PLANT SCIENCE TODAY
Vol 12(sp3): 01–07
https://doi.org/10.14719/pst.10260

eISSN 2348-1900

RESEARCH ARTICLE

Enhancing growth, yield and quality of mundu chilli (*Capsicum annuum* L.) through organic amendments for sustainable farming practice

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Received: 25 June 2025; Accepted: 09 September 2025; Available online: Version 1.0: 11 December 2025

Cite this article: Prabhu T, Vasanthakumar SS, Shenbagavalli S, Baskaran A, Satheeshkumar N, Rubika R, Rajangam J. Enhancing growth, yield and quality of mundu chilli (*Capsicum annuum* L.) through organic amendments for sustainable farming practice. Plant Science Today. 2025; 12(sp3):01–07. https://doi.org/10.14719/pst.10260

Abstract

A field study was conducted during 2023-24 in Ramanathapuram district, Tamil Nadu, to evaluate the effects of various organic amendments on the growth, yield and quality of mundu chilli (*Capsicum annuum* L.). The experiment involved ten treatments, including combinations of organic amendments like farmyard manure (FYM), vermicompost (VC), poultry manure (PM), fish amino acid (FAA), egg amino acid (EAA), Panchagavya and 3G extract, compared against the recommended dose of fertilizers (RDF) as a control, in a randomized block design with three replications. Significant variations were observed among treatments, with treatment T_8 (PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %) showing superior results. T_8 recorded the highest plant height (91 cm), number of branches (10.50). Yield attributes were also highest in T_8, including number of fruits per plant (58.50), fruit length (2.10 cm) and dry fruit yield per hectare (1224 kg). Quality parameters in T_8 were notably enhanced, with higher capsaicin content (0.50 %), oleoresin content (25.56 %) and colour values (ASTA 250.00).

Keywords: egg amino acid; organic farming; organic produce; poultry manure; sustainability

Introduction

Chilli (*Capsicum annuum* L.) is a vital spice crop cultivated globally, known for its pungency, flavour and medicinal properties. Among the diverse varieties, mundu chilli, with its distinct round fruits, is a popular cultivar in southern India, particularly in Tamil Nadu. In Tamil Nadu, mundu type chilli is cultivated in Ramanathapuram, Sivaganga, Tuticorin and Virudhunagar districts (1). This distinctive variant, cultivated exclusively for its spice, exhibits a round or oblong shape, with a diameter of 5.70 to 10.20 cm and a length of 1.55 to 2.80 cm, a thick pericarp ranging from 0.25 to 0.32 mm and thrives in the coastal saline regions of Ramanathapuram, Virudhunagar and Tuticorin districts (2). It is not only valued for its unique taste and nutritional profile but also plays a significant role in the regional economy. However, the cultivation of mundu chilli faces several challenges, including declining soil fertility, pest infestations and fluctuating yields, largely attributed to the overuse of chemical fertilisers and unsustainable agricultural practices. The rising awareness of environmental degradation and health risks associated with conventional farming has led to a growing interest in organic farming systems. Organic amendments, derived from natural sources, offer an eco-friendly approach to improving soil health, enhancing crop productivity and maintaining ecological balance (3).

Various organic inputs like farmyard manure (FYM), vermicompost (VC), poultry manure (PM), fish amino acids (FAA), egg amino acids (EAA) and bio-fertilisers such as Panchagavya and 3G extract have shown promising results in improving the growth and quality of crops by enriching soil nutrients and promoting biological activity. In this context, optimising the use of organic amendments in mundu chilli cultivation can serve as a sustainable solution to improve crop performance while reducing the dependency on chemical fertilisers. Organic amendments not only enhance plant growth and yield but also improve the quality of the produce, including traits like capsaicin content, ascorbic acid and oleoresin levels, which are crucial for market value and consumer health (4). This study was undertaken to evaluate the influence of different organic amendments on the agronomic performance, yield and quality of mundu chilli under the specific agro-climatic conditions of Ramanathapuram district, Tamil Nadu. The objective was to determine the most effective combination of organic inputs for optimising both the productivity and quality of mundu chilli sustainably.

Materials and Methods

The field experiment was conducted during 2023-2024 at a farmer's field in Kombuthi village, Ramanathapuram district, Tamil Nadu. The district, located between 9.05° to 9.50° N and 78.10° to 79.27° E,

experiences a hot and dry climate with an average annual rainfall of 827.0 mm, predominantly from the Northeast Monsoon. The crop used was mundu chilli (*Capsicum annuum* L.), variety S9 Red, known for its pungency and market demand. Seedlings were transplanted with a spacing of 65 cm between rows and 45 cm between plants, with a plot size of 4 m x 4 m. The experiment included ten treatments, each comprising various combinations of organic fertilisers and bio-stimulants. The treatments were as follows: T_1 - FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2-FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3- FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4– VC at 6 t ha^{-1} + Panchagavya at 3 % + 3G extract at 3 %; T_5- VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6- VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7- PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8- PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9- PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10}- Control (recommended dose of fertilizers (RDF) - 30:60:30 NPK) using randomized block design (RBD). The treatments were applied at planting, with foliar applications conducted regularly during the crop cycle. Agronomic practices such as irrigation and weeding were followed uniformly across all plots. Biometrical data, including plant height and the number of branches, were recorded at 30, 60 and 90 days after transplanting (DAT). Yield attributes, such as the number of fruits per plant and fruit length, were measured at harvest, along with dry fruit yield per hectare. Quality parameters, including capsaicin content, oleoresin content and colour value (ASTA), were analysed using standard spectrophotometric and extraction methods. Statistical analysis of the data was performed using ANOVA at 5 % significance level.

Results and Discussion

The data regarding growth, yield and quality parameters are presented.

Growth parameters

Plant height in cm at 30, 60, 90 and 120 DAT

The plant height of mundu chilli was significantly influenced by the different organic amendments shown in Table 1 and Fig. 1. At 30, 60, 90 and 120 DAT, the treatment with PM, FAA and 3G extract (T_8) consistently recorded the tallest plants, with heights of 36.00 cm, 50.00 cm, 64.00 cm and 91.00 cm, respectively. In contrast, the control (T_{10}) showed the shortest plants at all stages, with the lowest height at 120 DAT (70.00 cm). The superior plant height in T_8 is attributed to the synergistic effect of PM and FAA, which enhanced soil nutrient availability, particularly nitrogen, phosphorus and potassium, critical for promoting vegetative growth and photosynthesis. Research indicates that similar benefits of organic amendments on plant growth (5, 6). The control treatment (T_{10}), receiving only chemical fertilisers, produced shorter plants, underscoring the advantage of organic amendments in enhancing soil health and plant development. Overall, the combined use of PM, FAA and 3G extract proved most effective in promoting plant height, consistent with other studies demonstrating the benefits of integrating organic and bio-stimulant inputs (7).

Number of branches

The number of primary branches in mundu chilli was significantly affected by the various organic amendments applied, shown in Table 1 and Fig. 2. At 30 DAT, the highest number of primary branches was recorded in the T_8 treatment (4.35), followed by $T_5$and T_7, while the control (T_{10}) showed the lowest number (3.00). This trend continued at 60, 90 and 120 DAT, with T_8maintaining the highest number of branches (6.00, 8.00 and 10.50, respectively) across all stages, while the control consistently had the fewest (4.50, 6.40 and 8.50, respectively). The superior performance of T_8 is attributed to the combination of PM, FAA and 3G extract. PM, rich in essential nutrients like nitrogen, phosphorus and potassium, supports vigorous vegetative growth and branching by enhancing photosynthetic efficiency and root development. The addition of FAA, which is high in amino acids and micronutrients, boosts protein synthesis and overall plant health, leading to greater branch formation. These results align with previous studies that highlight the benefits of organic amendments in promoting plant growth and branching (8, 9). Overall, the synergistic effect of these organic components in T_8 created an optimal environment for enhanced vegetative growth, significantly increasing the number of primary branches compared to the control.

Yield parameters

Number of fruits per plant

The number of fruits per plant varied significantly across treatments shown in Table 2 and Fig. 3. T_8 (PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %) produced the highest number of fruits per plant (82.50), followed by T_5 (VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %) with 80.00 fruits. The control (T_{10}) recorded the lowest number of fruits per

Table 1. Effect of organic amendments on plant height and primary branches of mundu chilli

Treatment details	Plant height (cm)				Primary branches			
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT
T_1	31.60	43.50	57.50	82.00	3.50	5.00	7.00	9.00
T_2	32.20	44.30	58.10	83.00	3.75	5.25	7.30	9.20
T_3	30.80	42.80	56.50	80.50	3.45	4.95	6.85	8.85
T_4	33.50	46.00	59.50	84.50	4.00	5.70	7.70	9.40
T_5	35.50	49.50	63.00	89.00	4.25	5.95	7.95	10.20
T_6	33.00	45.50	59.00	84.00	3.85	5.35	7.40	9.35
T_7	34.50	47.50	61.00	87.00	4.20	5.85	7.85	9.75
T_8	36.00	50.00	64.00	91.00	4.35	6.00	8.00	10.50
T_9	33.80	46.50	60.00	85.00	4.10	5.65	7.65	9.50
T_{10}	28.00	39.00	52.00	70.00	3.00	4.50	6.40	8.50
Mean	31.93	45.77	58.33	84.45	3.95	5.42	7.31	9.38
SE(d)	0.68	1.11	1.30	1.26	0.07	0.20	0.37	0.41
CD (.05)	1.43	2.34	2.75	2.67	0.13	0.09	0.17	0.19

T_1 -FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2 - FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3– FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4– VC at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_5– VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6– VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7- PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8– PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9 – PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10} – Control (RDF - 30:60:30 NPK).

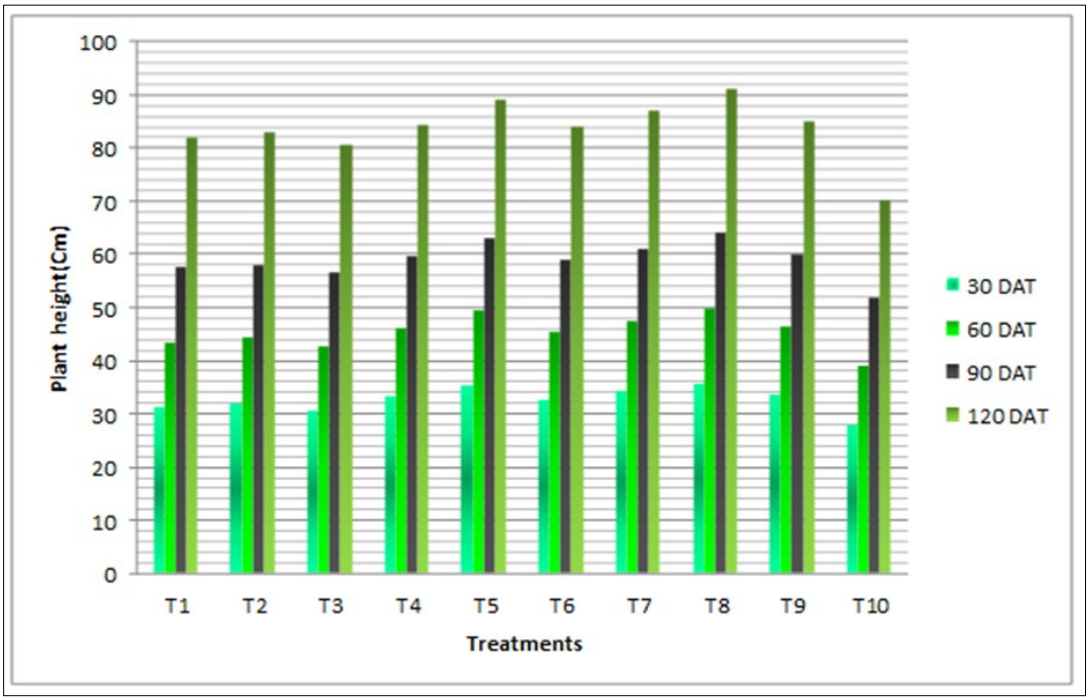

Fig. 1. Effect of organic amendments on the plant height of mundu chilli. T_1 – FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2 – FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3 – FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4 – VC at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_5 – VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6 – VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7 – PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8 – PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9 – PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10} – Control (RDF - 30:60:30 NPK).

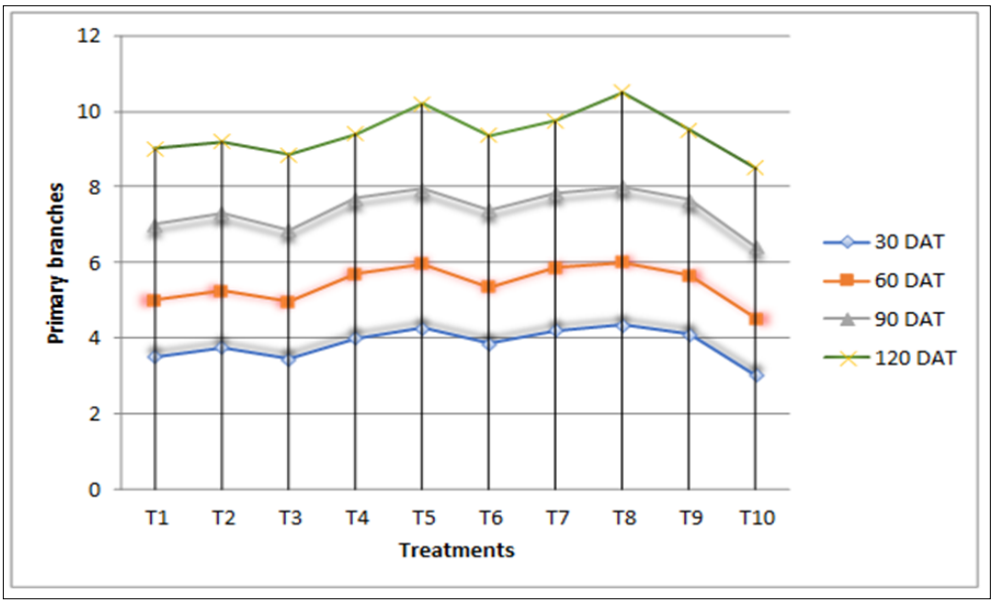

Fig. 2. Effect of organic amendments on primary branches of mundu chilli. T_1 – FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2 – FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3 – FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4 – VC at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_5 – VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6 – VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7 – PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8 – PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9 – PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10} – Control (RDF - 30:60:30 NPK).

plant at 55.00. The mean number of fruits per plant across all treatments was 63.37, indicating a strong advantage for treatments with organic amendments. The superior fruit production in T_8 can be attributed to the combination of PM, FAA and 3G extract. PM supplies essential nutrients, especially nitrogen (N), phosphorus (P) and potassium (K), which are crucial for flowering and fruit set. Nitrogen, in particular, stimulates meristematic activities and enhances photosynthesis, leading to increased assimilate production and better fruit formation (10). Moreover, FAA contributes by enhancing the plant's resistance to stress, boosting protein synthesis and stimulating cell division, all of which support higher fruit production (11, 12). This nutrient synergy created by organic inputs in T_8 likely explains its superior performance in terms of fruit number compared to the control.

Fruit length

Similar trends were observed in fruit length, where T_8 produced the longest fruits (3.50 cm), followed by T_5 (3.20 cm), while the control (T_{10}) had the shortest fruit length (1.90 cm). The mean fruit length across treatments was 2.575 cm, with significant differences between treatments recorded in Table 2 and Fig. 4, 5. The enhanced fruit length in T_8 can be credited to the positive effects of PM and FAA.

Table 2. Effect of organic amendments on the number of fruits per plant, fruit length and dry fruit yield per hectare of mundu chilli (kg/ha)

Treatment details	Number of fruits per plant	Fruit length (cm)	Dry fruit yield per hectare (kg/ha)
T_1	57.00	2.10	789.36
T_2	58.50	2.20	801.58
T_3	56.46	2.05	748.56
T_4	68.00	2.85	986.87
T_5	80.00	3.20	1163.48
T_6	60.00	2.60	1105.68
T_7	70.00	3.00	1136.74
T_8	82.50	3.50	1224.64
T_9	62.50	2.75	1043.78
T_{10}	55.00	1.90	717.25
Mean	63.37	2.575	979.60
SE(d)	1.324	0.055	20.953
CD (0.05)	2.804	0.117	44.361

T_1 –FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2 – FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3 – FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4 – VC at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_5 – VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6 – VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7 – PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8 – PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9 – PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10} – Control (RDF - 30:60:30 NPK).

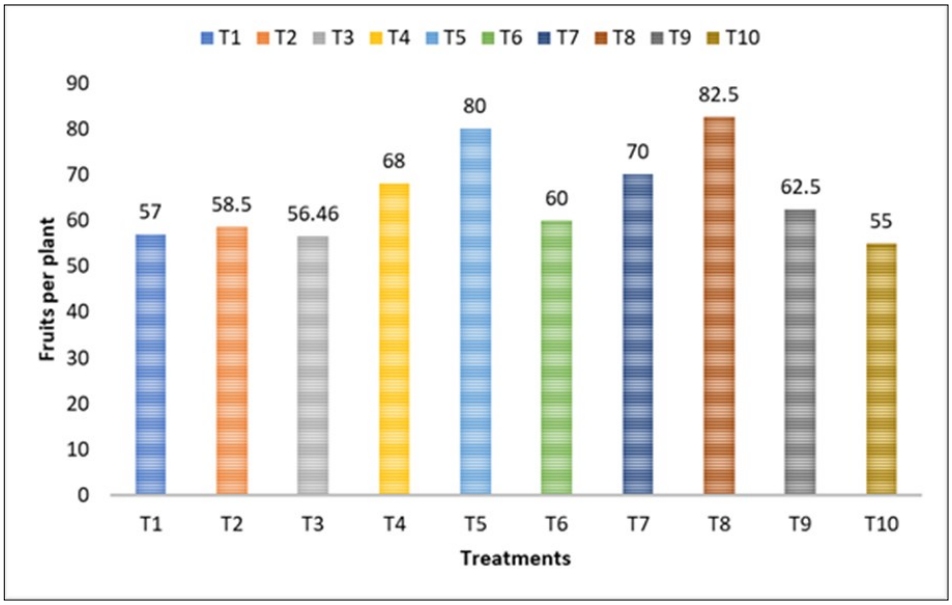

Fig. 3. Effect of organic amendments on the number of fruits per plant. T_1 – FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2 – FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3 – FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4 – VC at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_5 – VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6 – VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7 – PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8 – PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9 – PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10} – Control (RDF - 30:60:30 NPK).

PM rich nutrient profile, particularly potassium, improves fruit elongation by regulating carbohydrate translocation and preventing fruit drop. Potassium plays a critical role in photosynthesis and nitrogen metabolism, supporting vigorous fruit growth (13). FAA further aids by stimulating cellular processes, promoting nutrient absorption and protecting plants from oxidative stress, resulting in stronger and longer fruit development.

Dry fruit yield per hectare

Dry fruit yield also varied significantly among treatments shown in Table 2 and Fig. 6. T_8 achieved the highest yield of 1224.64 kg/ha, followed by T_5 (1163.48 kg/ha). The control (T_{10}) produced the lowest dry fruit yield at 717.25 kg/ha. The overall mean dry fruit yield was 979.60 kg/ha. The superior yield in T_8 is attributed to the combined benefits of PM and FAA. PM improves soil fertility and nutrient availability, promoting better root growth and synchronising nutrient uptake with crop demand. This results in higher fresh fruit weight and yield parameters. FAA enhances plant stress tolerance and supports metabolic processes, which directly contribute to increased dry matter accumulation and yield (14, 15). The combination of these organic amendments enhanced nutrient use efficiency and improved soil moisture retention, leading to better overall yield performance in T_8. In conclusion, the application of organic amendments, particularly in the T_8 treatment, significantly improved fruit production, fruit length and dry fruit yield, demonstrating the positive impact of integrating PM, FAA and 3G extract on plant growth and yield in mundu chilli.

Biochemical parameters

Capsaicin content

Among the treatments, the highest capsaicin content (0.50 %) was recorded in the T_8 treatment (PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %). The T_5 treatment (VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %) followed closely with a capsaicin content of 0.48 %. The control treatment (T_{10}), with 0.16 % capsaicin, showed the lowest value. The overall mean capsaicin content across treatments was 0.312 %, with a standard error of 0.006 % and a critical difference of 0.013 % was noted in Table 3 and Fig. 7. The increase in capsaicin content in the T_8

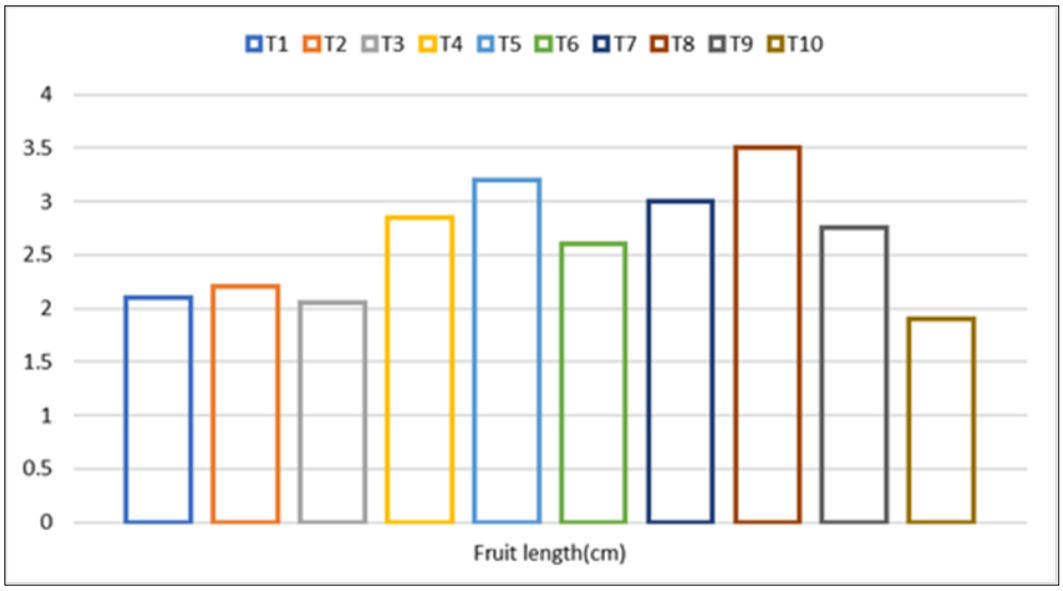

Fig. 4. Effect of organic amendments on fruit length of mundu chilli. T_1 – FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2 – FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3 – FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4 – VC at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_5 – VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6 – VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7 – PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8 – PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9 – PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10} – Control (RDF - 30:60:30 NPK).

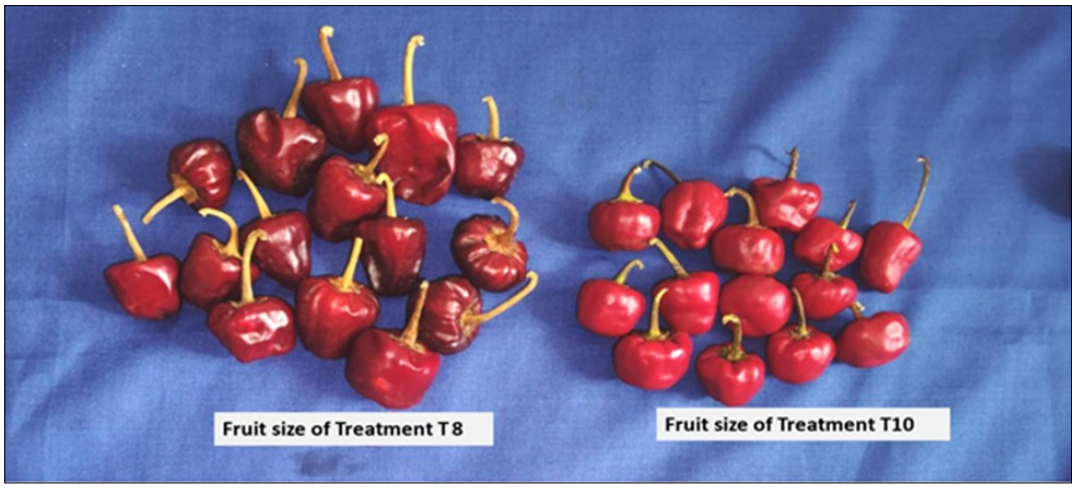

Fig. 5. Comparative image of the mundu chilli fruit length.

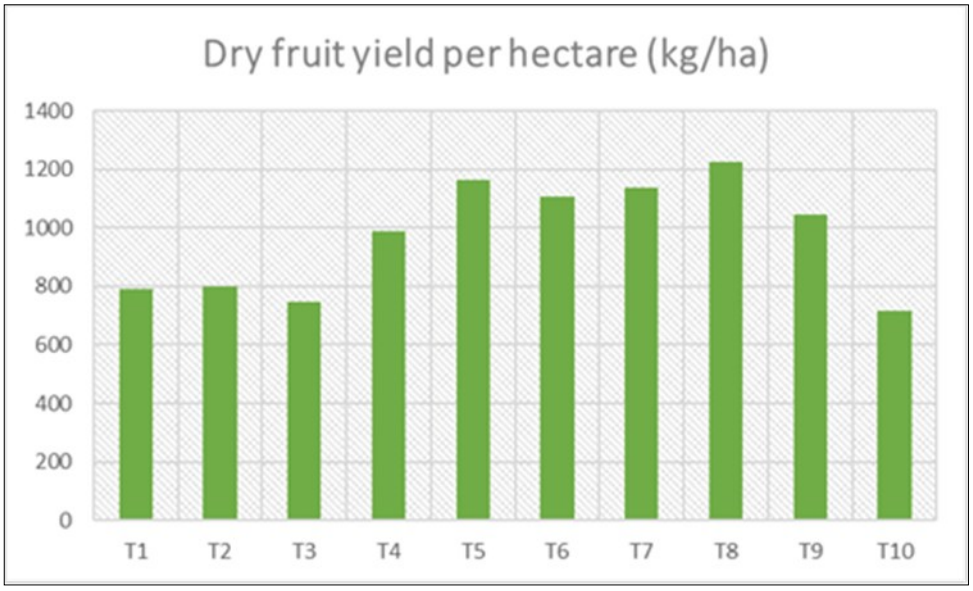

Fig. 6. Effect of organic amendments on dry fruit yield per hectare (kg/ha) of mundu chilli. T_1 – FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2 – FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3 – FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4 – VC at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_5 – VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6 – VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7 – PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8 – PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9 – PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10} – Control (RDF - 30:60:30 NPK).

treatment can be attributed to the combined effect of PM, FAA and the 3G extract. PM improves soil fertility, microbial activity and nutrient availability, which in turn enhances the synthesis of secondary metabolites like capsaicin (16). Capsaicin biosynthesis is strongly influenced by the availability of nitrogen and potassium, both of which are abundant in PM. FAA, rich in essential amino acids and natural growth hormones, further stimulate metabolic processes, contributing to the enhanced production of capsaicin (17).

Oleoresin content

The T_8 treatment also recorded the highest oleoresin content at 25.56 %, followed by the T_5 treatment, with 25.00 % as shown in Table 3 and Fig. 7. The control treatment (T_{10}) had the lowest oleoresin content at 14.00 %. The mean oleoresin content across all treatments was 20.20 %, with a standard error of 0.317 % and a critical difference of 0.670 %. The higher oleoresin yield in the T_8 treatment is due to the beneficial effects of PM, FAA and the 3G extract. PM enriches the soil with organic matter, improving soil structure and increasing microbial activity, both of which are crucial for nutrient uptake and oleoresin production. FAA serve as bio-stimulants, enhancing protein synthesis and metabolic activity, which in turn promotes higher oleoresin content (18, 19). The 3G extract likely enhances plant vitality, contributing to the overall increase in oleoresin yield.

Colour value (ASTA)

The T_8 treatment achieved the highest colour value of 90.50 ASTA, followed by the T_5 treatment, with 89.00 ASTA, as noted in Table 3 and Fig. 7. The lowest colour value was observed in the control treatment (T_{10}) at 63.00 ASTA. The mean colour value across treatments was 78.00 ASTA, indicating that the application of organic amendments and bio-stimulants significantly enhanced the colour intensity of the fruits. The superior performance of the T_8 treatment in terms of colour value is primarily due to the nutrient-rich environment created by the combination of PM, FAA and the 3G extract. Nitrogen and potassium from PM promote vigorous plant growth, while bio-stimulants like fish amino acids boost pigment production, resulting in higher colour values in chilli fruits. Organic amendments have been shown to enhance the quality parameters of chilli, including oleoresin and ascorbic acid content, which are closely linked to the intensity of fruit colouration (20, 21).

Conclusion

The study demonstrated that the use of organic amendments, particularly the combination of PM, FAA and 3G extract (T_8 treatment), significantly enhanced the growth, yield and quality of Mundu chilli. The T_8 treatment consistently outperformed other treatments, producing the tallest plants, the highest number of

Table 3. Effect of organic amendments on capsaicin content, oleoresin and colour value (ASTA) in mundu chilli

Treatment details	Capsaicin content (%)	Oleoresin (%)	Colour value (ASTA)
T_1	0.21	17.50	70.00
T_2	0.24	18.00	72.00
T_3	0.20	16.00	64.00
T_4	0.27	19.50	76.00
T_5	0.48	25.00	89.00
T_6	0.31	22.00	86.00
T_7	0.35	23.50	81.00
T_8	0.50	25.56	90.50
T_9	0.40	23.00	87.00
T_{10}	0.16	14.00	63.00
Mean	0.312	20.20	78.00
SE(d)	0.006	0.317	1.609
CD (0.05)	0.013	0.670	3.407

T_1 –FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2– FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3– FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4– VC at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_5– VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6– VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7– PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8– PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9– PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10}– Control (RDFs - 30:60:30 NPK).

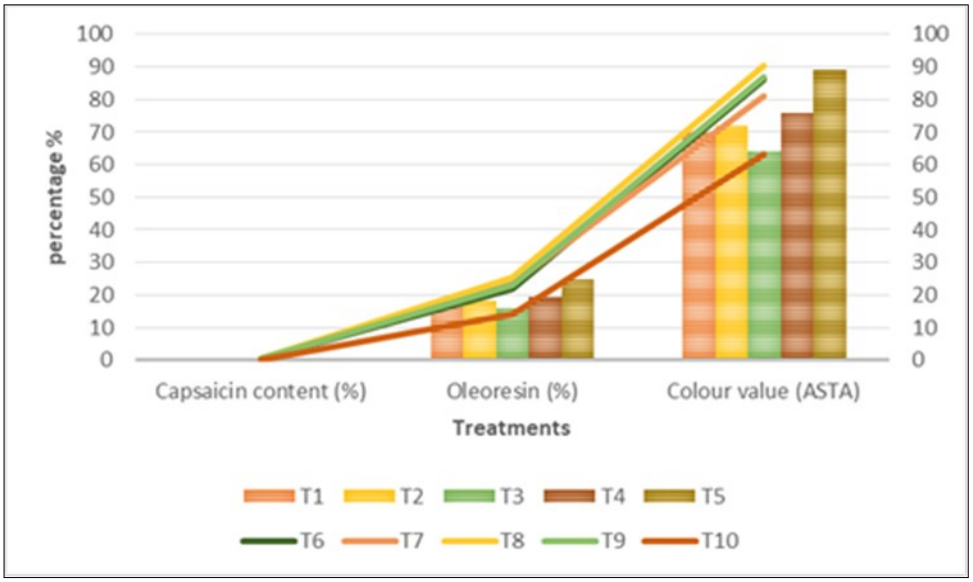

Fig. 7. Effect of organic amendments on capsaicin content, oleoresin and colour value (ASTA) in mundu chilli. T_1 – FYM at 12.5 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_2– FYM at 12.5 t/ha + FAA at 3 % + 3G extract at 3 %; T_3– FYM at 12.5 t/ha + EAA at 3 % + 3G extract at 3 %; T_4– VC at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_5– VC at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_6– VC at 6 t/ha + EAA at 3 % + 3G extract at 3 %; T_7– PM at 6 t/ha + Panchagavya at 3 % + 3G extract at 3 %; T_8– PM at 6 t/ha + FAA at 3 % + 3G extract at 3 %; T_9– PM at 6 t/ha + EAA at 3 % + 3G extract at 3 %; and T_{10}– Control (RDF - 30:60:30 NPK).

branches, the greatest number of fruits per plant and the longest fruit length, alongside the highest dry fruit yield per hectare. It also recorded the highest capsaicin, oleoresin content and ASTA colour value, showcasing the positive impact of these organic inputs on both productivity and biochemical parameters.

Acknowledgements

The authors are thankful to Krishi Vigyan Kendra, Ramanathapuram and Horticultural College and Research Institute, Periyakulam, for providing the necessary research facilities.

Authors' contributions

TP conceptualised the study and developed the methodology. SSV provided resources, managed data collection and statistical and laboratory analysis while the investigation was conducted collaboratively. SS did the formal analysis. AB, NS, RR and JR did the supervision. All authors have reviewed and approved the final version of the paper.

Compliance with ethical standards

Conflict of interest: The Authors declare that there is no conflict of interest.

Ethical issues: None

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