Greenhouse Tomato Production

HGA-00435

Fruit Set and Pollination

Development of large, smooth fruit requires successful completion of the sexual process within the tomato flower. Successful transfer of viable pollen from the anthers (male flower parts) to the stigma (part of the female organs) and subsequent fertilization of the ovules and development of the fruit are affected by the plant's environment and by inherited characteristics of the flower parts (figure 1). A series of processes is involved:

Photo by Penny Greb, USDA ARS

- Pollen must be produced in the anthers.
- The pollen must be viable.
- Pollen must be transferred to the stigma.
- A sufficient quantity of pollen must be transferred.
- The pollen must germinate rapidly and completely.
- The stigma must be receptive.
- The pollen tubes must grow through the style rapidly.
- Fertilization must take place.
- The ovary must be retained.
- The ovary must enlarge.

Failure of any of these processes prevents normal fruit development. The symptoms of unsuccessful pollination are "dry set" or rough fruit and could be due to adverse environmental conditions such as temperature, light, humidity, inadequate pollen transfer or poor nutrition.

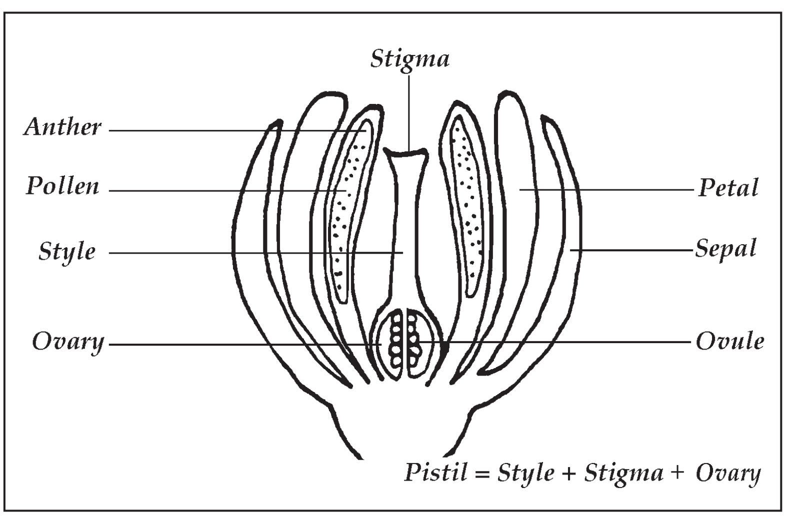

Figure 1. Schematic drawing of tomato flower parts

Environmental Conditions

Temperature

Greenhouse temperatures during the pollination period should not fall below 60°F at night or exceed 85°F during the day. At higher or lower temperatures, pollen germination and pollen tube growth are greatly reduced. Night temperatures are particularly important. Chemical growth regulators can be used to induce fruit development under lower than desirable night temperatures, but these fruit are usually seedless. Internal cavities and thin outer walls may make seedless fruit soft and greatly reduce their quality. No known growth regulator will induce normal fruit development under high temperature conditions. Chemical growth regulators are not recommended.

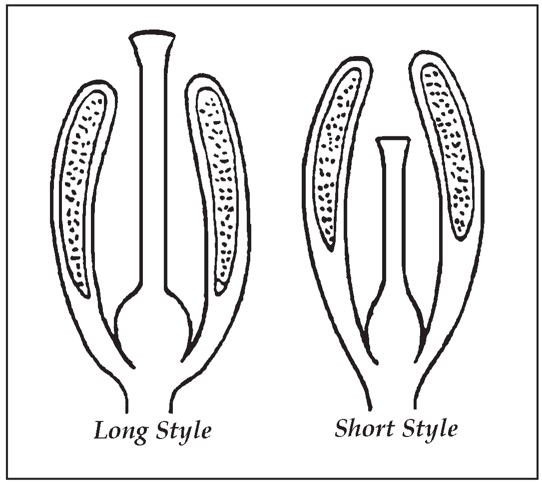

Figure 2. Style length may affect pollination

Light

Research has shown that prolonged dark, cloudy weather retards pollen development and germination in many tomato varieties, resulting in poor fruit set. Yields usually are directly related to the amount of available solar radiation. Pistil length — which affects the ease with which pollen is transferred from anther to stigma — is inversely related to the amount of available solar radiation. In some tomato varieties, the style grows so long that the stigma extends beyond the anthers, making adequate transfer of pollen difficult. If the style is short, the stigma is surrounded by the pollen sacs, making pollen transfer more certain (figure 2). Increased pistil length also is related to the combination of low carbohydrate and high nitrogen concentrations in plant tissue. These characteristics often occur under prolonged low light and a heavy, or even a moderate, fertilization program.

Humidity

High humidity keeps pollen damp and sticky and lessens the chances of sufficient pollen transfer from anthers to stigma. Research has shown that relative humidity of 70 percent is optimum for pollination, fruit set and fruit development.

Pollen Transfer

Assuming satisfactory environmental conditions and nutrition, the main factor affecting good fruit set is adequate pollen transfer from anthers to stigma. In the garden, air movement is sufficient for flowers to pollinate themselves. This generally is not true in a greenhouse because of higher humidity and lack of sufficient breeze to stir the blossom clusters.

Some form of mechanical assistance to pollination, best applied during the middle of the day, is required to produce greenhouse tomatoes.

Traditionally, battery-operated or electric handheld vibrators have been used. They can be homemade (for example, from an electric toothbrush or a doorbell solenoid) or purchased from greenhouse supply houses. The vibrating probe, momentarily held lightly against the flower cluster branch, shakes it with moderate vigor. Recently-opened flowers disperse pollen in a small, dusty, yellow cloud. To disperse pollen from every newly opened flower, branches must be vibrated daily, or at least every other day, creating an increased labor requirement.

Methods requiring less labor reduce yields and quality. Beating the support strings or wires to agitate the plant does not achieve good pollination. Although some growers have used mechanical blowers, such as back-pack dusters, fruit quality and yield are inferior to that obtained using individual cluster vibration. It has not been determined whether the saving in labor justifies the reduction in yield and quality. Growers can determine which practices work best in their own greenhouse. A simple tapping or vibrating of flower clusters should be a satisfactory method for the small grower. Excessive air flow can damage plants and blow pollen away from the flowers. In using blower pollination, the air flow should be controlled to duplicate the amount of flower cluster agitation achieved by a battery-operated or electric hand vibrator. Directing the air stream at individual clusters 7 to 8 feet down the row ahead will provide better results than indiscriminately brushing plants with the air stream. Work on one row of plants at a time to avoid missing some clusters.

Fruit Cracking

Symptoms of this stress problem are usually cracks radiating from the stem, almost always on maturing fruit, at any time, from a few days before pink color begins, to the red-ripe stage. Susceptibility to fruit cracking is known to be an inherited characteristic, and plant breeders have succeeded in developing at least moderate resistance in most modern varieties. Fruits of most varieties will crack when there are excessively high fruit temperatures and sudden changes in soil moisture supply to plants. High-temperature cracking is probably due to a heat-caused breakdown of cutinized epidermal tissues around the stem end and can occur under conditions of adequate, uniform soil moisture. Increased exposure due to lack of foliage can result in higher fruit temperatures. When low soil moisture conditions are followed by an irrigation, the sudden increase in water content of fruit cells may create internal pressures sufficient to crack fruit. Prevention, therefore, lies in selecting varieties for maximum resistance, avoiding high fruit temperatures and maintaining uniform soil moisture conditions.

Photo by Mason Masteka

Blotchy Ripening

Blotchy ripening is also known as gray wall or internal browning. Blotchy ripening is characterized by uneven coloring of the fruit wall in the form of irregular, light green or almost colorless areas. Brown necrotic areas are frequently found in the vascular tissue inside the fruit.

Blotchy ripening is associated with conditions of low light intensity, cool temperatures, high soil moisture, high nitrogen and low potassium. While these conditions may contribute individually to blotchy ripening, a combination of conditions probably produces the greatest occurrence of this disorder. Some varieties are more susceptible than others. To avoid blotchy ripening when light intensity is low, apply irrigation and fertilizer (especially nitrogen) less frequently, but do not attempt to elevate temperatures more than 10°F to 15°F over the night minimum. If blotchy ripening occurs under moderate to high light intensity, the cause may be purely nutritional (high nitrogen levels, low potassium) or high soil moisture.

Green Shoulder, Sunscald and Orange Fruit Color

These disorders are associated with high temperature or high light intensity. Fruit temperature, under high light intensity, can be considerably higher than greenhouse air temperatures, particularly in localized areas on the sides and shoulders of fruit exposed to the sun's rays. Avoid removing any leaves that might offer protection to fruit clusters, especially when the sun is at a higher angle and fruit may be exposed to its rays for longer periods.

Orange fruit color following ripening can be attributed to the inhibition of the lycopene (red) pigment due to prolonged high temperatures. Carotene, the principal yellow-orange pigment, is unaffected by temperature. The best red color develops in tomato fruit at 65°F to 75°F.

Sunscald occurs on exposed fruit shoulders in a large circular area where internal cell contents have reached the thermal death point or have been adversely affected by short-wave radiation from the incoming sunlight.

Persistent green shoulder may be more prevalent in varieties with inherited green-shoulder than those with the uniform-ripening characteristic.

Blossom End Rot

This is a physiological not a pathogenic disorder. Inadequate calcium and moisture stress combine to produce a gray black discoloration at the blossom end of the fruit. Maintaining an even moisture supply is the best preventative technique.

www.uaf.edu/ces or 1-877-520-5211

Lydia Clayton, Extension Faculty, Agriculture and Horticulture. Originally prepared by Wayne Vandre, former Extension Horticulture Specialist.

Published by the University of Alaska Fairbanks Cooperative Extension Service in cooperation with the United States Department of Agriculture. The University of Alaska Fairbanks is an affirmative action/equal opportunity employer and educational institution.

11-90/WV/4-14

Reviewed April 2010