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PROPAGATION METHODS FOR DIFFERENT FRUIT CROPS

Raja V, Mohamed Jassim J*, Gurudivya P and Thamizhvanan A
Department of Fruit Science, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam - 625 604, Tamil Nadu, India

Abstract

Propagation is a fundamental aspect of fruit crop cultivation, determining the uniformity, productivity, and quality of the resulting orchard. Fruit crops are propagated through both sexual (seed) and asexual (vegetative) methods, depending on species, desired characteristics, and economic considerations. While seed propagation is common in crops like papaya, phalsa, and jamun, it often results in genetic variability and delayed bearing. Therefore, vegetative methods are preferred in most commercial fruit crops to ensure true-to-type plants and early fruiting. Vegetative propagation methods include cutting, layering, grafting, budding, suckers, and micropropagation. Mango, sapota, citrus, and guava are commonly propagated through grafting or budding techniques such as veneer grafting, cleft grafting, and T- or patch budding. Banana and pineapple are propagated using suckers and slips, respectively, while grapes and fig are propagated using hardwood cuttings. Layering techniques are suitable for crops like litchi and pomegranate. Recent advances have seen the emergence of micropropagation, particularly effective in crops like banana, pineapple, strawberry, and kiwi, enabling mass multiplication of disease-free, uniform plants. The choice of propagation technique is influenced by factors such as plant physiology, climate, availability of planting material, and commercial scalability. Modern techniques including tissue culture, synthetic seed technology, and somatic embryogenesis are revolutionizing fruit crop multiplication, especially for elite and exotic genotypes. Integration of traditional and modern propagation approaches ensures sustainability, productivity, and resilience in fruit production systems. Understanding species-specific propagation requirements is essential for nursery management, orchard establishment, and long-term crop improvement programs.

Introduction

Propagation is a critical phase in fruit crop production, as it directly influences plant establishment, genetic fidelity, yield potential, and orchard longevity. The success of any fruit-based cropping system largely hinges on the adoption of appropriate propagation techniques suited to specific crops and agro-climatic conditions (Hartmann *et al*., 2011). Propagation can broadly be classified into sexual (seed) and asexual (vegetative) methods. While seed propagation is essential for raising rootstocks, breeding programs, and species conservation, it is limited in commercial fruit cultivation due to genetic heterogeneity, long juvenile phase, and inconsistent fruit quality (Dhatt & Mahajan, 2022). Vegetative propagation, on the other hand, ensures the production of true-to-type plants with uniformity in growth, flowering, and fruiting behavior. It is the preferred method for most perennial fruit crops like mango, guava, citrus, and apple, where clonal fidelity and early bearing are critical (Singh *et al*., 2021). Techniques such as grafting, budding, cuttings, layering, and suckering are widely employed, each tailored to the biological characteristics of the species. For instance, T-budding is highly successful in citrus (Ladaniya, 2008), while veneer grafting is the method of choice for mango and sapota (Naik *et al*., 2020). Banana and pineapple are propagated using suckers and slips respectively (Kumar *et al*., 2022), while hardwood cuttings are ideal for fig, grape, and pomegranate (Bose *et al*., 2011).

In recent years, micropropagation has emerged as a revolutionary tool, offering large-scale multiplication of disease-free, genetically uniform planting material within a short period. This is particularly advantageous for vegetatively propagated crops like banana, strawberry, and kiwi (Hesami & Jones, 2020). Tissue culture also allows for the conservation and exchange of elite germplasm, making it invaluable for both commercial and conservation purposes. Furthermore, advancements in propagation technology, such as synthetic seed production, somatic embryogenesis, and cryopreservation, are opening new avenues in the field of plant biotechnology and nursery management. An understanding of species-specific propagation techniques is vital for ensuring high survival rates, robust plant growth, and the ultimate success of orchards. Therefore, a comprehensive overview of propagation methods, both traditional and modern, is essential for enhancing productivity, improving fruit quality, and supporting sustainable horticultural development.

Propagation Methods for Different Fruit Crops

Classification of Propagation Methods

Propagation methods in fruit crops are primarily categorized into two types:

Sexual Propagation (Seed Propagation)

This method involves the use of seeds to raise new plants. It is commonly employed for rootstock production, breeding programs, and in crops where vegetative propagation is either difficult or not commercially viable. Though seed propagation results in greater genetic variability, it often leads to late bearing and non-uniform plant populations.

Asexual (Vegetative) Propagation

Vegetative propagation includes all methods where parts of a plant (root, stem, leaf) are used to produce genetically identical progeny. It enables early fruiting, maintains varietal purity, and is essential for commercial orchards. Artificial techniques such as grafting, budding, and tissue culture are widely adopted in horticulture.

Seed Propagation in Fruit Crops

Seed propagation plays a crucial role in species conservation and initial plant multiplication. However, due to its inherent genetic heterogeneity, it is mainly used in crops like:

- Papaya – Dioecious nature requires seed propagation; sex identification is vital.
- Jamun, Phalsa, and Ber – Still propagated by seed in traditional systems.
- Guava and Citrus – Seeds are used for raising rootstocks for subsequent grafting.

Challenges include prolonged juvenile phase, variability in traits, and delayed bearing. Pre-sowing treatments like seed soaking in GA_3, acid scarification, and seed priming improve germination.

Vegetative Propagation Techniques

Cuttings

Cuttings involve rooting detached plant parts such as stems or roots. Success depends on season, growth phase, and use of rooting hormones. IBA and NAA are frequently used to induce rooting.

- Hardwood Cuttings – Grapes, pomegranate, fig, mulberry
- Softwood/Semi-Hardwood Cuttings – Guava, lemon, hibiscus
- Root Cuttings – Apple (for rootstock), fig

Layering

Layering encourages roots to form on a stem while it is still attached to the parent plant.

- Air Layering – Litchi, guava, sapota
- Mound Layering – Apple, pear, gooseberry
- Serpentine Layering – Passionfruit

It is useful for difficult-to-root crops and ensures higher success than cuttings.

Grafting

Grafting involves joining a scion (desired variety) to a rootstock (established plant).

- Veneer and Stone Grafting – Mango, sapota
- Cleft and Wedge Grafting – Apple, pear
- Softwood Grafting – Jackfruit, tamarind

Advantages include dwarfing, disease resistance, and improved yield through compatible rootstocks.

Budding

Budding uses a single bud from a desired variety inserted into a rootstock.

- T-Budding – Citrus, rose, plum
- Patch Budding – Ber, rubber
- Ring and Chip Budding – Apple, cherry

This method is commonly used in nurseries due to ease and high success rate.

Suckers, Runners, and Slips

These are naturally produced vegetative structures.

- Suckers – Banana (sword and water suckers)
- Runners – Strawberry
- Slips and Crowns – Pineapple

They help in rapid multiplication with true-to-type characteristics.

Division and Offsets

Used in herbaceous and monocotyledonous fruit crops like:

- Date palm – Offshoots
- Banana – Rhizome division
- Plantain – Sucker division

These are simple and cost-effective for large-scale multiplication.

Modern Propagation Technologies

Micropropagation (Tissue Culture)

It includes in vitro multiplication of plants using meristematic tissues. Benefits include disease-free, clonal, and large-scale propagation.

- Crops: Banana, pineapple, strawberry, kiwi, date palm
- Stages: Initiation → Multiplication → Rooting → Hardening

Synthetic Seeds and Somatic Embryogenesis

These biotechnological techniques are useful for propagating elite genotypes and preserving germplasm.

- Somatic Embryogenesis – Citrus, mango
- Synthetic Seeds – Encapsulated somatic embryos or shoot buds

Cryopreservation

Used for long-term storage of germplasm at ultra-low temperatures. Particularly beneficial for conservation of endangered or rare cultivars.

Propagation methods for different fruit crops

Crop	Method	Remarks
Mango	Veneer grafting	True-to-type, early bearing
Banana	Suckers, tissue culture	High multiplication rate, disease-free
Citrus	T- or patch budding	Used on rough lemon or trifoliate rootstocks
Grapes	Hardwood cuttings	High success in spring
Guava	Air layering, budding	Clonal propagation, high rooting
Litchi	Air layering	Moisture critical for success
Pomegranate	Hardwood cuttings	Easy rooting, uniform plants
Papaya	Seeds	Dioecious, sex differentiation needed
Pineapple	Slips, crowns	Quick establishment, uniform growth
Fig	Hardwood cuttings	Easy propagation with IBA

Factors Affecting Success of Propagation

- Physiological age of the stock and scion
- Season and temperature – best results in spring and monsoon
- Use of plant growth regulators (PGRs) – IBA, NAA for rooting
- Humidity and media – well-drained, aerated media ensures rooting
- Rootstock-scion compatibility – critical in grafting and budding

Challenges and Limitations in Propagation

- Low rooting success in hard-to-root species (e.g., litchi)
- Spread of viruses and diseases through clonal propagation
- Rootstock-scion incompatibility leading to graft failure
- Skilled labor requirement for grafting/budding
- Seasonal limitations – success varies with environmental conditions

Recent Advances and Future Prospects

- Automation in nursery operations – mist chambers, rooting stations
- Use of biofertilizers and biostimulants – improves success in rooting
- Nanotechnology – controlled release of hormones and nutrients
- Molecular markers – for clonal fidelity and disease indexing
- Cryo-banking – long-term conservation of elite cultivars

Integration of traditional propagation with modern tools will boost fruit crop productivity and sustainability, particularly under climate change scenarios and the need for rapid varietal replacement.

Conclusion

Propagation is a cornerstone of fruit crop improvement and orchard management. The selection of an appropriate propagation method is vital to ensure high quality, true-to-type, and early-bearing plants. While traditional methods like grafting, budding, and layering remain widely used, modern technologies like tissue culture, synthetic seeds, and cryopreservation are offering new opportunities for large-scale, disease-free, and rapid plant multiplication. Future strategies must focus on combining these technologies with farmer-friendly approaches, supporting nursery standardization, and ensuring the conservation of genetic resources. A scientific understanding of propagation is thus essential for achieving sustainability and profitability in the fruit industry.

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