Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 06, Issue: 04 (JULY-AUG, 2026)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Polyembryony in Mangosteen: The Hidden Miracle Inside the Queen of Fruits

*Dr. Bhyravi B. M.
Asst. Professor, Department of Fruit Science, College of Horticulture, Mudigere, India
*Corresponding Author's email: bhyraviyadav@gmail.com

Mangosteen (*Garcinia mangostana* L.), popularly known as the "Queen of Fruits," occupies a special place among tropical fruits. Its deep purple rind, snow-white juicy arils and distinctive sweet–sour flavour have made it one of the most highly prized fruits of Southeast Asia. While consumers admire the fruit for its taste and appearance, fruit scientists are equally fascinated by what happens inside its seed. Mangosteen possesses an unusual reproductive behaviour that sets it apart from most cultivated fruit crops. Seeds can develop through apomixis, a form of asexual reproduction in which an embryo develops without the normal fusion of male and female gametes. More than one embryonic structure or seedling may sometimes develop from a single seed, a phenomenon commonly referred to as polyembryony or multiple-seedling formation in mangosteen (Abdullah and Ismail, 2010; Yao *et al*., 2023). This remarkable characteristic has made mangosteen an important crop for studying apomixis, clonal seed production, genetic uniformity and plant reproductive biology. It also has considerable implications for the propagation and conservation of this valuable fruit crop.

What Makes a Mangosteen Seed Special?

In most fruit crops, seed formation follows a familiar pattern. Pollen reaches the flower, fertilization occurs, and the fertilized egg develops into a zygotic embryo. The resulting seed contains an embryo carrying genetic contributions from both parents.

Mangosteen can follow a very different pathway.

In apomictic reproduction, the embryo develops from maternal tissues without the conventional process of fertilization. In mangosteen, embryological studies have associated adventive embryo development with somatic cells of the integumentary tissues of the ovule (Horn, 1940; Yao *et al*., 2023). This means that the mangosteen seed can essentially produce a new plant while bypassing the usual sexual process.

The phenomenon can be visualized simply as:

Conventional reproduction:
Male parent + Female parent → Fertilization → Embryo → Seedling
Apomictic reproduction in mangosteen:
Maternal tissue → Adventive embryo → Seedling

This unusual reproductive pathway is one of the reasons mangosteen has attracted scientific attention for more than a century.

When One Seed Gives Rise to Several Seedlings

The most fascinating aspect is that a single mangosteen seed may sometimes produce more than one seedling. During germination, multiple embryogenic regions may give rise to shoots and roots. Consequently, two or more seedlings can emerge from the same seed. Earlier studies have reported the occurrence of multiple seedlings in mangosteen, although the frequency varies among observations and experimental conditions (Krishnamurthi and Rao, 1965; Abdullah and Ismail, 2010). This is where the concept of polyembryony becomes particularly interesting. In a nursery, a grower may sow what appears to be one ordinary seed, only to discover several young shoots emerging from it. Each shoot has the potential to develop into an individual plant if successfully established. Such an occurrence is relatively uncommon compared with ordinary single-seedling emergence, but it demonstrates the extraordinary regenerative capacity of the mangosteen seed.

Is It Really the Same as Polyembryony in Citrus?

Although the term polyembryony is widely used for the occurrence of multiple embryos, it is important to understand that the mechanism in mangosteen is not necessarily identical to that observed in citrus. In many citrus species, additional embryos develop from the nucellus, giving rise to what is commonly called nucellar polyembryony. These nucellar seedlings are genetically similar to the maternal plant. Mangosteen, in contrast, has been associated primarily with adventive embryony from integumentary tissues. Therefore, the reproductive phenomenon in mangosteen is more accurately understood in the broader context of sporophytic apomixis and adventive embryony (Yao *et al*., 2023). This distinction is important because it explains why mangosteen is considered a particularly unusual example of asexual seed formation.

The Mystery of the "Clonal Seed"

One of the greatest attractions of apomixis is its potential to produce maternal or clonal offspring through seeds. Normally, sexual reproduction generates genetic variation. A seedling receives genetic material from two parents, and therefore it may differ from the mother plant in characteristics such as growth, fruit quality, flowering and yield. Apomictic reproduction works differently. Since the embryo develops from maternal tissues, the resulting plant is expected to retain the maternal genetic constitution. This gives mangosteen an extraordinary biological advantage:

A seed can behave like a vehicle for clonal propagation.

In practical terms, a superior mother tree can potentially produce seedlings that retain many of its desirable characteristics.

However, it is scientifically more appropriate to describe these seedlings as predominantly maternal or apomictically derived, rather than assuming that every seedling is invariably a completely identical clone. Recent research has emphasized that the reproductive biology and evolutionary history of cultivated mangosteen are more complex than previously believed (Yao *et al*., 2023).

Why is This Important for Mangosteen Cultivation?

Mangosteen is generally propagated by seed, and its reproductive biology therefore has direct importance for orchard establishment. If seeds produce predominantly maternal seedlings, growers can obtain relatively uniform planting material without relying entirely on conventional vegetative propagation. This is particularly valuable for maintaining desirable characteristics of selected trees. A superior mangosteen tree may possess:

- attractive fruit size and shape,
- high-quality edible arils,
- desirable flavour,
- good productivity,
- suitable tree architecture,
- better adaptation to local conditions, and
- other commercially valuable traits.

The ability to maintain these characteristics through apomictic seed development is one of the major horticultural advantages associated with mangosteen's unusual reproductive system.

A Natural Advantage—and a Breeder's Problem

What makes apomixis attractive to growers can make it challenging for plant breeders.

The success of a breeding programme depends on genetic variation. Breeders cross different parents to produce offspring containing new combinations of genes. They then select superior individuals from the resulting population. If a mangosteen seed develops predominantly through apomixis, however, the resulting seedling may simply reproduce the maternal genotype rather than generating a new genetic combination.

Therefore, apomixis presents a fascinating paradox:

For propagation, it is an advantage.

For conventional breeding, it can be a limitation.

This is one reason why understanding the reproductive biology of mangosteen is essential for future crop improvement.

Polyembryony in the Nursery

The occurrence of multiple seedlings from one seed also has practical importance in nursery management. When two or more seedlings emerge from a single seed, they may initially remain very close to one another. If each seedling is to be established as an independent plant, separation must be carried out carefully to avoid damaging the young root system. Mangosteen seedlings are relatively delicate during their early growth stages. Nursery success therefore depends on maintaining suitable moisture, providing a well-drained growing medium and avoiding unnecessary disturbance of developing roots. Another important consideration is seed freshness. Mangosteen seeds are generally considered recalcitrant, meaning they are sensitive to drying and lose viability relatively quickly under unsuitable storage conditions. Consequently, fresh seeds should preferably be sown soon after extraction from mature fruits (Dike *et al*., 2020). Thus, even though the mangosteen seed possesses remarkable regenerative potential, successful nursery production still requires careful handling.

A Treasure for Germplasm Conservation

The reproductive behaviour of mangosteen also has implications for the conservation of valuable genetic material. Mangosteen trees are long-lived and may take several years before reaching reproductive maturity. At the same time, their seeds cannot be stored for long periods under conventional dry-seed storage conditions because of their recalcitrant nature (Dike *et al*., 2020). Apomictic reproduction provides a natural mechanism through which desirable maternal genotypes can potentially be maintained in seed-derived populations. For conservation programmes, however, relying on seeds alone is not sufficient. Field gene banks, living collections, in vitro conservation and other clonal conservation approaches may be required to ensure long-term preservation of elite mangosteen genetic resources.

What About Genetic Diversity?

Although genetic uniformity is useful for maintaining desirable characteristics, it can also have disadvantages. A population with limited genetic diversity may have less capacity to adapt to changing environmental conditions, emerging pests and diseases or future climatic stresses. Therefore, while apomixis can help maintain elite planting material, conservation programmes should also preserve genetically diverse mangosteen populations and wild relatives. Maintaining diversity is particularly important because the cultivated mangosteen has a complex evolutionary history, and its relationship with related *Garcinia* species continues to be investigated (Yao *et al*., 2023).

A Window into the Evolution of Mangosteen

The unusual reproductive biology of mangosteen has also raised an important evolutionary question: Where did cultivated mangosteen come from?

The origin and domestication history of *Garcinia mangostana* have been debated for many years. Recent genetic and evolutionary studies suggest that cultivated mangosteen may have a more complex history than the simple assumption that it represents a straightforward hybrid origin.Understanding its reproductive system is therefore important not only for horticulture but also for reconstructing the evolutionary history of the crop (Yao *et al*., 2023).

Can Modern Science Unlock the Secret?

Traditional observations can tell us that multiple seedlings emerge from a seed, but they cannot always tell us where those seedlings originated genetically. Modern molecular techniques can provide the answer. DNA-based tools such as simple sequence repeats (SSRs), single nucleotide polymorphisms (SNPs) and other molecular markers can be used to compare seedlings with their mother plants.

Such approaches can help scientists determine:

- whether seedlings are genetically identical to the mother plant;
- whether multiple seedlings from one seed have the same genetic constitution;
- whether sexual reproduction occasionally occurs;
- how frequently apomixis occurs among different genotypes; and
- whether reproductive behaviour differs among mangosteen populations.

Combining molecular techniques with classical embryology and histology can therefore provide a much clearer picture of mangosteen reproduction.

Why Should We Care About Apomixis?

The importance of mangosteen apomixis extends beyond mangosteen itself. Scientists have long been interested in apomixis because it offers a fascinating possibility: producing genetically uniform plants through seeds. Imagine if a farmer could take the seed of a high-performing plant and obtain seedlings that retained the same desirable genetic characteristics generation after generation. Such a system could potentially reduce the dependence on conventional vegetative propagation. This is one reason apomixis is considered an important area of research in modern plant breeding and biotechnology. Understanding how plants such as mangosteen initiate embryos from maternal tissues may eventually contribute to broader efforts to develop or manipulate clonal seed production in crops (Heidemann *et al*., 2025).

The Road Ahead

Despite the progress made in understanding mangosteen reproduction, many questions remain unanswered. Future research should concentrate on identifying the precise cellular origin of the embryos, determining the genetic mechanisms controlling adventive embryony and understanding why some seeds produce multiple seedlings while others produce only one. Molecular studies should also be combined with controlled pollination experiments to determine the relative contribution of sexual and apomictic reproduction. Such research will be important for developing reliable breeding strategies for this economically valuable fruit crop (Yao *et al*., 2023). Improved propagation techniques, tissue culture and cryopreservation may further support the conservation and multiplication of elite mangosteen material.

Conclusion

Mangosteen is much more than the “Queen of Fruits.” Hidden inside its seemingly ordinary seed is an extraordinary reproductive system that allows the plant to bypass conventional sexual reproduction and produce seedlings through maternal tissues. The occasional emergence of multiple seedlings from a single seed makes the story even more fascinating. Although the phenomenon is commonly described in terms of polyembryony, the biology of mangosteen is more accurately linked with adventive embryony and apomixis. For horticulturists, this natural phenomenon offers an opportunity to maintain desirable planting material through seed propagation. For breeders, it presents a challenge because the same mechanism can restrict genetic recombination. For scientists, it provides a fascinating natural system for understanding clonal seed formation. Ultimately, the real wonder of mangosteen may not be its purple rind or its delicious white pulp. It is the tiny seed within the fruit—a seed capable of carrying an extraordinary story of reproduction, survival and genetic continuity.

References

1. Abdullah, N. A. P., & Ismail, M. F. (2010). Emergence of multiple seedlings from seed of *Garcinia mangostana* L. (Clusiaceae). *Acta Horticulturae*, 849, 211–214.

2. Dike, S. C., *et al*. (2020). Seed biology and conservation considerations in mangosteen (*Garcinia mangostana* L.). *Scientia Horticulturae*.
3. Heidemann, V., *et al*. (2025). To infinity and beyond: Recent progress, bottlenecks, and potential of clonal seeds by apomixis. *The Plant Journal*, 121.
4. Horn, C. L. (1940). The origin of the mangosteen. *Journal of the Arnold Arboretum*, 21, 60–68.
5. Krishnamurthi, S., & Rao, A. N. (1965). Studies on polyembryony in mangosteen (*Garcinia mangostana* L.). [Embryological studies cited in subsequent mangosteen research].
6. Yao, C. A., *et al*. (2023). The origin of cultivated mangosteen (*Garcinia mangostana* L. var. *mangostana*): Critical assessments and an evolutionary-ecological perspective. *Ecology and Evolution*, 13, e9792.