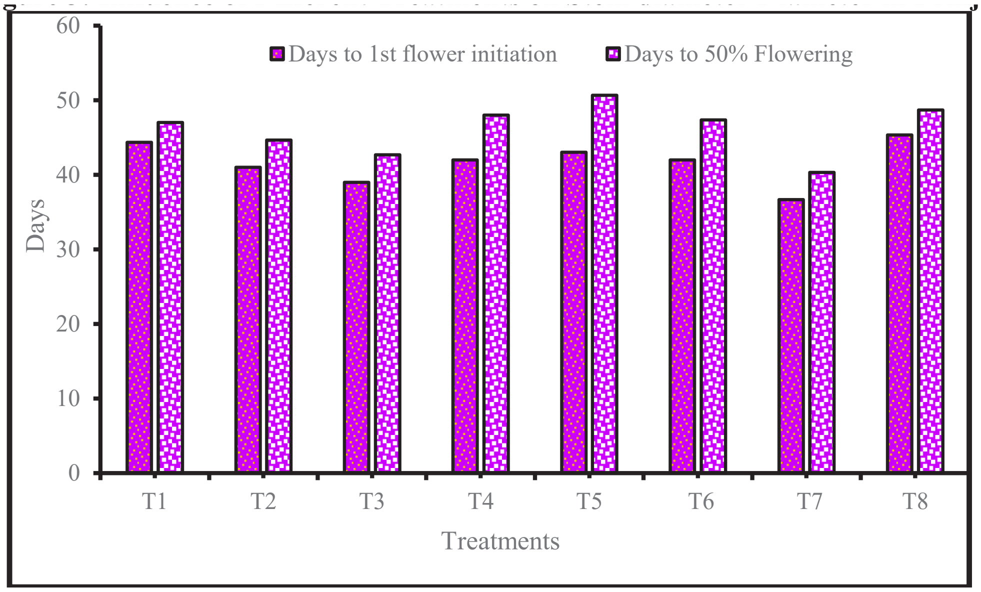

Figure 4: Influence of Different Treatments on Days to First Flower Initiation and 50 % flowering

values of 2.06 cm, 3.16 cm, and 4.04 cm, respectively, closely followed by T_1 (RDF) with 2.41 cm, 3.34 cm, and 4.44 cm stem diameter at 30, 60, and 90 DAT, respectively. The results indicated that the combined application of RDF along with micronutrients and biofertilizers (T_7) consistently produced significantly higher stem diameter throughout the crop growth period.

Days to first flowering and 50% flowering are important parameters indicating crop earliness. The earliest first flowering and 50% flowering were recorded in treatment T_7 (RDF + Borax + Zinc + PSB + Rhizobium) compared to other treatments. In contrast, the maximum number of days taken to first flowering and 50% flowering was observed in treatment T_8 (Control). The results indicated that the combined application of RDF along with micronutrients and biofertilizers (T_7) promoted early flowering compared to the control treatment.

Yield Parameters

The mean performance of eight treatments for yield parameters showed significant variation across different combinations of inorganic fertilizers, micronutrients, and biofertilizers. The number of fruits per plant ranged from 7.66 to 12.66, with the maximum number of fruits recorded in treatment T_7 (RDF + Borax + Zinc + PSB + Rhizobium) (12.66), followed by T_3 (RDF + Borax) (11.60), whereas the minimum number of fruits was observed in T_8 (Control) (7.66), closely followed by T_1 (RDF) (9.00). Fruit length varied from 8.69 cm to 10.75 cm, with the maximum fruit length recorded in T_7 (10.75 cm), followed by T_3 (10.23 cm), while the minimum fruit length was observed in T_8 (Control) (8.69 cm), closely followed by T_1 (9.76 cm). Fruit diameter ranged from 2.30 cm to 4.44 cm, with the maximum fruit diameter recorded in T_7 (4.44 cm), followed by T_3 (3.98 cm), whereas the minimum fruit diameter was observed in T_8 (Control) (2.30 cm), closely followed by T_1 (3.10 cm). Fruit weight ranged from 15.28 g to 39.98 g, with the maximum fruit weight recorded in T_7 (39.98 g), followed by T_3 (28.69 g), while the minimum fruit weight was observed in T_8 (Control) (15.28 g), closely followed by T_1 (19.30 g). Fruit yield per plant ranged from 0.22 kg to 0.34 kg, with the highest fruit yield per plant recorded in T_7 (0.34 kg), followed by T_3 (0.29 kg) and T_6 (0.26 kg), whereas the lowest fruit yield per plant was observed in T_8 (Control) (0.22 kg), closely followed by T_1 (0.22 kg) and T_2 (0.23 kg). Similarly, fruit yield per plot ranged from 1.02 kg to 2.95 kg, with the highest yield recorded in T_7 (2.95 kg), followed by T_3 (2.41 kg) and T_6 (2.32 kg), while the lowest yield per plot was observed in T_8 (Control) (1.02 kg), followed by T_1 (1.67 kg). Overall, the results indicated that the combined application of RDF along with micronutrients and biofertilizers (T_7) significantly improved yield and its contributing characters compared to other treatments.

DISCUSSION

The present experiment clearly indicated that the combined application of inorganic fertilizers,

Table 1. Effect of inorganic and bio-fertilizers on Yield Parameters in Brinjal

Name of treatments	No. of fruits/ plant	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	fruit yield/ plant (Kg)	Fruit yield/ plot (kg)
(T_1) RDF (NPK)	9.00	9.76	3.10	19.30	0.22	1.67
(T_2) RDF + Rhizobium	10.06	10.00	3.27	24.10	0.23	2.21
(T_3) RDF + Borax	11.60	11.42	3.98	28.69	0.29	2.41
(T_4) RDF + PSB	9.40	10.23	3.23	22.400	0.21	2.09
(T_5) RDF + ZnSO4	10.26	10.98	3.24	25.76	0.24	2.10
(T_6) RDF + PSB + Rhizobium	10.86	10.75	3.46	25.76	0.26	2.32
(T_7) RDF + Borax + Zinc + PSB + Rhizobium	12.66	14.49	4.44	30.98	0.34	2.95
(T_8) Control	7.66	8.69	2.30	15.28	0.14	1.02
CD	0.855	1.051	0.167	1.606	0.045	0.030
SE(m)	0.279	0.343	0.054	0.524	0.015	0.010

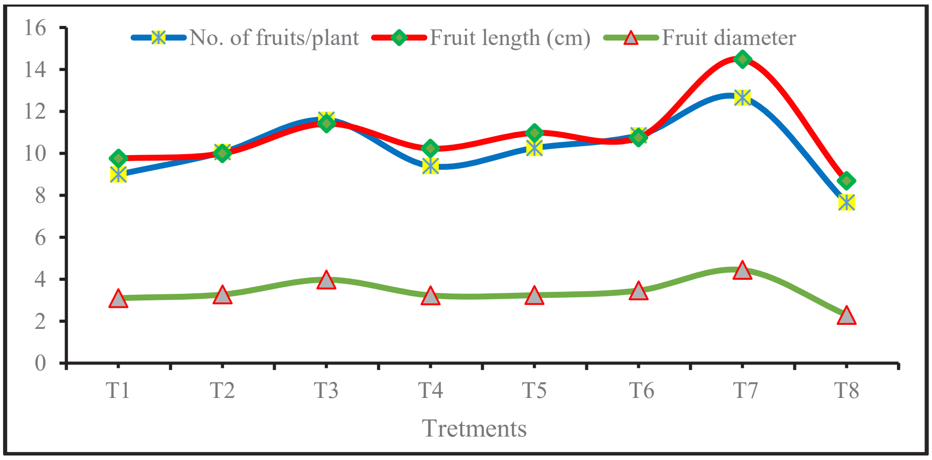

Figure 5: Influence of Different Treatments on Number of fruits/plant, fruit length, and fruit diameter

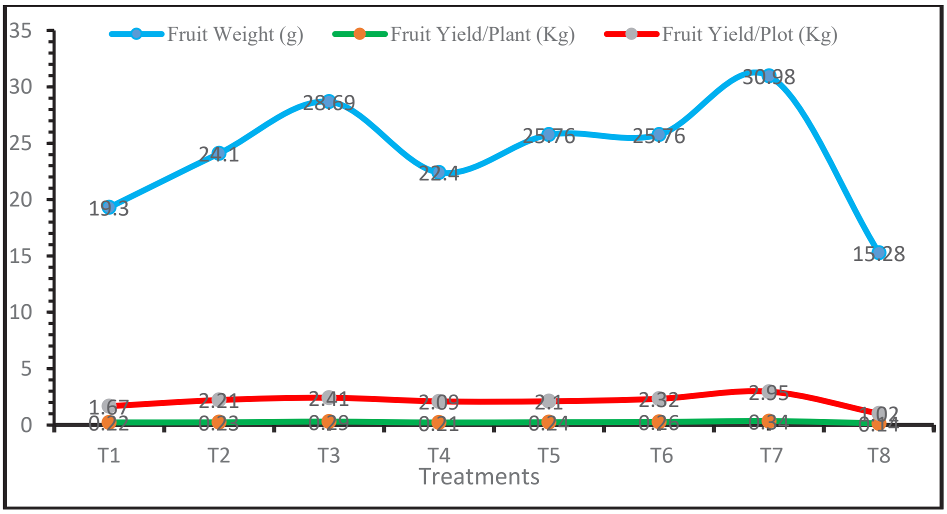

Figure 6: Influence of Different Treatments on fruit weight, fruit yield/plant, and fruit yield/plot

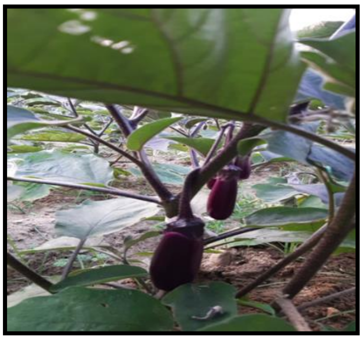

Plate 3: (A). Close view of 1st Flowering (B) . Close view of 1st Fruiting (C) Close view after harvesting

micronutrients, and biofertilizers significantly influenced the growth and yield parameters of brinjal cv. Pusa Purple Cluster under the mid-hill conditions of Srinagar Garhwal. Among all treatments, T_7 (RDF + Borax + $ZnSO_4$ + PSB + Rhizobium) consistently recorded superior performance in terms of plant height, number of primary branches, stem diameter, early flowering, and yield attributes compared to individual or partial nutrient treatments.

The significant increases in plant height, number of primary branches, and stem diameter under treatment T_7 may be attributed to the balanced, synergistic supply of essential nutrients. Nitrogen helps vegetative growth and chlorophyll formation, phosphorus enhances root development and energy transfer, while potassium regulates enzyme activity and nutrient translocation. The addition of micronutrients such as boron and zinc further improved meristematic activity, cell division, pollen formation, and carbohydrate metabolism, thereby enhancing vegetative growth. Biofertilizers such as PSB and Rhizobium improved nutrient availability by fixing atmospheric nitrogen and solubilizing unavailable phosphorus in the soil, thereby increasing nutrient uptake efficiency. Similar results were reported by Samantha et al., (2024), Baboo et al., (2024), Manickam et al., (2022), Rout et al., (2025), and Bhuvaneswari et al., (2023), who observed that integrated nutrient management improves plant vigor due to better root growth and efficient nutrient utilization. Earliness in flowering observed in treatment T_7 may be due to the combined effect of micronutrients and biofertilizers, which enriched metabolic activities and hormonal balance in plants. Boron plays an important role in pollen germination and fertilization, while zinc is involved in auxin synthesis, which promotes early flowering. The improved availability of phosphorus also enhances energy transfer and reproductive growth, resulting in reduced days to first flowering and 50% flowering. Similar findings have been reported in solanaceous crops where balanced fertilization accelerated reproductive development (Baboo et al., 2024; Bommi et al., 2025; Jat et al., 2023; Kumari et al., 2020)

Yield attributes, such as number of fruits per plant, fruit length, fruit diameter, fruit weight, fruit yield per plant, and fruit yield per plot, were significantly influenced by different nutrient combinations. Treatment T_7 recorded the highest number of fruits per plant (12.66), fruit weight, and yield per plot (2.95 kg), which may be attributed to improved vegetative growth and better translocation of photosynthates from source to sink (Sumanth et al., 2024; Patidar and Bajpai2018; Kumar 2016). Adequate nitrogen supply enhances leaf area and photosynthetic efficiency, while phosphorus and potassium improve fruit development and quality (Sharma et al., 2024; Chethan et al., 2024). Boron enhances cell elongation and sugar transport, and zinc plays an important role in enzyme activation and protein synthesis (Thakur et al., 2023; Sathe and Raskar, 2023; Kumari et al., 2025; Manickam et al., 2022). Biofertilizers improved soil biological activity, nutrient mineralization, and nutrient availability, thereby increasing yield components. The synergistic interaction among inorganic fertilizers, micronutrients, and biofertilizers improved nutrient-use efficiency and productivity (Kiran et al., 2010; Hossain and Akter, 2020; Sarkar et al., 2025; Thakur et al., 2023).

The comparatively lower performance observed in the control (T_8) treatment might be due to inadequate availability of essential nutrients, resulting in poor vegetative growth, delayed flowering, and reduced fruit development. Similarly, treatments receiving only RDF or individual biofertilizers showed moderate improvement, indicating that the sole application of inorganic fertilizers may not be sufficient to achieve maximum yield under hilly conditions. Integrated nutrient management ensures a sustained nutrient supply, improved soil structure, and enhanced microbial activity, ultimately contributing to improved crop performance. These findings are in close agreement with previous studies, which reported that integrated use of inorganic fertilizers and biofertilizers enhances productivity and maintains soil health under hill agro-ecosystems.

CONCLUSION

Based on the results of the present experiment, it can be concluded that the combined use of inorganic fertilizers, micronutrients, and biofertilizers significantly improved the growth, flowering, and yield parameters of brinjal cv. Pusa Purple Cluster under mid-hill conditions of Srinagar Garhwal, Uttarakhand. Among all treatments, T_7 (RDF + Borax + $ZnSO_4$ + PSB + Rhizobium) performed best in terms of growth and yield parameters. Therefore, it may be recommended that the application of RDF along with Borax, $ZnSO_4$, PSB, and Rhizobium can be adopted as a suitable integrated nutrient management practice under the hilly regions of Uttarakhand and similar agro-climatic conditions.

ACKNOWLEDGMENTS

The authors express their gratitude to their institution for providing the necessary facilities and AI-powered tools to improve language clarity, refine sentence structure, and check grammatical accuracy in this manuscript. However, all conceptual development, critical analysis, and final interpretations remain the original work of the authors.

Conflict of Interests

The authors declare no conflict of interest related to this research.

Funding and Acknowledgment:

The author(s) received no specific funding for this research work

Ethics Statement:

Ethical approval was not applicable for this research experiment as only plant materials were used.

Originality and Plagiarism:

The author confirms that this manuscript is original, has not been published previously, and is not under consideration for publication elsewhere. All sources used have been appropriately cited, and the manuscript has been prepared in compliance with plagiarism and publication ethics standards

Consent for Publication:

The Galley proof has been reviewed and approved by all Authors and consent to permission for publication.

Competing Interests:

The authors declare no conflict of interest related to this research. .

Data Availability:

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions:

RSN and SS conceptualized the study and designed the research framework; NJ carried out the field experiment; SS and RSN contributed to the implementation and logistical support of the research; NJ and SS drafted the original manuscript; RSN and SS coordinated the review and editorial revisions. All authors have read and approved the final version of the manuscript

REFERENCES

Abbas, Z., S.M. Mehdi, M. Nasir, M. Ashraf, S. Kausar, N. Iqbal, M.Z.K. Nazar, I. Ahmad, G. Murtaza and I. Ahmad. 2021. Evaluation of best dose of micronutrients (Zinc, Iron and Boron) to combat malnutrition in brinjal (Solanum melongena L.). Pakistan Journal of Agricultural Research, 34(1): 164-168. http://dx.doi.org/10.17582/journal.pjar/2021/34.1.164.168

Arti, D., Sharma, A. K., & Kumar, R. (2020). Performance evaluation of different genotypes of brinjal (Solanum melongena L.) under mid hill conditions of Himachal Pradesh. *Electronic Journal of Plant Breeding*, *11*(02), 405-410. https://doi.org/10.37992/2020.1102.071

Baboo, R., Bala, S., Prasad, L., Rajbhar, R., Kumar, R., & Vipin, V. (2024). Influence of Integrated Nutrient Management on Growth, Flowering Behaviour and Yield Of Brinjal (Solanum Melongena L.) Cv. Pusa Purple Round. *Plant Archives*. 24 (1): 632-638 https://doi.org/10.51470/plantarchives.2024.v24.no.1.086

Bhuvaneswari, P., Keerthi, A., Ramesh, E., Jyothi, M., & Kiran, S. B. (2023). Evaluation of Different Varieties of Brinjal (Solanum Melongena L.) for Growth and Yield Parameters. *Journal of Advanced Zoology* 44(S-7):269:277 https://doi.org/10.17762/jaz.v44is7.2760

Bommi, S., Parameswari, E., Dhevagi, P., Krishnan, R., Janaki, P., Suganthy, M., Sangeetha, S. P., Yazhini, G., & Ilakiya, T. (2025). Comparative Analysis of Effects of Nutrient Management Practices on Soil Microbiome and Rhizosphere Chemistry in Brinjal (*Solanum melongena L.*). Sustainability, 17(17), 7832. https://doi.org/10.3390/su17177832

Chethan, K. G., Tamadaddi, B. L., Sreenatha, A., Prasanna, S. M., Hadimani, H., & Ghandhe, A. R. (2024). Effect of Integrated Nutrient Management (INM) on Growth and Yield of Brinjal (Solanum melongena L.) in Northern Dry Zone of Karnataka, India. *International Journal of Plant and Soil Science*, 36(5), 463–470. https://doi.org/10.9734/ijpss/2024/v36i54543

Demir, Z. (2020). Effects of microbial bio-fertilizers on soil physicochemical properties under different soil water regimes in greenhouse grown eggplant (*Solanum Melongena L.*). *Communications in Soil Science and Plant Analysis*, *51*(14), 1888–1903. https://doi.org/10.1080/00103624.2020.1798983

Dias, J. S. (2012). Nutritional quality and health benefits of vegetables: A review. *Food and Nutrition Sciences*, *3*(10), 1354-1374 https://doi.org/10.4236/fns.2012.310179

Dias, P. (2023). Bioactive Nutrients in Vegetables for Human Nutrition and Health (pp. 57–72). https://doi.org/10.1007/978-981-19-9016-8_3

Harish, A., Pant, S. C., & Bahuguna, P. (2023). Performance evaluation of brinjal (Solanum melongena L.) under mid hill conditions of Uttarakhand, India. *International Journal of Plant & Soil Science*, *35*(19), 2122-2132. https://doi.org/10.9734/ijpss/2023/v35i193764

Hossain, S., & Akter, F. (2020). Effects of Trichoderma-enriched biofertilizer and farmyard manure on the growth and yield of brinjal (Solanum melongena L.). Dhaka University Journal of Biological Sciences, 29, 1-8. https://doi.org/10.3329/dujbs.v29i1.46525

Jat, A., Soni, A., Sharma, V., & Yadav, M. (2023). Effect of organic manures and micronutrients on yield of brinjal (Solanum melongena). *Current Horticulture*. https://doi.org/10.48165/chr.2023.11.2.13

Keatinge, J.D.H., Yang, RY., Hughes, J. *et al.* The importance of vegetables in ensuring both food and nutritional security in attainment of the Millennium Development Goals. *Food Sec.* **3**, 491–501 (2011). https://doi.org/10.1007/s12571-011-0150-3

Kudlu, C., & Stone, G. D. (2013). The Trials of Genetically Modified Food BT Eggplant and Ayurvedic Medicine in India. *Food, Culture, and Society,* 16(1), 21–42. https://doi.org/10.2752/175174413X13500468045326

Kumari, A., Horo, P., Sinha, A., Ekka, S., & Rani, J. (2025). Effect of Inorganic Fertilizers, Organic Manures and Biofertilizers on Growth and Yield in Brinjal (Solanum melongena L.) cv. Swarna Pratibha. *International Journal of Plant & Soil Science*. https://doi.org/10.9734/ijpss/2025/v37i35370

Kumari, N., Kant, K., Akhtar, S., Sangam, S., Kumar, S., Singh, V., Kumar, B., & Kumar, R. (2020). Economic Feasibility of Varied Nitrogen and Potassium Applicationin Eggplant in Middle Gangetic Plains of Bihar. *I. J. of Current Microbiology and Applied Sciences,* 9, 1224-1229. https://doi.org/10.20546/ijcmas.2020.910.147

Kumar, S., D., Sindhu, S., & Kumar, R. (2021). Biofertilizers: An ecofriendly technology for nutrient recycling and environmental sustainability. Current Research in Microbial Sciences, https://doi.org/10.1016/j.crmicr.2021.100094

Kumar, P., Prasad, V., & Singh, D. (2020). Effect to standardize the best treatment combination of organic and inorganic source for better growth and yield of Brinjal (Solanum melongena L.). *International Journal of Chemical Studies*, 8, 3193-3195. https://doi.org/10.22271/chemi.2020.v8.i4am.10143

Kiran, J., Vyakaranahal, B. S., Raikar, S. D., Ravikumar, G. H., & Deshpande, V. K. (2010). Seed Yield and Quality of Brinjal as Influenced by Crop Nutrition. *I. J of Agri. Research,* 44(1), 1–7. https://www.indianjournals.com/ijor.aspx?target=ijor:ijar2&volume=44&issue=1&article=001

Kumar, V. (2016). Use of integrated nutrient management to enhance soil fertility and crop yield of hybrid cultivar of brinjal (*Solanum melongena* L.) under field conditions. *Adv Plants Agric Res*.4(2):249-256 http://dx.doi.org/10.15406/apar.2016.04.00130

Mirza, S. S. (2023). Nutritional Quality and Health Benefits of Vegetables - A Review. *International Journal of*

Zoological Investigations, 9(1), 309–320. https://doi.org/10.33745/ijzi.2023.v09i01.036

Manickam, S., Suganthy, M., & Ganesh, R. (2022). Influence of Different Nutrient Management Practices on Growth, Yield, Quality and Economics of Brinjal (Solanum melongena. L). *Madras Agricultural Journal*, *108*(special), 1. https://doi.org/10.29321/maj.10.000594

Mishra, V.K., Kumar, S. and Pandey, V.K.,(2017) Effect of organic manure and bio-fertilizers on growth, yield and quality of brinjal (Solanum melongena L.), *Int. J. Pure App. Biosci.* 6(1): 704-707. http://dx.doi.org/10.18782/2320-7051.610

Padhiary, G., & Dubey, A. (2022). Response of Biofertilizers on Growth and Yield Parameters of Brinjal (Solanum melongena L.) cv. Azad B-3. *International Journal of Environment and Climate Change.* https://doi.org/10.9734/ijecc/2022/v12i12146

Patidar, P., & Bajpai, R. (2018). Effect of integrated nutrient management (INM) on yield parameters of Brinjal. International Journal of Chemical Studies, 6(3), 1158–1160. http://www.chemijournal.com/archives/2018/vol6issue3/PartQ/6-3-37-899.pdf

Rathore, G., Kaushal, R., Sharma, V., Sharma, G., Chaudhary, S., Dhaliwal, S. S., Alsuhaibani, A. M., Gaber, A., & Hossain, A. (2023). Evaluation of the Usefulness of Fermented Liquid Organic Formulations and Manures for Improving the Soil Fertility and Productivity of Brinjal (Solanum melongena L.). Agriculture, 13(2), 417. https://doi.org/10.3390/agriculture13020417

Rout, S., Saho, A., Mohanty, S., & Santra, G. (2025). Enhancement of productivity and profitability of grafted brinjal under integrated nutrient management practices. *Journal of Applied and Natural Science.* https://doi.org/10.31018/jans.v17i2.6048

Sachan, S., Bahadur, V., & Prasad, V. (2021). Effect of organic, inorganic and biofertilizer on growth, yield and quality attribute on brinjal crop. International Journal of Chemical Studies. 9(1): 2853-2856: https://doi.org/10.22271/chemi.2021.v9.i1an.11656

Saha, B., Saha, S., Roy, P., Fatima, A., Sahoo, S., Solankey, S., Singh, H., Basak, P., & Basak, N. (2023). Scheduling of Zn and B Fertilization for Brinjal (Solanum melongena L.): Impact on Yield, Nutrient Use Efficiency, and Fruit Quality. *Communications in Soil Science and Plant Analysis,* 54, 2551 - 2562. https://doi.org/10.1080/00103624.2023.2227220

Sarkar, S., Naik, S. K., Dutta, A., Purakayastha, T. J., & Mali, S. S. (2026). Vermicompost enhances soil fertility and brinjal yield in acidic alfisol. *International Journal of Vegetable Science*, *32*(1), 71–95. https://doi.org/10.1080/19315260.2025.2555552

Sathe, R. K., & Raskar, B. S. (2023). Effects of Non-Chemical Weed and Nutrient Management on Soil Available Nutrient, Uptake, Micronutrients, and Nutrient Balance in Organic Brinjal Production Systems (Solanum melongena L.). 8(4S):339-345 https://doi.org/10.22271/maths.2023.v8.i4Se.1089

Senthilkumar, N., Sindhuja, K., Vinithra, S., Senthilkumar, P., Ponsiva, S. T., Kumar, T. B., & Thirugnanakumar, S. (2019). Studies on genetic diversity in brinjal (Solanum melongena L.). *Electronic Journal of Plant Breeding*, *10*(04), 1554-1559. https://doi.org/10.5958/0975-928X.2019.00199.6

Singh, N. P., Mishra, A. C., & Pandey, V. (2014). Evaluation of Brinjal (Solanum melongena L.) Hybrids for Growth and Yield Characters under Rainfed Mid Hill Condition of Uttarakhand. *Annals of Agri Bio Research*, 19(1), 144–146. https://www.cabdirect.org/cabdirect/abstract/20143063989

Singh, R. P., Kasera, S., & Singh, D. (2020). Effect of bio-fertilizers on growth, yield and quality of brinjal (Solanum melongena L.) cv. Kashi Uttam. *Chemical Science Review and Letters*, *9*(35), 786-791. https://doi.org/10.37273/chesci.CS205107192

Sharma, M., Bhati, D. and Singh, S.K. (2024) Integrated Nutrient management approach for modulating growth performance in brinjal (Solanum melongena L.). Biopestic. Int., 20, 253–260. https://doi.org/10.59467/BI.2024.20.253

Sumanth BT, Shivanand Koti, S Joginder Singh, Chethan KC, Tammadi, HP Hadimani (2024) Influence of integrated nutrient management (INM) on growth, yield and quality of brinjal (Solanum melongena L.). Int J Res Agron 7(2):431-434. https://doi.org/10.33545/2618060X.2024.v7.i2f.357

Susmitha, J., R. Eswaran, and N. Senthil Kumar (2023). Heterosis breeding for yield and its attributes in brinjal (Solanum melongena L.).” *Electronic Journal of Plant Breeding* 14.1 (2023): 114-120. https://doi.org/10.37992/2023.1401.027

Suraj, B., Kuldeep, S., Sandeep, K., Anjali, C., Nayan, D., Simran, B., Ishant, D., & , N. (2025). Assessment of the effect of organic amendments on soil properties and yield of Brinjal (Solanum melongena L.). *Plant Science Today*. https://doi.org/10.14719/pst.6620

Towards Sustainable Horticulture in the Himalayas: A Development Framework from Uttarakhand, India. (2025). https://doi.org/10.5281/zenodo.17441174

Thakur, S., Kumar, A., Sepehya, S., & Kapoor, A. (2023). Effect of integrated nutrient management in brinjal (Solanum melongena L.) on micronutrient uptake and physical properties of soil. *Environment Conservation Journal*, *24*(2), 176–183. https://doi.org/10.36953/ECJ.13542397

Ülger, T. G., Songur, A. N., Çırak, O., & PınarÇakıroğlu, F. (2018). Role of Vegetables in Human Nutrition and Disease Prevention. IntechOpen. https://doi.org/10.5772/INTECHOPEN.77038