Recent Advances and Prospects for Dragon Fruit (*Hylocereus spp*.) Plant Propagation Techniques

ABSTRACT

Dragon fruit (*Hylocereus spp.*) is a recently introduced super fruit in India, gaining popularity both in rural and urban areas because of its attractive colour, delicious taste, and high nutritive and medicinal values. It is adaptable to humid as well as semi-arid tropical and subtropical conditions. The growing acceptance of this fruit along with its enormous medicinal and antioxidant properties has increased the demand for its cultivation followed by quality planting materials in the desired quantity. Propagation of Dragon fruit can be done by both micropropagation sexual via seeds and asexual methods via stem cuttings, grafting, and micropropagation. In this review, attempts have been made to cover various fruit propagation methods along with other related crop features about which there is relatively scanty information. The assessment also attempted to highlight the prospective propagation locations for dragon fruit, which calls for additional study to produce more information and advance crop propagation methods.

Keywords: Dragon Fruit, Plant Propagation Techniques, gaining popularity

INTRODUCTION

The dragon fruit (*Hylocereus undatus)* is a strong source of betalins and is high in a number of vitamins, minerals, and important fatty acids **(Morton, 1987)**. According to **Dahanayake** and **Ranawake (2011),** the fruit, which is a member of the Cactaceae family, grows best in arid tropical or subtropical climates with annual rainfall of between 20 and 50 inches. Due to the crop's enormous industrial, medical, and commercial potential, it is being grown all over the world (**Ortiz-Hernandez and Carrillo Salazar, 2012**). It has only lately been introduced to and is being grown in various parts of India. Because of its hardiness and low water and fertilizer needs, it may grow successfully in harsh weather conditions and poor soils. Due to the low seed viability of stored dragon fruit, stem cuttings are frequently employed as propagation materials. In stem cuttings, the complete cladode segment or cuttings that range in length from 10 to 60 cm are employed **(Zee et al. 2004)**. The length of cuttings is a major factor in determining the success of roots and plays a substantial role in it **(Leakey 2004)**.

Similarly, maximizing cutting length is essential because smaller cuttings have a negative impact on poor roots and establishment while longer cuttings waste resources. Furthermore, there is a correlation between cutting length and rooting that depends on the species. For instance, **Aminah et al. (2015)** observed that in ***Tinospora crispa***, longer cutting lengths led to increased success. In contrast, shorter (10 cm) cuttings resulted in higher (15 and 20 cm) roots in ***Larix kaempferi*** **(Wang et al. 1997)**. However, better roots were also produced by intermediate cuttings **(Naidu and Jones 2017)**. According to **Tangana and Khasa (2008)**, the rooting of ***Allanblackia floribunda*** was not significantly impacted by the cutting length. Micropropagation is a different technique for producing plantlets on a big scale, but there is not much information on the protocols for using this technique to produce high-quality planting material. This review intends to draw attention to several propagation techniques that can be utilized to grow healthy, high-quality dragon fruit plants.

Sexual Propagation

Dragon fruit is sexually reproduced through its seeds. The viability of the dragon fruit seeds is 83% **(Ahmed, 2006)**. However, due to the lengthy-time period needed for the seedlings to produce, sexual propagation is uncommon in this crop. In comparison to seedlings propagated vegetatively, the seedlings generated are also less robust and less true to type **(Tripathi *et al*., 2014).** However, seed propagation is a crucial tool in genetic studies since it gives seedlings genetic diversity, a longer life span, and a certain level of disease and pest resistance**.** The literature on dragon fruit seed propagation is extremely scarce. The fruit's seeds are small and black in colour. When seeds are planted shortly after extraction, a higher germination rate is attained. Seeds are sown in polybags or trays, and then two-month-old seedlings are moved into pots and held there until they are prepared for planting in the main field. Even a year after germination, according to **Tripathi *et al*. (2014)**, the seedlings are not yet ready to be transferred into the main field. The fruit's seed germination is influenced by several variables, including the growing medium, temperature, and light intensity. **Ahmed (2006)** found that a peat moss + sand mixture (1:1) at 24 o C had the highest germination percentage (82%) and required a minimum of 18 days for germination in peat moss. At 16 ℃, germination occurred most quickly. Germination decreased by 19% when light intensity was increased by 2000 lux from 12 hours per day to 24 hours per day.

Asexual Propagation

According to **Hartmann *et al*. (2011)**, every plant cell could grow into a new plant. Many plant parts, including cuttings, buds, nodes and internodes, leaves, scion, bulbs, and corms, among others, have been employed in plant propagation as a result **(Poethig, 2013)**. For dragon fruit, stem cuttings are the most typical method of propagation. On the other hand, very little research has been done on grafting-based propagation.

Stem cutting

Stem cutting is the most popular method of dragon fruit growth since it produces fruits that are true to type in the shortest amount of time. The length of the cutting, age or maturity of the cuttings, timing of taking cuttings, stem portion used for cutting, media used for rooting the cuttings, application of PGRs, fresh weight of the cuttings, and environmental conditions for raising environmental conditions all play a role in this propagation technique's success.

Length of cutting

Given that longer cuttings resulted in earlier root and shoot initiation of higher quality due to a higher rate of photosynthesis leading to higher carbohydrate content in the tissues, cutting length is important for the rooting and shoot initiation of dragon fruit. In his study, **Mickymaray (2019)** noted that even without the use of IBA, a cutting size of 15 cm resulted in greater roots and shoot development in this fruit. **Kakade *et al*. (2019)** advocated cuttings of 35–45 cm in length for improved growth and development, however, **Ahmed (2006)** found that 5 cm of cutting length was an effective size when treated with a 10 mM IBA solution. Another study by (**Kakade *et al*., 2019**) revealed that when cuttings of length 35–40 cm were employed for multiplication 30 days after planting (DAP), the length and dry weight of shoots and fresh weight of roots were higher. On the other side, taking 20–25 cm long cuttings resulted in the greatest growth in fresh weight of shoots, number of first-order roots, and length of longest first-order root. Nevertheless, the average length of new shoots (33.06 cm), average weight of shoots (32.56 g), average number of first-order roots (7.25), and average length of largest first-order root (32.37 cm). Longer cuttings (>30–35 cm) had fresh and dried root weights of 12.52 and 4.75 grams, respectively. On the other hand, shoot fresh weight was greatest at cutting lengths of 25 to 30 cm, while the lowest values were seen at 60 DAP in smaller cuttings. The study demonstrates that even if dragon fruit is propagated using a variety of cutting lengths, larger cuttings (40–5 cm) are praised for greater growth and development.

Age of Cuttings

The age or maturity of the chosen stem is a crucial consideration that must be made when choosing the stem of the mother plant to be utilized for the manufacture of the cuttings. **Fumuro (2011)** suggested using stems that are one to two years old for greater cutting survival and growth**.**

Time of Cuttings

Because the amounts of endogenous plant growth regulators, rooting cofactors, and glucose levels in the mother plant vary throughout the year, a precise time of year should be observed when taking cuttings for propagation **(Hartman *et al*. 2011)**. The fluctuations in phenolic compound levels in the mother plant may be responsible for the seasonal variation in cutting success. Shoot RNA levels, which are high during the season with the greatest number of successful cuts, also have a role in the seasonal fluctuation in cutting success **(Davies, 1984)**. It was discovered that the root initials need a specific amount of protein and DNA synthesis to begin dividing and that the genes responsible for this synthesis are controlled by an increase in shoot RNA activity **(Molnar, 1972; Davies, 1984)**. Studies by **(Wodzicki *et al*., 1978, Cabahug *et al*. 2018, and Nandi, Tarai and Ghosh (2019)** all found higher cambial activity during the season with the highest rooting percentage. This may have been because endogenous auxin levels were higher during the months of November to March, which may have increased the cambial activity. In a similar vein, the dragon fruit's highest survival rate was also noted around this time. However, the lowest survival rates were seen in September and October.

Effect of Plant Growth Regulators

Cuttings rooting is caused by plant growth regulators, mainly auxins and cytokinins. Auxins encourage roots while cytokinins hinder it. Although endogenous auxin concentrations are highest during the peak period for cutting, exogenous auxin administration is increasingly important to continue cutting production year-round and to improve roots in smaller cuttings. Numerous experiments have been conducted in an attempt to establish the ideal concentrations of Indole-3-Acetic Acid (IAA) and Indole Butyric Acid (IBA) for promoting the roots of cuttings. According to a report by **Ahmed (2006)**, cuttings of up to 5 cm in length produced at a concentration of 10 mM IBA are of high quality. Additionally, Ahmed (2006) and Siddiqua, **Thippesha (2018)** recommended 100 ppm, 7000 ppm, and 6000 ppm IBA solutions, respectively, for improved cutting establishment. **Malsawmkimi *et al*. (2019)**

investigation revealed that the shoots treated with 250 ppm IBA concentration acquired the highest levels of protein and nitrogen.

Effect of portion of the stem used for cutting

To ascertain which part of the stem—proximal, central, or distal—produces better quality roots and shoot characteristics, numerous researches have been conducted. The basal or proximal section of the stem has the highest percentage of roots, according to **Fumuro (2011)**. While **Nandi, Tarai and Ghosh (2019)** showed that when cuttings are prepared from the centre region of the stem, the maximum live cuttings, maximum length of roots, and maximum root numbers are achieved.

Effect of the media used for the rooting of the cuttings

The cuttings' rooting depends heavily on the rooting medium. The media should have a suitable water holding capacity as well as a suitable drainage capacity in order to avoid water stagnation in the medium and give enough water to the cuttings. Peat moss had the most roots (43), and sand had the longest roots (8.2 cm), according to **Ahmed (2006). Tripathi *et al*. (2014)** suggested a soil, farmyard manure, and sand mixture in a 1:1:2 ratio for the stem cuttings of dragon fruit.

Effect of fresh weight of the cuttings

The fresh weight of the cuttings is crucial for the success of the cuttings because the food components that are stored in them aid in the rooting of dragon fruit. According to **Fumuro (2011),** when the fresh weight of the cuttings was 6–7 g per cm of cutting length, the percentage of rooting and root fresh weight was maximum.

Effect of environmental conditions

In general, environmental factors including the amount of sunlight, the air temperature, and the relative humidity are crucial for the rooting of dragon fruit cuttings. In order for the cuttings to continue the photosynthetic process and to have minimal endogenous auxin degradation, the cuttings should receive an ideal amount of sunshine, as it has been discovered that light causes the destruction of the pre-existing auxins **(Hartman *et al*., 2011)**. Therefore, the cuttings should be given the best possible shade. For enhanced root and shoot growth in dragon fruit cuttings, **Lone *et al*. (2018)** suggested partial shade of 23% - 42%.

However, there are currently no published papers on the requirements for ambient temperature and relative humidity for dragon fruit cuttings.

Grafting technique in dragon fruit propagation

An essential asexual proliferation method for dragon fruit is grafting. It enables the use of a species of dragon fruit that is more suited to certain soil and climatic circumstances as rootstock and the use of a species of dragon fruit that has desired characteristics but is less suited to the soil and climatic conditions in question as scion. Wang obtained a patent for the following dragon fruit grafting method. A sensitive shoot with a wedge-shaped base was chosen for the scion. An appropriate rootstock is chosen, and the above piece is removed after making a transverse cut in the stem to serve as the rootstock. At the center of the surface of the transverse cut, a longitudinal cut is formed. The rootstock's longitudinal cut is promptly filled with the scion. The rootstock has been freed of its thorns. The union is covered with a plastic bag and securely fastened with plastic tape. It was asserted that it offers a survival rate of above 95%. Other researchers have also experimented with and patented dragon fruit grafting procedures **(Ziyou, 2015; Zain *et al*., 2019).**

Micropropagation

One of the best strategies for producing quick and disease-free plants is the propagation method for dragon fruit using in vitro tissue culture. Even though numerous studies have been done on various fruit propagation techniques, there is relatively little knowledge available regarding protocols for producing high-quality planting material using tissue culture. Young shoots of various cultivars of dragon fruit were cultured by (Bozkurt et al., 2020) using Murashige and Skoog (MS) basal media that was treated with various plant growth regulators, including 6-benzylaminopurine (BAP), gibberellic acid (GA3), and indole-3-butyric (IBA). The findings showed that the Halley's Comet variety, which was grown in MS medium supplemented with 2 ppm BAP, had the highest rate of multiplication, whereas the Bloody Mary cultivar had the lowest rate in MS medium supplied with 2 ppm BAP. However, adding 1 ppm IBA to MS medium led to the best rooting results.

Dahanayake and Ranawake (2011) published the results of another investigation on the direct shoot regeneration of Dragon fruit explants utilizing leaf and stem cuttings. The explant type had a significant impact on the ability of shoot buds to regenerate, according to the results. In comparison to explants taken from leaves (3 buds/explant), stem explants showed a larger ability for regeneration (18 buds/explant). In contrast to other hormonal combinations, MS media supplemented with 2.5 ppm BA and 0.01 ppm NAA ppm saw the greatest number of shoots regenerate from stem and leaf explants. When 0.01 ppm NAA was added to MS medium, mature shoot regeneration showed the highest rooting.

In order to create a better micropropagation procedure for the Dragon fruit 'Da Hong' cultivar, **Lee and Chang (2022)** conducted a study. It was found that an increase in NAA concentration caused a reduction in root length but an increase in root number. The addition of activated charcoal (AC) lengthened shoots and prevented the regrowth of aberrant, clustered, and dried-out shoots. On treatment with 200 mg/L AC and 0.10 mg/L NAA, the plantlets' maximum shoot number was seen. We found a significant relationship between plantlet shoot surface area and weight.

Yasseen (2002) described another micropropagation investigation using explants removed from juvenile joints of mature plants that were cultivated on MS containing 0.5 mM NAA and 0.5 mM TDZ. In order to produce secondary explants, shoots that sprouted from these primary explants were either decapitated or divided longitudinally into three sections. These secondary explants were then grown on MS that was supplemented with 0.5 M NAA and either 0.01, 0.09, 0.5, or 0.9 M TDZ. It was shown that compared to longitudinal explants, decapitation explants produced a higher number of shoots more frequently. The distal regions of both types of secondary explants produced the majority of the shoots.

Conclusion

The aforementioned assessment leads to the conclusion that dragon fruit is a very profitable product with outstanding export potential. In tropical and subtropical environments, this fruit is easily multiplied by sexual and asexual means. In vitro tissue culture, also known as micropropagation, is regarded as one of the greatest processes for producing plants quickly and without disease. Several techniques that can be employed for the in vitro method of mass-producing Dragon fruit have been discussed. However, due to the significant expense involved, it is typically out of reach. It may be argued that stem cuttings are the best method for propagating this fruit. More research is required to compare the field performance of dragon fruit cultivated using various methods/techniques.

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