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Popular Article

Parthenocarpic induced Seedlessness: A Potential Trait to Exploit in Fruit Crops

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Abstract

Parthenocarpy is an important approach to producing seedless fruits, which are advantageous for growers due to the lack of pollination and less time for the breeding of new varieties. Seedless fruits are obtained through different types of parthenocarpy that are produced naturally and induced artificially in plant populations. The development of seedless fruits is influenced by genetic and environmental factors. various approaches, including the use of plant growth regulators, mutation breeding, ploidy manipulation, and innovative breeding techniques, are used to produce seedless fruits. Parthenocarpic fruits are mainly advantageous with improving the fruit quality traits, yield, and early harvesting of fruits, which increases the consumer demand in the fresh and processing industries.

Introduction

Seedlessness is one of the most desirable traits in the fruit industry from consumer as well as processing point of view. Formation of seedless fruits without pollination and fertilization is known as parthenocarpy. This term Parthenocarpy was given by 'Null' in 1902. Parthenocarpy induces less number of seeds/ complete seedless fruits due to the association of self-incompatibility, male sterility, and lack of viable pollen. In earlier research, it is shown that, parthenocarpy occurs more in plurispermic (multi seeded) species than monospermic (single-seeded) (Picarella and Mazzucato, 2019) It is also reported that this phenomenon occurs more in cultivated species than in wild species. Induction and utilization of parthenocarpy in fruit crops are of great importance.

Types of Parthenocarpy (Premachandran *et al.,* 2019)

i. **Natural/ Obligatory/Autonomic parthenocarpy:** It is caused due to genetic sterility and fruits are always seedless. This type of parthenocarpy is adopted in vegetatively propagated crops. e.g., Banana, Pineapple, Japanese persimmon

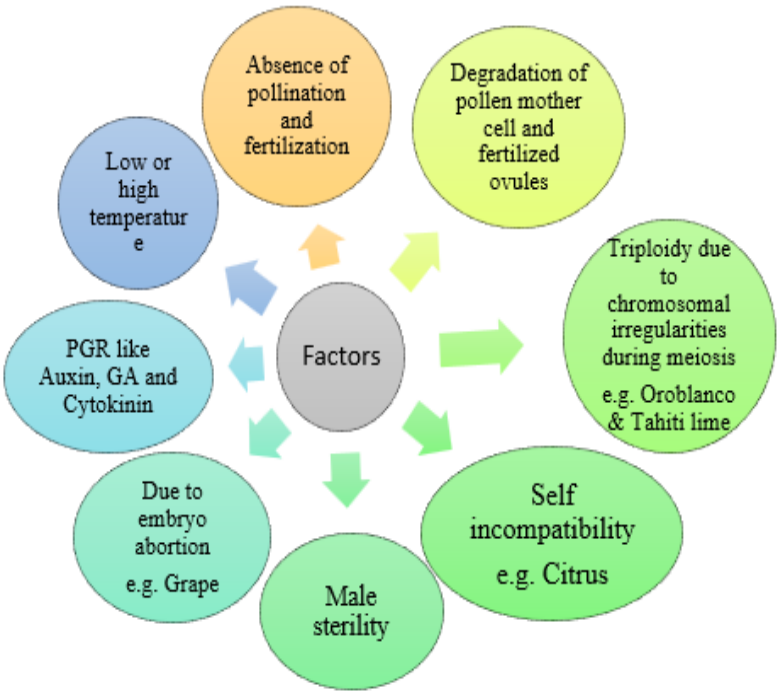
ii. **Facultative parthenocarpy:** Adverse pollination or fertilization conditions or genetic sterility causes this type of parthenocarpy. e.g., Satsuma mandarin, Washington navel orange, Oroblanco pummelo hybrid.

iii. **Vegetative parthenocarpy:** It occurs naturally without any external stimulation. e.g., Banana, Breadfruit, Pineapple, Fig, Apple, Pear, and Persimmon.

iv. **Stimulative parthenocarpy:** Requires external stimulus like pollination for parthenocarpic fruit development. e.g., Black Corinth variety of Grape, Pear, Himalayan blackberry, Litchi, Durian, Breadfruit

v. **Stenospermocarpy:** Initially normal pollination and fertilization occurs but the abortion of the embryo leads to Seedlessness. e.g., Sindhu variety of Mango, Grape, Jamun

vi. **Artificial induction of parthenocarpy:** It can be induced by pollen extract or dead pollen or by applying growth regulators.



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vii. **Spontaneous mutations:** Spontaneous mutation-induced Seedlessness is very common in Apple, Citrus.

Factors Responsible for Parthenocarpy Induced Seedlessness:

Techniques to Induce Seedlessness

1. **Phytohormones:** Indigenous synthesis of phytohormones induce Seedlessness in fruits like citrus, apples, and grapes (Pandolfini, 2009).

- Auxin is responsible for the autonomic development of parthenocarpic fruit e.g: citrus and strawberry
- Gibberellic acid (GA) is also synthesized endogenously in seedless fruit e.g., apples, jamun, Grape, and loquat
- Cytokinin also has induced parthenocarpic fruit development e.g., Japanese pears, and kiwifruit.

2. **Ploidy manipulation:** Induction of seedless triploid by crossing diploids and tetraploids e.g., Pummelo hybrid 'Oroblanco' and 'Melogold', Loquat, Guava.
3. **Mutation breeding:** To induce Seedlessness colchicine treatment, application of fast neutrons, x-rays, and gamma rays e.g., Citrus
4. **Endosperm culture:** Endosperm is the fusion of three haploid nuclei. Technically it is a triploid cell and has three nuclei and it can overcome barriers obtained from sexual hybridization resulting from apomixis and embryo abortion. e.g., Sweet Tangor.
5. **Biotechnological intervention:** In grapes, Seedlessness is controlled by three complementary recessive genes, through the transcriptomic level, cisgenesis, and transgenesis and CRISPR cas9 mediated genome editing techniques (Varoquaux *et al.,* 2000; Moniruzzaman, *et al.,* 2023).

Advantages of Seedlessness

- It is a desirable trait in fruit crops with hard seeds e.g., Guava, Banana, Pineapple, etc.
- Increases fruit quality in terms of taste, palatability, and shelf-life.
- Early harvesting of fruits.
- Fruit setting is less hampered by environmental factors in seedless type as compared to seeded one.
- Increase production in dioecious fruit crops where pollinizer is essential.
- Increase processing and value addition.

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Drawbacks of seedless fruits

- Prevents breeding through hybridization.
- Deformed fruits with small and irregular-size.
- Malformed fruits.
- It is an undesirable trait in nut crops.
- No commercial seed production.

Conclusion

Seedlessness is of great importance in the fruit industry as fruits are set without pollination. It also facilitates consumption, and processing, because it is easy to manipulate from a processing point of view. Hence it can be used as a new breeding tool to enhance yield, quality, and earliness in fruit crops.

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