UF IFAS Extension UNIVERSITY of FLORIDA

HS1248

Hand Pollination of Tomato for Breeding and Seed Production[1]

Monica Ozores-Hampton[2]

Pollination is the transfer of pollen from the male floral part called the stamen to the female floral part called the pistil (Fig. 1). Flowers can be male, female, or "complete," which means the flower has both male and female parts. Plants may be either cross-pollinators or self-pollinators depending on the species. Cross-pollinators require the transfer of pollen between two different plants, while self-pollinators can be fertilized by pollen transfer within the same plant (Warmund 2002; Lerner and Hirst 2002).

Cultivated tomatoes have complete flowers and are self-pollinators. The pollination process starts with the pollen grains being discharged from small sacs in the stamen called the anthers (Fig. 1). The stigma is at the top of the pistil and has a sticky surface where the pollen grains are caught after being released by the anthers. The pollen grains germinate and pollen tubes grow down the style to the base of the pistil, where the male pollen cell unites with the female cell in the ovary, producing the ovule. The fertilized ovules become the seeds and the ovary becomes the fruit. Because the fruit produced is the ovary of the female part of the flower, the fruit will be genetically identical to the mother plant, while the seed of this fruit will be a hybrid of the mother and father plants (Warmund 2002; Lerner and Hirst 2002).

Since tomatoes have complete flowers and are self-pollinated, it usually is unnecessary to hand pollinate the flowers for fruit production. If there is a lack of wind and insects or the humidity is high, you can simply shake the plant gently to help distribute the pollen.

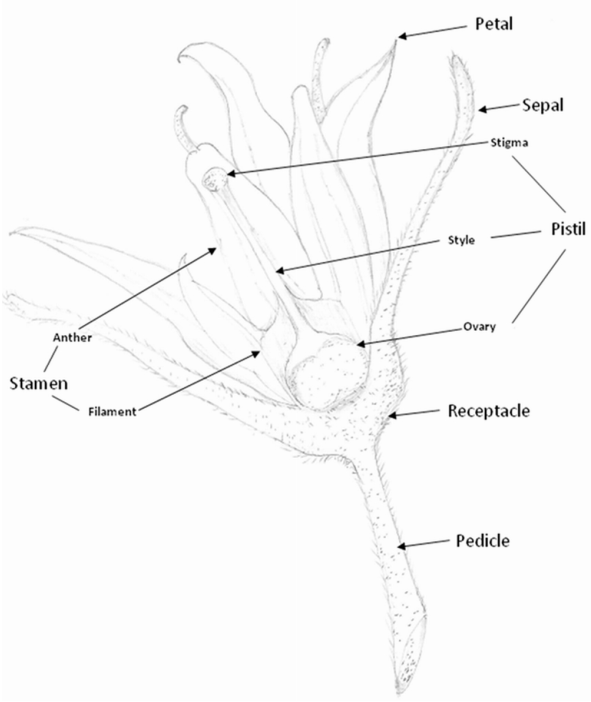

Figure 1. Diagram of a complete flower.
Credits: Carlos Ozores

Hand pollination is a technique that is used for breeding new tomato varieties with desirable characteristics such as plant vigor, disease resistance, and uniform fruit quality and plant growth. When hand pollinating for breeding, it is important to select two varieties that are true to type. This

1. This document is HS1248, one of a series of the Horticultural Sciences Department, UF/IFAS Extension. Original publication date August 2014. Visit the EDIS website at http://edis.ifas.ufl.edu.

2. Monica Ozores-Hampton, assistant professor, UF/IFAS Southwest Florida Research and Education Center, Immokalee, FL 34142.

means that the seed produced from the fruit will produce offspring identical to the parent plant. The seed of the tomato from the true-to-type cross will be a new F1 hybrid and will have traits from both of the original parent plants. The F1 hybrid will not be true to type, so the seed produced from the fruit of this plant will not be identical to the parent plant and cannot be saved to reproduce the same plant the following season (Delahaut and Newenhouse 1997).

A guide for hand pollination of tomato flowers for breeding and seed production

Step 1. Selection and emasculation of flowers from the mother plant receiving pollen: Newly formed, unopened flower buds which are expected to open within the next 1–2 days should be selected (Chetelat and Peacock 2013; Contreras 2006). This can be determined by daily observations of the plant. Tomato flower clusters open in sequence. If the first flower opens today, the next flower in that cluster will open tomorrow, and so forth.

Tomatoes have flowers that are large enough for the easy removal of the anthers by hand or forceps. Hold the flower at the pedicle and pull the anther out (Fig. 2). Tag the flowers by wrapping a twist tie around the stem. Remove all open flowers near the selected flower to prevent pollen exposure to the newly emasculated flower.

When selecting flower buds on the mother plant for emasculation and subsequent cross-pollination, it is important to select flower buds at the proper developmental stage. If emasculation is performed at the wrong time, the pistil could be damaged and/or the stigma might not yet be receptive to the pollen. If emasculation is performed too late in the flower's development, the pollen from that flower could have shed already, resulting in self-pollination (Contreras 2006).

Figure 2. Emasculation of the flower leaving the stigma exposed for pollination.
Credits: Monica Ozores-Hampton

Step 2. Pollen collection and drying from the father plant: Select open, dark yellow flowers from the father plant for pollen or anther removal (Fig. 3). If humidity is low, pollen collection can be done easily without removal of the flower from the father plant. Collect the pollen by using a dissecting needle or scalpel to cut a slit in the anther cone and using the tip of the needle or scalpel to remove the pollen (Chetelat and Peacock 2013).

Under very humid conditions the pollen may be tacky and will not release. If this is the case, the flowers should be removed from the plant and left to dry at room temperature for a couple of hours. If the pollen is still too tacky, emasculate the flower by removing the anthers from the flowers using either fingers or forceps. Hold the flower at the pedicle, pull the anther out (Fig. 4), and leave the anthers to dry in the sun or under an incandescent lamp that is placed at least 18 inches away (Fig. 5) (Chetelat and Peacock 2013). After drying, anthers should split and release the pollen. If the pollen does not release, tap the flower to remove the pollen. Pollen can be stored for 1–2 months if left in a dry, cool (32–41˚F) place, or kept at –112˚F if storage is needed for longer periods of time.

Figure 3. Collection of tomato flowers for pollen removal.
Credits: Monica Ozores-Hampton

Figure 4. Removal of the stamen from the pedicle.
Credits: Monica Ozores-Hampton

Figure 5. Anthers drying under an incandescent light.
Credits: Monica Ozores-Hampton

Step 3. Pollination of the stigma: Pollination is performed 24 to 72 hours after emasculation, usually early in the morning. The pollen is applied by dipping the exposed stigma into the pollen (Fig. 6) or with a small paint brush or a dissecting needle (Chetelat and Peacock 2013).

It is very important to not damage the pistil during this process. Pollen from a single flower from the father plant can pollinate 12–18 flowers. Fertilization occurs around 24–50 hours after pollination, and a swollen ovary should appear within the next couple of days (Fig 7). (Rai and Rai 2006; Snyder 2010; Ozores-Hampton et al. 2012).

Figure 6. Pollination of the stigma from the cap of a test tube.
Credits: Monica Ozores-Hampton

Figure 7. Swollen ovary starting to resemble fruit after successful pollination.
Credits: Monica Ozores-Hampton

Problems due to improper pollination

Puffiness is caused by incomplete fertilization due to too low or high temperatures, low light, rainy conditions, high nitrogen, or low potassium levels (Ozores-Hampton et al. 2012). It is characterized by flat-sided or angular fruit. Cat facing also can be a problem if the plant is exposed to extreme high or low temperatures during fruit set. It is characterized by malformed and scarred fruit (Ozores-Hampton et al. 2012). Zippering is a condition characterized by brown tissue running along the side of the fruit that resembles a zipper. It is caused by an anther remaining attached the ovary during excessive humidity. When the fruit size increases the anther is pulled from the fruit, leaving a scar (Ozores-Hampton et al. 2012).

Conclusion

Optimum temperatures and humidity are important in tomato flower pollination. Favorable temperature ranges are between 70–85˚F, with around 70 percent air relative humidity. If morning temperatures rise above 90˚F before 10 a.m. flowers will abort and blossoms will drop. If night-time temperatures drop below 55˚F or rise above 75˚F pollen grains can become damaged and pollen tubes will fail to develop (McCrea 2005; Ozores-Hampton et al. 2012; Whiting et al. 2012). If humidity rises above 80 percent the pollen will become tacky and will not release from the anthers. If humidity is below 60 percent for prolonged periods of time pollen grains may become dry or the stigma may dry out and the pollen cannot stick (McCrae 2005; Snyder 2010; Ozores-Hampton et al. 2012).

References

Chetelat R. and S. Peacock. 2013. "Guidelines for emasculating and pollinating tomatoes." Univ. California, Davis, Tomato Genet. Resource Ctr. http://tgrc.ucdavis.edu/Guidelines_Emasculating_and_Pollinating_Tomatoes.pdf.

Contreras, S. 2006. "Tomato and Pepper—Seed Biology." Ponificia Univ. Catolica of Chile, Dept. Sci. Veg. http://seedbiology.osu.edu/HCS630_files/May%2017/tomato%20and%20pepper,%20text.pdf.

Delahaut, K. A. and A. C. Newenhouse. 1997. "Growing tomatoes, peppers, and eggplants in Wisconsin: a guide for fresh-market growers." Univ. Wisconsin, Coop. Ext. http://learningstore.uwex.edu/assets/pdfs/a3687.pdf.

Lerner, B. R. and P. Hirst. 2002. "Pollination of fruits and nuts." Purdue Univ. Coop. Ext. Serv. HO-174-W. http://www.hort.purdue.edu/ext/ho-174.pdf.

McCrea S. 2005. "Why blossoms of some vegetables fail to set fruit." Washington State Univ. Spokane County Ext. http://www.spokane-county.wsu.edu/Spokane/eastside/Fact%20Sheets/C148%20Why%20Blossoms%20Fail%20%2005.pdf.

Ozores-Hampton, M., K. Fnu, and G. McAvoy. 2012. "Blossom drop, reduced fruit set and post-pollination disorders in tomato." Univ. Florida, Inst. Food and Agri. Sci. HS1195. http://edis.ifas.ufl.edu/hs1195.

Rai, N. and Rai, M. 2006. *Heterosis breeding in vegetable crops*. New Delhi, India: New India Publishing Agency.

Snyder, R. G. 2010. *Greenhouse tomato handbook*. Mississippi St. Univ. Ext. Srv. http://msucares.com/pubs/publications/p1828.pdf

Warmund, M. R. 2002. "Pollinating fruit crops." Univ. Missouri. Ext. G6001. http://extension.missouri.edu/p/g6001.

Whiting D., C. O'Meara, and C. Wilson. 2012. "Growing Tomatoes." Colorado State Univ. Ext. http://www.ext.colostate.edu/mg/gardennotes/717.html#pollination.