

## Role of parthenocarpy in Vegetable Crops

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### Introduction

In normal fruit development, pollination and fertilization of the ovules occur, leading to the formation of seeds within the fruit. However, in parthenocarpy, the fruit develops without the need for pollination. Parthenocarpy trait has proven to be highly useful in developing fruits under unfavourable environmental conditions for successful pollination and fertilization, particularly in greenhouse cultivation and cross-pollinated crops. In which phytohormones play an important role in fruit setting and their genetic manipulation can lead to seedlessness. In cases of some other vegetables which have seeds in fruit are undesirable due to bitter taste, presence of toxic compounds, hard texture, allergens and affect on the palatability. Seedlessness replacing the seeds and seed cavities with edible fruit tissue is an attractive offer to the consumers and challenge to the researchers. So, the parthenocarpy fruits are expedient for improving the quality of fresh as well as of the processed fruit and it has been observed in cucumber, eggplant, watermelon and tomato.

### Advantages of Parthenocarpic Vegetable Crops

- ✚ **Seedlessness:** Parthenocarpic vegetables produce fruits without the development of viable seeds or with underdeveloped seeds. This seedlessness is desirable for consumers who prefer seedless vegetables, as it eliminates the need for seed removal during preparation and consumption like Pusa bedana watermelon.
- ✚ **Improved quality:** Parthenocarpic fruits often exhibit improved quality characteristics such as uniformity in size, shape, and color. This uniformity enhances their visual appeal and market value like seedless pickled gherkin.
- ✚ **Extended shelf life:** Parthenocarpic vegetables tend to have a longer shelf life. This attribute is beneficial for both producers and consumers, as it allows for better storage, transport, and availability of fresh produce.



- ✚ **Enhanced palatability:** In some cases, the absence of seeds in parthenocarpic vegetables can result in improved flavour and texture. The elimination of bitter or undesirable seed components can enhance the overall palatability of the vegetable, making it more enjoyable for consumption.
- ✚ **Vertical fruit harvest:** Growing parthenocarpic cucumbers in greenhouses offers the advantage of continuous fruit set on the vine, leading to increased profits. This cultivation method eliminates the need for pollen vibrators and manual pollination, which are typically required for greenhouse grown vegetables.

## Types of Parthenocarpy

### 1. Artificial parthenocarpy

- ✚ **Hormonal Application:** Application of plant growth regulators, such as auxins (IAA), gibberellins (GA) and cytokinins can stimulate the development of parthenocarpic fruits. These hormones can be applied externally to flowers or developing fruit to initiate fruit growth without fertilization (Talon *et al.*, 1992). Exogenous auxin application to flowers for induction of parthenocarpy was first reported by Gustafson (1936).
- ✚ **Genetic modifications:** Genetic engineering techniques can be employed to introduce specific genes into plants, resulting in parthenocarpic traits. For example, the introduction of genes involved in auxin synthesis or signaling pathways can induce seedless fruit development. Transgenic tobacco, eggplant, and tomato plants have been developed with parthenocarpic traits. These plants have been modified to contain the *iaaM* gene coding region from *Pseudomonas syringae* pv. *savastanoi*, controlled by the placental-ovule-specific *dejh9* gene regulator sequences from *Anthriscum majus*.
- ✚ **Use of mutant varieties:** Mutant varieties are naturally occurring or artificially induced plants with genetic mutations that result in parthenocarpic fruit development. These mutations can affect the hormone synthesis, signaling pathways, or fruit development processes, leading to the initiation and growth of parthenocarpic fruits.
- ✚ **Use of hybrid varieties:** Hybridization is a commonly used breeding technique to develop parthenocarpic hybrid varieties. By crossing parent plants with different genetic backgrounds, breeders can combine desirable traits, including parthenocarpic characteristics, into the resulting hybrids.

### 2. Natural parthenocarpy

Elevated level of endogenous hormones in the ovary in the absence of pollination and fertilization causes the natural parthenocarpy. Like eggplant, cucumber and capsicum (Tiwari *et al.*, 2011).

- ✦ **Genetic factors:** Some plant species inherently possess genes that promote parthenocarpy, resulting in the development of fruits without fertilization. These genetic factors can control hormone synthesis, hormone signalling pathways, or fruit development processes, leading to the initiation and growth of parthenocarpic fruits.
- ✦ **Environmental factors:** Favourable conditions, such as suitable temperatures, light, Stress factors and humidity can stimulate parthenocarpic fruit development in some plant species. Conversely, unfavorable environmental conditions may suppress or inhibit parthenocarpy.
- ✦ **Pollination limitations:** If pollinators, such as bees or other insects, are scarce or unavailable, plants may initiate fruit development without the need for fertilization. This ensures fruit production even in the absence of efficient pollination.
- ✦ **Hormonal imbalances:** Natural parthenocarpy can result from hormonal imbalances within the plant. Hormones like auxins, gibberellins and cytokinin play crucial roles in fruit development.

| Quality parameters of parthenocarpy vegetables |  |
|--|--|
| Eggplant                                       | High yield and fruit quality   |
| Watermelon                                     | The shape, flavor and yield are as good as seed-producing cultivars and have a longer shelf life.  |
|  | No significant differences in sugar contents between seeded and seedless watermelon  |
| Cucumber                                       | The total sugar content of parthenocarpic fruits is significantly lower than that of the pollinated fruits, with significant negative effects on the sweet taste of fruit. |
| Tomato   | Seedless tomato fruits are tastier, more dry-matter (up to 1%), contain more sugars, less acidity and less cellulose.  |
|  | More soluble solids  |

|  |  |
|--|--|
|  | The fruit size, morphology and jelly fill in the locules of seedless fruits were comparable with seeded fruits of the parental line. |
|--|--|

| Achievements in India |               |   |
|-----------------------|---------------|---|
| Institute             | Crop          | Varieties developed   |
| IARI, New Delhi       | Cucumber      | DPaC-6, 4 DPaC- 9 and 5 DPaC-10                                   |
|                       | Watermelon    | Pusa Bedana   |
| GBPUAT, Pantnagar     | Cucumber      | Pant Parthenocarpic Cucumber-2 and Pant Parthenocarpic Cucumber-3 |
| IVRI, Varanasi        | Pointed gourd | IIVRPG- 105   |
| KAU, Kerala           | Watermelon    | Shonima (Red) and Swarna (Yellow)                                 |
| IIHR, Bengaluru       | Watermelon    | Arka Madhura  |

### Conclusion

Parthenocarpy, which is the ability of a plant to produce fruit without fertilization, is an essential characteristic for enhancing vegetable crop yield, quality, and processing traits. The utilization of parthenocarpy has proven to be highly advantageous in greenhouse cultivation, especially in vegetable crops that rely on cross-pollination. It is well-established that phytohormones play a crucial role in fruit development. However, through genetic manipulation, the introduction of parthenocarpy can result in the production of seedless fruits. Moreover, the utilization of biotechnological tools can significantly improve the efficiency and identification of parthenocarpy genes across various crops, ultimately benefiting humankind.

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