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Bojan A
Department of Fruit Science, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu, Tamil Nadu, India

B Gopu
Department of Fruit Science, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu, Tamil Nadu, India

V Gopi
Department of Fruit Science, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu, Tamil Nadu, India

R Angelin Silviya
Department of Soil Science and Agricultural Chemistry, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu, Tamil Nadu, India

Corresponding Author:
B Gopu
Department of Fruit Science, SRM College of Agricultural Sciences, SRM Institute of Science and Technology, Baburayanpettai, Chengalpattu, Tamil Nadu, India

Integrated application of organic manures and rhizosphere bioinoculants enhances yield in white-fleshed dragon fruit (*Selenicereus undatus*)

Bojan A, B Gopu, V Gopi and R Angelin Silviya

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Abstract
The study of standardization of organic amendments for dragon fruit (*Selenicereus undatus*) cultivation under Chengalpattu conditions this research was conducted at the farmer field at Vadamanipakkam Village on Chengalpattu district, Tamil Nadu during 2024-2025, the experiment trail have been conducted in RBD with 3 replication using 9 different treatments *viz.*, T_1 = Control, T_2 = 100 per cent N through poultry manure, T_3 = 100 per cent N through poultry manure + AM fungi @ 25 g/pillar, T_4 = 100 per cent N through poultry manure + PSB @ 10 ml/pillar, T_5 = 100 per cent N through poultry manure + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar, T_6 = 100 per cent N through vermicompost, T_7 = 100 per cent N through vermicompost + AM fungi @ 25 g/pillar, T_8 = 100 per cent N through vermicompost + PSB @ 10 ml/pillar, T_9 = 100 per cent N through vermicompost + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar. Among all treatments, the combination of 100 per cent N through poultry manure + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar (T_5) consistently recorded superior results in new shoot length, areole distance, new branches per pillar, flower length, and yield per pillar.

Keywords: Dragon fruit, PSB, Poultry manure, VAM, Vermicompost

1. Introduction

Dragon fruit (*Selenicereus undatus*), commonly known as pitaya or pitahaya and also referred to as strawberry pear, queen of the night, belongs to the Cactaceae family. It is a recently introduced superfruit in India, where it is popularly known as Kamalam. It is a fast-growing perennial climbing cactus that originates from Mexico and parts of South America. It thrives in warm climates and performs well in semi-arid tropical environments, making it suitable for cultivation in both tropical and subtropical regions. Dragon fruit is classified as a non-climacteric fruit, which does not undergo significant ripening after harvest. This fruit has quickly gained popularity among farmers due to its vibrant appearance, soft white pulp filled with edible black seeds, and various nutritional values and health benefits.

Dragon fruit cultivation has been expanding in several countries, including Nicaragua, Colombia, Vietnam, Australia, the United States, Thailand, Taiwan and Malaysia (Merten, 2003; Jamilah *et al.,* 2011) [20, 14]. Dragon fruit is a long-day plant that produces large fragrant flowers, which bloom at night. One of the unique advantages of dragon fruit is its compatibility with organic farming, as it can be grown without relying on chemical pesticides or synthetic fertilizers. This makes it a promising fruit crop for organic cultivation and an attractive option in health-conscious and export-oriented markets. In fact, due to increasing international demand for organically grown fruits, many countries have shifted towards using organic inputs for dragon fruit production, creating export opportunities for India.

Organic farming, also known as eco-farming or biological farming, offers an environmentally sustainable alternative to conventional agriculture. It emphasizes the use of organic inputs such as farmyard manure (FYM), vermicompost, poultry manure, sheep and goat manure, and compost, along with liquid organic manures like cow urine, panchagavya, vermiwash, bio-digested liquids, jeevamruta, and biofertilizers including PSB, VAM, *Azotobacter* and *Rhizobium*. These inputs play a vital role in promoting long-term productivity and efficient utilization of on-farm resources (Singh *et al.,* 2004; Singh and Singh, 2004; Singh *et al.*, 2011 and Siddiqua *et al.*, 2024) [29, 27, 28, 26]. Organic manures such as poultry manure or well-decomposed compost are being used for improving the growth and quality of fruits by producing phytohormones and enhancing the uptake of plant nutrients, thus helping in sustainable crop production through the maintenance of soil fertility and productivity (Singh *et al.*, 2011) [28]. The combined application of organic manures and biofertilizers has been reported to result in better crop yields compared to individual treatments (Verma *et al.*, 2019) [31].

Vermicompost provides essential macronutrients, beneficial microorganisms and growth-promoting hormones that collectively enhance plant growth, development and overall productivity (Gopu *et al.*, 2022 and Hariwinsrimedha *et al.*, 2025) [7, 10]. Similarly, both vermicompost and poultry manure are excellent sources of macro- and micronutrients that can improve soil productivity when used in conjunction with biofertilizers and crop residues (Singh *et al.*, 2011) [28]. Vermicompost serve as a chelating agents and regulate the availability of micronutrient to plants, thereby increases the growth and yields by provide nutrient in a available form (Suresh *et al.*, 2022) [30]. Despite its growing importance, scientific literature on the nutritional management of dragon fruit using organic inputs remains scarce, as it is a relatively new crop under commercial cultivation. Therefore, it is essential to explore the potential of organic manures and biofertilizers in enhancing the growth, flowering, and yield performance of dragon fruit. Hence, the present investigation was undertaken to assess the effect of organic manures and biofertilizers on the growth, flowering and yield of white-fleshed dragon fruit.

Materials and Methods

The experiment was conducted in the farmer's field at Vadamanipakkam Village, Madhurantagam Taluk, located 15 kms away from SRM College of Agricultural Sciences, Chengalpattu, Tamil Nadu. The area is between 12°21'52"N latitude and 79°39'58"E longitude. Annual rainfall in the area is about 91.7 mm. The soil in the experimental area was sandy loam. The research experiment was carried out from February to July. The dragon fruit plants, aged seven years, were established at a spacing of 3 × 3 m, with each concrete pillar supporting four individual plants. The experimental setup followed a Randomized Block Design (RBD), consisting of nine treatments and three replications. These poultry manure, vermicompost, AM fungi, and PSB were applied as per treatments. The treatments are T_1: Control, T_2: 100 per cent N through poultry manure, T_3: 100 per cent N through poultry manure + AM fungi @ 25 g/pillar, T_4: 100 per cent N through poultry manure + PSB @ 10 ml/pillar, T_5: 100 per cent N through poultry manure + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar, T_6: 100 per cent N through vermicompost, T_7: 100 per cent N through vermicompost + AM fungi @ 25 g/pillar, T_8: 100 per cent N through vermicompost + PSB @ 10 ml/pillar and T_9: 100 per cent N through vermicompost + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar. The observations were recorded for new shoot length (cm), distance between areoles (cm), new shoot circumference (cm), number of new branches per pillar, number of flowers per pillar, flower length (cm), flower breadth (cm) and yield per pillar (kg). The experimental data were statistically analyzed using the General R-Based Analysis Platform Empowered by Statistics (GRAPES), which was developed by the Department of Agricultural Statistics at Kerala Agricultural University, Kerala (www.kaugrapes.com). The analysis of variance (ANOVA) was carried out to compare treatment means at a significance level of $P \leq 0.05$.

Results and Discussion

Effect of organic manures and rhizosphere bioinoculants on new shoot length (cm) in dragon fruit

The new shoot length is found to be maximum in T_5 (100 per cent N through poultry manure + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar) followed by T_3 (100 per cent N through poultry manure + AM fungi @ 25 g/pillar) while, the treatment T_1 (control) registered the lowest new shoot length (Table 1.). The increase in length of the new shoot with the application of poultry manure, which supplies nitrogen to the soil and bio-fertilizers, may be due to the stimulatory activity of microflora in the rhizosphere, which has led to the availability of nutrients and vigorous growth of the plant. The increase in plant growth parameters might have also been due to the build-up of colonies with the applied bio-fertilizer (PSB and AM fungi) inoculates and their growth-promoting substances, as reported by Kumar *et al.* (2019) [17] in dragon fruit, Binepal *et al.* (2013) [3] in guava and Ghosh *et al*. (2014) [6] in orange.

Effect of organic manures and rhizosphere bioinoculants on the distance between areoles in dragon fruit

The treatment T_5 (100 per cent N through poultry manure + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar) recorded the highest areoles distance, followed by T_3 (100 per cent N through poultry manure + AM fungi @ 25 g/pillar) while, the treatment T_1 (control) registered the lowest areoles distance (Table 1.). It was due to the poultry manure supported higher nutrient availability, in turn supporting higher accumulation of photosynthates in the plant enriched by AM fungi and PSB, solubilizing and mobilizing the organic form of nutrients from the fixed form of soil, which ultimately contributed to increased shoot length, which in turn gives better distance between areoles. This result might be due to an increase in the length of the cladode may influence the improvement of the distance between areoles. This outcome was closer confirmatory with the findings of Sandoval *et al.* (2009) [24] and Flavio (2010) [4] in their investigation on vegetative traits of dragon fruit.

Effect of organic manures and rhizosphere bioinoculants on the new shoot circumference in dragon fruit

The circumference of the new shoot increased across the various treatments, with the highest circumference (11.90 cm) observed in treatment T_9 (100% nitrogen supplied through vermicompost, combined with AM fungi at 25 g/pillar and PSB at 10 ml/pillar), followed by T_8. The lowest new shoot circumference was recorded in the control (T_1) (Table 1). This increase in circumference under T_9 and T_8 could be attributed to the synergistic effect of vermicompost and bio-fertilizers, which likely improved soil fertility. The bio-fertilizers also aided in nutrient solubilization and mobilization, contributing to enhanced new shoot circumference. Additionally, the shorter shoot length in T_9 and T_8 may have further facilitated the increase in circumference. The results conform with the studies of Kumar *et al.* (2019) [17] and Siddiqua *et al.* (2024) [26] in dragon fruit, Kumar and Kumar (2013) [16] in mango and Hebbera *et al*. (2006) [11] in sapota.

Effect of organic manures and rhizosphere bioinoculants on the new branches per pillar in dragon fruit

In the present study the maximum new branches per pillar was observed in treatment T_5 (100 per cent N through poultry manure + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar) followed by T_9 (100 per cent N through vermicompost + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar) and minimum new branches per pillar was recorded in control (T_1) (Table 1). This might be due to the fact that the presence of vermicompost around the plants throughout the period of growth, which is a source of humus, N- N-fixers and nutrients, might have resulted in the higher values of vegetative parameters. This increase in the branches and canopy spread may be due to the direct role in plant nutrition as poultry manure has high nitrogen that improves vegetative growth and makes nutrients available to the plant. These results are in accordance with Kakehzadeh *et al*. (2014) [15] in apple, Ibe *et al*. (2011) [12] in citrus and Marathe *et al*. (2017) [19] in pomegranate.

Table 1: Effect of organic manures and rhizosphere bioinoculants on growth characters of dragon fruit in dragon fruit

Treatments	New shoot length (cm)	Distance between areoles (cm)	New shoot circumference (cm)	Number of new branches per pillar
T_1	51.00	4.10	10.80	15.60
T_2	58.00	4.30	11.10	16.50
T_3	61.00	4.40	11.40	18.00
T_4	57.00	4.30	11.20	17.20
T_5	63.00	4.50	11.30	22.00
T_6	55.10	4.20	11.10	18.00
T_7	59.00	4.30	11.50	18.20
T_8	55.00	4.30	11.70	18.10
T_9	60.00	4.30	11.90	20.50
SE (d)	0.929	0.059	0.18	0.389
CD (0.05)	1.970	0.125	0.382	0.825

Effect of organic manures and rhizosphere bioinoculants on the number of flowers per pillar in dragon fruit

The number of flowers per pillar differed significantly by the application of farm yard manure. Plants supplied with 100% nitrogen through vermicompost along with biofertilizer (PSB and VAM) application per pillar recorded the maximum number of flowers (30.52), and the minimum number of flowers was recorded in the control (T_{11}) (Table. 2). This might be due to an increase in photosynthate production due to phosphorus contents in vermicompost, which helped to break bud dormancy and increased flowering sites. These results are identical to the results obtained by Ali *et al.* (2003) [1] Strawberry, Sharma and Pruthi (2007) [25] in strawberry. Additionally, the use of biofertilizers aids plants in producing more dehydrogenase, alkaline phosphatase, nitrogenase, and hydrolysis enzymes. This encourages more flowering and fruit retention because photosynthates are produced and supplied at critical levels, which results in more flowering and fruit retention. The outcomes are also in close conformity with the findings of Goswami *et al.* (2012) [8] in guava and Hari *et al.* (2010) [9] in *ber*.

Effect of organic manures and rhizosphere bioinoculants on the length and breadth of flowers in dragon fruit

In the present study, the highest length of flower was recorded in the treatment $T_{5,}$ followed by T_3 and was on par with T_9. However, the least was recorded by T_1 (Table 2). Moreover, the breadth of the flower was highest recorded by 100% nitrogen supplied through vermicompost, combined with AM fungi at 25 g/pillar and PSB at 10 ml/pillar (T_9), followed by T_7. However, the treatment control (T_1) recorded the lowest breadth of flower (Table 2). However, the increased nutrient availability from the organic manures and bio-fertilizers has increased various endogenous hormonal levels in the plant tissues, which were present in worm castings (vermicompost/poultry manure), which might be responsible for enhanced tube growth, which ultimately little difference in the length and breadth of the flower. The above results conform with the findings of Perween and Hasan (2018) [21] in Dragon fruit and Yadav *et al*. (2011) [32] in Mango.

Effect of organic manures and rhizosphere bioinoculants on the yield per pillar in dragon fruit

The application of different organic amendments significantly influenced the yield per pillar. The maximum yield per pillar was recorded in T_5 (100 per cent N through poultry manure + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar) followed by T_9 (100 per cent N through vermicompost + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar) and minimum yield per pillar was recorded in control (T_1) (Table. 2). Organic amendments like poultry manure and vermicompost are rich sources of essential nutrients, particularly nitrogen, and also improve soil physical, chemical, and biological properties. Poultry manure generally releases nutrients faster than vermicompost, making them more readily available to plants. The addition of AM fungi enhances the root system's ability to uptake water and nutrients, especially phosphorus, thus promoting better plant growth and yield. The PSB further assists by converting insoluble forms of phosphorus in the soil into forms that plants can absorb. Therefore, the combination of these organic amendments with beneficial microbes leads to improved nutrient availability and uptake, resulting in significantly higher yields. Among the treatments, T_5 showed the maximum yield, likely because poultry manure provides more readily available nutrients compared to vermicompost, and the synergistic effect of AM fungi and PSB further boosted nutrient uptake and plant productivity. However, these organic inputs facilitated the mobilization of essential micronutrients and phosphate in the soil towards the plants, leading to improved flowering. The obtained results are consistent with the findings of Perween and Hasan (2018) [21] in dragon fruit. These results are in conformity with the observations made by Ram and Pathak (2007) [23] in sweet orange, Ram *et al.* (2007) [22] and Manojkumar *et al.* (2025) [18] in in guava and Garhwal *et al.*

(2014) [5] in kinnow mandarin, Sharma and Pruthi (2007) [25] and Iqbal (2009) [13] in Strawberry and Babu and Sharma (2005) [2] in banana.

Table 2: Effect of organic manures and rhizosphere bioinoculants on flowering and yield characters in dragon fruit

Treatments	Number of flowers pillar	Length of flower (cm)	Breadth of flower (cm)	Yield per pillar (kg)
T_1	22.60	23.90	10.70	4.28
T_2	26.30	25.10	10.90	5.85
T_3	28.60	26.30	10.90	6.67
T_4	29.50	25.80	10.80	7.03
T_5	31.30	26.50	11.20	8.25
T_6	28.00	25.00	10.40	5.86
T_7	30.00	26.10	11.80	6.89
T_8	29.00	25.70	11.70	7.08
T_9	30.50	26.20	12.60	7.83
SE (d)	0.417	0.53	0.221	0.144
CD (0.05)	0.885	1.124	0.469	0.305

Conclusion

The application of organic manures and rhizosphere bioinoculants significantly enhanced the vegetative growth, flowering characteristics, and yield of dragon fruit compared to the control. Among all treatments, the combination of 100 per cent N through poultry manure + AM fungi @ 25 g/pillar + PSB @ 10 ml/pillar (T_5) consistently recorded superior results in new shoot length, areole distance, new branches per pillar, flower length, and yield per pillar. Vermicompost-based treatments, especially when combined with the same bio-inoculants (T_9), most effectively improved new shoot circumference, flower breadth, and also contributed to increased yields. The observed benefits are attributed to improved nutrient availability, promoted by the rapid nutrient release from poultry manure and the sustained release from vermicompost. The synergistic action of AM fungi and PSB further enhanced nutrient uptake, especially phosphorus, resulting in vigorous plant growth, better flowering, and higher yields. These results highlight the importance of integrating organic manure with beneficial soil microbes to sustainably boost dragon fruit productivity and overall plant health.

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