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Manual emasculation and pollination techniques for tomato

Tomato (*Solanum lycopersicum* L.) is a globally significant crop with a high economic value and optimizing pollination is crucial for enhancing fruit yield and quality. This article focuses on the methods of hand emasculation and pollination in tomato plant, aiming to provide insights into the practices that contribute to improved fruit set and overall crop productivity. Hand emasculation involves the removal of male reproductive organs (anthers) from tomato flowers to control and direct the pollination process. This technique is particularly relevant in hybrid seed production, where controlled pollination ensures the desired genetic traits. The timing and precision of emasculation are critical factors, as they influence the success of subsequent pollination efforts. Various pollination techniques are employed to transfer pollen from the male (anther) to the female (stigma) flower parts. Natural pollination by wind and insects is common in open-field cultivation, but controlled environments such as greenhouses often require manual intervention. Hand pollination, using brushes or vibrating tools, allows growers to exert precise control over the pollination process, leading to increased fruit set and uniformity. Understanding the floral biology of tomatoes, including flower structure, timing of anthesis and pollen viability, is essential for successful hand emasculation and pollination. Factors such as temperature, humidity and light conditions also influence the effectiveness of these techniques. Additionally, the choice of cultivar and the specific goals of cultivation, such as fruit size, shape and yield impact the selection of appropriate hand emasculation and pollination method.

TOMATO (*Solanum lycopersicum* L.) is one of the most popular self-pollinated crop with chromosome number of 2n=24, belongs to solanaceae family; and widely grown as annual vegetable crop. Peru-Ecuador region is considered to be the center of origin of tomato. It has germination rate of 70%. Tomato is cultivated in tropics and subtropics of the world and all over India. It is being cultivated in kitchen gardens, commercial fields, shade house, net house, polyhouse and soilless culture or hydroponic systems. It is the second most widely grown vegetable crop in the world after potato.

It is rich in minerals, vitamins, essential amino acids (0.9 g), sugars (2.6 g), dietary fibres (1.2 g), vitamin B-6 (0.08 mg), vitamin C (39 g), iron (0.27 mg) and phosphorus (43 mg). It has become a very popular vegetable in India especially during the last thirty to fourty years. Its fruits are consumed as salads or cooked in sauces, soup and meat or fish dishes. The tomatoes are available in the market almost all the year round. In the past, hybrid vegetable production has become very popular among the vegetable growers. Now-a-days the area under cultivation of tomato hybrids is increasing as the demand for quality seed of tomato is also increasing. Hybrid seed production in tomato is carried out under protected environment, the male and female plants are grown alternately *i.e.,* for every five plants of female, one male plant is grown.

Developing hybrids is the best way to combine disease resistance, fruit quality and marketable fruit yield from breeding lines, although hybrid vigour is not reported in tomato and hybrid seed production by hand emasculation and pollination method is widely used to pollinate the flower with desired pollen. Inspite of the high cost of hybrid seed, its use is increasing because of the several advantages like uniformity, high yield and resistance to biotic and abiotic stresses over the open pollinated varieties and the development of tomato hybrids has become increasingly important in fresh and processing tomato production. Though the tomatoes are naturally self-pollinating and typically do not require hand pollination for regular fruit production, but hand emasculation and pollination technique of hybrid seed production is essential in controlled breeding to develop new varieties with specific and desirable traits.

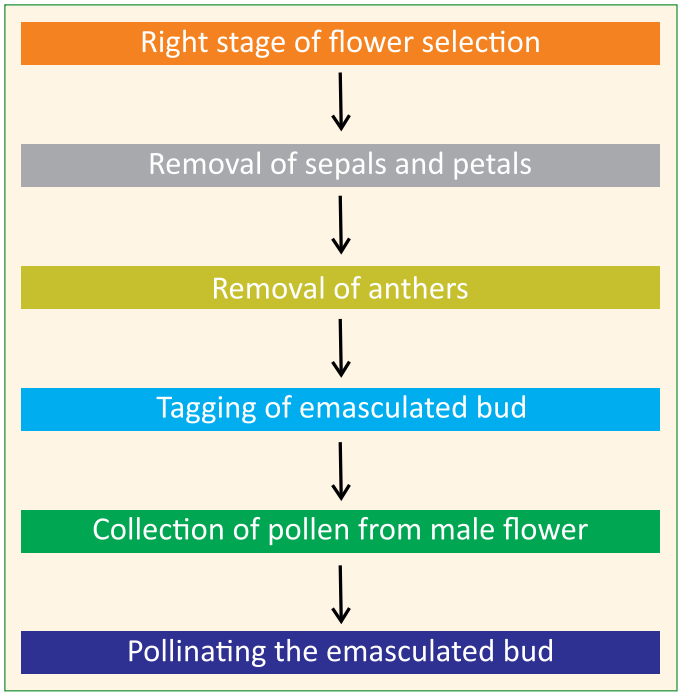
Emasculation and pollination in tomato

Emasculation is the process of removal of stamens or anthers without damaging the female part in bisexual flower to promote cross pollination. Pollination is the transfer of pollen from the male floral part called the stamen to the female floral part, pistil. For hybrid seed production of tomato, hand emasculation and pollination is essential and it is used to produce tomato varieties with desirable characteristics like plant vigour, disease resistance and good fruit quality.

Steps for emasculation and pollination for hybrid seed production in tomato

1. ***Right stage of flower selection:*** Tomato flowers are large for easy removal of anthers. In female plant, select the flower bud which are newly formed and not opened yet. Remove all the flowers that are opened around the bud in each inflorescence as they may release pollen. Normally immature buds at 1-2 days stage are suitable for emasculation.
2. ***Removal of sepals and petals:*** After selecting the bud, remove the sepals carefully with the help of scalpel. The removal of sepals is an mark to identify the bud that is to be cross-pollinated. The petals are also removed carefully without pinching the anthers.
3. ***Removal of anthers:*** Anthers are removed carefully with scalpel by making a cut at down side and pull them suddenly without causing any damage to female part.

The emasculation is to be performed at right stage and if it is performed early, the anthers will not detach properly from the selected bud and that leads to dispersal of pollen; if removal of anthers is performed late, the pollen will shed resulting in self pollination.



Steps of the hybrid seed production of tomato

4. ***Tagging of emasculated bud:*** After emasculation, the bud is to be tagged for identification purpose for pollination. While tagging, care should be taken not to damage the stigma and style of emasculated bud.
5. ***Collection of pollen from male flower:*** From the male parent, mature male flowers of bright yellow colour are to be selected. It is essential to collect the pollen when the humidity is low but if the humidity is high, then collect the flowers and keep them at room temperature for few hours for proper release of pollen. After some time, open the anther cone by giving longitudinal slice with the help of needle. To ensure that the male flower is having pollen, check the needle tip, while slicing the anther. Collect the whitish clump of anthers from the male flowers and then make multiple crosses with the collected pollen.
6. ***Pollinating the emasculated bud:*** 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 needle. Ensure that the pollen cover the entire stigma for good fruit set. Fertilisation occurs around 24 to 50 hours after pollination. If fertilisation is successful, then after few days, ovary swelling is seen and if not, the pollinated bud may abort and abscise.

Between the crosses, the needle should be sterilised and hands should be washed properly. The excess pollen can be stored for 1-2 months in a dry, cool place. For proper fruit set, the tomato flowers need right temperature and humidity, they prefer 25-29°C and 70% humidity, and finally successful pollination is visible within one week as the fruit starts to enlarge.

Problems during emasculation and pollination

While hand emasculation and pollination are essential techniques in hybrid seed production, several challenges and problems may arise during the process. Here are some common problems encountered during emasculation and pollination in tomatoes.

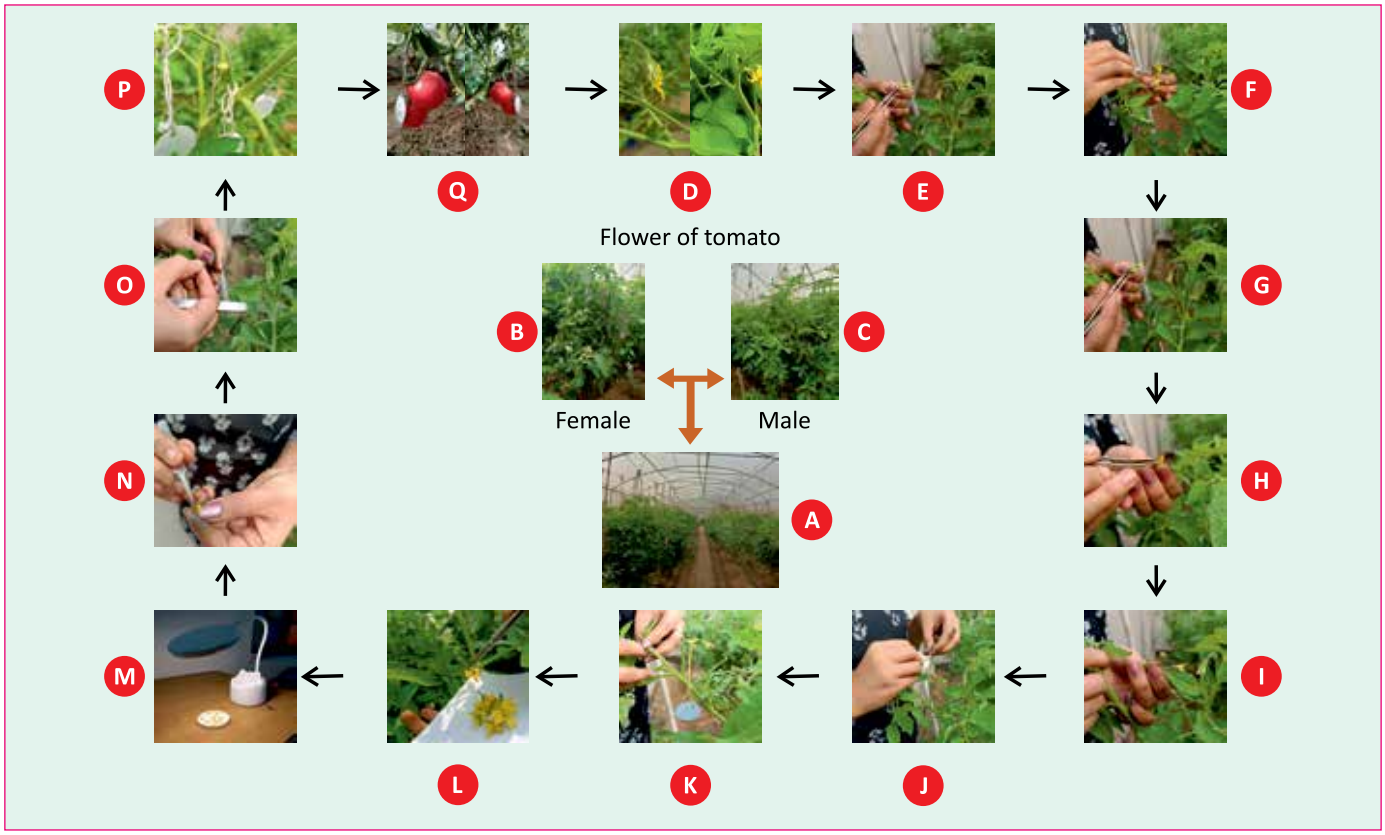
- **Timing issues**

Emasculation timing: If emasculation is not performed at the right time, there is a risk of accidental self-pollination or cross-pollination before the desired pollination can occur. And also if performed at the wrong time, the pistil could be damaged or the stigma might not be receptive to the pollen.

Pollination timing: Pollination should be synchronized with the receptivity of the female reproductive organs (pistil). Failure to match the timing can result in poor fruit set.

- **Damage to female reproductive organs:** During emasculation, there is a risk of unintentional damage to the female reproductive organs (pistil), affecting the overall success of pollination.
- **Inadequate removal of anthers:** Incomplete removal of anthers during emasculation can lead to

Hand emasculation and pollination



A, Poly-house of tomato; B, Female plant; C, Male plant; D, Flower of tomato; E, Removal of flowers around the bud that is to be emasculated; F, G and H, Removal of sepals and petals; I, Emasculated bud; J and K, Bagging and tagging; L, Collection of male flowers for pollination; M, Keeping them under room temperature for release of pollen; N, Collection of pollen; O, Pollinating the emasculated bud; P, Tagging for identification; Q, Fruit formation.

self-pollination or contamination, compromising the genetic purity of the resulting seeds.

- **Environmental factors:** Environmental conditions, such as temperature and humidity, can influence pollen viability and receptivity of the pistil. Unfavourable conditions may reduce the success rate of pollination. The perfect humidity range for the pollination of tomatoes is between 40-70%. High levels of humidity can clog the pollen, on the other hand, low levels of humidity can make the flowers so parched that pollen fails to stick to the stigma.
- **Insect interference:** Insects may interfere with the pollination process by introducing foreign pollen, leading to unintentional cross-pollination. Protective measures may be required to prevent insect interference.
- **Genetic incompatibility:** In some cases, plants may exhibit genetic incompatibility, resulting in poor fruit set even when emasculation and pollination are performed correctly.
- **Labour intensiveness:** Hand emasculation and pollination are labour-intensive processes, especially in large-scale breeding programs. Adequate resources and skilled labour are necessary for successful implementation.
- **Seed contamination:** Contamination during seed extraction or handling may lead to mixed seed lots, compromising the genetic purity of the seeds obtained from the pollinated flowers.

Improper pollination and fertilization may cause puffiness, as the fruit becomes lighter with no juice inside the fruit. Cat facing *i.e.*, the fruits are misshapen in the blossom end and zippering.

Measures to increase emasculation and pollination

- ***Precision techniques:*** New tools and techniques are being developed to improve the precision and efficiency of hand emasculation in tomatoes. These tools help in removing the anthers without damaging the rest of the flower, thus improving the success rate of controlled pollination.
- ***Training and best practices:*** Training programs for workers on the best practices of hand emasculation are being emphasized. Proper training ensures that the process is done correctly, minimizing damage to the flowers and increasing the success rate of pollination.
- ***Time of day:*** Studies have shown that the time of day when emasculation is performed can significantly impact success rates. Early morning is often preferred as the flowers are more turgid and easier to manipulate.

CONCLUSION

Hand emasculation and pollination in tomatoes are effective and precise techniques employed in hybrid

development programs to ensure desired genetic characteristics in the resulting plants. This technique allows plant breeders to carefully select and cross-pollinate plants with specific traits, such as disease resistance, fruit size or flavour profile. The success of hand emasculation and pollination relies on careful timing, observation and skilled hands to prevent unwanted cross-pollination or contamination. Thus, hand emasculation and pollination contribute significantly to the advancement of tomato breeding programs, enabling the development of new varieties with enhanced characteristics and adaptability to changing agricultural needs. The precision and control offered by these techniques make them essential tools in the hands of plant breeders striving for continuous improvement in tomato crops.

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Floral Diversity on Display

ICAR-Directorate of Floricultural Research, Pune in association with AICRP centers showcased the latest technologies, varieties, native ornamentals, value-added products during ICAR Foundation Day and Technology Day on 15-16 July 2024 at NASC Complex, New Delhi. The display contained some of the unique specimens of ornamental pineapple, curcuma, ornamental ginger, bird of paradise, pandanus (kevda), besides unique value-added products like rose infused honey, vacuum dried honey, rose candy, epoxy resin souvenirs, herbal gulal, essential oils, agarbatti, room/ car freshners and dry flower products.

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