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From Emasculation to Pollination: Why Tomato Hybridization Demands Expertise

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Abstract

Tomato (*Solanum lycopersicum* L. 2n = 2X = 24) is one of the most important vegetable crops worldwide and hybrid cultivars dominate commercial production due to their superior yield, uniformity, quality, and resistance to biotic and abiotic stresses and also provide quick and convenient way of combining desirable characters. Unlike open-pollinated varieties, hybrid seed production in tomato relies on controlled crossing between selected parental lines. The process involves delicate operations such as flower selection, emasculation, pollen collection, hand pollination, tagging, and maintenance of genetic purity. Since tomato flowers are naturally self-pollinated, successful hybridization requires precision, timing and trained personnel. Hence, it requires lot of skilled labours as a result of which, seed production has become costly. This article discusses the critical role of technical expertise in each stage of tomato hybridization and explains why skilled workers remain indispensable in hybrid seed production.

Introduction

Hybrid breeding has transformed tomato cultivation by enabling the development of cultivars with improved productivity, adaptability and fruit quality. The production of F_1 hybrid seed depends on controlled pollination between genetically distinct parental lines. However, the self-pollinating nature of tomato flowers makes artificial hybridization technically challenging. Any mistake during crossing may result in selfed seeds, contamination or poor seed set, leading to economic losses.

Therefore, tomato hybridization is not merely a routine agricultural operation but a specialized skill requiring extensive training and experience.

Equipment Required for Tomato Hybridization

1. Fine Forceps (Tweezers)

- Used for removing anthers during emasculation without damaging the stigma.

- Stainless steel forceps are preferred.

2. Needle or Fine-pointed Scalpel

- Helps in opening flower buds and removing floral parts carefully.

3. Magnifying Lens or Dissecting Microscope

- Useful for observing small floral structures and ensuring complete anther removal.

4. Cotton swab or small cotton plug

- The crossed flower is covered with a cotton swab to prevent contamination and unwanted cross-pollination.

5. Tags or Labels -Essential for recording:

- Date of emasculation
- Date of pollination
- Crossing number

6. Camel Hair Brush or Soft Brush/ Pollinating ring

- For pollen transfer in tomato hybridization a **fine camel hair brush of size 0 or 00** is commonly used because it allows gentle and precise handling of pollen grains without damaging the stigma or floral parts.
- A Tomato Pollination Cup cum Ring is a wearable plastic tool used during manual hand pollination.

7. Petri Dishes or Small Containers

- Anthers from the male parent are collected in Petri dishes for pollen extraction.



1.Male flower collection 2. Separation of anther cone 3. Pollen extraction

8. Marker Pen or Waterproof Pen

- For writing information on tags and labels.

9. Scissors

- Used for trimming flower parts or cutting bags and tags.

10. Notebook or Field Record Sheet

- For maintaining detailed records of crosses and fruit set.

11. Seed Extraction Equipment

- Sieves or strainers
- Plastic containers or beakers
- Drying trays

Key Steps Requiring Expertise in Tomato Hybridization

1. **Understanding Floral Biology**

A successful hybridization programme begins with a thorough understanding of tomato floral biology, including:

- Flower morphology and reproductive structures- The inflorescence is extra axillary cymes with dichotomous or polycotomous branching. It is lateral and arises from the stem opposite to the leaf. It may be terminal or may continue with the vegetative shoot. The plant produces bright yellow flowers. The flowers are pentamerous, bisexual, regular, complete, ebracteate, and hypogynous. The pistil has two to several carpels. The anthers connate appearing in the throat of the corolla and their dehiscence is introrsely **longitudinal** and occurs soon after or during the corolla opening. Usually, the style is shorter than anther therefore, a high degree of self-pollination takes place.
- Timing of anthesis and anther dehiscence- The anthesis of flowers starts around 6 a.m. and the flower continues to open until 11 a.m. The peak period of anther dehiscence is between 8 to 11 a.m. depending upon the initiation of sunshine, atmospheric temperature, and humidity.
- Pollen viability period- At temperatures ranging between 18° to 25°C, the pollen remain viable from 2 to 5 days.
- Stigma receptivity duration- The stigma becomes receptive 16 to 18 hours before
- anthesis and retains the receptivity up to 6 days after anthesis.

Knowledge of these factors allows breeders to perform crossing operations at the optimum time for maximum fruit set and seed recovery.

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2. **Selection of Suitable Flower Buds**



Fig. Different stages of flowering in tomato.

Choosing flower buds at the correct developmental stage is crucial.

- After initiation of flowering about 30-35 days after transplanting flowers were manually emasculated at the right stage.
- The buds to be opened the next day are selected in the female parent.
- Overmature flowers may already have undergone self-pollination.

3. **Precision During Emasculation**



Emasculation involves removing anthers from the female parent without damaging the stigma, style, or ovary. This step demands:

- Steady hands and careful manipulation.
- Proper use of forceps and dissecting tools.
- Ability to avoid accidental pollen contamination.

Even minor injuries to floral organs can reduce fruit set significantly.

4. **Collection of Viable Pollen**

Pollen must be collected from freshly opened flowers of the male parent at peak viability. Skilled workers are required to:

- For pollination, fully opened flowers were plucked in afternoon from pollen parents and anther cones were separated from sepals and spread over newspaper or Petri Dishes for drying overnight at ambient temperature. The petri dish is shaken vigorously by holding tightly by hand to separate pollen from the anthers. The pollen was then collected by fine brush. This pollen was used for pollination in next morning.
- Protect pollen from excessive moisture and temperature.
- Prevent contamination from foreign pollen sources.

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5. **Accurate Hand Pollination**

Pollination is to be carried out with utmost care and it is done 24 to 72 hours after emasculation. Early in the morning, hold the emasculated bud in one hand and apply pollen to the stigma using camel hair brush. Fertilisation occurs around 24 to 50 hours after pollination.

The transfer of pollen to the receptive stigma is one of the most critical operations in hybrid seed production. Successful pollination depends on:

- Proper pollen load on the stigma.
- Pollination at the right time of day
- Favorable environmental conditions.



1. Pollination with brush 2. Tagging 3. Covered with cotton plug

6. **Tagging and Record Keeping**

Hybrid seed production requires meticulous documentation, including:

- Cross combinations.
- Date of emasculation and pollination.
- Parent line information.

Errors in labeling may compromise the identity and value of hybrid seed lots.

7. **Maintenance of Genetic Purity**

Commercial hybrid seed production demands high genetic purity standards. Skilled personnel ensure:

- Isolation from unwanted pollen sources- For seed production the tomato varieties should be 50 m for foundation seed and 25 m for certified seed. For Hybrid seed production the distance should be 200 m for foundation seed and 100 m for certified seed.
- Roguing of off-type plants.
- Proper field sanitation and monitoring.

Maintaining genetic purity directly influences the commercial success of hybrid cultivars.

8. **Environmental Management**

Temperature, humidity, and light conditions strongly influence pollination success. Experienced hybridizers adjust crossing schedules according to prevailing environmental conditions to maximize seed set and reduce flower drop.

Why Skilled Personnel Are Indispensable

Tomato hybridization combines biological knowledge with manual dexterity. Unlike mechanized agricultural operations, many stages still depend heavily on human precision and judgement. A trained hybridizer can:

- Increase fruit set percentage.
- Improve hybrid seed recovery.
- Reduce contamination and selfing.
- Ensure uniform and high-quality seed production.

Thus, the success of tomato hybrid seed production largely depends on the expertise of the personnel involved.

Conclusion

From selecting the right flower bud to ensuring genetic purity of harvested seed, every step in tomato hybridization requires technical competence and experience. The self-pollinating nature of tomato makes controlled crossing particularly demanding, emphasizing the importance of skilled labour in hybrid seed production systems. Investment in training and capacity building of hybridization personnel is therefore essential for improving efficiency, seed quality, and profitability in tomato breeding programmes.

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