Vegetative Propagation of Fig (*Ficus carica* L.)- A Review

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Abstract

Fig can be propagated through sexual and asexual method. In sexual method, seed is employed only to produce new varieties by hybridization and to produce root stock. In asexual method, it can be successfully propagated by cuttings, air layering, grafting and budding. Among all the asexual techniques, cutting is the easiest method but rooting in hard wood cuttings is the fundamental problem in the practical application, whereas, air layering in fig is the oldest technique in asexual propagation since air layering is simple and rapid method of fig propagation. Therefore, the aim of the present review of literature was to gather information referring to advances in research related to fig propagation. Auxin application has been found to enhance the histological features like formation of callus and tissue and differentiation of vascular tissue.

Keywords: *Ficus carica*, propagation, cutting, layering, rooting

Introduction

Ficus carica (Fig) is a subtropical fruit that belongs to the Moraceae family. The important species are *Ficus benjamina*, *Ficus callosa*, *Ficus carica*, *Ficus religiosa*, *Ficus elastica*, *Ficus pumia* and *Ficus hawaii*. It is a classical fruit tree of antiquity associated with the beginning of horticulture in Asia Minor and Mediterranean basin (Siddiqui and Hussain, 2007). Fig is consumed fresh or in processed form though dried form being the most popular since dry figs have high nutritive value and are rich source of protein, calcium, iron and calorie (Chadha, 2007). Fig contains various medicinal properties, *i.e.*, laxative and appetizer. A fresh or dry fig with warm water, if taken before sleep, brings a healthy result within five to seven days (Aghera and Makwana, 2018).

Fig is propagated through both sexual and asexual methods. In asexual method, it can be successfully propagated by cutting, layering and grafting. Among all the asexual techniques, cutting is the easiest method of producing true to type plants but rooting in hard wood cutting is a fundamental problem in the practical application. For this, the use of plant growth regulators is most important. According Hartmann *et al*. (2011), cutting is the propagation method, in which, the induction of adventitious rooting occurs in segments of the mother plant, which once introduced to favourable conditions gives rise to a seedling. Plant growth regulators including indole butyric acid or para hydroxy benzoic acid promote good rooting. Hardwood cuttings when planted after giving IBA 500 ppm treatment resulted in maximum number of leaves (Singh, 2014).

Auxin application has been found to enhance the histological features like formation of callus and differentiation of vascular tissue (Mitra and Bose, 1954; Singh, 2018). IBA and PHB (500-1500 ppm) when applied together generated maximum rooting and showed maximum survival percentage (Ram *et al*., 2005). Plant growth regulators including indole butyric acid promote rooting in cuttings. Therefore, keeping in view the importance of root promoting substances, the concerned information was collected and have been reviewed below:

1. Cutting

Cutting has been the most useful method for the cloning of woody plants on a large scale and depends on the rooting ability of each species, the quality of the root system and the later plant development (Neves *et al*., 2006; Gratieri-Sossella *et al*., 2008). Dias *et al*. (2013) verified that cuttings that exhibited larger diameter values presented better development of shoots since because cuttings with larger diameters contain larger reserves of carbohydrates.

Fig cuttings are usually easy to root but sudden changes in air temperature and moisture status of the soil affect rooting and development of shoots (Kabasakal *et al*., 1990). Based on data regarding number of leaves, number of roots, root length and sprouting percentage, it was concluded that 20 cm long cuttings collected from two cultivars Sawari and Tarnab Inzar were found the best option for commercial production of fig nursery plants (Hussain *et al*., 2018).

IBA Concentration

The maximum percentage of rooting, number of roots, longest root length and survival percentage of rooted cuttings was obtained with IBA 2500 ppm + NAA 2500 ppm treatment followed by IBA 2500 ppm in both hardwood and semi-hardwood cuttings of fig (Reddy *et al*., 2008). Basal cuttings treated with IBA 3000 ppm were considered best for the propagation of fig under open conditions (Sivaji *et al*., 2014). Among the different concentrations of IBA, treating with IBA 2000 ppm recorded the significantly maximum percentage of rooted cuttings (75.98%), length of roots (22.13 cm), fresh (2.82 g) and dry (1.84 g) weight of roots per cutting and survival (75.98%) at 90 days after planting (Aghera and Makwana, 2015).

The ability of branch cutting to sprout and root is determined by various internal and external factors, which include the types of cutting, seasons, concentrations of endogenous and exogenous phytohormones, physiological basis and other internal basis (Arya *et al*., 1994; Jat *et al*., 2017). Plant growth regulators improve rooting in cuttings by stimulating the production of adventitious roots (Blazich, 1988; Singh, 2018). Singh *et al*. (2014) observed that among the treatments, the number of sprouted cuttings, length of the roots per cutting, percentage of rooted cuttings and root length of the longest sprout were observed maximum in treatment IBA 2000 mg L^{-1}.

Based on evaluation of traits results, it was observed that semi-hard wood cuttings of wild fig treated with IBA 6000 ppm performed best among the treatments during experimentation (Mewar *et al*., 2018), which might be due to the increased division of the cells and their differentiation under the influence of rooting chemicals and enhanced hydrolysis of nutritional reserves, resulting in increased root formation (Mitra and Bose 1954; Satpal *et. al*., 2014; Singh *et al*., 2011).

The quick dipping in solution of IBA 3000 ppm proved to be the best in terms of minimum days to first sprouting, maximum percentage of rooting, sprouting and survival, number of roots per cutting, root length, average shoot length and diameter, number of leaves and total leaf area (Kaur *et al*., 2017). Earliness in sprouting might be because of that there was better utilization of stored carbohydrates, nitrogen and other factors with the help of growth regulators (Chandramouli, 2001).

According to Pizzatto *et al*. (2011), during the rooting period, cytokinin is gradually metabolized in favour of bud sprouting and root growth or simply inactivated by the plant tissue, if there are not enough reserves for their metabolism.

Among the concentrations of IBA, 3000 ppm recorded the significantly maximum percentage of rooted cuttings, number of roots, root length and survival percentage in cuttings of cv. Conadria (Kuntagol *et al*., 2018).

The action of auxin in root is like that in stem but that the concentration of auxin to stem growth is inhibitory to root growth. In other words, roots are found more sensitive to auxin than stem, and real stimulation of root elongation may be achieved if low concentration of Auxin is used. Application of relatively high concentration of IBA to root not only retarded root elongation but also increased the number of branched roots (Devlin, 1974; Singh *et al*., 2018; Singh *et al*., 2019). Similar experiments were also conducted by number of researchers in different plant species on various parameters of cuttings and root formation with minimum time in respect of different concentrations of growth substances (Hartmann *et al*., 2002; Pio *et al*., 2002; Singh *et al*., 2002; Tchoundjeu *et al*., 2002; Dhillon and Sharma, 2002; Reddy *et al*., 2003; Ahmed *et al*., 2003).

Among the IBA treatments, quick dipping of cuttings in solution of IBA 3000 ppm proved to be the best in terms of minimum days to first sprouting, maximum percentage of rooting, sprouting and survival, number of roots per cutting, root length, fresh and dry weight of roots, number of shoots per cutting, average shoot length and diameter, number of leaves and total leaf area (Kaur *et al*., 2017), which might be due to the presence of large number of chemically and physiologically related compounds such as phenols, gibberellins, abscisic acid and others (Hiss, 1968; Gerter, 1969).

The fig cuttings quickly dipped in 3000 ppm solution of IBA showed best results in terms of minimum days to first sprouting, maximum sprouting, rooting and survival percentage, number of roots per cutting, root length, fresh weight of roots, dry weight of roots, number of shoots per cutting, average shoot length and diameter, fresh and dry weight of shoots, number of leaves and total leaf area (Kaur *et al*., 2018). Low auxin activity and its slow degradation by auxin destroying enzyme (IAA oxidase) led to the growth and vigour of roots, which might be due to the reserved food in cuttings (Singh *et al*., 2014).

Rooting Media

The survival rates and rooting were observed better in most viable medium, *i.e.*, vermiculite, Plantimax® and carbonized rice hulls when the first one was provided after 35 days of cutting (Corte, 2004). The maximum percentage of rooted cuttings, length of roots, fresh and dry weight of roots per cutting and survival percentage of cuttings was recorded under soil + sand (1:1) rooting medium (Aghera and Makwana, 2015).

In herbaceous cuttings of fig cv. Roxo de Valinhos, Pio *et al*. (2005) recommended coconut fiber and Plantmax® substrates for good rooting. For good rooting in woody cuttings of fig cv. Sarilop, Sirin *et al*. (2010) found perlite and peat + perlite the best alternative substrates.

Type of Cutting

The herbaceous cuttings of fig cv. Roxo de Valinhos in the presence of leaves showed higher percentage of rooting and sprouting with higher number of shoots (Pio *et al*., 2004). Pio *et al*. (2006) concluded that the cuttings from apical portion provided higher rates of rooting, number of roots, mean length of roots and shoots and number of shoots as compared to cuttings from middle and basal portion. Nogueira *et al*. (2007) found the cuttings from woody portion of fig plant unsuitable for rooting even under the most appropriate conditions. The material used for cuttings should be woody stem obtained from meddle and basal portion of branches originating from winter pruning in the month of July to September (Araújo, 2005; Alvarenga *et al*., 2007; Sousa *et al*., 2013).

Girdling of stem, which blocks the downward translocation of carbohydrates, hormones and other possible root promoting factors, if covered with sphagnum moss promotes root formation, which is considered one of the most important methods of vegetative propagation (Hartmann and Kester, 1983). Paula *et al*. (2009) also verified that herbaceous cuttings of fig cv Roxo de Valinhos gave better propagation results, allowing a longer period for the cutting accomplishment. Bisi *et al*. (2016) observed that sprouting and rooting in herbaceous cuttings of lemon cv. Bêbara Branca and Pingo de Mel was better than hardwood cuttings (Nogueira *et al*., 2007).

Time of Cutting

The maximum sprouting percentage with roots was noticed for the early cuttings (Chalfun *et al*., 2003). Carbohydrate reserves affected by season and other factors such as temperature, light and availability of nutrients to the alive cuttings are responsible for maximum sprouting (Singh *et al*., 2020). According to Paula *et al*. (2009), September and January are the best months for herbaceous fig cuttings without the use of IBA because in these months, the best results are obtained for sprouting and rooting due to enhanced activity of hydrolysing enzymes and adequate mobilization of reserve food material and the enhanced hydrolysis activity in the presence of optimum production of endogenous hormones (Nanda and Anand, 1970; Singh *et al*. 2019). Poor rooting in cuttings, which were planted during cooler time of the season, might be due to the presence of more inhibitor and higher nitrogen to carbohydrate ratio, however, the low rooting percentage during winter might be attributed to temperature level at the time of planting (Ozcan *et al*., 1993; Singh *et. al*., 2017; Singh *et al*. (2014). In this context, the adoption of alternative methods for vegetative propagation from fig cuttings, such as layering (Pio *et al*., 2007; Daneluz *et al*., 2009), hardwood cuttings of the basal portion of the branches (Ohland *et al*., 2009a), herbaceous cuttings originating from sprout removal (Pio *et al*., 2005) and herbaceous cuttings obtained during the growing season (Nogueira *et al*., 2007) could provide higher rooting in cuttings, which will have low rooting when propagated by the current method of hardwood cuttings. Bastos *et al*. (2009) observed that the maximum percentage of survival and rooting cutting was recorded under 2000 ppm concentration of IBA.

2. Air Layering

Pre-conditioning treatments such as girdling, blanching and etiolation of shoots have been shown to induce roots in some fruit plants in which rooting is difficult, however, etiolation stimulates rooting at etiolated portion. Reddy *et al*. (2014) observed that air layering with soil + poultry manure + sphagnum moss + IBA 3000 ppm showed early root initiation (8.73 days), required minimum number of days for bulk root appearance (20.80) and maximum number of primary (39.20 and 58.87) and secondary (155.93 and 250.73) roots, primary (16.53 and 17.48 cm) and secondary (2.36 and 3.37 cm) root length at 30 and 45 days and fresh weight of shoot (34.10, 35.96 and 43.53 g) and root (5.63, 6.63 and 7.73 g) biomass, dry weight of shoot (16.49, 24.91 and 30.88 g) and root (1.65, 2.13 and 2.81 g) biomass, survival percentage of air layers (90.93, 88.53 and 83.46) at 45, 60 and 75 days after planting of fig air layers, respectively. The treatment combination (etiolation + IBA 750 ppm) was numerically effective in reducing the period for first rooting and rooting percentage, increasing the number, length and weight of root, number of primary and secondary roots, number and length of shoots with maximum survival percentage of air layers (Kahlon and Kaur, 2020).

3. Grafting

Grafting is a technique widely used in the production of seedlings of fruit trees of commercial interest and is composed of the rootstock responsible to produce the root system and the graft, which will constitute the crown, *i.e.*, productive part of interest. Souza (2008) considers grafting the important method to increase fig production, while cleft grafting can be an efficient process for the rapid formation of seedlings. The author also concluded that table grafting by plunging and cleft grafting are viable techniques to be used in the production process of fig cv. Smyrna, Troyana or Palestino and Roxo de Valinhos, reporting 100% of survival rate of cuttings grafted by plunging and cleft grafting for the above cultivars. Silva (2010) also confirmed the feasibility of grafting methods by plunging in fig cv. Genoveso, which presented the maximum survival rate at 20 days after grafting (plate plunging) and in cv. Troyano, which at 60 days showed the maximum survival rate, rooting, number of leaves and number of roots. The grafting of fig cv. Roxo de Valinhos can be done by plunging and cleft grafting. Plunging should be performed in August by the normal “T” method, which coincides with the beginning of budding of branches of plants in the field, *i.e*., end of the dormancy period. For grafting by cleft graft method, the cuttings should be treated with IBA and forks should be protected for 60 days with transparent plastic bags (18 x 3 cm) for better percentage of sprouted forks and average sprout length (Kotz, 2011). Casaroti (2010) observed high fruit production mainly during offseason when the Bonato variety of fig was used as a rootstock and Roxo de Valinhos variety as a scion. In studies related to the development and production of Roxo de Valinhos fig fruits on different rootstocks, Silva (2010) found that there was an effect of Turco and Palestino rootstocks on the production of green figs and Bonato and Caprifigo rootstocks on the production of ripe fruits, providing high productivity and quality. By cleft grafting in Roxo de Valinhos fig tree, Kotz *et al*. (2011) obtained adequate results in relation to the percentage of live grafts (81.7%), demonstrating satisfactory development of seedlings and good morphophysiological compatibility.

4. Budding

The maximum budding success was recorded in variety King and Brown Turkey and the least success in Black Fig (Rattanpal *et al*., 2014). There was no significant difference among the cultivars *viz*., Black Fig, Brown Turkey, California Brown Turkey, Conadria, Deanna, Dinkar, Genoa, Golden Celeste, King, Panache, Poona, San Piero and Texas for number of days taken from budding to sprouting. Besides, no incompatibility was recorded in any cultivar even two years after budding operation. In most of cultivars, the union became smoother with time. Though fig culture is new in Punjab, this technique will help in the quick spread of cultivars suitable for Punjab (Rattanpal and Sidhu, 2017).

Conclusion

Fig can successfully be propagated by cutting with the application of plant bio-regulators and time of planting, therefore, increasing the production of fig, cutting is one of the easiest processes for developing fig plant in minimum possible time.

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