

# DRAGON FRUIT COUNTRY REPORT FROM INDIA

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## INTRODUCTION

Dragon fruit (*Hylocereus* spp.), a herbaceous perennial climbing cactus, widely known as Red Pitaya, has recently drawn much attention among the Indian growers, not only because of its attractive red or pink color and economic value as fruit, but also valued for its high antioxidant potential, vitamins and minerals content. Being a native of Southern Mexico, Guatemala and Costa Rica, dragon fruit was introduced in India during the late '90s and still the area under its cultivation is gradually increasing. Farmers in the Indian states of Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Orissa, West Bengal, Andhra Pradesh and Andaman & Nicobar Islands have already taken up its cultivation, and the estimated total area under Dragon fruit cultivation in these regions may be less than 400 ha. Majority of the dragon fruits presently available in Indian markets are imported from Vietnam, Thailand, Malaysia and Sri Lanka. Being a cactus family and requires long day for flowering, dragon fruit cultivation is well suited in the agro-climatic regions of Southern, Western and North Eastern India that are dry and frost-free. Due to high demand both in domestic and international markets, dragon fruit production could be an economical avocation to both backyard growers as well as entrepreneurs of medium and large scale plantations. Cultivation of dragon fruit already started in different parts of India with many success stories of farmer from different regions. Many nursery men started propagation for raising planting material of dragon fruit. One of the widely grown cultivars and most commonly available dragon fruit is the red color epicarp with white and pink pulped sub-sweet juicy pulp matrix. It is a fast return perennial fruit crop with economic production in the first year after planting, and full production within three to five years. It was also noted to initially produce in its first years on wards provided desirable cultural management practices are applied. Although the initial investment is relatively high, profit is substantial within 4-5 years. The red flesh species *i.e* *H. costaricensis* are additionally rich in *betalains*, meeting the increasing trade interest for antioxidant products and natural food colorant. Fruits are easy to keep fresh under room condition. The crop is hardy and can survive in any type of climatic condition favorable for flowering and fruiting and soil condition provided with good drainage.

### Biochemical constituents of dragon fruit

Dragon fruit is considered to be one of the tropical super foods due to its nutrient richness. It is rich in various nutrients and low in calories. Reports suggest that it is believed to help in the control of chronic illnesses, improves the health of alimentary canal and boosting the body's immunity. It is also rich in various vitamins, minerals and dietary fibres. All these beneficial factors make dragon fruit as the best option for weight loss treatment, control of diabetes, lowering the cholesterol level, etc.

### Dragon fruit nutrition

Dragon fruit is classified as two types; one with white pulp and the other one with red/pink pulp. As stated earlier, it is low in calories and rich in phenolics, flavonoids and antioxidant potential. Study was conducted to determine the major biochemical constituents in both white and red pulped dragon fruit. The biochemical analysis of 100 g fresh fruits revealed that the fruit have moisture content of about 83-88%. The fruit is slightly acidic and the titratable acidity varied between 0.20 to 0.30 mg lactic acid equivalents. Organic acids present in the fruits are major constituents responsible for acidity and thus the acidity is the indirect measure of total organic acids in the fruit. Organic acids involves in various

function in the human system including growth and maturation. They also highly influence the organoleptic properties such as flavor, color and aroma as well as fruity taste. They also play a vital role in the post-harvest management of fruits since they increase the shelf life, stability and microbial safety (Al-Farsi *et al.*, 2005; Nour *et al.*, 2010).

The total soluble solids (TSS) varied between 8-12°Brix. When evaluating a fruit for consumer acceptance, soluble solids alone won't give the effective picture of the consumer acceptability, but with perceived sweetness, which is determined largely by the relative levels of total soluble solids and acids in the fruits. The total soluble solids are composed of all the soluble solids which are present in the fruits. Different kinds of organic acids and the extent of their concentration play an important role in the flavor of a fruit. Usually high acidity gives better blend and flavor. Thus, presence of considerable quantity of acidity and the presence of total soluble solids in the dragon fruit make them highly acceptable to the consumers.

Dragon fruit is one of the rich sources of Vitamin C, and the vitamin C content ranged between 4 to 10 mg/100 g. Vitamin C is one of the most important water-soluble vitamins, naturally present in fruits and vegetables, and it is widely used as a food additive and antioxidant. Humans, unlike most animals, are unable to synthesize vitamin C endogenously, so it is an essential dietary component (Li and Schellhorn, 2007). Recommended dietary allowance (RDA) for vitamin C is about 80 mg/day. Consumption of 100g fresh dragon fruit provide about 8-14% RDA of vitamin C. The total sugar content is about 3.5 to 7.0 g/100 g fresh fruit.

Fruits with pink flesh have higher phenolics and flavonoids content (40-60 mg GAE and 20-40 mg CE, respectively) compared to white fleshed fruits (15-20 mg GAE and 10-20mg CE, respectively). Similarly, the antioxidant activity measured by DPPH method also revealed that the antioxidant activity of the pink fleshed fruits (250 to 400 mM TE/100 g) are higher than the white fleshed fruits (100 to 125 mM TE/100 g). Phenolic compounds have been associated with color, sensory qualities, and nutritional and antioxidant properties of foods. Phenolics act as antioxidants, due to the free radical scavenging activity of the phenol moiety (hydroxyl substituent on the aromatic ring). Flavonoids are the predominant class of phenolics and account for approximately two-thirds of the dietary phenols while, phenolic acids account for almost all of the remaining third, and there is an increasing awareness and interest in the antioxidant behaviour and potential health benefits associated with these simple phenolic acids. Beyond the protective antioxidant behaviour, other biological activities of phenolic acids have also been reported. For example, caffeic acid, one of the most prominent naturally occurring cinnamic acids, is known to selectively block the biosynthesis of leukotrienes, components involved in immuno regulation diseases, asthma, and allergic reactions (Koshihara *et al.*, 1984). Presence of numerous health promoting phenolic acids and flavonoids in both fresh sap and its value added products make them functional food.

Considering the climatic condition in Indian states of Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Orissa, West Bengal, Andhra Pradesh and Andaman & Nicobar Islands can be ideal for dragon fruit production. Besides, according to observation on the agro-physical characteristics of Dragon Fruit, the level of risk in producing the crop is lesser and to some extent more tolerant to adverse weather conditions as compared to the production of other high-value commercial crops like rambutan, mangosteen and durian. However, available sources of information on crop management and multiple cropping schemes integrating dragon fruit to other crops in location specific areas are still unavailable. R and D activities on dragon fruit production were initiated at IIHR, Bengaluru, India during 2014.

Climatic Requirements, although a member of the family Cactaceae requires adequate water because they originated from tropical rainforest unlike other cacti which are of desert origin. Hence, it is very ideal to be grown in most parts of the India except the area less rainfall. The reported rainfall requirement of dragon fruit is 1145- 2540 mm/year. Evaluation studies on dragon fruit in relevance to adaptability and production aspects was under taken Coorg, Karnataka. Dragon fruit plant prefers a dry tropical climate with an average temperature of 20-29°C, but can withstand temperatures of 38-40°C, and as low as 0°C for short periods (Karunakaran, *et.al.*, 2014). The plants will be damaged at temperatures above 40°C, cause yellowing of the stem. Heavy rain fall areas are not suitable for the crop, as excessive rain causes flower drop and fruit drop (Karunakaran and Arivalagan, 2019)

Soil Requirements- Dragon Fruit could be grown in wide range of soil types provided it is well-drained. However, the most ideal soil type is rich in organic matter and slightly acidic. Since the area to be used is sub-marginal, organic fertilizer will be applied to patch up the lacking amount of organic substances in the soil. Dragon fruit plants prefer sandy loam with high organic matter and grow well in soil having good drainage.

## Propagation

Dragon fruit plants can easily multiply through stem cutting. Generally 20-25cm long stem cuttings are used for planting. The cutting should be prepared one–two days prior to planting and the latex oozing out of cut is allowed to dry. The cutting should be taken from elite mother plants after the fruiting season. The cutting should be treated with fungicides to prevent diseases. These cuttings are planted in 12 x 30 cm size polyethylene bags, filled with 1:1:1 ratio of soil, farmyard manure and sand. The bags are kept at a shady place for rooting. Excess moisture should be avoided for prevention of rotting of cutting. These cutting roots profusely and become ready for planting with 5-6 months (Tripathi, *et.al.*, 2014)

The seed propagation studies carried out that seedlings remain smaller with thin stem even after one year of planting. Further the plants produced from seeds are not true to type and there is there lot of variability among the plants. Thus seed are generally not used for commercial multiplication of dragon fruit (Tripathi, *et.al.*, 2014).

## Planting

Dragon fruit cultivation prefers full sunlight open area is very suitable for planting. The shady areas are not suitable for dragon fruit planting. Generally in single post system planting is done at 3x3 m distance. Single post vertical height of pole 1.5 m to 2 m at which point they are allowed to branch and hang down. The Dragon fruit may be planted near the poles to enable them to climb easily. Number of plants per pole may be 2 to 4 plants depending on the climatic condition. Lateral shoots must be limited and 2-3 main stems are allowed to grow. Because lateral shoots must be removed time to time. It is important to arrange round metal/concrete frame to maintain balanced shrub. Because it spread the hanging shoots balance way. The addition of dolomite and organic fertiliser at planting is beneficial. The media consisted of the soil enriched with organic inputs like farmyard manure, coir compost and vermin-compost along with biofertilizers. The growth of dragon fruit vines was so fast that an average growth rate of 8.2 cm was observed per week. In about 8 months after planting the dragon fruit forms a thick dense mass of vines on top of the trellis which lies drooping to the ground.

Study carried out Orissa, India about phenological stages of dragon fruit according to the extended BBCH (Biologische Bundesantalt, Bundessortenamt und Chemische Industrie) scale using three-digit numerical system which contributes to the standardization of its phenological stages. Seven principal growth stages, viz., bud development (0), shoot development (1), vegetatively propagated organ development (4), reproductive development (5), flowering (6), fruit development (7) and fruit maturation (8) have been described. A total of 40 secondary growth stages have been described and defined. The extended BBCH scale for dragon fruit is broadly applicable because it describes all the phenophases pertaining to vegetative and reproductive stages and their relative importance in crop management and improvement. The developed scale will act as a useful tool for adoption of effective crop management practices like nutrient management, pollination, plant propagation, timely harvest of fruits and pest management. (Kundan Kishore, 2016)

## Training systems

The Dragon fruit plants are fast growing vines and produce more thick dense of branches during the initial stage. The lateral buds and branches should be pruned to grow towards stands. Once vines reach up to the top of the stands the branches are then allowed to grow. The removal of tip of main stem is done to allow growth of new shoots to grow laterally and climb at the ring to form an umbrella like structure of vines where flowers will emanate and develop into fruits which would induce lateral branching. This pruning referred as structural pruning or making a structure on the trellis. The well grown vine may produce 30 to 50 branches in one year and may be more than 100 branches in-four years (Fig.1).



Figure 1. Field view dragon fruit established with trellis system

Many trellis designs are used in India. The IIHR Bengaluru, India evaluated four different trellis system of Single pole with cement and iron ring, continuous pyramid stands and 'T' stands with two different cultivars. For our analysis, each trellis consisted of one 6 feet height by 5 or 6 inch thickness of poles erected 2 feet depth. Single pole system showed better performance in growth and yield when comparatively other trellis system. Single pole with ring type of trellis that can support the weight of the plants and allow easy access to flower and fruit will work for commercial production (Fig.2.). The wooden poles are hard but their durability is least compare to cement poles. It is not possible to change the poles in between because of the growth and entangled branches. Therefore it is better to go with concrete poles its cost may be high for cement pole but they are durable and can be used

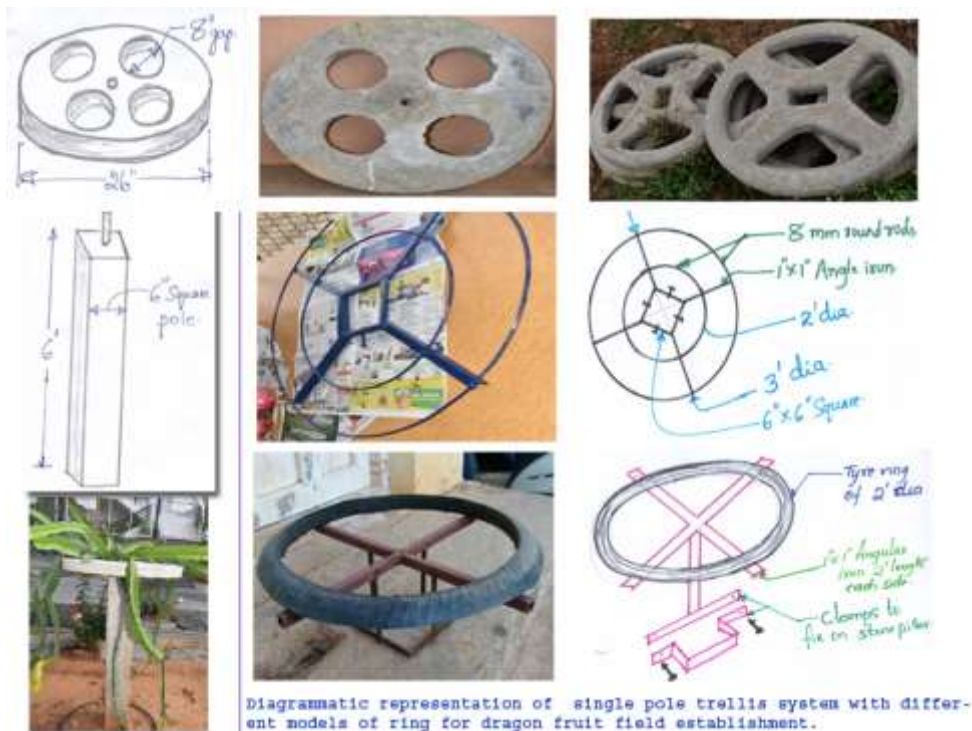


Figure 2. Diagrammatic representation of single pole trellis system with different models of ring for dragon fruit field establishment

## Flowering

The flowers starts with on small spiral button type attract structures at the stem margins. These develop to flower buds in 10-15 days. The beautiful hermaphrodite nature flowers length (25-30cm), white inside and greenish yellow with purple dyes on the outside (Fig.3.) They are scented and only blooming at night and last one only night. Flower production generally takes place during May - August and fruit harvest 30-40 days after fruits set. Quality of the fruit does vary between varieties, but harvest time has a much greater effect on quality than varietal differences. There are self-compatible and self-incompatible varieties. There is considerable variation in fruit size and shape between the varieties. At present, very little knowledge available on varietal and production aspects ((Karunakaran and M. Arivalagan,2019).



Figure 3. Dragon fruit flowering and fruiting

## Nutrient management

For better yield performance of the crop proper nutrient requirement is needed. Dragon fruit plant root system is superficial and can rapidly assimilate even the smallest quantity of nutrients. Mineral and organic nutrition is particularly advantageous and, when they are combined, their experiment conducted in BCKV, Kolkatta, India for different combination of N, P, K fertilizer doses revealed the dose of N 450: P<sub>2</sub>O<sub>5</sub> 350: K<sub>2</sub>O 300 perform best result for yield and quality. The nutrients were supplied as per treatment schedule in four split doses to each pillar having four plants @ 10, 10 and 30% of total, before flowering, 20, 40 and 25% at fruit set, 30, 20 and 30% at harvest and finally 40, 30 and 15 % of total N P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O after two months of harvest (Anon, 2017).

A combination of organic manure with neem cake and 100g of complete fertilizer (19-19-19) is applied every three to four months. Regularly prune the plants to obtain an open and manageable umbrella shape canopy which will induce new shoots for the next cropping season (Karunakaran, *et.al.*, 2014).

Dragon plants can survive with very low rainfall, many months of drought, when good quality fruits are required, a regular water supply is needed. Regular irrigation is important, because it enables the plant to build sufficient reserves not only to flower at the most favorable time but also to ensure the development of the fruits. Since the rainfall is distributed for eight months in the Andaman Island, irrigation is not required but in the dry season, the growing media is kept moist by irrigation through drip system on alternate days. Weed control is an important operation in dragon fruit cultivation and the use of weed mat efficiently reduced the weeds growth and also aids in soil moisture conservation([www.icar.org.in](http://www.icar.org.in)).

Dragon fruit root system is shallow and distributed in 15 to 30 cm depth. Hence irrigation should be insured to provide sufficient water during dry season. Excessive irrigation may cause fungal disease. Therefore proper drainage should be provided in rainy season. Frequent dry period without irrigation reduces the yield and quality of fruits. The dry period before flowering is required for production of more fruits. Local drip irrigation found beneficial for better yield and growth. Irrigation by flooding is not recommended as it wastes water and increases work of weeding. Approximately 2-4 litres of water weekly twice per plant is sufficient during the summer/dry days. Water requirement may increase or decrease depending upon soil, climate and plant health.

## Fruit quality parameters

Fruit has excellent taste and its texture. The average fruit was recorded in white pulped (457.0 g) higher than the red pulped cultivar (331.0 g). Among the two cultivars evaluated, the maximum fruits per pole was recorded in red pulped (22.40) comparatively white pulped (14.40) one year old plants. It has 74.44 % and 70.28% pulp recovery ratio, respectively wherein abundant dark brown or black seeds are distributed (Table 1). The cultivar having deep red or purple color pulp (11.54 °B) with the higher values of TSS as compared to the one having white colour pulp (9.75 °B), which is an important parameter related with fruit quality (Karunakaran and Arivalagan, 2019).

Table 1. Dragon fruit quality parameters

Cultivars	*No. of fruits /pole	Fruit Wt., (g)	Fruit Length (cm)	Fruit Breadth (cm)	Pulp Wt., (g)	Skin Wt., (g)	Seed Wt., (g)	Pulp Recovery Ratio (%)	TSS (°Brix)
White Fleshed	14.40	457.00	15.21	27.35	321.20	122.60	2.02	70.28	9.75
Red Fleshed	22.40	331.40	14.56	24.31	246.70	84.00	1.88	74.44	11.54

## Harvesting

The plant start yielding after 12-15 months from the date of planting and the fruit maturity could be optimized with the change of fruit epicarp color from green to red. Proper time of harvesting was found after seven days of color transition. The plants yield the fruits in the months between June to September, and harvest could be done three to four times in a month, The fruit weight ranged between 300-800g, and the average yield from the single post is realized about 30 to 35 kgs from the three years old planting. Present farm gate price ranged between INR. 80.00 to 120.00 per kg.

## Processing

Dragon fruit pulp and juice with solution containing 1.5 per cent pectin, 55% sugar and 0.9 per cent citric acid solution improved the colour as well as other organoleptic characteristics of dragon fruit jam and jelly. In case of dragon fruit RTS beverage 14 per cent pulp, 12 per cent sugar and 0.9% was found to be most suitable. The prepared product was found to be organoleptically acceptable. Prepared products can be stored for the period of more than three months at ambient storage condition without microbial spoilage or any considerable loss in quality (Sharma, 2016).

## Sun burn injury

Sun burn injuries were noticed in majority of the plantations in many parts of India. Symptoms appeared during in the month of March and April when the day and night temperature recorded wide variation, particularly the region temperature crosses above 38°C. In this regard, trail has been attempted for growing dragon fruit under shade net house and spraying antitranspirants to control the sun burn injury on dragon fruit plants. Further, filler crop also attempted to control the physiological injury. IIHR has initiated experiment on off season dragon fruit production. The study still under progress

## Expected pests and Diseases

Dragon Fruit is a kind of crop which is comparatively free of pests and diseases. Prevalence of common insects like ants, scale insects, mealy bugs and the like will be controlled through the application of common insecticide

### Scenario of pests and diseases of dragon fruit in India

In general dragon fruit is tolerant to major pests and diseases. Important diseases that affect dragon fruit crop are anthracnose, brown spots and stem rots (fungal and bacterial pathogens). Heavy rainfall and overwatering or waterlogged conditions predispose the crop for these diseases. Anthracnose that has been reported in other countries has been reported in India also from Andaman

islands (Abirami *et al.* (2019). It is caused by *Coletotrichum siamense* in India. Reddish or orangish brown concentric lesions with *ascervuli* (black colored pin heads) Starts near ribs of vine generally at points where spines emerge from the edge Attack fruits too Preventive spray with Chlorothalonil / mancozeb at 2g/L and curative spray with carbendazim at 1g/L. We have observed the wilt disease due to fungal pathogen *Fusarium* species. The symptoms include the drying or loss of turgidity (Unpublished data).

Rotting diseases are caused by different species of *Alternaria*, *Bipolaris*, *Rhizopus* and *Dothirella* species. These diseases have not been reported in India so far. Bacterial rot is caused by *Xanthomonas campestris* and *Erwinia carotovora*. Too much of light makes the plant vulnerable to bacterial rot. Sun burn and Ca deficiency aggravates the disease. Copper oxy chloride (at 0.2%) can be used for managing this disease. Though there are reports on fruit flies viz. *Anastrepha* species there is no report of this pest in India.

## CONCLUSION

Marketability of dragon fruit in the region is expected to be very high because of limited number of commercial producers and high demand. There is a potential for off season production of Dragon fruit in India, and the market price remains as high as INR 150.00 to 250.00 per kg during off season. In the future, production is expected to rise; hence, marketing strategies need to be critically examined. In case of any market glut, there is a strong need to explore the avenues of value addition through processing, so that the production will be continue to increase and the surplus produce shall be processed. Available sources of information on crop management and multiple cropping schemes integrating Dragon fruit to other crops cultivation in location specific areas are still unavailable. Hence, there is an urgent focused efforts on R and D is prominently flagged as area under dragon fruit cultivation is steadily increasing.

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