

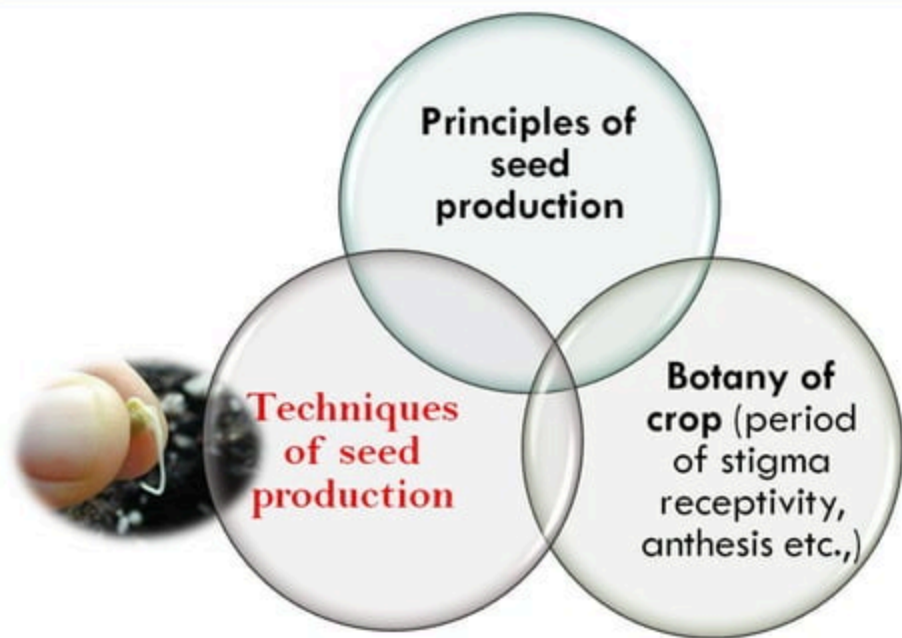
# HYBRID SEED PRODUCTION IN VEGETABLES



# Seed.....?

- An embryo, a living organism embedded in the supporting or the food storage tissue.
  - A carrier of new technologies
  - A basic tool for secured food supply
  - The principal means to secure crop yields in less favorable production areas
  - A medium for rapid rehabilitation of agriculture in cases of natural disaster

# For hybrid seed production one should know



# Principles of Seed Production

## Genetic

Mechanical admixtures

Natural crossing

Developmental variations

Minor genetic variations

Selective influence of  
disease

## Agronomic

Environmental  
requirements

Land requirements

Pollination requirements

Isolation requirements

## Scope and Importance of Vegetables

- Vegetables are considered as "Protective Supplementary Food"
- Different uses of vegetables –
  - Cooking, salad, pickle, fried, stuffed
  - High medicinal value
  - Use as ornaments
  - Different industrial uses
- Vegetable make effective use of land and labour resources
- They play an important role in national economy
- Increase vegetable production through use of hybrid seeds



## Why hybrids are adopted by farmers?

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- **Greater productivity**
- **Longer harvest duration**
- **Better adaptability to variable environments**
- **Better tolerance to diseases and pests**
- **Uniform produce**
- **Better market acceptability**
- **Better nutritional quality**



**Table 1: The most commonly utilized mechanisms for developing commercial**

**hybrids in vegetables and flowers**

<b>Mechanism</b>	<b>Commercially exploited in</b>
Hand emasculation + HP	Tomato, eggplant, sweet pepper, okra, hot pepper
Remove staminate flowers + HP	Cucurbits (bitter gourd, bottle gourd, etc.)
Male sterility + HP	Tomato, hot pepper, sweet pepper
Male sterility + NP	Onion, cabbage, cauliflower, carrot, hot pepper, Petunia, Marigold, Dianthus, Zinnia
Self incompatibility + NP	Most of cole vegetables like broccolis, cabbage, Petunia, Marigold, Ageratum, Bellis etc.
Gynoecism + NP	Cucumber, muskmelon.
Remove staminate flowers + NP	Cucurbits including bitter gourd, summer squash, winter squash, etc.

HP = Hand pollination    NP = Natural pollination

# Emasculation and Pollination



# Steps in emasculation and pollination

## 1. Emasculation:



- ✓ Next day opening flower buds are selected
- ✓ To be done before anther dehiscence
- ✓ To be done with hand/ forceps



## 2. Pollen Collection



Put the dried anther cones in a cup then transfer to pollen lid cup



Dry anthers at 30°C for 24 hrs



Anther cones are taken and put in glassine envelopes



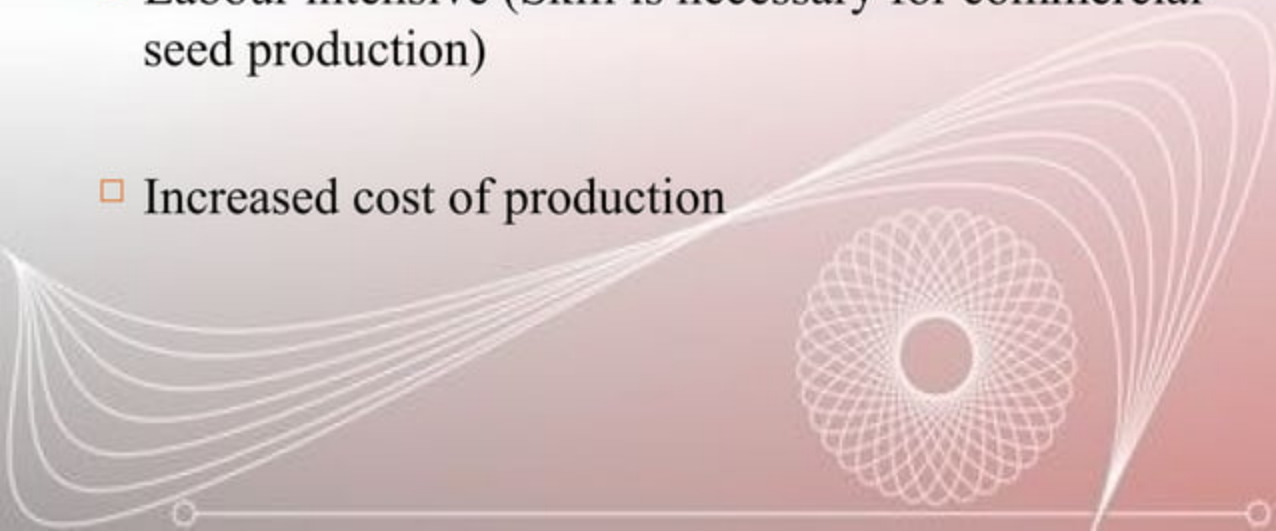
Flower collection

## 3. Pollination



# Limitations of Emasculation and Pollination

- Time consuming
- Labour intensive (Skill is necessary for commercial seed production)
- Increased cost of production





## WHY MALE STERILITY AND SELF INCOMPATIBILITY?



- Production of large scale of  $F_1$  seeds.
- Reduced cost of hybrid seed production.
- Speedup the hybridization programme.
- Commercial exploitation of hybrid vigour.

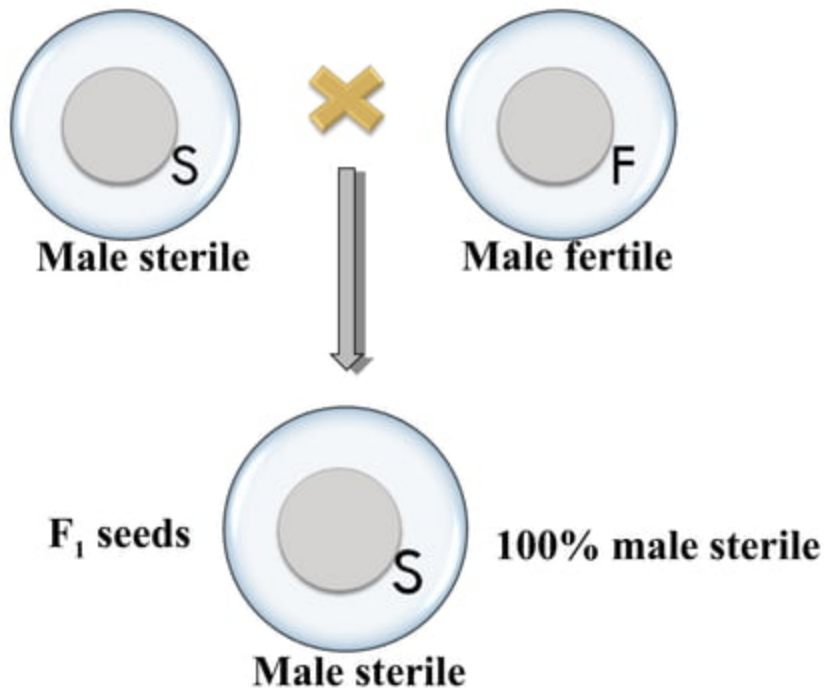




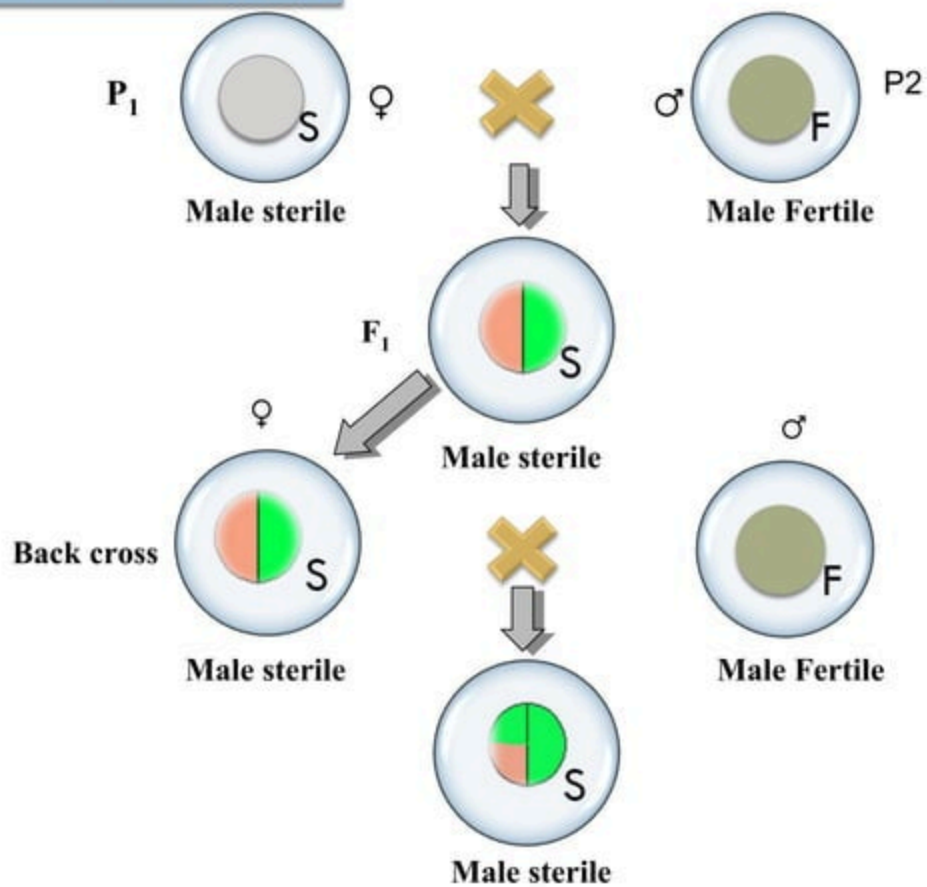
**MALFERTILITY**  
**STE**



# Cytoplasmic male sterility



# Genetic Male Sterility



# Types of male sterility

## A) Genetic male sterility( GMS) :

- wide occurrence in plants
- mostly governed by a single recessive gene , *ms*
- male sterile alleles arise spontaneously or may be artificially induced

## B) Cytoplasmic male sterility (CMS) :

- determined by the cytoplasm
- it is the result of mutation in the mitochondrial genome (mtDNA)
- CMS transfer easily to a given strain

## C) Cytoplasmic-genetic male sterility (CGMS) :

- nuclear gene restores the fertility in the male sterile line
- also known as nucleoplasmic male sterility
- fertility restorer gene *R* is required

## D) Chemically induced male sterility :

- IAA, IBA, Ethrel, etc.



# SOURCES FOR MALE STERILITY

- ⊕ **Natural population**
- ⊕ **Artificially induced through mutagenesis**
- ⊕ **Genetic engineering**
- ⊕ **Protoplast fusion**



**Table 8: Different male sterile mutants in tomato.**



Mutant	Description	Inheritance	Governing by single recessive gene
Stamenless	Stamens absent	Monogenic recessive	sl
Positional sterility	Stigma exerted	Monogenic recessive	ps
Pollen sterility	Pollen abortive	Monogenic recessive	<i>ms</i> series
Functional sterility	Anththers do not dehisce	Monogenic recessive	ps-2

# SELF INCOMPATIBILITY



## Self incompatibility:

- Inability to set seed from application of pollen produced on same plant or it refers to failure of viable pollen of a given plant to fertilise the ovules of the same plant, but it capable of fertilising effectively the ovules of the most other plant of the same variety.
- Self incompatibility occurs in more than 3000 sp belonging to 250 genera, spread in about 70 families.

# Types of self incompatibility

## 1. Gametophytic.

**SI reaction of a pollen is determined by its own genotype not by the genotype of the plant on which the pollen is produced**

## 2. Sporophytic.

**SI reaction of pollen is governed by the genotype of the plant on which the pollen is produced and not by the genotype of the pollen.**

The superior self incompatible lines for hybrid seed production should possess the following characters

- ✓ Stable self incompatibility.
- ✓ High seed set of self pollination at bud stage.
- ✓ Favorable and uniform economic characters.
- ✓ Desirable combination ability.

# Conclusion

- Hand emasculation and pollination is time consuming method but can be practiced if skilled labour available.
  - Tomato, Chilli, Bhendi, etc.,
- Male sterility and self incompatibility are two best methods of hybrid seed production.
  - GMS: Chilli
  - CMS: Onion, Potato, etc.,
  - CGMS: Chilli, etc.,
  - Colecrops, Petunia, etc.,

# Hybrid seed production- Introduction

- Hybrid varieties have been evolved in those high valued vegetable crops that exhibit marked heterosis
- Solanaceous vegetables (tomato, eggplant, sweet pepper)
- Cucurbits (melons, cucumber, pumpkin and gourds)
- Root and bulb crops (onion, radish, carrot)

# Techniques of hybrid seed production

- SOLANACEOUS CROPS

- ✓ **Tomato**



# Techniques of hybrid seed production- Tomato

- **Hybridization techniques:**
- Indeterminate tomato varieties staked and trained with either single stem or double stem, while determinate varieties are trained with 3 stems
- Usually 1st to 4th cluster on each branch selected
- The emasculation involves in holding the corolla at the base and with a single upward pull pick off the corolla along with all the stamens
- Usually the anthers are picked off a day before anthesis with the help of forceps leaving the petals intact

# Techniques of hybrid seed production- Tomato

- Fresh pollen collection on the day of anthesis by a vibrator are shed by vibrating the flowers
- Pollens are collected in a glass tube or on a glass plate from the male line and are transferred to the stigma by finger or by inserting the stigma into a glass tube containing the pollen grains. Left over pollen grains in the glass tube are not used on the next day because its viability is reduced considerably

# Techniques of hybrid seed production- Tomato

- **Physiological Parameters Affecting Tomato Seed Yield and Vigor**
- Prolonged high temperature affect pollen fertility and physiology of fertilization leading to poor seed set
- Age of pollen and stigma, abundant or scarce pollination, height of inflorescence and fertilizer application exert an influence on vigor of plant

# Techniques of hybrid seed production- Tomato

## □ **Seed extraction and Drying**

- By fermentation method
- By acid or alkali treatment: 10cc or 36% NaOH added in 4kg tomato pulp for 15 minutes.

## □ **Seed Yield**

- 1kg tomato produce 3-4g of seed yield. Av. Seed yield: 60-70kg/ha

# Techniques of hybrid seed production-Eggplant and Pepper

- **Manifestation of Heterosis:**
- Heterosis in sweet pepper ranged 35-40%
- Eggplant 50-150%
- In eggplant it is manifested by earliness, fruit number per plant & fruit weight
- Sweet pepper: plant height, days to flower, fruit weight, early and total yield

# Techniques of hybrid seed production-Eggplant and Pepper

- **Hybridization techniques:**
- Stigma is receptive a day prior to anthesis in eggplant
- Bud pollination possible giving good fruit set and seed yield
- In sweet pepper, emasculation done a day prior to anthesis, whereas, pollination done in the morning on the day of anthesis
- Natural cross pollination ranged from 0.2-46.8% in eggplant flowers
- Pepper flowers are visited by honey bees occasionally. Fresh pollen grains are collected on the day of anthesis by a vibrator and can be stored for a period of 1 to 2 months at 0°C using silica gel for proper drying of the

# Techniques of hybrid seed production-Eggplant and Pepper

- **Use of Male Sterility in Hybrid Seed Production in Eggplant and Sweet Pepper**
- Male sterile lines available in eggplant (genic male sterility) & sweet pepper (genic and ems) but not successful at commercial seed production
- Seed set on male sterile lines ranged from 46-67% in capsicum
- Cytoplasmic male sterility used now in chilli pepper to produce F1 hybrid commercially by several seed companies

# Techniques of hybrid seed production-Eggplant and Pepper

## □ **Seed Extraction**

- ▮ Eggplant harvested 50-55 days after anthesis and stored for 10 days for post harvest ripening
- ▮ Sweet pepper: 60-65 days after anthesis
- ▮ Ripe fruits crushed and seeds separated by washing. Dry air at 28-30°C

## □ **Seed Yield**

- ▮ Eggplant: 150-200kg/ha
- ▮ Peppers: 100-200kg/ha. 1kg yields 5-7g of seed.



# Techniques of hybrid seed production- Cucurbits

- **Steps of Hybrid Seed Production in Cucurbitaceous Vegetables**
- Production of inbred lines by inbreeding for 3 to 5 generations.
- Selection of inbred parents through combining ability tests and potential hybrid production ability.
- Production of hybrid seeds (preferably single cross hybrids and pistillate parent preparation is relatively easy, and single fruit produces quite a large number of seeds)
- Maintenance of inbred parents

# Techniques of hybrid seed production- Watermelon

- **Technique of Hybrid Seed Production**
- Hybrid seeds of watermelon can be produced by two ways
  1. Through artificial pollination.
  2. Removal of maleflower and use of insect pollination.

# Techniques of hybrid seed production- Watermelon

## 1. **Artificial pollination:**

- Field lay-out
- Selection of female flowers
- Bagging of female & male flowers
- Collection of male flowers
- Period of pollination
- Seed fruit management
- Harvesting
- Extraction, washing and drying of seeds
- Seed yield 150-300kg/ha based on varieties, extent of pollination & field condition

# Techniques of hybrid seed production- Watermelon

## 2. **Removal of male flowers & Use of Insect Pollination**

- In this technique, male flowers of female plant completely removed before opening
- Fruits from female parent harvested as crossed fruits and other variety as self fruit of male variety
- Used in commercial hybrid seed production
- Also referred as crossing block method

# Techniques of hybrid seed production- Pumpkin

- **Production of inbred lines**
- Seed sowing of diversified genotypes in Nov-Jan for winter ecotypes. For summer ecotypes, seed sowing after the 1st monsoon
- Bagging of male and female flowers one day before anthesis
- Select the vigorous inbreds after 4-5 generations of inbreeding

# Techniques of hybrid seed production- Pumpkin

## □ **Production of Hybrid Seeds**

- ▮ Planting of female and male inbred parents in 4:1 ratio
- ▮ Spray 50-100 ml of ethephon per litre of water on pistillate parent to increase female flowers
- ▮ Bagging of flowers before anthesis. Rebag the female flowers after pollination for another two days
- ▮ Harvest fruits after 60 days of pollination
- ▮ Remove seeds from the fruits, wash and dry for 3-4 days and sun dry for another 3-4 days.
- ▮ Preserve the seeds in sealed polyethylene bags at low temperature (4-5°C)

# Techniques of hybrid seed production- Bottle gourd

## □ **Production of Inbred Lines of Diverse Genetic Background**

- ▮ Bagging of male & female flowers
- ▮ Inbreeding at anthesis through following morning and rebagging of the female flowers for another 2 to 3 days.
- ▮ Inbreeding done for 4-5 generations and select better types by discarding the poor performers.

# Techniques of hybrid seed production- Bottle gourd

## □ **Production of Hybrid Seeds**

- ▮ Planting of female and pollinator inbreds in 4:1 ratio.
- ▮ Bagging of female and male flowers before anthesis
- ▮ Harvesting of mature fruits after senescence of the plant, remove seeds, wash and dry. Store in sealed polyethylene bags at low temperature

## □ **Maintenance of Inbred Parents**

- Inbreeding of parents to produce seeds should be done when the parental stock is depleted. Produce large quantity of seeds to maintain genotypic & phenotypic integrity of the hybrid.



# Techniques of hybrid seed production- Bulbous crops

- **Heterosis in Onion:**
- Ranged from 14-67%. It is manifested in uniform bulb size, bulb weight & efficient source sink ratio
- **Male Sterility in Onion:**
- Controlled by combination of cytoplasmic factor '5' together with recessive nucleus gene in its homozygous form

# Techniques of hybrid seed production- Bulbous crop: Onion

- **Hybrid Seed Production Techniques**
- For the production of hybrid seed in onion, male and cytoplasmic female lines planted in the ratio of 2:8
- Success of hybrid seed production depends upon the pollen distribution pattern from fertile to sterile plants in the crossing block

# Techniques of hybrid seed production- Onion

- **Factors Affecting Hybrid Seeds in Onion**
- Weak inbred lines
- Abnormal florets where ovary started to develop but failed to produce seed
- Aborted ovule
- Excessive heat damaging the flowers
  
- **Seed Yield**
  - ▮ Hybrid seed yield in onion ranges from 300-350 kg/ha

# Techniques of hybrid seed production- Cole crops

- **Manifestation of heterosis:**
- Heterosis in cabbage: 25-61%
- Cauliflower: 20-60%
- Broccoli: 26-58%
- Manifested by head/curd size, early maturity, head/curd weight and plant weight

# Techniques of hybrid seed production- Cole crops

- **Male Sterility and Hybrid Seed Production**
- Cytoplasmic male sterile lines and their maintainers have been developed in cauliflower, cabbage and broccoli using radish cytoplasm for male sterility
- Cytosterile plants of broccoli, cabbage and cauliflower are petaloid with large nectarines responsible for bee attraction and good female fertility
- **Seed Yield**
  - It varies from 500 - 800 kg/ha

Thank you!

