Effect of organic manures and bio-fertilizers on growth, yield and quality of Dragon fruit (*Hylocereus undatus* L.) under western Uttar Pradesh conditions

Abstract

The field experiment was conducted at the Horticultural Research Centre, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, during 2023. All treatments were applied in a randomized block design with three replications, including T0- Control (No manures), T1- 100% N as FYM, T2- 100% N as FYM + Jeevamrut + Panchagavya, T3- 100% N as FYM + NPK Microbial Consortium, T4- 100% N as FYM + Jeevamrut + Panchagavya + NPK Microbial Consortium, T5- 100% N as Vermicompost, T6- 100% N as Vermicompost + Jeevamrut + Panchagavya, T7- 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium, and T8- 100% RDF. The application of treatment 100% N as Vermicompost +Jeevamrut + Panchagavya + NPK Microbial Consortium (T7) was found significantly superior in terms of number of new branches per pillar (12.67, 16, 18.67 and 20.33) at 30, 60, 90 and 120 days after treatment, plant canopy spread (5.10 and 5.27 m^2) at initial and harvest stage, number of flower per pillar(24), days taken from flowering to fruit harvest (29.93), number of fruits per pillar(19.33), length of the fruit (9.81cm), width of the fruit (9.02cm), fruit weight (390.85 g), peel thickness (3.65 mm), specific gravity(1.12), fruit yield per pillar (7.55 kg), fruit yield per hectare (8.38 t/ha), TSS (14.17° ºBrix), ascorbic acid content (8.74 mg/100 g) and minimum titratable acidity (0.24 %) of dragon fruit. The study highlights the potential of integrating organic manures and bio-fertilizers to enhance the growth, yield and quality of dragon fruit, offering a sustainable and eco-friendly alternative to chemical fertilizers. Further research can explore the long-term impacts of these organic treatments on soil health, nutrient dynamics, and their adaptability to different agro-climatic regions for broader applicability.

Keywords: *Hylocereus undatus* L. *:Organic Manures; Bio-fertilizers: Vermicompost: Growth and Yield; Fruit Quality*

Introduction:

Dragon fruit (*Hylocereus undatus* L.), is a member of the Cactaceae family of cactus, has gained global popularity due to its unique appearance, nutritional value and potential health benefits (Singh & Kumar 2023; Zaid *et al.* 2024). It is a tropical and subtropical fruit that has captivated the interest of both producers and consumers, not only because of its vibrant color and exotic flavor but also due to its rich content of antioxidants, vitamins, minerals and fiber. As demand for dragon fruit continues to rise, there is increasing interest in optimizing its cultivation practices to improve both the quality and quantity of yield. Among the various factors influencing crop growth, organic manures and bio-fertilizers have emerged as sustainable alternatives to synthetic fertilizers, which often have detrimental effects on soil health, environmental sustainability and long-term agricultural productivity.

In recent years, the shift toward organic farming has been driven by the growing concerns over soil degradation, loss of biodiversity and the accumulation of chemical residues in food products. Organic manures and bio-fertilizers, rich in essential nutrients and beneficial microorganisms, play a crucial role in enhancing soil fertility and promoting plant growth (Sahu, 2023; Kumar *et al.* 2022). Key organic practices include using Jeevamrit, a microbial culture made from cow dung, urine, jaggery, soil, pulse flour, and water, which promotes crop growth and pest resistance (Kumari *et al.* 2022). Panchagavya and compost tea are also emphasized for enhancing soil health and crop productivity (Maity *et al.* 2020). Farmyard manure (FYM), consisting of livestock waste and feed, improves soil structure, moisture retention, and nutrient availability, thus supporting healthy crop growth (Chahal *et al.* 2020). Additionally, vermicompost, produced by earthworms, serves as an effective organic fertilizer that boosts plant development and acts as a biocontrol agent against pests, promoting sustainable agriculture (Joshi *et al.* 2015).

These organic inputs improve soil structure, water retention and nutrient availability, creating a favourable environment for plant roots to thrive (Arden-Clarke & Hodges 1988; Fageria 2012; Murphy 2015). Additionally, bio-fertilizers containing nitrogen-fixing bacteria, phosphate-solubilizing microorganisms and mycorrhizal fungi help in enhancing nutrient uptake and improving the plant's resistance to biotic and abiotic stress (Chaudhary *et al.* 2022; Rabani *et al.* 2023).

Despite the recognized benefits of organic inputs in crop production, there is a limited understanding of their specific effects on dragon fruit cultivation, particularly in terms of growth and yield parameters. While several studies have demonstrated the positive impact of organic manures and bio-fertilizers on other fruit crops, comprehensive research on their application to dragon fruit remains scarce. The limited research on dragon fruit's response to these organic inputs creates a significant knowledge gap, especially with respect to the interaction between different organic amendments and the physiological and quality traits of the crop.

Previous studies have largely focused on conventional fertilizers, leaving a gap in understanding the potential of organic alternatives to improve both the agronomic performance and quality attributes of dragon fruit (Srivastava *et al.* 2021). This study aims to evaluate the impact of different organic manures and bio-fertilizers on the growth and yield parameters of dragon fruit, as well as to assess how these organic inputs influence the quality attributes of the fruit. By addressing these research gaps, the study seeks to provide insights that can guide sustainable dragon fruit cultivation practices, contributing to both agricultural productivity and environmental sustainability.

Material and Methods

The field experiment was conducted on well-established dragon fruit orchard situated at Horticulture Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology in Meerut, Uttar Pradesh, during 2023. Meerut district is situated in the Indo- Gangetic plains of India, with geographical coordinates ranging between 28°57' to 29°02' Northlatitude and 77°40' to 77°45' East longitude. The effect of organic manures and bio-fertilizers was noted on dragon fruit yield with 9 treatments and 3 replications. All the treatments applied in randomizedblock design with three replications *viz*. T0- Control (No manures), T1- 100 % N as FYM, T2- 100 % N as FYM + Jeevamrut + Panchagavya, T3- 100 % N as FYM + NPK MicrobialConsortium, T4- 100 % N as FYM + Jeevamrut + Panchagavya + NPK Microbial Consortium, T5- 100% N as Vermicompost, T6- 100% N as Vermicompost + Jeevamrut +Panchagavya, T7- 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK MicrobialConsortium and T8- 100% RDF.

Observations were recorded for various parameters across growth, fruit physical traits, yield and quality. New branches were counted at 30, 60, 90, and 120 days after treatment for each pillar, and the mean number was recorded. The canopy spread was measured in North-South and East-West directions at 0 days and final harvest using a measuring tape, and the canopy size was calculated in square meters (m^2). The number of flowers per pillar was counted up to final harvest, and the average number per plant was determined. The number of days from full bloom to fruit harvest was recorded by tagging ten flowers per plant and calculating the mean for all replications. The total number of fruits per pillar was counted at harvest, and the average number of fruits per pillar was calculated. The length of ten randomly selected ripe fruits was measured using a scale and recorded in centimeters (cm). The width of ten randomly selected fruits at their broadest point was measured using a scale and recorded in centimeters (cm). The weight of ten randomly selected fruits was recorded in grams (g) using an electronic balance, and the average weight was calculated. The peel thickness was measured at the midpoint of the fruit using a Vernier caliper and recorded in millimeters (mm). The specific gravity of the fruits was calculated by dividing the weight of the fruit by its volume, determined using the water displacement method. Fruit yield per pillar was recorded until the final harvest and expressed in kilograms (kg). The yield per hectare was calculated in tons per hectare (t/ha) by multiplying the yield per pillar by the number of pillars per hectare. The total soluble solids in the ripened fruit were measured using a hand refractometer and expressed in °Brix. The ascorbic acid level was determined by titrating a known weight of fruit sample with 2, 6-dichlorophenol indophenols dye and oxalic acid, and expressed as mg/100g of fruit pulp. The titratable acidity was determined by titrating the fruit pulp with N/10 NaOH using phenolphthalein as an indicator and expressed as a percentage (%). The data recorded for the parameters was statistically analyzed by following Randomized Block Design (RBD) at 5% level of significance as suggested by Gomez and Gomez (1996).

Result and Discussions

The current result of different treatments affect the growth, yield and qualityof dragon fruit

Growth parameters

Number of new branches per pillar

The data presented Table 1 treatments had wide range of variations in respect of all the characters of growthparameters. All the parameters were influenced significantly due to the effect of various treatments. The data revealed that various treatments significantly enhanced the number of new branches per pillar. The maximum number of new branches per pillar was reported with treatment 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium (12.67, 16, 18.67 and 20.33) at 30, 60, 90 and 120 days after treatment, respectively. The minimum averagevalue in terms of number of new branches per pillar was recorded under the control (4.33, 6.33, 8, 8.33) at 30, 60, 90 and 120 days after treatment, respectively. It clearly indicates the dosage of100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium works better than the other treatments. The results are in accordance with the finding of **Khatun *et al.* (2023)**, **Singh *et al* (2022), Rawat *et al.* (2022)** and **Verma *et al.* (2019)** in dragon fruit.

Plant canopy spread (m²)

The significant differences in the canopy spread were recorded due to application of different combinations of manures and bio-fertilizers. The maximum canopy spread of plant was recorded in 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium treatment (5.10 and 5.27 m^2) at initial and harvest stage which remained at par with 100% N as Vermicompost + Jeevamrut + Panchagavya. It was discovered that the control had minimum plant canopy spread (3.19 and 3.31 m^2) at initial and harvest stage in Table 1. The enhanced plant canopy spread is related to the gibberellin synthesis and presence in vermicompost, Gibberellins encourage cell elongation and division, which in turn causes an increase in the spread of the plantcanopy. The positive effect of vermicompost and bio-fertilizers on plant canopy spread has been reported by **Ghosh *et al.* (2014)** in sweet orange, **Jain *et al.* (2020)** in guava, **Om, P.M. (2020)**in mango and **Rashmi (2019)** in dragon fruit.

Number of flowers per pillar

The maximum number of flowers per pillar (24) were recorded in T7- 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium treatment which remained at par with T6- 100% N as Vermicompost + Jeevamrut + Panchagavya (22.67) in Table 1. It was discovered that the control had minimum number of flowers per pillar. As reported by the earlier researcher, the application of manures and vermicompost combined with biofertilizers producedthe largest number of flowers per pillar and greatly increased the number of microorganisms in the soil. **Khatun *et al.* (2023)** and **Sahu (2023)** also observed the similar results in dragon fruit.

Days taken from flowering to fruit harvesting

The minimum number of days taken from flowering to fruit harvesting was recorded in 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium (29.93) followed by 100% N as Vermicompost + Jeevamrut + Panchagavya (30.45) and 100 % N as Vermicompost (30.79). Whereas maximum number of days taken to fruit picking was recorded in control (35.82) followed by 100% N as FYM. Due to the combined effect of various manuresand bio-fertilizers, the fruit reached a marketable maturity slightly earlier than control. Results obtained are in close conformity with the findings of **(Pushpakumara *et al.* 2005), Parween** *et al.* **(2018**) and **Pandey (2023)** in Dragon fruit.

Table 1 Effect of organic manures and bio-fertilizers on number of new branches per pillar, Number of flower per pillar and Days taken from flowering to fruit harvest of Dragon fruit

Treatments	Number of new branches per pillar				Plant canopy spread (m^2)		Number of flower perpillar	Days taken from flowering to fruit harvest
	30 DAT	30 DAT	30 DAT	30 DAT	Initial	At harvest		
T0-Control (No manures)	4.33	4.33	4.33	4.33	3.19	3.31	16.67	35.82
T1-100 % N as FYM	7.0	7.0	7.0	7.0	4.07	4.18	19.33	32.16
T2-100 % N as FYM + Jeevamrut + Panchagavya	7.67	7.67	7.67	7.67	4.22	4.34	20.00	31.81
T3-100 % N as FYM + NPK Microbial Consortium	8.33	8.33	8.33	8.33	4.32	4.46	20.67	31.99
T4-100 %N as FYM + Jeevamrut + Panchagavya + NPK Microbial Consortium	9.67	9.67	9.67	9.67	4.50	4.63	21.67	31.37
T5-100 % N as Vermicompost	10.33	10.33	10.33	10.33	4.61	4.75	21.33	30.79
T6-100 % N as Vermicompost + Jeevamrut + Panchagavya	12.0	12.0	12.0	12.0	4.86	5.02	22.67	30.45
T7-100 % N as Vermicompost +Jeevamrut + Panchagavya + NPK Microbial Consortium	12.67	12.67	12.67	12.67	5.10	5.27	24.00	29.93
T8-100 % RDF as inorganic	11.33	11.33	11.33	11.33	4.75	4.90	22.00	31.04
Mean	9.25	9.25	9.25	9.25	4.40	4.54	20.92	31.71
SE(m)±	0.417	0.417	0.417	0.417	0.208	0.149	0.578	0.795
C.D. @ 5%	1.262	1.262	1.262	1.262	0.445	0.451	1.749	2.403
C.V. %	8.663	8.742	8.521	8.649	6.023	5.92	4.948	4.286

Physical parameters of fruit

Number of fruits per pillar

Among the treatments, 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium had received highest number of fruits per pillar (19.33) followed by 100% N as Vermicompost + Jeevamrut + Panchagavya and 100% RDF. While the minimum number of fruits (12.33) were observed in control followed by 100 % FYM (15) and 100% N as FYM + Jeevamrut + Panchagavya (15.67). The fact that there were more fruits per pillar might be because vermicompost, a nutrient-rich fertilizer, has raised the soil's concentration of macro and micronutrients. Consequently, their combined application assisted in promoting the plants' vegetative and reproductive phases. The similar results were reported by Choudhary *et al.* (2022) in pomegranate and Rashmi (2019) in dragon fruit.

Length of the fruit (cm)

The maximum fruit length (9.81 cm) was recorded with T7- 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium treatment which remained at par with 100% N as Vermicompost + Jeevamrut + Panchagavya (9.57 cm) but significantly higher than rest of the treatments. On the other hand, minimum fruit length was recorded under T0- control (7.17 cm) in Table 2. This might be because vermicompost increases soil moisture retention and microbial activity, which in turn leads to enhanced enzymatic activity and improved growth parameters, which may have translated into longer fruit. This is in accordance with the results of (Verma *et al.* 2019) and Ayesha (2022) in dragon fruit.

Width of the fruit (cm)

The result showed under T0-control gave minimum width of the fruit (8.64 cm) followed by T1- FYM + Jeevamrut + Panchagavya (7.59 cm) in Table 2. The maximum width of the fruit was recorded in T7- 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium (9.02 cm) followed by T6- 100% N as Vermicompost + Jeevamrut + Panchagavya (8.85 cm). The results are line with Rashmi (2019) and Ayesha (2022) in dragon fruit.

Fruit weight (g)

The maximum fruit weight (390.85 g) was reported in 100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium followed by 100% N as

Vermicompost+ Jeevamrut + Panchagavya (373.2 g) and 100 % RDF (365.61 g) in Table 2. However, minimum fruit weight (312 g) was observed in control followed by 100% N as FYM (330.67 g) and 100% N as FYM + Jeevamrut + Panchagavya (336.81 g) in Table 2. This is because some growth-promoting compounds generated by biofertilizers may have improved root development, water movement, nutrient deposition, and uptake. The present study is in line with the findings of (Pawar *et al.* 2020) in sweet orange, Bindu and Renjan *et al.* (2024) in papaya and Prerna (2023) in dragon fruit.

Peel thickness

The data presented in Table 2 revealed that, highest peel thickness (3.65 mm) was registered in treatment T7-100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium which was found at par with treatment T6-100% N as Vermicompost + Jeevamrut + Panchagavya (3.53 mm) and the least peel thickness (2.32 mm) was recorded in treatment T0- control. IAA and GA3 found in vermicompost, jeevamrut, and panchagavya may have stimulated cell division, wall expansion, meristematic activity, and photosynthetic efficiency in plants, which aid in fruit development and increased peel thickness, as a result of the beneficial effects of a balanced supplement of major and micronutrients. Similar result was reported by Verma *et al.* (2019) and Rashmi (2019) in dragon fruit.

Specific gravity

The data revealed that maximum specific gravity (1.12) of the fruit was recorded in treatment T7-100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium followed by T6-100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium and T8-100 % RDF, while the minimum specific gravity (0.91) of fruit was reported under T0-control in Table 2 . Similar findings were observed by Pandey (2023) and Ayesha (2022) in dragon fruit.

Table. 2 Effect of organic manures and bio-fertilizers on Number of fruit per pillar, length, width, weight, Peel thickness and Specific gravity of the dragon fruit

Treatments	**Number of fruits per pillar**	**Length of the fruit (cm)**	**Width of the fruit (cm)**	**Fruit weight (gm)**	**Peel thickness (mm)**	**Specific gravity**
T0-Control (No manures)	12.33	7.17	6.36	312.0	2.32	0.91
T1-100 % N as FYM	15.0	8.3	7.59	330.67	2.70	0.97
T2-100 % N as FYM + Jeevamrut + Panchagavya	15.67	8.54	7.82	336.81	2.85	1.0
T3-100 % N as FYM + NPK Microbial Consortium	16.0	8.68	8	339.37	2.96	1.02
T4-100 %N as FYM + Jeevamrut + Panchagavya + NPK Microbial Consortium	17.33	9.2	8.4	354.3	3.09	1.05
T5-100 % N as Vermicompost	17.0	8.98	8.25	345.29	3.24	1.07
T6-100 % N as Vermicompost + Jeevamrut + Panchagavya	18.33	9.57	8.85	373.2	3.53	1.10
T7-100 % N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium	19.33	9.81	9.02	390.85	3.65	1.12
T8-100 % RDF as inorganic	18.0	9.43	8.64	365.61	3.38	1.09
Mean	16.55	8.853	8.103	349.78	3.08	1.036
SE(m)±	0.51	0.248	0.238	8.380	0.093	0.026
C.D. @ 5%	1.542	0.749	0.719	25.340	0.281	0.079
C.V. %	5.569	4.986	5.237	4.263	5.485	4.442

Yield parameters

Fruit yield per pillar (kg/piller)

The application of various manures and bio-fertilizers were significantly improved the fruit yield per pillar as compared to control during the fruiting season in Table 3. The pillars fertilized with 100%N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium gave the highest fruit yield (7.55 kg/ piller) followed by 100% N as Vermicompost + Jeevamrut + Panchagavya (6.84 kg/ piller) and 100% N as Vermicompost (6.58 kg/ piller) . This is because the plant has more readily available nutrients and a higher level of various endogenous hormones as a result of applying vermicompost, jeevamrut and panchagavya. These factors may have improved flowering and pollen germination, which in turn increased the number of fruits per plant and the set of fruits, which may have directly affected the fruit yield. The present study is in line with the findings of **(Rathod *et al.* 2022)** in Mango, **Khatun *et al.* (2023)** and **Rashmi (2019)** in Dragon fruit.

Fruit yield per hectare (t/ha.)

The maximum fruit yield per hectare (8.38 t/ha) was recorded under the treatment T7 100%N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium followed by T6 100% N as Vermicompost + Jeevamrut + Panchagavya and T8 100 % RDF (7.6 and 7.31 t/ha, respectively), whereas minimum fruit yield (4.26 t/ha) was recorded under control treatment during field experiment. Improved physical, chemical, and biological qualities of the soil led to a greater supply of plant nutrients that were mobilized and solubilized, which in turn produced good crop development and yield. Higher yield response resulting from application of organic manures coupled with bio-fertilizers is attributed to these improved features. These results are inconformity with the findings of **(Dwivedi *et al.* 2010)** in Guava, **Khatun *et al.* (2023), Then (2014)** and **Rashmi (2019)** in Dragon fruit.

Qualitative parameters

Total Soluble Solid

The data presented in Table 3 revealed that, maximum total soluble solid (14.17° B) was recorded in Dragon fruit with T7-100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium followed by T6 (13.68° B) and T8 (13.41° B), while minimum total soluble solid (10.15° B) was recorded in T0-control. Because to the use of micronutrient-rich vermicompost and biofertilizers, beneficial soil microbes such as bacteria that fix nitrogen and phosphate, as well as growth hormones including auxins, gibberellins, and cytokinins, have been found. Its porosity, aeration, drainage, and water-holding capacity are exceptionally good (Shina *et al.* 2013). The TSS content of fruits could have increased if these growth hormones had stimulated GA production and prevented GA inactivity. Mehraj *et al.* (2014) reported that availability of micronutrients through vermicompost increased sweetness along with other chemical characters in strawberry. The present study is in line with the findings of (Changotra *et al.* 2017) in strawberry, Kumar and Kumar (2014) in mango, Choudhary *et al.* (2023) in pomegranate and Rashmi (2019) in Dragon fruit.

Ascorbic acid content

Maximum ascorbic acid content (8.74 mg/100g) in fruit was found with T7-100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium followed by T6-100% N as Vermicompost + Jeevamrut + Panchagavya and T8- 100% RDF (8.39 and 8.02 mg/100g respectively), while minimum ascorbic acid content (5.11 mg/100g) in fruit was found under T0- control. Similar results were reported by Patidar *et al.* (2018) in Cape gooseberry, Prerna (2023) and Sahu (2023) in Dragon fruit.

Titratable acidity

The result showed in Table 3 that the minimum titratable acidity (0.24%) was recorded in the treatment T7-100% N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium followed by treatment T6 (0.25%), while the maximum value (0.39 %) was noticed in T0-control and was found on par (0.34 %) with treatment T1. When various organic manures were applied in conjunction with bio fertilizers, the titratable acidity of fruits decreases. This could be because micronutrients have a beneficial effect on the conversion of acids into sugar and their derivatives through the glycolytic pathway or be employed in respiration. This may be the possible reason behind decrease fruit acidity as the acidity of fruit is inversely proportional to TSS (Singh *et al.* 2010). Similar results were also reported by Pandey (2023) and Prerna (2023) in Dragon fruit.

Table 3 Effect of organic manures and bio-fertilizers on Fruit yield per pillar (kg) and Fruit yield (t/ha), TSS, Ascorbic acid and Titratable acidity of Dragon fruit

Treatments	**Fruit yield per pillar (kg)**	**Fruit yield (t/ha)**	**T.S.S. (⁰Brix)**	**Ascorbic acid (mg/100gm)**	**Titratable acidity (%)**
T0-Control (No manures)	3.84	4.26	10.15	5.11	0.39
T1-100 % N as FYM	4.96	5.51	11.74	6.43	0.34
T2-100 % N as FYM + Jeevamrut + Panchagavya	5.27	5.85	11.91	6.69	0.32
T3-100 % N as FYM + NPK Microbial Consortium	5.43	6.03	12.37	7.25	0.31
T4-100 %N as FYM + Jeevamrut + Panchagavya +NPK Microbial Consortium	6.14	6.82	12.82	7.57	0.30
T5-100 % N as Vermicompost	5.87	6.52	13.26	7.83	0.28
T6-100 % N as Vermicompost + Jeevamrut +Panchagavya	6.84	7.60	13.68	8.39	0.25
T7-100 % N as Vermicompost + Jeevamrut + Panchagavya + NPK Microbial Consortium	7.55	8.38	14.17	8.74	0.24
T8-100 % RDF as inorganic	6.58	7.31	13.41	8.02	0.26
Mean	5.83	6.475	12.612	7.336	0.29
SE(m)±	0.201	0.225	0.365	0.238	0.013
C.D. @ 5%	0.609	0.68	1.104	0.718	0.039
C.V. %	5.171	5.888	7.047	5.888	7.047

Conclusion

The study demonstrates that the application of treatment 100% N as Vermicompost +Jeevamrut + Panchagavya + NPK Microbial Consortium (T7) was found significantly superior in terms of number of new branches per pillar, plant canopy spread (m^2), number of flower per pillar, number of fruits per pillar, length of the fruit (cm), width of the fruit (cm), fruit weight (g), peel thickness (mm), specific gravity, fruit yield per pillar (kg), fruit yield per hectare (t), TSS (ºBrix), ascorbic acid content (mg/100 g) highlight the positive impact of organic manures and bio-fertilizers. Additionally, the reduction in flowering-to-harvest duration and titratable acidity underscores their effectiveness in enhancing fruit development. These findings confirm the potential of organic bio-fertilizer combinations to boost productivity while promoting sustainable eco-friendly horticultural practices.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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