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**Chandni V Mori**

Ph.D. Scholar, College of Horticulture, S.D. Agricultural University, Jagudan, Mehsana, Gujarat, India

**AR Patel**

Ph.D. Scholar, College of Horticulture, S.D. Agricultural University, Jagudan, Mehsana, Gujarat, India

**VK Parmar**

Ph.D. Scholar, College of Horticulture, S.D. Agricultural University, Jagudan, Mehsana, Gujarat, India

**GS Patel**

Associate Professor and Head, Department of Vegetable Science, College of Horticulture, S. D. Agricultural University, Jagudan, Mehsana, Gujarat, India

**Corresponding Author:**

**Chandni V Mori**

Ph.D. Scholar, College of Horticulture, S.D. Agricultural University, Jagudan, Mehsana, Gujarat, India

## Dragon fruit (Kamalam): An excellent exotic fruit crop of India

Chandni V Mori, AR Patel, VK Parmar and GS Patel

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### Abstract

Dragon fruit (*Hylocereus* spp.) is one of the exotic fruit grown across the world. The fruit has a very attractive colour and mellow mouth melting pulp with a black colour seed embedded in the pulp along with tremendous nutritive properties which attract growers from different parts of India to cultivate this fruit crop which originated in Mexico and Central & South America. It is a long day plant with beautiful night blooming flower that is nick named as “Noble Woman” or “Queen of the Night”. Fruit is named as pitaya because of the bracts or scales on the fruit skin and hence the name of pitaya means “the scaly fruit”. Pitaya fruit is the most nutritious and wonderful exotic fruits. It is a favourite to many, particularly people of Asian origin.

There are four types dragon fruit based on their colour.

1. *Hylocereus undatus* i.e., red colour fruit with white colour flesh.
2. *Hylocereus polyrhizus* i.e., red colour fruit with red colour flesh.
3. *Hylocereus megalanthus* i.e., yellow colour fruit with white colour flesh.
4. *Hylocereus costaricensis* i.e., pink colour fruit with violet red colour flesh.

**Keywords:** Dragon fruit, exotic fruit, nutritious, flesh colour

### Introduction

Dragon fruit is the Wondrous Fruit of the 21<sup>st</sup> Century and is set to ring in a revolution in the Indian Horticulture Scenario. It is a boon to the farmers and consumers. Its plant is attractive due to its exotic appearance (Liaotrakoon, 2013) [12]. It was initially used as ornamental plant and latter due to its health benefits and market value emerged as a new fruit crop. Owing to its rich nutrient contents and antioxidant properties, it is emerging as a super fruit worldwide. Belongs to the family Cactaceae, basically, it is perennial semi epiphytic climbing cactus vine. Originated from Central and South America, It is successfully grown commercially in Thailand, Malaysia, Vietnam, Sri Lanka, Bangladesh and now knocking at our door in India. It is tolerant to abiotic stresses and resistant to pests and diseases. It has many advantages including low water and nutrient requirements, relatively less requirement of resources for establishing the orchard and maintenance; multiple harvest of fruit in a year; potential to sustain high yield up to 20 years; high benefit to cost ratio; and high nutraceuticals and functional properties (e.g. rich in antioxidants and fibres). All these qualities are attracting the growers worldwide to establish and expand dragon fruit farming, provide opportunity for global export and encourage for high quality produce to meet the market demand. Being a crassulacean acid metabolism (CAM) plant with xerophytes' characters, it has got ability to grow in a wide range of agro-climates including areas of high temperature and water scarcity regions. The dragon fruit can be cultivated commercially up to altitude of 1700 m with rainfall ranging from 500-1500 mm. With shallow roots (<40 cm), it is not much choosy in requirement of soils and can be cultivated in wide range of soils but without excess moisture. Dragon fruit is also known as pitaya, strawberry pear (*Hylocereus* spp. and *Selenicereus* spp.), Kamalam, Red Pitahaya, Night blooming Cereus, Strawberry Pear, Belle of the Night, conderella plant. Chintapalli.

Dragon fruit has great potential as a new crop for Mediterranean growers due to the requirement of little water and well adaption to high temperatures (Trivellini *et al.*, 2020) [26]. There are different types of dragon fruit like most *Hylocereus* species have red-purple pigmented skin, while the pulp color ranges from white (in *H. undatus*) to red and purple (in *H. polyrhizus* and *H. costaricensis*).

Dragon fruit is an excellent source of vitamin C and therefore are abundant with minerals, particularly calcium supplement as well as phosphorus. Also, it is a good source of natural pigments in food processing, due to their high content of betalains. Pitahaya is considered a promising crop to be grown commercially in dry regions. This species is found to have high water-use efficiency. One of the pitahaya mechanisms to secure water requirement is developing aerial roots from the sides of the stem to collect water from the surroundings. Pitaya fruit has red or pink thornless skins, while its juicy flesh can range from white to magenta. The skin is covered with bracts or scales. The fruit has a very attractive colour and a fluffy pulp with a black edible seed embedded in the pulp with huge nutrient properties. The most advantage of this crop is that once it is planted, it will grow for about 20 years, and one hectare could accommodate 1000 to 1200 Dragon fruit plants. More importantly, it is a fast return perennial fruit crop with production in the second year after planting and full production within five years. Dragon fruit is suitable for everyone to eat. Flesh and seeds are edible parts and they are eaten altogether. It supplies fiber which is digestive and helpful for healthy liver. Dragon fruits consist of phytoalbumins, which may have anti-oxidant qualities which help to stop the development of cancer cells. Dragon fruit also reported to have health benefits including prevention of memory losses, control of blood glucose level in diabetic patients, prevention of oxidation, aiding in healing of wounds etc. In addition, it has the ability to promote the growth of probiotics in the intestinal tract (Rahad-2016) [15].

The aims of this article were to draw up a list of literature currently available on *Hylocereus*, grouping the references which covers importance, nutritional values and health benefits, cultivation, manuring, pollination, harvesting, pest & disease based on recent updates of philanthropist works and some of the research findings. So that everyone become familiar with dragon fruit.

## History

About 100 years ago the French brought dragon fruit from Guyana to Vietnam as an ornamental plant and latter it was grown for the king. Dragon fruit was introduced in India during the late '90s as a garden crop and still the area under its cultivation is gradually increasing. Dragon fruit was introduced to Sri Lanka in 1997. In Indonesia, dragon fruit become popular since 2000 and during Chinese New Year celebration, pitaya has a special place in the hearts of Chinese ethnic in Indonesia because they believe that pitaya brings good luck for them. Commercial pitaya plantings can be found in Vietnam, Taiwan, Malaysia, and Israel. Majority of the dragon fruits presently available in Indian markets are imported from Vietnam, Thailand, Malaysia and Sri Lanka.

## Importance of dragon fruit

### Nutritional benefits

Proximate nutraceutical values in g or mg per 100 g edible portion of white-flesh dragon fruit are as follows: moisture (85.3%), protein (1.1), fat (0.57), crude fiber (1.34), energy (Kcal) (67.7), ash (0.56), carbohydrates (11.2), glucose (5.7), fructose (3.2), sucrose (not detected), sorbitol (0.33); vitamin C (3.0), vitamin A (0.01), niacin (2.8), Ca (10.2), Fe (3.37), Mg (38.9), P (27.75), K (272.0), Na (8.9) and Zn (0.35) and for red-flesh fruit, moisture (82.5-83.0), protein (0.159-0.229), fat (0.21-0.61), crude fiber (0.7-0.9) and ascorbic acid

(8-9). The total soluble solids (TSS) varied between 8-12°Brix. 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) [11]. 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. Dragon fruit, is also considered to be rich in pectins. Nur Izalin *et al.* (2012) [14] has reported yield of pectin extracted from dragon fruit about 14.96 to 20.14 percent of the dried peels. Certain studies (Ruzainah *et al.*, 2009) [16] have suggested that premature stem of dragon fruit being higher in ascorbic acid content compared to dragon fruit flesh. Ruzainah *et al.*, (2009) [16] study on proximate analysis of dragon fruit (*Hylocereus polyrhizus*) at Putra University, Malaysia. They observed premature stem of dragon fruit has more ascorbic acid value than the mature stem. Sonawane, (2017) [22] studied on dragon fruits pulp contain nutrient parameters at MOU, Nashik, and she found higher contain of dietary fiber, calcium, iron and phosphorous.

### Health benefits

Dragon fruit has an extremely low amount of cholesterol, which ultimately reduces the chance of heart attack and other diseases caused by accumulation of cholesterol. It's the perfect fruit to maintain weight. It contains protein as well as omega-3 and omega-6 fatty acids that can help prevent cardiovascular diseases. It is an excellent source of monounsaturated fats, helping the heart stay in great condition. It helps to clean up digestive system. It has high fiber content, which can assist with poor digestion and constipation. Eating the flesh and seeds, which contain good protein, will keep body fortified. It is a good natural source of anti-oxidants, which help to prevent the dangers of free radicals, which can cause cancer and other undesirable health detriments. Dragon fruit is believed to be able to lower cholesterol concentration, to balance blood sugar concentration, to prevent colon cancer, to strengthen kidney function and bone, to strengthen the brain workings, increasing the sharpness of the eyes as well as cosmetic ingredients (Suryono, 2006) [23]. The number, quantity, and variety of antioxidants in dragon fruit is completely unmatched by many food supplement or pills. It contains 2.2 g more fiber than Mango, 1g more than sweet orange, 2.4 g more than Banana. The high amount of fiber in dragon fruit can ultimately help regulate diabetes, as it can stabilize blood sugar levels by suppressing sugar spikes. People who suffer from the vector-borne diseases like malaria, dengue, and their platelet count become low and can be fatal if not treated timely. A healthy person normally has 150,000 to 450,000 platelets every micro liter of blood and platelets' function is to stop bleeding by clumping and clotting blood vessel injuries. Dragon fruit helps in improving platelet count in dengue patients because of its antioxidant properties. Hence, doctors recommend dragon fruit for dengue patients. Widyaningsih *et al.* (2017) [30] have proved statistically significant effect of red dragon fruit juice on hemoglobin and erythrocyte levels in pregnant women and thereby suggesting an alternative

treatment to deal with anemia among pregnant women. Eating a dragon fruit especially red flesh one with its rich antioxidants can keep the skin tight and young. Anti-aging face-masks can be prepared by using fruit combined with honey. It can be good alternative for face masks. Arthritis directly affects the joints and causes severe irritation and immobility. Adding dragon fruit to diet can help to cure these ailments. Dragon fruit's benefits for people suffering from arthritis are so great that it's commonly referred to as the "anti-inflammatory fruit". As dragon fruit is rich in vitamin C and B<sub>3</sub>, it is reported that it helps to cure problems like acne and burned skin. 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.

### Popular types of dragon fruit

#### 1. *Hylocereus undatus*

- Also known as Pitahaya.
- Variety has a white flesh with pink skin and green scale.
- Edible black seeds. Shown in fig 1



Fig 1: *Hylocereus undatus*

#### 2. *Hylocereus costaricensis*

- Violet red flesh and pink skin
- It's also known as Costa Rican Pitaya
- It's native to Costa Rica
- The fruit is magenta and the seeds are pear shaped. Shown in Fig 2



Fig 2: *Hylocereus costaricensis*

#### 2. *Hylocereus megalanthus*

- Native to South America.
- White flesh with yellow skin. Shown in fig 3



Fig 3: *Hylocereus megalanthus*

#### 3. *Hylocereus polyrhizus*

- Also known as Red Pitaya.
- Variety has a red flesh with its pink skin.
- Native to Mexico.
- Most popular type now grown in many countries. Shown in fig 4



Fig 4: *Hylocereus polyrhizus*

### Why becoming popular?

- The biggest advantage of this crop is once it planted, it will grow for about 20 years.
- One hectare could accommodate 1000 to 2000 plants.
- The agronomic practices are easy and less expensive.
- Tolerant to the arid environment.
- Adaptive to various marginal soil conditions.
- It bears fruit in the second year after planting.
- Attains full production within five years.
- Maintenance cost is low.
- Low requirement of water and tillage practices.
- Plant cuttings can be used for further propagation/resale.
- Dragon fruits have excellent demand in local & export markets.
- Aftercare is minimal due to fewer pest and disease attacks.
- Fast return perennial crop.
- It has great nutritional and health benefits value.

### Global leading suppliers and market

Major dragon fruit supplier countries:

- **Asia:** Vietnam, China, Thailand, Taiwan, Indonesia, Malaysia, Philippines, Cambodia, India and Sri Lanka.
- **Middle East and Europe:** Israel, Switzerland and EU.
- **America:** Mexico, Colombia, Ecuador, Guatemala and Costa Rica.

### Demand of dragon fruit in the world markets

#### 1) Asia market

Asia has the largest numbers of consumers of dragon fruit, especially in the Chinese community, due to the belief in the good fortune brought by the dragon fruit's name, shapes, and

colours. Consumers in Asia, particularly China, buy dragon fruit mainly for fire-worship, so they often focus on the form of dragon fruit. However, the Japanese do not like the big dragon fruit; they value the flavour more than the size.

## 2) European market

The European market is the world's leading importer of fresh fruits and vegetables and is quite open to new products. Therefore, although the dragon fruit is relatively new and not widely advertised, the price is high, but still very promising and attracting more and more consumers in the continent. With the reduction in the cost and further enhancement in the nutritional value, dragon fruit will certainly reach most of the population in European countries.

## 3) US market

Dragon fruit is traditionally good for Asian consumers in the US. Due to the high Asian and Vietnamese communities, demand for dragon fruit is relatively high. For other ethnic groups, dragon fruit is relatively new and only known in the high-end market segment. However, analysts say this is a fast-growing market in the near future, as farm owners in Florida and California have begun planting dragon fruit to meet market demand.

## Dragon fruit production in India

Gujarat, Karnataka and Maharashtra are the leading producers contributing about 70% of India's dragon fruit production the water-scarce areas of Kutch in Gujarat, Northern Karnataka, and Western Maharashtra are major dragon fruit growing regions of the country. Overall, southern and western states are contributing a major share to the production of dragon fruit since they have been growing dragon fruit for the last 5-8 years. For example, more than 600 farmers from Karnataka alone have taken up dragon fruit cultivation in the last five years after seeing the performance of the fruit. In Karnataka, the area under dragon fruit cultivation was about 8-10 ha during 2012, amplified to about 500 ha in 2020 and it is likely to reach around 5000 ha in the next five years. Presently over 200 farmers in Gujarat's Kutch are cultivating this fruit in approx. 800 ha of land (Wakchaure *et al.*, 2020) <sup>[29]</sup>.

## Cultivation practices for dragon fruit cultivation

### Soil requirement

Dragon fruit could be grown in a wide range of soils, but the soil should be well drained as water logging for long period hampers its growth and favours rotting of stems. The sandy loam soil, rich in organic matter is good for its commercial cultivation. The soil pH of 5.5-6.5 is optimum. It is very shallow rooted crop; mostly roots are confined up to 40 cm, therefore, depth of soil may not be problem for cultivation. It prefers slightly acidic soil and can tolerate some salts in soil.

### Climatic requirements

Being originated from tropical rainforest regions, cultivation of dragon fruit is commercially good in areas with sufficient rainfall. But over time, this fruit crop has been acclimatized well in dry climates with low rainfall also. About 500-1500 mm of rainfall with proper distribution is good for its growth. Excess water leads to the abscission of flowers and young fruits. 20-30 °C temperature is optimum for the cultivation. It

can be cultivated up to altitude of 1700 m above mean sea level. 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) <sup>[8]</sup>. 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) <sup>[7]</sup>.

## Land preparation

Before planting land should be given 2 to 3 deep ploughing. The field is weed free and it is better to have a fence around the field to protect from any predators. Dig the pit and fixed pole then add manures and fertilizers around pole before planting. Plantation of plantlets around the pole in four direction. Prepare the beds of 45-50 cm high and 3 meter broad but it may be various according to rainfall conditions. Full sunlight open area is very suitable for planting. Number of poles depends on the spacing. Poles should have 12 cm in diameter and 2 meter long. These poles should at least 1.4 to 1.5 meter high from ground level.

## Propagation

The dragon fruit can be propagated by sexual (by seed) as well as asexual (by cuttings and tissue culture) means. The seed propagated plants are not true to type and possess longer juvenile period. The best and fastest way of multiplying the dragon fruit is by cuttings. 15-30 m long and slant cut stem are used for planting. The cutting should be prepared one-two days prior to planting. Pile up cuttings 1-2 days prior to potting. Mature stem is more resistant to insect and snail damage. Should be collect early in the morning. Can be obtain through the year. Preferable to collect cutting after fruiting season of mother plant. IBA encourage quick rooting formation (10-15 instead of 40-50 days). Dry cow dung, top soil and sand (1:1:2). Easiest and cheapest method. Start fruiting 1-2 year after planting. True to type plant. Develop root system within 3 to 4 months. Though seed propagation method is very simple but seeds are not true to type due to cross pollination (Andrade *et al.*, 2005) <sup>[2]</sup>. Therefore, large number of plantlets with healthy shoot and root system can be produced to meet the demand of increasing commercial cultivation through vegetative propagation methods like cuttings in India. Dragon fruit which are propagated by stem cuttings may be directly planted in the field or in pots (Zee *et al.*, 2005) <sup>[31]</sup>. Cuttings of many plants are normally dipped in rooting hormone before planting to boost root formation. (Lalit *et al.* 2018) <sup>[10]</sup>. Seran and Thiresh (2015) <sup>[18]</sup> studied on effect of IBA concentrations on number of roots and length of longest root & shoot per cutting at 60 days after planting at Chenkalady increase root and shoot growth. Rahad *et al.*, (2016) <sup>[15]</sup> conducted an experiment on effect of different rooting media (treatments) on plant growth and development of Dragon fruit at BAU, Bangladesh. They observed that maximum results from cutting treated with IBA solution. This finding also supported by Siddiqua *et al.*, (2018) <sup>[21]</sup>, Lalit *et al.*, (2018) <sup>[10]</sup>, Siddiqua *et al.*, (2019) <sup>[20]</sup>. Shown in fig 5, 6, 7.



Fig 5, 6, 7: Propagation cycle

**Planting**

Rainy season with the onset of monsoon (June to August), is the best time for planting but it can be planted in other seasons too with the provision of irrigation. It is a semi epiphytic vine plant; therefore support system needs to be erected before planting. Around the pole, 2-4 plants should be planted in pits of (0.5 x 0.5 x 0.5 m) which are filled with top soil along with FYM and other fertilizers. After planting of cuttings, regular watering in basin prepared around plants is required to ensure satisfactory rooting. Planting can be done at 2.5 x 2 m, 3 x 1.5 m, 3 x 3 m, and 4 x 3 m etc. Therefore, as per the situations planting can be done at above spacing. This result was showed that the higher planting density until 1,815 trellis plants/ha was not affected the average fruit weight of red pitaya. The growth of red pitaya fruit normally exhibited a sigmoid pattern, where the growth of fruit length, diameter and weight was rapid during 25 days after flower anthesis (A. Nerd *et al.*, 1999) <sup>[1]</sup>. The increase of plant growth hormone, such as Gibberellic acid in red pitaya fruit content (S. Nor Shariah *et al.*, 2014) <sup>[17]</sup>, cross-pollination of red pitaya with other *Hylocereus* spp. and the total numbers of viable seeds in the red pitaya fruit were the major factors that improved the fruit weight of red pitaya. They studies on total yield per hectare of red pitaya (*Hylocereus polyrhizus*) in

various planting densities at Kuala Lumpur, Malaysia. He noticed higher yield per hectare (48.53 t/ha) with trellis planting system at planting distance 3.0 m x 1.8 m as compared to planting distance 3.0 m x 2.1 m and 3.0 m x 2.4 m. (Then, 2017) <sup>[25]</sup>. The study carried out in 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) <sup>[9]</sup>. Shown in Fig 8.

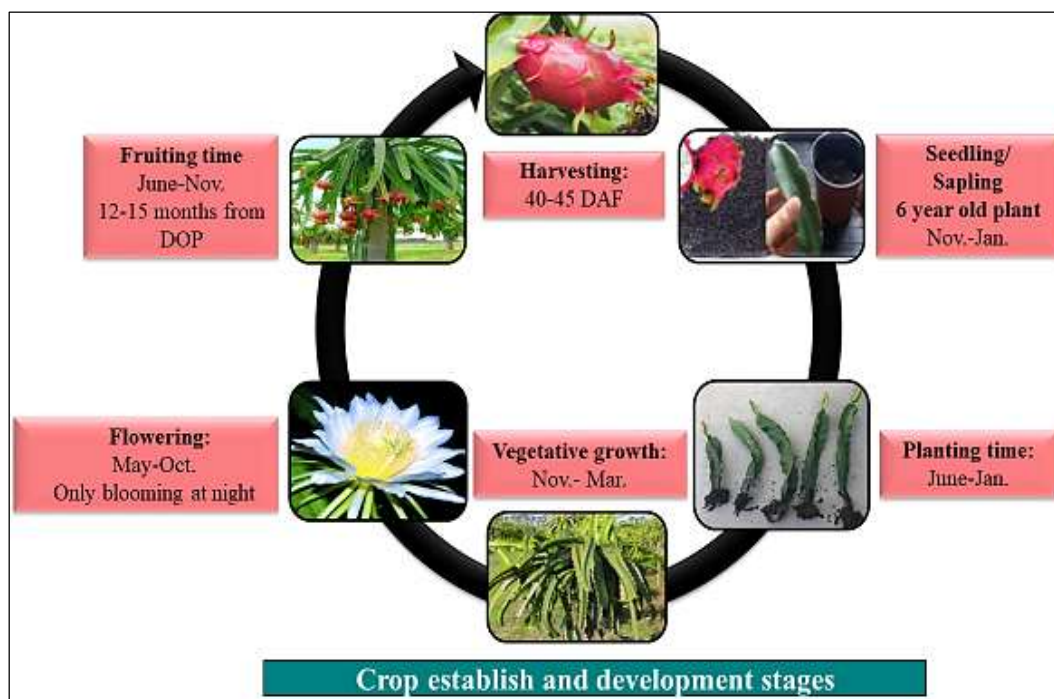


Fig 8: Crop establish and development stages

### Manure and fertilizer

Dragon fruit is not exhaustive fruit crop but having a superficial root system; it can assimilate smallest quantity of nutrients. Judicious application of manures and fertilizers is necessary for higher fruits yield with better quality. There are different fertilizers doses are observed in different countries. Generally 1 to 2 year old plants should be given 10 to 15 kg of FYM and for >3 year old is should be given 20 kg FYM. It can be grown organically without applying chemical fertilizers and pesticide. These organic fruits have more demands in the market. Oil cakes, beneficial micro-organisms and organic manures performed very well in dragon fruit. In India, ICAR-NIASM, Pune (MS) has recommended dose for dragon fruit grown in rocky degraded lands in which for first two years, 500 g urea and 500 g P and 300 g K is applied to each pole per year in four splits at three months interval. After two years each pole/year should be fertilized with 800 g N, 900 g P and 550 g K, which should be well distributed in six splits (Nangare *et al.*, 2020) [13]. Chakma *et al.*, (2014) [3] carried out a trial on the effect of NPK doses on the yield of Dragon fruit at BARI, Bangladesh. They recorded maximum fruit length, number of fruits per pillar, Average individual fruit weight and fruit yield with dose of N<sub>540</sub> P<sub>310</sub> K<sub>250</sub> fertilizer. Effect of different fertilizer rate on flower number, fruit production, yield and average fruit weight of red pitaya at Selangor, Malaysia. They observed maximum flowers, fruit production, yield with mixture fertilizer 1.2 kg N: P: K: Mg (9.6: 4.8: 17.6: 2.4) and compost 12 kg. While higher fruit weight was recorded with mixture fertilizer 1.8 kg N: P: K: Mg (9.6: 4.8: 17.6: 2.4) and compost 12 kg. (Then, 2014) [24]. Effect of organic, inorganic and bio-fertilizers on vegetative characters of dragon fruit (*Hylocereus undatus* L.) plant at BBAU, Lucknow. They noticed that higher plant height (129.30 cm), maximum no. of branches per plant (7.61), no. of thorns (58.41) and stem diameter (19.13 cm) with 15 kg FYM, 75% NPK (200:250:100) along with bio fertilizers (Azotobacter + PSB). (Verma *et al.*, 2019) [28]

### Irrigation requirement

It is having high water use efficiency and low water requirement compare to C<sub>3</sub> and C<sub>4</sub> crops. It develops aerial roots from the sides of the stem to collect water from the surroundings and for anchorage. It requires only 10% of the water required by most of other fruit crops such as pear, citrus, peach, etc. 120 to 150 mm of irrigation/year is recommended to meet its water requirement. Dragon fruit is very shallow rooted crop, its water requirement and frequency of irrigation is higher than other cacti. Small quantity of irrigation at shorter interval is more effective to ensure proper growth and higher fruit yields. Flowering and fruit enlargement stages are the critical stages. Micro-irrigation is recommended to avoid uneven and excess watering that can result in flowers and early fruit drop.

### Flowering & Fruiting

Hermaphrodite nature of flowers. Flowering in flushes and it depend on the species and age of plant. The blooming of is affected by temperature and light intensity. There are self-compatible and self-incompatible varieties. Pitaya is pollinated by moths, flies and bees in the evening and hand pollination can enhance fruit set and size. The flowers start 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 (25-30 cm), white inside and greenish yellow with purple dyes on the outside. 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) [7].

### Training and Pruning

Plants are fast-growing vines and produce 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 the 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. The post-harvest pruning encourages the growth of new young shoots that will bear flowers the following year. The well grown vine may produce 30 to 50 branches in one year and may be more than 100 branches in-four years. Plant is a climbing cactus with segmented stem. They have aerial roots used to attach themselves to supports. It has a life span of 15-20 years and weight of one plant may be goes up to 100kg. Commercial orchards need well designed trellis system. The IHR Bengaluru, India evaluated four different trellis system of Single pole with cement and iron ring, continuous pyramid stands and 'T' stands. Single pole system showed better performance in growth and yield when comparatively other trellis system. Each trellis consisted of one 6 feet height by 5- or 6 inch thickness of poles erected 2 feet depth. Cost may be high for cement pole but they are durable and can be used.

### Single stands

The single cement poles and rings are used for support. In some areas rubber tires cut across is placed on the top of the poles. Plant may be planted near the poles to enable them to climb easily. 2-4 plants/pole depending on the climatic condition. Cheap method as compared to others. Most preferable in India. Shown in Fig 9.



Fig 9: Single stands

### 'T' stands

'T' shape structure of the stand. Plant planted between the two poles. Initial investment is high, around 6-6.5 lack/acre. After 4<sup>th</sup> year become clouded and chances of insect pest attack. Not prefer by the farmers. Shown in Fig 10.



Fig 10: 'T' stands

### Continuous pyramid stands

Continues type Stands are made of G.I. pipe and G.I. angles can also be used. This pyramid shape with a length of 10-15 meter. More number of plants may be planted. Provided adequate aeration to avoid disease and pests. Plant may be planted at 2-3 feet distance both the sides of the structure. The distance between two structures maybe 5-6 m. Shown in Fig 11.



Fig 11: Continuous pyramid stands

### Harvesting

The harvesting time mostly falls between July-November, which comes in 6-7 flushes. During initial fruit development period, the outer skin of immature fruit looks bright green in colour and gradually turns 85% pick as the ripening progress.



Fig 12, 13: Off season flower production in dragon fruit

### Pest and Diseases management

Dragon Fruit is a kind of crop that is comparatively free of pests and diseases. The 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

The dragon fruit is matured 30-35 days after flowering. Simply move the fruit in clock wise direction and twisting the fruit cause less or no injury to the fruits. An additional advantage of the crop is that depending upon the market demand, there is a scope for adjusting the harvesting time. For local market, fruit can be harvested three to four days after the skin colour changes from green to red/pink colour, while for far markets/export purpose it can be harvested a day after colour change.

### Yield

It is a fast-return perennial fruit crop. In well-managed orchards, the flowering may start from 2<sup>nd</sup> year onwards and potential yield can be realized in 2<sup>nd</sup> or 4<sup>th</sup> year. The average yield can be 10 to 12 tonnes/ha. But in well managed commercial orchards the yield of 16-27 tonnes/ha can be possible from 3<sup>rd</sup> year onwards under favorable climatic and properly managed conditions Average weight of fruit is 300-800 g.

### Off season flower production in dragon fruit

Under natural conditions, dragon cactus produced flowers and bears fruit only during the long-day months from May to October. Change in timing of fruit ripening can satisfy the market demand during off-season. By providing additional light during the short-day period to induce flowering at the required period. The off season flowering of dragon cactus can be induced by supplemental lighting, breaking up the dark period by turning lights on for four in the middle of the night known as night-break. This can be done between 10 o'clock in the evening until 2 o'clock the following morning using CFL or LED bulbs. The bulbs line is hanging between two rows of pitaya at the high of 0.7 m to 1.2m or we can keep one bulb in the central of four pitaya trees, the light should distribute in all direction of the tree. Off-season production from November to April. Cool season are more desired in the market than fruits from summer crops because the off-season fruits are larger and sweeter. However, high cost of electricity is one of the constraints of this technology. Price remains as high as INR 150.00 to 250.00 per kg during off season. Shown in fig 12, 13.



Fig 14, 15: Pest and diseases of dragon fruit

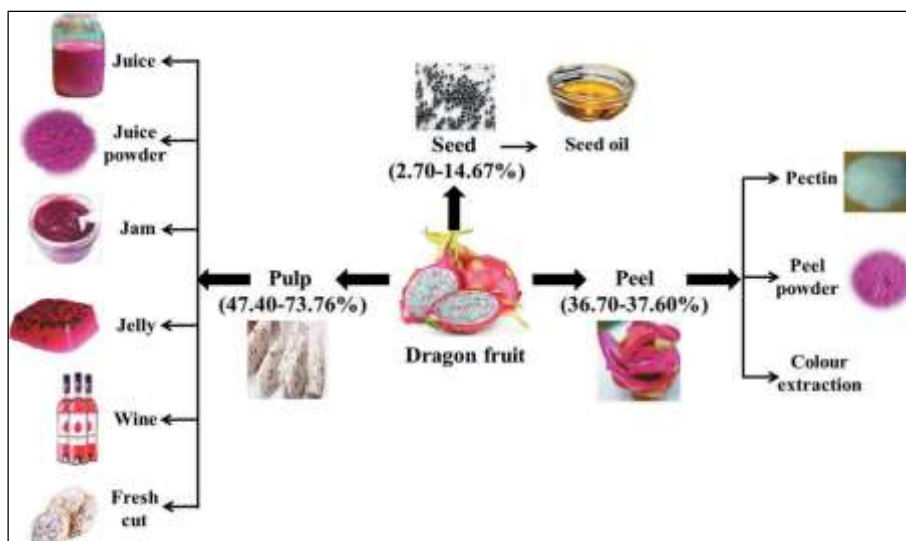


Fig 16: Value added products

### Processing and value addition

Dragon fruit pulp and juice with a solution containing 1.5 percent pectin, 55% sugar and 0.9 percent citric acid solution improved the colour as well as other organoleptic characteristics of dragon fruit jam and jelly. In the case of dragon fruit RTS beverage 14 percent pulp, 12 percent sugar and 0.9% were found to be most suitable. The prepared product was found to be organoleptically acceptable. Prepared products can be stored for a period of more than three months at ambient storage conditions without microbial spoilage or any considerable loss in quality (Sharma, 2016) <sup>[19]</sup>. The fruit pulp is used to make juice, wine, jam, jelly, candy, syrup and preserve. Peel has utilization for the extraction of natural food colorant as well as a source of pectin. Seeds are mainly utilized to extract the oil from it which contains about 50% essential fatty acids. Also, the seeds have application as an ingredient in many food products such as syrup, ice cream, sherbet, candy, yoghurt and pastries. Shown in Fig 16.

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