

## Propagation of Ornamental Figs (*Ficus*)

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### Abstract

Many species of *Ficus* are used for interiorscaping and landscaping. Their growth habits range from prostrate groundcovers to shrubs, trees, and vines. Nearly all are easily propagated by the usual vegetative techniques of cutting, layering, grafting, and micropropagation. Fewer are propagated by seed as pollination requires specialized wasps, but some of those that do produce seed have become invasive. *Ficus* species are suitable

subjects for plant propagation classes as many, such as *F. elastica*, *F. rubiginosa*, and *F. benghalensis*, can be propagated by single-node cuttings as well as by stem cuttings and air layers. Aerial roots are characteristic of some species, which also signal ease of rooting. Many of the selections used in interiorscapes have been tissue cultured, giving rise to diverse forms, some of which are more compact and better branched.

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### INTRODUCTION

Among the most celebrated *Ficus* species are the edible fig (*F. carica*), the Bo (Bohdi) tree (*F. religiosa*, associated with Buddha), and the Indian Banyan (*F. benghalensis*, associated with three Hindu gods). All have been propagated vegetatively to maintain lines known for their eating qualities or religious connections. Another with religious connections is *F. sycamorus*,

associated with the Egyptian goddesses Isis, Hathor, and Nut. Many citations on *Ficus* propagation can be found in an online search, but only a small selection is cited in this review.

### CUTTINGS

Citing the ancient Greek philosopher and botanist Theophrastus, Condit (1947)

related that “the fig is propagated by cuttings more readily than any other fruit tree.” Branches up to 4 feet in length would be planted in deep holes directly in the field where they would be grown, or shorter cuttings would be produced in a nursery row, then transplanted to the final site. According to Condit (1947), any wood up to 2 or 3 years of age could be used, with a diameter of  $\frac{3}{8}$  to  $\frac{3}{4}$  inches and about 9 inches in length. These would be handled as hardwood cuttings and heeled into the ground or nursery beds until callused, then lined out in the field and grown for a season, and dug, heeled in, and planted out in the second season. Such practices would probably work for ornamental *Ficus*, but since the target use is not as an orchard, there would be little need to follow such protocols. Condit noted that rooting occurred so readily that rooting hormones were not necessary.

Among the early foliage plants produced in south Florida were members of the genus *Ficus* (Neel, 1975, 1979). Many cultivars of *F. elastica* were propagated by air layering as was the large-leaved *F. lyrata* (Henley, 1979). Henley also noted that *F. benjamina* was produced from semi-hardwood cuttings. Neel (1979) provided tables reporting common methods of tropical plants in which cuttings were most used for *F. benjamina* and *F. microcarpa* and air layering was used for *F. elastica* and *F. lyrata*.

Conditions for rapid multiplication of leaf-bud cuttings of *F. elastica* ‘Robusta’ were evaluated by Morgan and Lawlor (1976). Rate of rooting improved as bottom heat increased from 18°C to 30°C; a pH between 4.5 and 5.5 for a peat-based medium yielded the longest roots; and the rooting hormones NAA and IBA enhanced rooting in comparison with controls, with a powdered formulation of 0.8% IBA generally being most effective. In the best treatments, root initiation was evident in 15 days and, at 3 weeks, roots of 3 to 5 cm length were

recorded. Gooch and Criley (1980) reported that node position influenced extent and rooting percentage of *F. elastica* ‘Decora’ with node positions 6 through 11 having the highest rooting potential (node position 1 was at the fourth expanded leaf as nodes of the terminal three leaves were too immature). Wang (1988) reported that bottom heat (28°C) enhanced root development of *F. benjamina* as did higher light levels (290  $\mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$  versus 90  $\mu\text{mol}\cdot\text{s}^{-1}\cdot\text{m}^{-2}$ ) in the propagation bench.

Propagation of *F. elastica* by single-node cuttings consisting of a section of stem, a healthy bud, and a leaf trimmed to one-third or one-half its length is also noted by Henley (1979). Single-node cutting propagation produces more plants than air layering, but development of a sizable plant takes longer. During the glory days of the foliage plant trade in Florida, Poole and Conover (1984, 1990) described the use of single-node cuttings of the large-leaved *Ficus* (five cultivars of *F. elastica* and *F. lyrata*) to produce more plants from a stock plant than the then common method of air layering. Whole leaves with a portion of stem and the axillary bud could be used, but the leaf had to be rolled and held with a rubber band to reduce the space used in the mist propagation bench. They reported that a leaf could be reduced to 50% of its area and still achieve a satisfactory root grade and shoot production. Treatment of the base of the stem with 0.8% IBA was beneficial. The leaf-and-eye method used for *F. elastica* is often coupled with a foliar spray of 10 ppm IBA (Griffith, 2006). High nutrition levels for the stock plant also yielded single node cuttings with better root systems (Poole and Conover, 1979). Dole and Gibson (2006) also advocated single-node (leaf-bud) cuttings for large leaved *Ficus*, noting that leaf size can be reduced to accommodate more cuttings in the propagation bench.

Among the more recent and accessible reports on propagation of *Ficus* are those noted by Griffith (2006). For the smaller-leaved varieties of *F. benjamina* and *F. microcarpa*, cuttings prepared with or without rooting hormone root readily under mist or high humidity with bottom heat (28°C). Griffith (2006) notes that *F. lyrata* is mostly propagated by tissue culture, which may have produced new compact forms. *F. maclellandii* ‘Alii’ and the newer ‘Amstel King’ are propagated by air layering to obtain larger sized trees quickly, as cutting propagation is more difficult.

Dole and Gibson (2006) provided a table suggesting that cuttings are preferred for vining type *Ficus* species such as *F. pumila*, whereas upright types should be propagated by tip cuttings or layers. Single-eye and leaf-bud cuttings are less preferred techniques. Seed propagation is noted but is seldom available. Stock plant management and the physiological status of the plant influence ease of rooting, with *F. benjamina* rooting readily from tip or leaf bud cuttings in any medium, whereas *F. maclellandii* ‘Amstel King’ and ‘Alii’ are considered difficult to root. *F. benjamina* tip or leaf-bud cuttings from the more distal part of a shoot root more readily than cuttings made from the stem base. Aging also influences ease of rooting as Davies and Joiner (1980) and Davies (1983) found juvenile *F. pumila* cuttings rooted more readily than cuttings from mature wood.

Although *F. pumila* normally produces adventitious roots during its vining (juvenile) phase, the mature tissues are more difficult to root. Davies and Joiner (1980) reported that 1000-1500 ppm IBA was best for juvenile leaf bud cuttings, whereas mature cuttings required treatment with 2000-3000 ppm IBA to achieve the best root number, quality, and length, and took longer to root than did the juvenile cuttings. Juvenile stem cuttings rooted in 40 days or less with IBA treatments,

whereas mature cuttings were still not rooted and required up to 90 days to achieve 60% to 80% rooting (Davies and Joiner, 1978). Juvenile leaf-bud cuttings were likewise faster to root and had higher rooting percentages than mature cuttings, even when both types were treated with 1000 ppm IBA. Interestingly, a small percentage of leaf cuttings (blade and petiole only) from mature plants rooted with a treatment of 1000 ppm IBA/NAA, but none did so from juvenile plants, likely because of insufficient petiole (juvenile leaves are sessile).

## LAYERING

According to Condit (1947), Thomas Jefferson propagated his edible fig by simple layers in which a slant cut is made in recently matured wood, and the shoot is bent into the ground and covered with soil leaving the tip exposed and in an upright position. Condit (1947) also describes trench layering, stooling (mound layering), and air layering as useful practices for edible fig. For ornamental figs, however, air layering has been a more common practice.

Hartmann and Kester (1983), in the fourth edition of their plant propagation book, provided a photo series of air layer practices for *Ficus elastica*. Air layering of *F. elastica* was also the focus of a paper by Broschat and Donselman (1981) who recommended two lengthwise slits through the stem, rather than complete removal of bark by girdling, to minimize leaf spotting due to water stress.

Both *F. benjamina* and *F. elastica* have been propagated by air layers, rooting in about 6 weeks with application of an auxin (Wadewitz, 1981). A length of 1.5 to 2 feet (48 to 61 cm) was recommended; also, the terminal end of *F. elastica* shoots should have about 6 or 7 leaves distal to the girdled zone.

## GRAFTING

As cuttings have been so widely used to propagate *Ficus*, little attention has been given to grafting or budding, except with respect to the edible fig. Condit (1947) noted that rootstock selection for tolerance to diseases, nematodes, and various soil conditions or for improved growth of weak-growing varieties led to evaluation of other species on which *F. carica* could be grafted. These sometimes were only successful in the short run (e.g., *F. carica* grafted onto species native to Florida), whereas other rootstocks [*F. cocculifolia*, *F. gnaphalocarpa*, *F. glomerata* (syn. *F. racemosa*), and *F. palmata*] showed longer-term success with no incompatibility for chip-budded or grafted *F. carica* (Krezdorn and Glasgow, 1970).

Budding and grafting of edible fig trees were done in the 3rd century B.C. (Cato, cited by Condit, 1947). Figs were topworked using shield buds and patch buds. Cleft grafts and bark grafts have also been used on branches up to 4 or 5 inches in diameter. The author recently observed an ornamental wax ficus (*Ficus microcarpa* var. *crassifolia*) bark-grafted onto a rootstock to produce bonsai-like ornamental plants. The technique might be a useful addition to plant propagation laboratories or for student plant sales.

The practice of stenting (in which a scion is grafted onto a non-rooted rootstock and the formation of the union and adventitious roots on the rootstock occurs simultaneously) was successful for the production of the variegated *F. benjamina* 'Starlight' onto the green-leaved cultivar 'Green Leaf' (Babaie et al., 2014). An omega cut was used for the graft and the rootstock was treated with 2000 to 6000 ppm IBA. Scion and rootstock were 5 to 10 cm in length and 5 to 10 mm in diameter. After 7 weeks, the best rooting occurred using the 4000 and 6000 ppm IBA treatments and grafting take ranged from 83% to 90%.

## MICROPROPAGATION

The edible fig, *F. carica*, was initially propagated aseptically using shoot tips with 3 or 4 leaf primordia to free plants of a fig mosaic virus (Murithi et al., 1982; Demiralay et al., 1998; Gunver and Ertan, 1998), but later work was initiated to produce plants in quantity for high density fig orchards (Pontikis and Melas, 1986). A key to their success was the incorporation of phloroglucinol into the multiplication medium. The highest rooting percentage (80%) was achieved with 4.9  $\mu\text{M}$  IBA and no BA in the rooting medium. Nobre and Romana (1998) excised 5-6 mm shoot tips with 2 or 3 leaf primordia and achieved shoots at 15 weeks.

The antioxidant polyvinylpyrrolidone (0.05%) was required for differentiation and growth of these shoot tips, which were then subcultured from single nodes. Benzylaminopurine (BAP at 1  $\text{mg}\cdot\text{L}^{-1}$ ) was essential for proliferation of multiple shoots from axillary buds on stem segments of the variegated *F. benjamina* 'Starlight' (del Amo and Picazo, 1992) as was phloroglucinol (80  $\text{mg}\cdot\text{L}^{-1}$ ). Rooting was superior using IBA (0.5 to 1.0  $\text{mg}\cdot\text{L}^{-1}$ ) versus NAA with only a 3- to 5-day induction period and subsequent transfer to PGR-free medium. On the other hand, NAA (1  $\text{mg}\cdot\text{L}^{-1}$ ) was effective for rooting microshoots of *F. religiosa* derived after stimulation with BAP (1  $\text{mg}\cdot\text{L}^{-1}$ ) from callus of stem segments of mature trees (Jaiswal and Narayan, 1985).

Prior to the development of tissue culture, conventional propagation techniques were used throughout the foliage industry. Debergh and Wael (1977) used 1- $\text{cm}^2$  leaf sections containing the main vein and achieved plantlet development with rootable shoots in 8 weeks. In the 1980s, Twyford Plant Laboratories in California developed tissue culture systems for several cultivars of *F. benjamina*, *F. lyrata*, and *F. elastica* (Lloyd, 1990). An Australian nursery has had great success with microcuttings of *F. lyrata*

taken from micropropagated plants that had been established *ex vitro* (Bunker, 1981). Such cuttings were found to root quickly, and a large inventory could be built up quickly.

Makino et al. (1977) described in detail the medium and phytohormone additions, explants, subculturing, conditions of culture and rooting, and establishment that led to successful micropropagation of *F. benjamina*, *F. elastica*, and *F. pandurata* (*F. lyrata*). Initially using 3- to 5-mm shoot tips, Jona and Gribaudo (1987) were later successful in inducing adventitious buds from fragments of young leaves of *F. lyrata*. To their modification of a Nitsch and Nitsch medium, various cytokinins were added singly and in combination in increasing combinations of 24, 48, or 72  $\mu\text{M}$ . Adventitious shoot production increased with cytokinin concentration, but rooting was inhibited at the higher concentrations. GA3 at 4  $\mu\text{M}$  improved shoot elongation before rooting, which was induced on individual shoots with a 7-day exposure to 5  $\mu\text{M}$  IBA or NAA in the medium.

## SEED

According to Condit (1947), Theophrastus (Father of Botany) tells of growing figs from seed in the 3<sup>rd</sup> century B.C. Fertile seeds were separated from sterile seeds by immersion in water, with the former sinking and the latter floating. Germination occurs as readily as for tomato seeds. Except for breeding efforts with the edible fig (*Ficus*

*carica*), there has been little use of seed to produce *Ficus* for ornamental uses.

For the most part, this is due to a lack of seed set with no natural pollinators and a complex floral structure that does not easily lend itself to artificial pollination. In Hawaii and a few other areas, seedlings of *F. microcarpa* and *F. religiosa* are invasive plants spread by birds that consume the fruits. Germination is rapid and young plants are found on trees and in sidewalk cracks and rain gutters and dispersed throughout the landscape. Were these desirable ornamental species, such seedlings could be used in the landscape trade, but their invasiveness, ultimate tree size of both species, and insect damage occurring on *F. microcarpa* render such usage unlikely.

Propagation and planting techniques for six Asian dioecious *Ficus* species were evaluated for their inclusion in forest restoration plantings. *F. auriculata*, *F. fulva*, *F. hispida*, *F. oligodon*, *F. semicordata*, and *F. variegata* were efficiently and more economically produced from seed than by cuttings (Kuaraksa and Elliott, 2013). Matthew et al. (2011) reported germination percentages of seeds of *F. racemosa*, *F. microcarpa*, *F. religiosa*, and *F. benghalensis* were 5.0, 2.3, 27.7, and 82.0%, respectively, but seeds of the first two were short-lived (< 6 months), whereas seeds of *F. religiosa* began declining in viability after 12 months and seeds of *F. benghalensis* were still viable at 18 months.

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