



Plant Archives

Journal homepage: <http://www.plantarchives.org>

DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.2.048>

STANDARDIZATION OF NUMBER OF PLANTS PER POLE IN DRAGON FRUIT (*Hylocereus* SPP.): A MULTI LOCATION STUDY IN ASSAM, INDIA

Bhoirab Gogoi^{1*}, Shourov Dutta², Lipika Nath³, Puja Basumatary⁴, Sukanya Gogoi⁵, Dorodi Priyom Duarah⁶, Jyotsna Das⁷, Rocktim Baruah⁸, Amrita Khound Sharmah⁹, Utpal Kotoky¹⁰ and Manoranjan Neog¹¹

¹Krishi Vigyan Kendra, Jorhat, Assam Agricultural Univeristy, Teok - 785 112, Assam, India.

²Krishi Vigyan Kendra, Karbi Anglong, Assam Agricultural Univeristy, Diphu-782 462, Assam, India.

³Krishi Vigyan Kendra, Barpeta, Assam Agricultural Univeristy, Howly-781 316, Assam, India.

⁴Krishi Vigyan Kendra, Kokrajhar, Assam Agricultural Univeristy, Gossaigaon-783 360, Assam, India.

⁵Krishi Vigyan Kendra, Morigaon, Assam Agricultural Univeristy, Jhargaoon-782 411, Assam, India.

⁶Krishi Vigyan Kendra, Kamrup, Assam Agricultural Univeristy, Ganakpara-781 017, Assam, India.

⁷Krishi Vigyan Kendra, Lakhimpur, Assam Agricultural Univeristy, Boichagarumaria-787 032, Assam, India.

⁸Krishi Vigyan Kendra, Golaghat, Assam Agricultural Univeristy, Khumtai-785 619, Assam, India.

⁹Krishi Vigyan Kendra, Darrang, Assam Agricultural Univeristy, Gelaidingi-784 146, Assam, India.

¹⁰Department of Horticulture, College of Agriculture, Assam Agricultural Univeristy, Jorhat-785 013, Assam, India.

¹¹Director of Extension Education, College of Agriculture, Assam Agricultural Univeristy, Jorhat-785 013, Assam, India.

*Corresponding author E-mail : bhoirab.aau@gmail.com

(Date of Receiving-22-05-2026; Date of Revision-28-07-2026; Date of Acceptance-16-08-2026)

ABSTRACT

Dragon fruit (*Hylocereus* spp.) has emerged as a promising high-value fruit crop in India due to its adaptability, nutritional value and increasing market demand. However, standardized cultivation practices for maximizing productivity under Indian agro-climatic conditions remain limited. The present study entitled “Standardization of Number of Plants per Pole in Dragon Fruit” was conducted across eight Krishi Vigyan Kendras (KVKs) in Assam during 2021 to 2025 to evaluate the effect of different planting densities per support pole on vegetative growth, fruit characteristics, yield and economics. The experiment was laid out in a Randomized Block Design (RBD) with three treatments comprising two plants per pole (T_1), three plants per pole (T_2) and four plants per pole (T_3). Observations were recorded over four years. The results revealed significant variations among treatments for vegetative growth, fruit yield and economic returns. Treatment T_2 (three plants per pole) recorded the highest average fruit weight (269.32 g), number of branches (12.88), stem diameter (7.96 cm), pulp-to-peel ratio (4.06) and fruit yield (132.64 q/ha). T_2 also exhibited the shortest duration from anthesis to harvesting (25.36 days) and the highest benefit-cost ratio (3.41). Although, T_3 produced a greater number of fruits per pole, the fruit size and overall quality were comparatively lower. The study concluded that planting three dragon fruit plants per pole is the most suitable planting density for achieving higher productivity and profitability under Assam conditions.

Key words : Dragon fruit, *Hylocereus* spp., Planting density, Pole system, Yield, B:C ratio, Assam.

Introduction

Dragon fruit (*Hylocereus* spp.), commonly known as Pitaya or Strawberry pear, is a climbing cactus belonging to the family Cactaceae (Mizrahi, 2014; Le Bellec *et al.*, 2006). The crop is gaining popularity in

tropical and subtropical regions due to its attractive fruit appearance, high nutritional value, medicinal properties and excellent market potential (Esquivel and Araya, 2012; Wu *et al.*, 2006). Dragon fruit contains vitamins, antioxidants, dietary fiber and minerals, making it highly valued among health-conscious consumers.

In India, commercial cultivation of dragon fruit has expanded rapidly in recent years, particularly in northeastern states because of favourable climatic conditions (Singh and Sharma, 2018; ICAR, 2021). However, scientific information regarding optimum cultivation practices under Indian conditions is still inadequate. Among the major agronomic factors influencing growth and productivity, the number of plants maintained per support pole plays a crucial role in canopy development, nutrient competition, fruit quality and yield (Patel and Patel, 2019).

Dragon fruit plants are generally trained on concrete or cement poles for support. Farmers often adopt different planting densities per pole without scientific recommendations, resulting in inconsistent productivity. Therefore, identifying the optimum number of plants per pole is essential for efficient utilization of space, better light interception and increased economic returns. The present investigation was undertaken to standardize the number of plants per pole in dragon fruit under Assam conditions through a coordinated multi-location trial involving several Krishi Vigyan Kendras of Assam.

Materials and Methods

Experimental location

The experiment was conducted during 2021 to 2025 across eight Krishi Vigyan Kendras (KVKs) in Assam, India, viz.,

1. KVK, Kokrajhar
2. KVK, Morigaon
3. KVK, Golaghat
4. KVK, Karbi Anglong
5. KVK, Barpeta
6. KVK, Kamrup
7. KVK, Baksa
8. KVK, Lakhimpur

These locations represented diverse agro-climatic conditions of Assam.

Experimental Design

The experiment was laid out in a Randomized Block Design (RBD) with three treatments and eight replications.

Treatments

- T_1 : 2 plants per pole
- T_2 : 3 plants per pole
- T_3 : 4 plants per pole

Crop details

The experiment was conducted using a pink-fleshed dragon fruit variety, which is widely cultivated because of its superior fruit quality, attractive pulp colour, higher market demand and better adaptability under tropical and subtropical climatic conditions. The crop was established under a pole training system, which is the standard method adopted for commercial dragon fruit cultivation. The plants were spaced at 2.5 m $\times$ 2.5 m $\times$ 3.0 m to provide sufficient space for canopy expansion, sunlight penetration, aeration and intercultural operations. Proper spacing is essential in dragon fruit cultivation because overcrowding may reduce light interception and increase competition for nutrients and moisture. Concrete support poles having a height of 1.8 m were used for training the plants. Dragon fruit is a climbing cactus and requires external support for proper growth and fruiting. The pole system facilitates upright growth, encourages branching at the top canopy, improves flowering and fruit set and simplifies management practices such as pruning, harvesting and nutrient application. The planting materials used in the experiment were healthy, vigorous and disease-free rooted cuttings collected from established mother plants. Vegetative propagation through stem cuttings was adopted because it ensures true-to-type plants, early establishment, uniform growth and quicker bearing compared to seed propagation. The cuttings were allowed to cure before planting in order to reduce the chances of fungal infection and rotting.

Uniform seedlings prepared from cuttings were planted near the concrete support poles and trained properly to promote healthy vegetative growth and canopy formation. Proper care was taken during planting to maintain uniformity in plant size and vigor across all treatments. The study evaluated three different planting densities per pole, namely two plants per pole (T_1), three plants per pole (T_2) and four plants per pole (T_3), in order to determine the optimum number of plants that can maximize growth, yield, fruit quality and economic returns under Assam conditions.

Manure and Fertilizer application

Proper nutrient management practices were followed throughout the experimental period to ensure healthy vegetative growth, flowering and fruit development in dragon fruit plants. Organic manure in the form of well-decomposed farmyard manure (FYM) along with recommended doses of inorganic fertilizers was applied uniformly in all treatments. During the first year, FYM @ 10 kg per plant and Urea, Single Super Phosphate (SSP) and Muriate of Potash (MOP) @ 70:90:40 g per plant were applied in two equal splits at the third and

sixth month after planting. From the second year onwards, the fertilizer dose was increased to FYM @ 15 kg per plant along with Urea, SSP and MOP @ 150:150:300 g per plant. These fertilizers were applied in three equal splits during April, July–August and December. Balanced application of nutrients helped in maintaining vigorous growth, improved flowering, enhanced fruit development and increased yield performance of the crop.

General observations

The following observations were common across all experimental stations:

Table 1 : General observations across the stations.

S. no.	Parameter	Observation
1	Time from planting to flowering	18 months
2	Onset of flowering	April to May
3	Flowering duration	Up to November
4	Number of flowering flushes/year	4 to 5
5	Bud initiation to flowering	18 to 21 days
6	Time of anthesis	7:30 to 8:30 pm
7	Duration of anthesis	4 to 6 hours
8	Anthesis to dehiscence	7 to 9 hours
9	Flowering to harvesting	27 to 30 days
10	Fruit TSS	12.3 to 12.8°B

Parameters recorded

The following parameters were recorded during the study:

- Plant height (cm)
- Number of branches
- Stem diameter (cm)
- Fruit length (cm)
- Fruit breadth (cm)
- Fruit volume (cc)
- Days from anthesis to harvest
- Average fruit weight (g)
- Number of fruits per pole
- Pulp-to-peel ratio
- Yield per pole (kg)
- Yield per hectare (q/ha)
- Benefit-cost ratio

Results and Discussion

Vegetative Growth Parameters

Plant height : Plant height increased progressively over the years under all treatments. During the fourth

year, T₃ recorded the maximum plant height (268.20 cm), followed closely by T₂ (259.31 cm), whereas T₁ recorded the minimum height (241.36 cm). The higher plant height in T₃ may be attributed to greater plant density and competition for light, which encouraged vertical growth (Patel and Patel, 2019).

Number of branches : The number of branches is an important indicator of canopy development and fruit-bearing potential (Nerd and Mizrahi, 1997). T₂ recorded the highest number of branches (12.88) in the fourth year, indicating balanced vegetative growth and better canopy architecture.

Stem diameter

Stem diameter significantly differed among treatments. T₂ recorded the highest stem diameter (7.96 cm) during the fourth year, followed by T₁ (7.72 cm) and T₃ (7.16 cm). Greater stem diameter may reflect improved nutrient uptake and structural strength under balanced planting density conditions (Kumar *et al.*, 2020).

Fruit characteristics

Fruiting was observed from 2nd Years after planting.

Fruit length and breadth

Fruit length did not show significant differences among treatments. However, T₂ consistently produced slightly larger fruits. Fruit breadth was significantly higher under T₂ during the third year.

Fruit volume

Fruit volume was highest in T₂ during all years of observation, indicating improved assimilate partitioning and fruit development (Le Bellec *et al.*, 2006). During the fourth year, T₂ recorded 278.22 cc fruit volume, indicating superior fruit development.

Days from Anthesis to harvest

T₂ showed the shortest duration from anthesis to harvesting (25.36 days) during the fourth year, indicating faster fruit maturity.

Average Fruit weight

Average fruit weight increased with plant age. T₂ recorded the highest fruit weight (269.32 g) during the fourth year, while T₃ recorded the lowest (226.76 g).

Number of Fruits per pole

The maximum number of fruits per pole was recorded under T₃ (34.8 fruits) during the fourth year due to higher planting density. However, individual fruit size was comparatively lower.

Yield parameters

Table 2 : Effect of number of plants per pole on vegetative characters.

Treatments	Plant height (cm)				Number of branches				Stem diameter (cm)			
	1 st year	2 nd year	3 rd year	4 th year	1 st year	2 nd year	3 rd year	4 th year	1 st year	2 nd year	3 rd year	4 th year
T ₁	142.68	207.39	220.23	241.36	5.84	6.99	8.02	10.36	3.53	4.01	6.43	7.72
T ₂	161.54	235.21	251.25	259.31	7.02	8.28	11.88	12.88	3.67	4.11	6.75	7.96
T ₃	167.87	236.94	267.47	268.20	7.42	8.23	9.96	11.83	3.65	4.20	6.63	7.16
SEd	3.6	6.32	3.15	3.24	1.36	1.61	2.87	1.06	-	0.21	-	0.26
CD(5%)	12.42	14.77	14.16	11.31	1.44	1.89	3.12	2.32	NS	0.47	NS	0.65

Table 3 : Effect of number of plants per pole on fruit characters.

Treatments	Fruit length (cm)			Fruit Breadth (cm)			Fruit volume (cc)		
	2 nd year	3 rd year	4 th year	2 nd year	3 rd year	4 th year	2 nd year	3 rd year	4 th year
T ₁	9.41	9.62	9.67	8.01	7.94	8.10	261.12	266.4	272.36
T ₂	9.57	9.66	9.68	8.75	8.65	8.77	262.22	273.15	278.22
T ₃	9.59	9.52	9.37	8.46	8.27	8.37	236.45	248.05	267.08
S.Ed	-	-	-	-	0.05	-	5.28	5.22	3.26
CD(5%)	NS	NS	NS	NS	0.12	NS	12.31	11.19	9.66

Table 4 : Days from Anthesis to harvest and fruit yield per pole.

Treatments	Days from anthesis to harvest			Average fruit weight (g)			No. of fruits per pole		
	2 nd year	3 rd year	4 th year	2 nd year	3 rd year	4 th year	2 nd year	3 rd year	4 th year
T ₁	34.15	31.51	25.60	211.17	238.26	250.36	12	21.61	25.66
T ₂	31.73	30.29	25.36	215.72	255.36	269.32	12.86	23.59	30.8
T ₃	33.15	30.85	27.50	211.15	231.40	226.76	13.92	25.17	34.8
SEd	0.22	0.10	0.23	2.11	4.89	3.33	0.67	0.42	0.47
CD(5%)	0.63	0.22	0.54	6.80	10.5	7.58	0.81	0.89	0.96

Table 5 : Effect of Number of plants per pole on Pulp to peel ratio and yield.

Treatments	Pulp : Peel ratio			Yield (Kg/pole)			Yield (q/ha)		
	2 nd year	3 rd year	4 th year	2 nd year	3 rd year	4 th year	2 nd year	3 rd year	4 th year
T ₁	3.46	3.77	3.89	2.53	5.14	6.42	40.48	81.60	102.72
T ₂	3.88	3.98	4.06	2.77	6.02	8.29	44.32	96.00	132.64
T ₃	3.81	3.91	3.96	2.93	5.82	7.89	46.88	92.80	126.40
SEd	0.13	0.02	0.12	0.11	0.19	0.22	4.36	6.36	4.24
CD(5%)	0.21	0.04	0.14	0.62	0.41	0.46	6.63	9.15	8.36

Pulp-to-Peel Ratio

The pulp to peel ratio was highest under T₂ (4.06) during the fourth year, indicating better edible portion and fruit quality.

Yield per Pole and Yield per Hectare

Yield increased steadily from the second to fourth year in all treatments. T₂ recorded the highest yield per pole (8.29 kg) and yield per hectare (132.64 q/ha) in the

fourth year. The higher yield under T₂ may be attributed to optimum plant density that allowed better nutrient utilization, light interception and reduced competition among plants (Patel and Patel, 2019; Das *et al.*, 2021).

Economic analysis

Economic analysis indicated that T₂ was the most profitable treatment. During the fourth year, T₂ recorded a gross return of ` 39.79 lakh per hectare with the highest B:C ratio of 3.41. Although, T₃ produced a greater number

Table 6 :

	T ₁ : 2 plants per pole			T ₂ : 3 plants per pole			T ₃ : 4 plants per pole		
	2 nd year	3 rd year	4 th year	2 nd year	3 rd year	4 th year	2 nd year	3 rd year	4 th year
Gross cost per ha (lakh)	16.7	18.01	19.32	17.79	19.36	20.93	18.9	20.74	22.58
Gross return (lakh)	12.14	24.48	30.81	13.29	28.80	39.79	14.06	27.84	37.92
B:C Ratio	-	2.03	2.74	-	3.16	3.41	-	2.84	3.19

of fruits, the increased production cost and lower fruit weight reduced overall profitability.

Discussion

The present investigation demonstrated that the number of plants maintained per pole significantly influences the vegetative growth, yield and profitability of dragon fruit cultivation (Singh and Sharma, 2018; Kumar *et al.*, 2020). Increased plant density enhanced vegetative growth and fruit number however, excessive density resulted in competition for light, nutrients and moisture. Treatment T₂ (three plants per pole) achieved a balance between vegetative growth and reproductive performance, similar to findings reported in earlier density management studies (Patel and Patel, 2019). The treatment produced superior branch development, higher stem diameter, improved fruit quality and maximum yield. Better canopy management and optimum resource utilization under T₂ may have contributed to higher productivity. In contrast, T₃ produced the highest number of fruits per pole, but the average fruit weight and pulp quality were lower. This suggests that overcrowding may adversely affect assimilate partitioning and fruit development.

The economic analysis further confirmed that T₂ was the most profitable treatment due to its higher yield and better marketable fruit quality, supporting recommendations for optimum density management in commercial dragon fruit cultivation (FAO, 2020; ICAR, 2021).

Conclusion

The present study conclusively demonstrated that planting three dragon fruit plants per pole (T₂) is the most suitable and economically viable practice under the agro-climatic conditions of Assam. This treatment significantly enhanced vegetative growth, fruit quality, yield and profitability, recording the highest average fruit weight (269.32 g), maximum number of branches (12.88), greatest stem diameter (7.96 cm), superior pulp-to-peel ratio (4.06) and highest yield (132.64 q/ha). In addition, T₂ exhibited the shortest duration from anthesis to harvest

(25.36 days), indicating early fruit maturity and improved production efficiency. Economic analysis further revealed the maximum benefit-cost ratio (3.41), confirming its commercial feasibility. Therefore, maintaining three plants per pole can be recommended as an optimum planting density for achieving higher productivity, better fruit quality and greater economic returns in dragon fruit cultivation under Assam conditions.

References

- Bartholomew, D.P. and Paull R.E. (1985). *The Pineapple: Botany, Production and Uses*. CAB International.
- Crane, J.H., Balerdi C.F. and Maguire I. (2005). *Dragon Fruit Growing in the Florida Home Landscape*. University of Florida IFAS Extension.
- Das, P., Bora L. and Saikia A. (2021). Evaluation of dragon fruit cultivation in Assam under different management practices. *J. Crop and Weed*, **17**(2), 145–151.
- Esquivel, P. and Araya Y.Q. (2012). Characteristics of pitahaya (*Hylocereus* spp.) and their potential applications in the food industry: A review. *Trends Food Sci. Tech.*, **25**(1), 42–54.
- Food and Agriculture Organization (FAO) (2020). *Good Agricultural Practices for Tropical Fruit Production*. FAO Publications.
- Indian Council of Agricultural Research (ICAR) (2021). *Improved Cultivation Practices for Dragon Fruit in India*. ICAR Publication.
- Kumar, R., Singh A.K. and Patel R.K. (2020). Performance of dragon fruit under northeastern Indian conditions. *Indian J. Horticult.*, **77**(3), 455–461.
- Le Bellec, F., Vaillant F. and Imbert E. (2006). Pitahaya (*Hylocereus* spp.): A new fruit crop, a market with a future. *Fruits*, **61**(4), 237–250.
- Lim, H.K., Tan C.P., Karim R., Ariffin A.A. and Bakar J. (2010). Dragon fruit (*Hylocereus polyrhizus*) as a potential source of natural colourant. *Food Res. Int.*, **43**(4), 1133–1137.
- Merten, S. (2003). A review of *Hylocereus* production in the United States. *J. Professional Assoc. Cactus Develop.*, **5**, 98–105.
- Mizrahi, Y. (2014). Vine-cacti pitayas: The new crops of the world. *Revista Brasileira de Fruticultura*, **36**(1), 124–138.

- Mohamed-Yasseen, Y., Barringer S.A., Splittstoesser W.E. and Costanza S. (1994). The role of seed coats in seed viability. *Botanical Review*, **60**, 426–439.
- National Horticulture Board (NHB) (2022). *Area and Production Statistics of Fruit Crops in India*. Ministry of Agriculture and Farmers Welfare, Government of India.
- Nerd, A. and Mizrahi Y. (1997). Reproductive biology of cactus fruit crops. *Horticult. Rev.*, **18**, 321–346.
- Nerd, A., Gutman F. and Mizrahi Y. (2002). Ripening and postharvest behaviour of fruits of two *Hylocereus* species (Cactaceae). *Postharvest Biol. Technol.*, **26**, 231–238.
- Ortiz-Hernandez Y.D. and Carrillo-Salazar J.A. (2012). Pitahaya (*Hylocereus* spp.): A short review. *Comunicata Scientiae*, **3(4)**, 220–237.
- Patel, N.L. and Patel B.N. (2019). Influence of planting density on growth and yield of dragon fruit. *Int. J. Chem. Stud.*, **7(5)**, 2145–2149.
- Paull, R.E. and Duarte O. (2012). *Tropical Fruits*. CAB International.
- Pushpakumara, D.K.N.G., Gunasena H.P.M. and Singh V.P. (2005). *Underutilized Fruit Trees in Sri Lanka*. World Agroforestry Centre.
- Singh, D. and Sharma R.R. (2018). Advances in dragon fruit cultivation in India: Opportunities and challenges. *Agricult. Rev.*, **39(2)**, 139–147.
- To, L.V., Ngu N., Duc N.D. and Huynh N. (2002). Dragon fruit quality and storage life: Effect of harvesting time, use of plant growth regulators and modified atmosphere packaging. *Acta Horticulturae*, **575**, 611–621.
- Weiss, J., Nerd A. and Mizrahi Y. (1994). Flowering behaviour and pollination requirements in climbing cacti with fruit crop potential. *HortScience*, **29(12)**, 1487–1492.
- Wu, L.C., Hsu H.W., Chen Y.C., Chiu C.C., Lin Y.I. and Ho J.A.A. (2006). Antioxidant and antiproliferative activities of red pitaya. *Food Chem.*, **95(2)**, 319–327.
- Yah, A.R.C. and Hameed S.N.A. (2019). Growth and yield response of dragon fruit under different nutrient management practices. *Int. J. Agricult. Sci.*, **11(7)**, 8120–8124.
- Zee, F., Yen C.R. and Nishina M. (2004). Pitaya (Dragon Fruit, Strawberry Pear). Fruits and Nuts, College of Tropical Agriculture and Human Resources, University of Hawaii.