



## Techniques for Producing F1 Hybrid Seeds

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Hybrid seed production plays a vital role in improving vegetable crop yields, enhancing disease resistance, and developing desirable traits. By harnessing the benefits of hybridization, farmers can access improved varieties that contribute to the nutritional needs of the population and support sustainable agriculture. However, there are several important vegetable crops for which hybrids have been successfully developed for commercial cultivation. These crops include ladies' finger, brinjal, tomato, onion, cabbage, cauliflower, chilies, carrot, cucumber, bottle gourd, watermelon, and muskmelon. Hybrid seed production in these crops follows specific practices to ensure desirable traits and high-quality seeds.

### The following points describe various aspects of hybrid seed production in vegetable crops:

1. Hybrid seed production is primarily carried out for released and notified hybrids. This means that the production of hybrid seeds is focused on specific hybrid varieties that have been officially recognized and approved.
2. Both the National Seed Corporation and private seed companies are involved in the production of hybrid seeds. These entities play a crucial role in ensuring the availability of hybrid seeds to farmers and the market.
3. Unlike in some other crops, in vegetable crops, the economic produce is not the seed itself but rather other parts such as leaves, fruits, flowers, and roots. However, cytoplasmic male sterility (CMS) can still be utilized for hybrid seed production. CMS is a genetic trait that prevents the production of functional pollen, making it necessary to cross-pollinate with a different plant to obtain viable seeds.
4. Since the economic produce in vegetable crops is not the seed, there is no need for restoring fertility in the F1 hybrids. This means that in vegetable crops, the use of cytoplasmic genic male sterility (CGMS) systems, which involve the restoration of fertility in hybrid plants, is not necessary for hybrid seed production.
5. Hybrid seed production in vegetable crops can be achieved through various methods. These include:

- a. Conventional method: Hand emasculatation and pollination, where the male reproductive organs (stamens) are removed manually to prevent self-pollination, and then the female reproductive organ (pistil) is pollinated with pollen from another plant.
- b. Gynoecy method: Some crops like cucumber exhibit a condition called gynoecy, where only female flowers are produced. These female flowers are pollinated with pollen from a different plant to produce hybrid seeds.
- c. Genetic and cytoplasmic male sterility: This method involves utilizing genetic and cytoplasmic traits to induce male sterility in specific plants. These male-sterile plants are then cross-pollinated with other plants to produce hybrid seeds.
6. Self-incompatibility, which refers to the inability of a plant to produce viable seeds when self-pollinated, is effectively utilized in certain crops such as cabbage for hybrid seed production. By preventing self-pollination, the plants can be cross-pollinated with other compatible plants to produce hybrid seeds.

### Mode of pollination and isolation distance for some important vegetable crops

Name of the crop	Mode of pollination	Isolation distance(m) for Foundation hybrid seed production	Isolation distance(m) for certified hybrid seed production
Okra	Often cross pollinated	400	200
Brinjal	Often cross pollinated	200	100
Chillies	Often cross pollinated	400	200
Tomato	Self-pollinated	50	25
Onion	Cross pollinated	1000	500
Cabbage	Cross pollinated	1600	1000
cauliflower	Cross pollinated	1600	1000
Carrot	Cross pollinated	1600	800
Cucumber	Cross pollinated	1000	500
Bottlegourd	Cross pollinated	1000	500
Watermelon	Cross pollinated	1000	500
Muskmelon	Cross pollinated	1000	500

Hybrid seed production in vegetable crops involves several important steps and factors that contribute to the success of the process. The following four major steps are involved in hybrid seed production:

1. **Planting of Female and Male Parents:** The female and male parental lines are planted in the proper ratio to ensure successful seed production. The ratio may vary depending on the specific crop. This step ensures that the necessary parental plants are available for the hybridization process.
2. **Providing Isolation Distance:** To maintain genetic purity and prevent contamination from undesirable sources, prescribed isolation distances are established around the seed

production plot. This prevents unintended cross-pollination with other varieties or related species that may compromise the desired traits of the hybrid.

3. **Removal of Off-Types:** Off-type plants that deviate from the desired characteristics of the parental lines are removed to ensure the purity of the hybrid seed. This step helps maintain the genetic integrity and consistency of the hybrid.
4. **Field Inspections:** Regular field inspections are conducted to ensure compliance with the prescribed norms for hybrid seed production. This includes monitoring the isolation distance, checking for off-types, and ensuring adherence to quality standards. These inspections help maintain the quality and integrity of the hybrid seed production process.

In vegetable crops, several factors are important for successful hybrid seed production. These factors include:

1. **Genetic Purity of Parents:** Pure seeds of parental lines, either breeder or foundation seed, should be used to ensure genetic purity. This ensures that the desired traits are passed on to the hybrid offspring.
2. **Flowering Synchrony:** The parental lines should have synchronized flowering to facilitate successful cross-pollination. This ensures that the female flowers are receptive to pollen from the male parent during the appropriate period.
3. **Male Sterility or Self-Incompatibility:** In some cases, genetic male sterile lines or self-incompatible lines are used as female parents. These lines should have stable performance with regard to male sterility or self-incompatibility, which ensures controlled pollination and the production of hybrid seeds.
4. **Resistance to Pests and Diseases:** The parental lines should possess a high degree of resistance to major insect pests and diseases. This helps ensure that the hybrid offspring inherits the necessary resistance traits, leading to healthier and more productive plants.
5. **Yielding Ability and Keeping Quality:** The parental lines should exhibit high yielding ability and good keeping quality. This ensures that the resulting hybrids are productive and have a longer shelf life, making them commercially viable.

**In vegetable crop production, different methods of hybrid seed production are employed based on the specific crop species. Here are the commonly used methods:**

**Hand Emasculation and Pollination Method (Conventional Method):** This method involves manually removing the anthers (male reproductive organs) from the female flowers, a process known as emasculation. After emasculation, the desired pollen is applied to the stigma of the emasculated flowers through hand pollination. This method ensures controlled cross-pollination between desired parental lines.

**Genetic Male Sterility:** This method eliminates the need for emasculation. It involves using male sterile lines as the female parent. These male sterile lines do not produce viable pollen, thereby preventing self-pollination. However, approximately 50% of the male fertile plants need to be removed from the female parent population to prevent unwanted self-pollination.

**Cytoplasmic Male Sterility:** This method also eliminates the need for emasculation. The female parent population is entirely male sterile due to specific cytoplasmic factors. As a result, no viable pollen is produced by the female parent. Pollen from the male parent is used to fertilize the female flowers, leading to hybrid seed production.

**Self-Incompatibility:** Self-incompatibility is utilized in some vegetable crops like cabbage for hybrid seed production. In this method, the female parent possesses a self-incompatibility mechanism that prevents self-pollination. The self-incompatibility line should exhibit stable performance, and the mechanism should not be influenced by temperature variations. This ensures that successful cross-pollination occurs with pollen from the male parent.

**Use of Gynoecy:** Gynoecious (pistillate) lines are available in certain vegetable crops, such as cucumber. Gynoecious lines have predominantly female flowers. The use of gynoecious lines eliminates the need for emasculation. Gynoecious lines have been used as female parent in developing hybrids in cucumber. Gynoecious lines can produce staminate flowers if treated either with silver nitrate (50-100 ppm spray) or silver thiosulphate (25-50 ppm spray) at 2-3 true leaf stage. The intermating of pistillate and staminate flowers leads to maintenance of gynoecy.

These methods play a crucial role in hybrid seed production, allowing breeders to efficiently cross-pollinate specific parental lines to produce hybrid offspring with desirable traits. It is important to note that the choice of method depends on the crop species and the specific breeding goal.

### Methods of Hybrid Seed Production in Different Vegetable Crops

Name of the crop	Types of Hybrids developed	Method of Hybrid seed production used
Okra	Single cross	Hand emasculation and pollination Genetic male sterility
Brinjal	Single cross	Hand emasculation and pollination Genetic male sterility
Tomato	Single cross	Hand emasculation and pollination Genetic male sterility
Onion	Single cross	Cytoplasmic male sterility
Cabbage	Single cross Double cross	Self incompatibility, Genetic male sterility and Cytoplasmic male sterility
Cauliflower	Single cross	Genetic male sterility and Cytoplasmic male sterility
Chillies	Single cross	Hand emasculation and pollination Genetic male sterility
Carrot	Single cross Three-way	Genetic male sterility and Cytoplasmic male sterility
Cucumber	Single cross	Gynoecious
Bottle gourd	Single cross	Hand removal of staminate flowers from female plant
Watermelon	Single cross Triploid cross	Hand removal of staminate flowers from female plant
Musk melon	Single cross	Hand removal of staminate flowers from female plant



**Pepper male fertile flower**



**Pepper male sterile flower**



### Emasculation procedure

#### Reference

1. Phundan Singh (2013). Practical and numerical problems in plant breeding. Kalyani publishers, 2<sup>nd</sup> edition