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Effect of Integrated Nutrient Management (INM) on Growth and Yield of Brinjal (*Solanum melongena* L.) in Northern Dry Zone of Karnataka, India

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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

A field experiment was carried out at Department of Vegetable Science experimental block at College of Horticulture, Bagalkot during Rabi season of the year 2022-23 to study the influence of integrated nutrient management (INM) on growth and yield of brinjal. The experiment was laid out in

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Randomized Complete Block Design (RCBD) comprised of ten treatments with three replications. Organic manures like FYM and Vermicompost are used in different combinations along with inorganic fertilizers and biofertilizers. Among the different combinations of treatments, treatment T10 where 50% RDN supplied through inorganic fertilizer + micro nutrients Fe, Mn, Cu & Zn recorded higher growth parameters like plant height, number of primary branches, stem girth and plant spread (E-W) and (N-S) at 45 and at 90 DAT of brinjal and these growth parameters were lowest in treatment T5 where 75 per cent RDN through inorganic fertilizer + 25 per cent RDN through FYM and Vermicompost + Azotobacter + AM + PSB. The earliness parameters like number of days to first flowering, days to 50 per cent flowering and days to first harvest were lowest in T5 and were highest in treatment T10. The yield attributes like number of fruits per plant (63.91), fruit yield per plant (3.88 kg/plant), yield per plot (77.53 kg/plot) and yield per hectare (53.92 t ha-1) were significantly highest in treatment T5 and were lowest in T10. Hence the combination of organic and inorganic fertilizer like 75 % RDN through inorganic fertilizer + 25 % RDN through FYM and Vermicompost + Azotobacter + AM + PSB) could be recommended for the farmers for higher growth and yield along with enhancing crop productivity of brinjal with enhancing soil productivity.

Keywords: Integrated nutrient management; brinjal; fruit yield and vermicompost; fruit yield; environmental sustainability.

1. INTRODUCTION

Agriculture, being the cornerstone of human sustenance, constantly seeks innovative approaches to enhance productivity while ensuring environmental sustainability. Among the various factors influencing crop productivity, nutrient management stands out as a critical determinant. The judicious application of nutrients not only supports plant growth but also plays a pivotal role in achieving optimal yields. Brinjal (*Solanum melongena* L.), a widely cultivated vegetable globally, serves as a prime candidate for investigating the effects of integrated nutrient management (INM) due to its economic significance and nutritional value. Brinjal, commonly known as eggplant, aubergine, or baingan, holds a prominent place in culinary traditions across diverse cultures. Its cultivation spans various agroecological zones, making it indispensable in global food systems. However, like most cultivated crops, brinjal's yield potential is inheritably linked to the availability and balance of essential nutrients in the soil. Brinjal is a long duration crop that occupies the land for around 6-8 months. It is also a high-yielding crop that consumes substantial amounts of nutrients in a single cycle of plant growth resulting in rapid nutrient depletion from the soil. Singh and Nath [1]. The quest for sustainable agricultural practices has led to the exploration of integrated approaches that synergize organic and inorganic nutrient sources, thereby optimizing nutrient utilization efficiency and mitigating environmental risks. The concept of integrated nutrient management (INM) embodies a holistic strategy that integrates organic, inorganic, and biofertilizer inputs to enhance soil fertility and crop productivity. By harnessing the complementary effects of diverse nutrient sources, INM seeks to address nutrient deficiencies, improve soil health, and foster sustainable agricultural intensification. In the context of brinjal cultivation, the adoption of INM practices holds promise for optimizing plant nutrition, enhancing growth parameters, and ultimately augmenting yield potential. However, use of inorganic fertilizers for enhancing the yield has depleted the population of beneficial microorganisms in the soil, lowering nutrient use efficiency, making fertilizer consumption uneconomical and producing negative effects on the environment. Aulakh and Adhya [2]. While the individual contributions of organic and inorganic fertilizers to crop nutrition are well-documented, the synergistic effects of integrated nutrient management on brinjal growth and yield remain relatively unexplored. Understanding the intricate interactions between different nutrient sources and their cumulative impact on brinjal performance is imperative for devising tailored nutrient management strategies that align with both agronomic and environmental objectives. Against this backdrop, this research endeavors to investigate the influence of integrated nutrient management (INM) on the growth and yield of brinjal (*Solanum melongena* L.). By elucidating the effects of diverse nutrient management practices on brinjal productivity, this study aims to contribute insights that inform sustainable agronomic practices and facilitate the optimization of brinjal cultivation in diverse agroecological contexts. Through a comprehensive assessment of growth parameters, yield components and nutrient uptake dynamics, this research seeks to unravel the nuanced responses of brinjal to integrated nutrient management strategies. Hence such type of study helps in studying nutrient availability, soil fertility and crop performance and provide valuable knowledge that empowers farmers to harness the potential of integrated nutrient management for enhancing brinjal productivity in a sustainable manner.

2. MATERIALS AND METHODS

A field experiment was carried out at the Department of Vegetable Science experimental block at College of Horticulture, Bagalkot during *Rabi* season of the year 2022-23. The texture of the experimental soils is red sandy loam. The soil was low in organic C, low in available N and medium in available P and available K with pH of 8.1 with non-saline condition. Climatic condition of experiment is depicted in Fig.1.The experiment was carried out in Randomized Complete Block Design (RCBD) with ten treatments which replicated thrice *viz.* T-1:100 % RDF [125(N) : 100(P_2O_5) : 50(K_2O)], T-2 : 100 % RDF + Azotobacter + AM + PSB, T-3 : 75% RDN supplied through inorganic fertilizer + 25% RDN through FYM, T-4 : 75% RDN supplied through inorganic fertilizer + 25% RDN through vermicompost, T-5: 75% RDN supplied through inorganic fertilizer + 25% RDN through FYM and vermicompost + azotobacter + AM + PSB, T-6: 50% RDN supplied through inorganic fertilizer + 50% RDN through FYM, T-7: 50% RDN supplied through inorganic fertilizer + 50% RDN through vermicompost, T-8: 50% RDN supplied through inorganic fertilizer + 50% RDN through FYM and vermicompost + azotobacter + AM + PSB, T-9:75% RDN supplied through inorganic fertilizer + micro nutrients Fe, Mn, Cu & Zn and T-10: 50% RDN supplied through inorganic fertilizer + micro nutrients Fe, Mn, Cu & Zn.

Urea was applied as source of inorganic fertilizer for RDN. All the agronomic practices were followed as per the standard packages of practices to raise the brinjal crop. In order to study and analyze different growth and yield parameters like plant height (cm), number of primary branches, stem girth(cm), plant spread, fruit length (cm), fruit diameter (cm), fruit volume (cc), average fruit weight (g), number of fruits per plant, fruit yield per plant (kg/plant), fruit yield per plot (kg/plot) and fruit yield (t/ha) were recorded at different growth stages of brinjal crop. Plant growth parameters like height of the plant, number of primary branches, stem girth (cm), plant spread were recorded at 45 and 90 days after transplanting from five randomly selected plants. The earliness parameters like number of days to first flowering, days to 50 per cent flowering and days to first harvest were recorded in each treatment by counting the days from the date of transplanting. Yield parameters like fruit length (cm) and fruit diameter (cm) at marketing stage were measured by using vernier callipers. Number of fruits per plant was documented by counting the total number of fruits harvested from randomly selected five tagged plants and average was expressed. Fruit yield per hectares (t ha^{-1}) was calculated by using fruit yield per plot (kg $plot^{-1}$).

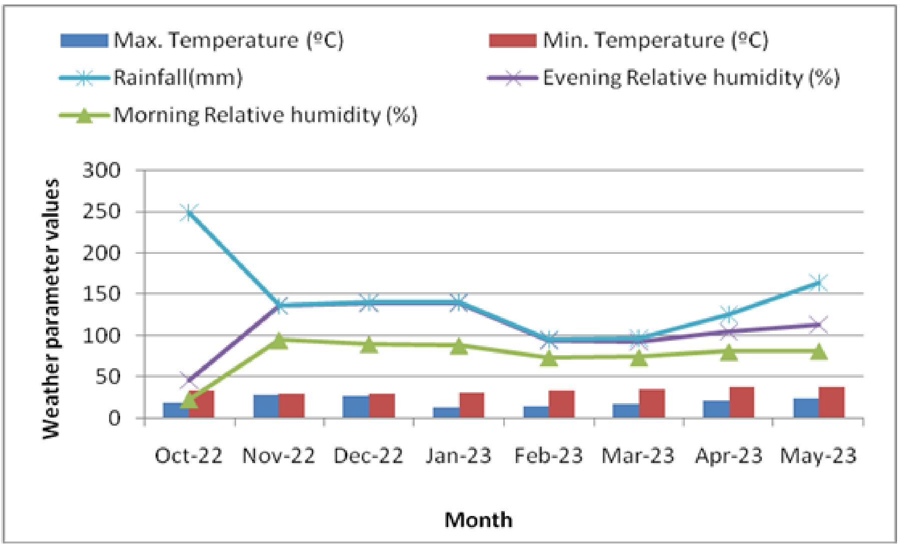

Fig. 1. Meteorological data recorded during the experimental period of 2022-2023

3. RESULTS AND DISCUSSION

The growth characters like plant height, number of primary branches, stem girth and plant spread reading at 45 and 90 DAT were significant among the treatments due to the practice of integrated nutrient management (Table. 1 and Fig. 2). Amongst the treatment T_5 showed significantly higher plant height, number of primary branches, stem girth and plant spread reading of (E-W) and (N-S) at 45 and 90 DAT of brinjal, respectively. These growth parameters were significantly lowest in treatment T_{10}. This might be due to the concurrent application of inorganic fertilizers, organic manures and biofertilizers contribute to the elevated plant growth parameters. This is primarily due to the quick release of nutrients by inorganic fertilizers which enhanced nutrient absorption by plants, and improved utilization at early stage of the crop. Additionally, vermicompost and farmyard manure serve as valuable sources of plant nutrients which also act as chelating agents to regulate nutrient availability, ultimately fostering plant growth. Biofertilizers, on their part, secrete growth-promoting substances that are likely to enhance root development and more efficient water and nutrient transportation to crop plants. Similar results were observed in the findings of Solanki et al. [3], Chumei et al. [4], Thingujam et al. [5], Thakur et al. [6], Raj et al. [7], Manimegala and Gunasekaran [8].

The data on earliness parameters of brinjal like days to first flowering, days to 50 per cent flowering and days to first maturity or harvest were significant among the treatments due to practice of integrated nutrient management (Table 2). Amongst the treatments, T_5 resulted in earliness of the crop with respect to days to first flowering (41.12), days to 50 per cent flowering (46.25) and days to first maturity (50.26) respectively. Lesser days taken for earliness parameters indicate the better growth and development of brinjal plant. This might be due to combined application of organic and inorganic sources with biofertilizers results in balanced supply of required amount of nutrient to the crop plants. Which induces early flowering and maturity. A similar result was reported by Jaishwal et al. [9].

The data related to yield and yield attributes of brinjal showed that there was significant difference among the treatments (Table 3 & Fig. 3, 4 a & b). Amongst the treatments T_5 showed higher fruit length, fruit diameter, fruit volume, average fruit weight, number of fruits per plant, yield per plant, yield per plot and yield per hectare of 6.89 cm, 4.91 cm, 87.46 cc, 60.38 g, 63.91, 3.88 kg/plant, 77.53 kg/plot and 53.92 t/ha, respectively where 75 per cent of RDN was supplemented through inorganic fertilizer + 25 per cent N through FYM and vermicompost + azotobacter + AM + PSB, however these parameters were lowest in T_{10}. The correlation studies showed that the No. of fruits/plant and fruit volume were highly and positively correlated with with fruit yield (97%)(Fig. 4 a & b). The improvement in crop growth and yield in T_5 may be attributed due to the increased availability of plant nutrients and a well-balanced supply of essential nutrients from organic, inorganic, and biofertilizer sources. Consequently, this led to heightened cell division, expanded cell walls, increased meristematic activity, improved photosynthetic efficiency, and enhanced nutrient absorption through increased root activity. All these factors collectively contribute to the improved growth, yield and yield attributes of the crop as reported by Veena [10]. Similar findings were reported by Mishra et al. [11], Mohanty et al. [12].

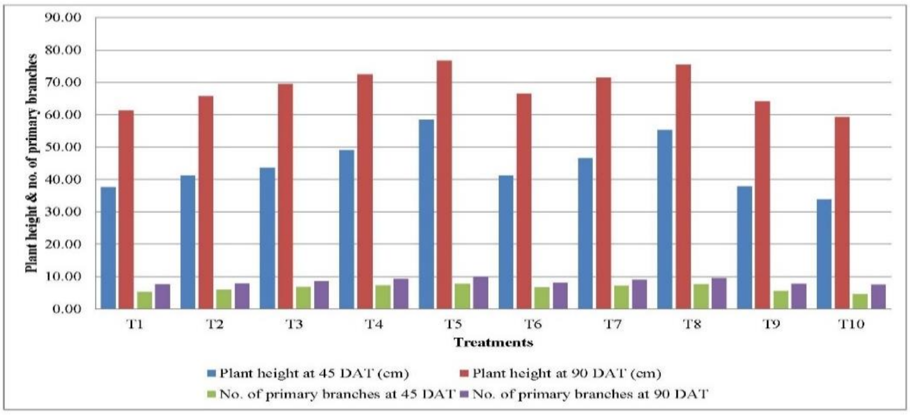

Fig. 2. Effect of INM on plant height and No. of branches of brinjal

Table 1. Effect of integrated nutrient management on plant growth parameters of brinjal

Treatments	Plant height (cm)		Number of primary branches		Stem girth (cm)		Plant spread E-W (cm)		Plant spread N-S (cm)	
	45 DAT	90 DAT	45 DAT	90 DAT	45 DAT	90DAT	45 DAT	90 DAT	45 DAT	90 DAT
T_1	37.50^{ef}	61.29^{de}	5.15^{ef}	7.63^{e}	1.45^{cd}	1.95	57.19^{ef}	94.77^{e}	57.42^{ef}	98.32^{cd}
T_2	41.21^{cde}	65.61^{bcde}	5.97^{cd}	7.82^{de}	1.49^{bcd}	2.07	60.75^{df}	103.45^{de}	63.3^{cde}	104.35^{bcd}
T_3	43.59^{bcd}	69.41^{abcd}	6.75^{bc}	8.63^{bcd}	1.57^{abc}	2.15	64.4^{cde}	110.2^{bcd}	65.38^{bcd}	107.85^{abcd}
T_4	49.09^{b}	72.5^{ab}	7.33^{ab}	9.35^{ab}	1.63^{abc}	2.23	69.9^{bc}	115.39^{abc}	69.47^{abc}	114.53^{ab}
T_5	58.43^{a}	76.69^{a}	7.73^{a}	9.92^{a}	1.71^{a}	2.35	76.39^{a}	122.63^{a}	74.12^{a}	118.67^{a}
T_6	41.27^{cde}	66.61^{bcde}	6.65^{bc}	8.11^{cde}	1.55^{abc}	2.11	61.73^{def}	106.04^{cde}	63.44^{cde}	106.69^{abcd}
T_7	46.47^{bc}	71.33^{abc}	7.09^{ab}	8.95^{bc}	1.59^{abc}	2.19	66.53^{ed}	111.55^{abc}	66.33^{bcd}	110.77^{abc}
T_8	55.29^{a}	75.53^{a}	7.57^{a}	9.57^{ab}	1.67^{ab}	2.27	73.85^{ab}	119.89^{ab}	71.45^{ab}	117.76^{a}
T_9	37.77^{dfe}	64.05^{cde}	5.59^{def}	7.77^{de}	1.47^{cd}	2.03	58.49^{ef}	97.67^{e}	61.52^{df}	102.07^{bcd}
T_{10}	33.87^{f}	59.24^{e}	4.63^{f}	7.45^{e}	1.35^{d}	1.91	55.41^{f}	94.73^{e}	55.08^{f}	96.7^{d}
S. Em±	1.98	2.82	0.27	0.32	0.06	0.08	2.35	3.86	2.29	4.37
CD (5%)	5.88	8.37	0.79	0.96	0.19	NS	6.97	11.49	6.93	12.97

T_1- 100 % RDF [125 (N) : 100 (P_2O_5) : 50 (K_2O)], T_2- 100 % RDF + Azotobactor + AM + PSB, T_3- 75% RDN supplied through inorganic fertilizer + 25% RDN through FYM, T_4- 75% RDN supplied through inorganic fertilizer + 25% RDN through Vermicompost, T_5- 75% RDN supplied through inorganic fertilizer + 25% RDN through FYM and Vermicompost + Azotobacter + AM + PSB, T_6- 50% RDN supplied through inorganic fertilizer + 50% RDN through FYM, T_7- 50% RDN supplied through inorganic fertilizer + 50% RDN through Vermicompost, T_8- 50% RDN supplied through inorganic fertilizer + 50% RDN through FYM and Vermicompost + Azotobacter + AM + PSB, T_9- 75% RDN supplied through inorganic fertilizer + Micro nutrients Fe, Mn, Cu & Zn, T_{10}- 50% N supplied through inorganic fertilizer + Micro nutrients Fe, Mn, Cu & Zn. AM- Arbuscular Mycorrhiza, PSB- Phosphate solubilizing bacteria, FYM- Farm yard manure.
Source: Original research findings

Table 2. Effect of integrated nutrient management on earliness parameters

Treatments	Days to first flowering	Days to 50% flowering	Days to first harvest
T_1- 100 % RDF [125 (N) : 100 (P_2O_5) : 50 (K_2O)]	47.91^{ab}	56.99^{a}	58.63^{ab}
T_2- 100 % RDF + Azotobactor + AM + PSB	47.55^{ab}	55.43^{ab}	55.13^{abcd}
T_3- 75% RDN supplied through inorganic fertilizer + 25% RDN through FYM	45.09^{abcd}	53.97^{ab}	54.06^{abcd}
T_4- 75% RDN supplied through inorganic fertilizer + 25% RDN through Vermicompost	43.26^{bcd}	51.95^{abc}	51.73^{cd}
T_5- 75% RDN supplied through inorganic fertilizer + 25% RDN through FYM and Vermicompost + Azotobacter + AM + PSB	41.12^{d}	46.25^{c}	50.26^{d}
T_6- 50% RDN supplied through inorganic fertilizer + 50% RDN through FYM	46.26^{abc}	54.94^{ab}	56.50^{abc}

Treatments	Days to	Days to	Days to
T_7- 50% RDN supplied through inorganic fertilizer + 50% RDN through Vermicompost	44.12[abcd]	53.55[ab]	52.93[bcd]
T_8- 50% RDN supplied through inorganic fertilizer + 50% RDN through FYM and Vermicompost + Azotobacter + AM + PSB	41.73[cd]	49.6[bc]	50.84[cd]
T_9- 75% RDN supplied through inorganic fertilizer + Micro nutrients Fe, Mn, Cu & Zn	47.72[ab]	52.39[abc]	57.97[ab]
T_{10}- 50% N supplied through inorganic fertilizer + Micro nutrients Fe, Mn, Cu & Zn	48.59[a]	57.33[a]	58.95[a]
S. Em±	1.63	2.17	1.96
CD (5%)	4.85	6.52	5.83

AM- Arbuscular Mycorrhiza, PSB- Phosphate Solubilizing Bacteria, FYM- Farm Yard Manure.
Source: Original research findings

Table 3. Effect of integrated nutrient management on yield and yield attributing characters of brinjal

Treatments	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (cc)	Average fruit weight (g)	Number of fruits per plant	Fruit yield per plant (kg/plant)	Fruit yield per plot (kg/plot)	Fruit yield (t/ha)
T_1	5.63[c]	4.07[d]	68.67[e]	54.08	53.79[ef]	2.90[ef]	58.06[ef]	40.36[ef]
T_2	5.95[bc]	4.21[bcd]	71.53[d]	56.19	54.43[def]	3.05[def]	61.12d[ef]	42.35[ef]
T_3	6.20[abc]	4.42[abcd]	76.23[bcd]	57.74	55.28[cde]	3.19[cde]	63.95[cde]	44.33[cde]
T_4	6.32[a]	4.68[abc]	81.86[ab]	58.93	59.69[bc]	3.51[bc]	70.26[bc]	48.90[bc]
T_5	6.89[bc]	4.91[a]	87.46[a]	60.38	63.91[a]	3.88[a]	77.53[a]	53.92[a]
T_6	6.03[abc]	4.35[bcd]	73.27[cde]	57.47	53.29[def]	3.06[def]	61.19[def]	42.54[def]
T_7	6.26[ab]	4.57[abcd]	79.98[abc]	58.85	57.29[bcd]	3.37[bcd]	67.43[bcd]	46.85[bcd]
T_8	6.57[c]	4.74[ab]	84.49[abcd]	59.73	61.12[ab]	3.65[ab]	73.18[ab]	50.67[ab]
T_9	5.68[c]	4.15[cd]	71.48[de]	55.53	51.47[ef]	2.86[ef]	57.08[ef]	39.63[ef]
T_{10}	5.53[c]	4.04 [e]	66.16[e]	53.95	50.59[f]	2.73[f]	54.68[f]	37.90[f]
S. Em±	0.27	0.19	2.75	2.09	2.00	0.12	2.25	1.65
CD (5%)	0.82	0.57	8.36	NS	5.95	0.35	6.68	4.89

T_1- 100 % RDF [125 (N) : 100 (P_2O_5) : 50 (K_2O)], T_2- 100 % RDF + Azotobactor + AM + PSB, T_3- 75% RDN supplied through inorganic fertilizer + 25% RDN through FYM, T_4- 75% RDN supplied through inorganic fertilizer + 25% RDN through Vermicompost, T_5- 75% RDN supplied through inorganic fertilizer + 25% RDN through FYM and Vermicompost + Azotobacter + AM + PSB, T_6- 50% RDN supplied through inorganic fertilizer + 50% RDN through FYM, T_7- 50% RDN supplied through inorganic fertilizer + 50% RDN through Vermicompost, T_8- 50% RDN supplied through inorganic fertilizer + 50% RDN through FYM and Vermicompost + Azotobacter + AM + PSB, T_9- 75% RDN supplied through inorganic fertilizer + Micro nutrients Fe, Mn, Cu & Zn, T_{10}- 50% N supplied through inorganic fertilizer + Micro nutrients Fe, Mn, Cu & Zn. AM- Arbuscular Mycorrhiza, PSB- Phosphate solubilizing bacteria, FYM- Farm yard manure

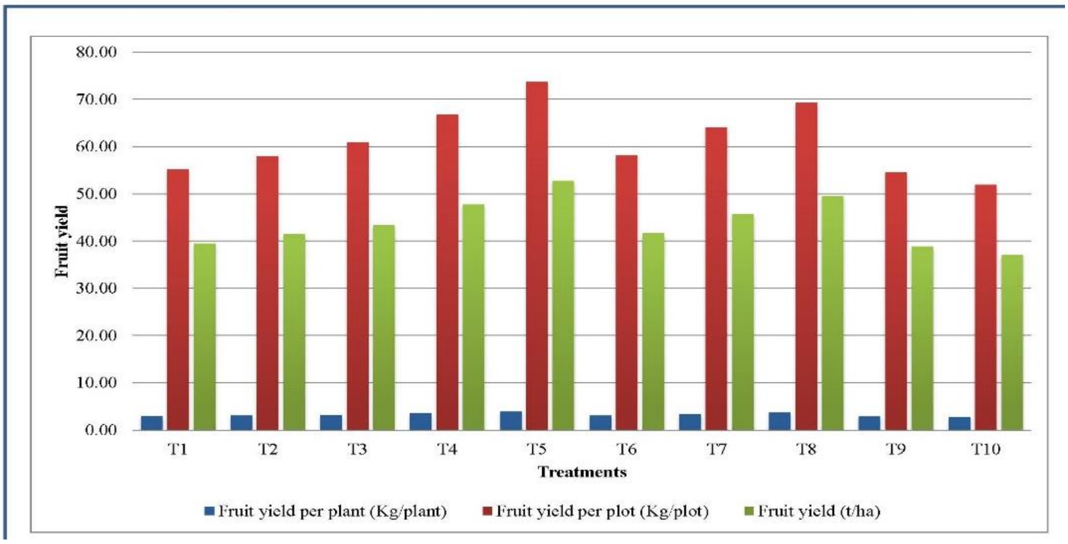

Fig. 3. Effect of INM on fruit yield per plant and fruit yield per plot of brinjal

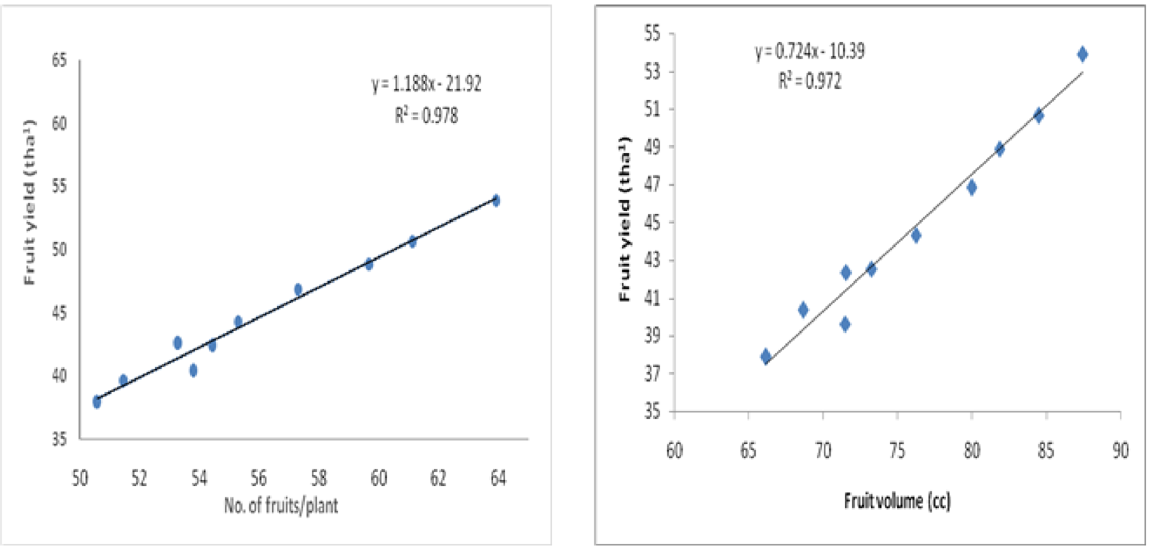

Fig. 4. (a & b) Correlation of No. of fruits/plant and fruit volume with fruit yield of brinjal

4. CONCLUSION

In essence, this research contributes valuable knowledge to the agricultural community by emphasizing the significance of integrated nutrient management in achieving sustainable and high-yielding brinjal cultivation. The adoption of various nutrient management practices like integrated approaches, blending organic with inorganic and biofertilizer inputs, acts as a promising strategy to enhance soil fertility, crop productivity and overall agricultural sustainability. Higher values for growth and yield atributes underscored the effectiveness of the integrated nutrient management approach in optimizing brinjal productivity. The findings advocate for the adoption of holistic nutrient management practices that consider the complementary effects of organic, inorganic, and biofertilizer inputs. This research encourages farmers to harness the potential of integrated nutrient management for cultivating brinjal in a manner that is not only economically viable but also environmentally sustainable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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