# Greenhouse Tomatoes

## Culture

## Varieties

### Red Beefsteak Types

Varieties ranked according to yield of marketable fruit and average fruit size (spring crop data).

Cobra—resistant to fusarium wilt races 1 & 2, verticillium wilt, and tobacco mosaic virus—yield 8.2 lbs/plant and fruit size 6 oz—source of seed = Vilmorin Inc., P.O. Box 707, Empire, CA 95319.

Stresa—resistant to fusarium wilt races 1 & 2, verticillium wilt, tobacco mosaic virus, rootknot nematodes and cladosporium leaf mold—yield 8.6 lbs/plant and fruit size 5.8 oz—source of seed = Bruinsma Seeds B.V., R.R. 3, site 39C, Summerland, B.C., Canada VOH 1ZO.

Capello—resistant to fusarium wilt races 1 & 2, verticillium wilt, tobacco mosaic virus and cladosporium leaf mold—yield 8.4 lbs/plant and fruit size 5.4 oz—source of seed = DeRuiter Seeds Inc., 3001 Bethel Road, Suite 207, P.O. Box 20228, Columbus, OH 43220.

Trust—resistant to fusarium crown and root rot, fusarium wilt races 1 & 2, verticillium wilt, tobacco mosaic virus and cladosporium leaf mold—yield 8.2 lbs/plant and fruit size 5.8 oz—source of seed = DeRuiter Seeds Inc.

Caruso—resistant to fusarium wilt races 1 & 2, verticillium wilt, tobacco mosaic virus and cladosporium leaf mold—yield 7.9 lbs/plant and fruit size 6 oz—source of seed = DeRuiter Seeds Inc.

Belmondo—resistant to fusarium wilt races 1 & 2, verticillium wilt, tobacco mosaic virus and cladosporium leaf mold—yield 7.9 lbs/plant and fruit size 5.7 oz—source of seed = Bruinsma Seeds B.V.

## Seeding

Purchase the best quality seed available. One oz of well-matured seed should contain 6,000-12,000 seeds.

A separate greenhouse isolated from the crop producing area is recommended for plant production and seedage.

Sow seed in flats 12-14 inches wide, 20-20 inches long and 2.5-3 inches deep. Approximately 2,000-3,000 seedlings should be grown per seed flat. Space seed evenly in 1/4 inch deep furrows, 1.5 inches apart in the flat. Cover seed 1/4 inch deep and firm the surface of the germination medium.

Hold the germinated seed flats at 70-75°F day temperature and 60-65°F night temperature until the seedlings are large enough to transplant. This is when they are 3/4-1 inch high, with the cotyledon leaves expanded and the true leaves still confined within the apical whorl.

If watering is necessary, apply early enough in the day so plant foliage and the growing medium surface are dry by 5-6 p.m.

## Transplanting

Use sterile or new pots. Fill container to a point where it is easy to transplant the seedling into relatively firm soil. There should be a 1/2 to 3/4 inch difference between soil surface and lip of the container after one or two waterings.

In the center of each container, place the seedling in a hole 0.5-0.75 inch deep.

### Non-containerized transplants

Instead of placing seedlings ready for transplant into individual containers, some growers prick them into beds of peatlite mix. One cubic yard contains the following materials:[1]

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|---|---|
| Shredded sphagnum peat[2] | 11 bu |
| Horticultural vermiculite (size 2 or 3) | 11 bu |
| Limestone | 10 lb |
| Superphosphate (20%) | 2 lb |
| Calcium or potassium nitrate | 1 lb |
| Iron chelate 330[3] | 1 oz or 1 level Tbsp |
| Borax 11% B, or 20 Mule Team Borax | 1/2 oz or 1/2 level Tbsp |

[1] From: *Growing Greenhouse Tomatoes in Ohio*, Special Bulletin 19, Ohio Cooperative Extension Service (out of print).

[2] Measurements of peat are for loose peat.

[3] Where fritted trace elements are available, use 2 oz or 4 level Tbsp FTE 503 in place of iron chelate and borax.

## Age of plant at time of transplanting

Most research studies reveal that an overly large plant usually does not produce as much early or total fruit as one that might have been considered "too small." With the fall crop, a properly grown 5- to 6-week-old transplant, from the time of transplanting the seedlings, generally has performed better in relation to early and total yield than 3- to 4-week-old or 7- to 8-week-old plants. For the spring crop, a properly grown 8- to 9-week-old plant generally performs better than 6- to 7-week-old or 10- to 11-week-old plants.

# Plant Spacing

Plant populations in greenhouses vary from 8,000-11,000 plants/A. The most common plant populations are about 9,500 plants/A (about 4.5 sq ft/plant) for the spring crop and 10,000 plants/A for the fall crop. In general, rows should be 36 inches apart with 18 inches between plants in a row, giving a total of 9,685 plants/A.

# Temperatures

## Fall Crop

Night temperature should be from 65-70°F. Day temperature should be from 75-80°F. Use shading compounds or other shading techniques to keep day temperature below 85°F.

## Spring Crop

Night temperature following a bright day can be held in the range of 62-65°F. Night temperature following a dark or cloudy day should be held in the range of 60-62°F. A constant night temperature of at least 62°F should be held during the pollination stage.

## Application of Fertilizer in Irrigation Water

Application of water-soluble fertilizer salts, such as ammonium nitrate and potassium nitrate, in the irrigation water can be carried out successfully using available equipment. The fertilizer goes directly to the plant root at desired daily intervals and desired concentrations. For further information, see Ohio State University Extension Special Bulletin 19, *Growing Greenhouse Tomatoes in Ohio* (out of print).

## Mulching

Four-mil-thick, white-polyethylene, light-reflective plastic mulch is recommended in place of all other mulches. The white plastic mulch increases light reflectivity within the crop canopy and also increases temperature by allowing less evaporation from the soil. Having less evaporation allows for better ventilation and lowers humidity levels, thus decreasing the chance of disease.

## Pruning and Tying

Greenhouse tomatoes are pruned to a single stem by removing all lateral shoots. Suckering should be done weekly or more frequently during the younger, rapidly growing stage after transplanting. The pruning procedure usually is done during the tying or training operations. Plastic twine is used for tying up the plants because it is not treated with chemicals that may injure the plant stem. One end of the twine is attached to the base of the plant with a small, nonslip loop of sufficient size to permit stem expansion. The other is attached to a galvanized No. 9 gauge (or slightly larger) wire 6-8 ft above the plant row. The growing tip is pinched off or "topped out" 6-7 weeks before scheduled plant removal. This prevents additional fruit set and improves sizing and maturing of fruit already set.

## Pollination

The hand-held electric vibrator is the most widely used and efficient means of pollination. All other forms of pollination should be considered supplemental. Research indicates that relative humidities of 70% are optimal for good pollination and fruit set. Pollen does not shed at humidity levels of 90% or higher. Pollinating each cluster every other day is generally adequate under proper conditions. Less pollen is produced during cloudy days and thus better pollination is required at these times to ensure good fruit set.

## Carbon Dioxide Enrichment

When carbon dioxide levels are below ambient (340 ppm), there is a decrease in fruit production and overall plant growth. To ensure that levels are not depleted during cold days when no ventilation is used to resupply the $CO_2$ level, carbon dioxide enrichment is necessary, either by ventilation or the use of carbon dioxide enrichment equipment.

## Bag Culture Method

One way to have more precise control of crop growth and to better manage diseases is through the use of bag culture. Instead of growing plants in soil, they are grown in white, 4-mil, polyethylene plastic bags. The bags are filled with a commercial or grower-prepared peatlite formula. The plants receive water and fertilization through an automatic drip irrigation system.

Further information is available in Special Circular 108, *Bag Culture Production of Greenhouse Tomatoes,* Section of Communications and Technology, Ohio Agricultural Research and Development Center, Wooster OH 44691.

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# Disease Control

# Greenhouse Sanitation

Sanitation is essential in greenhouse management to limit the populations of disease and insect pests that may attack crops. It must be done continuously at every stage of the growing cycle to be effective.

## Crop Removal

1. Remove all leaves, fruits, vines and root systems of crops and weeds.
2. Dispose properly away from the site—Do not pile outside.
3. Disinfest glass, pipes, walkways, etc.

## Soil Management

1. Produce the crop in pest or disease-free soilless systems.
2. Consider steam disinfestation—(180°F for 4 hours) or fumigation of soil.
3. Guard against reintroduction of diseases or pests—the problems may return.

## Pest-Free Transplant Production

1. Isolate and disinfest transplant production houses.
2. Use pest-free growth media.
3. Make sure you use clean hands, clothes, tools, pots.
4. Keep pots off ground or isolate from soil with plastic or other barrier. Soil may be a source of infection.

## Sanitation During Crop Growth

1. Pay timely attention to pest development and control.
2. Routinely disinfest tools and walkways.
3. Make sure workers have clean hands, clothes, boots.
4. Keep dogs and cats from wandering the greenhouse.
5. Continually remove and properly dispose of crop debris.
6. Control weeds in the crop—they harbor diseases and pests.
7. Remove weeds and debris bordering outside of greenhouse.

## Pesticide Use in Greenhouses

**According to the Ohio Department of Agriculture**, regulations PERTAINING TO GREENHOUSES, AND THE DIRECTIONS FOR USE ON THE PESTICIDE LABELS, MUST BE FOLLOWED. Restricted use pesticides can only be used by Certified Pesticide Applicators with THE greenhouse CERTIFICATION ON THEIR APPLICATOR LICENSE. Restricted use pesticides are identified prominently on the label.

**Pesticides that are not restricted use and are labeled for tomatoes but without specific greenhouse use directions may be used unless greenhouse use is expressly prohibited on the label**. Thus, a specific label for greenhouse use is not required; but the label must be carefully read to be certain the greenhouse use is not restricted. For more information about fungicide usage allowances in high tunnels and greenhouses, please contact the Ohio Department of Agriculture (614-728-6389).

Copper products, Tanos, and Manzate, Dithane and other EBDC fungicides may be used for management of leaf mold and late blight in greenhouses. The fungicide Gavel may be used for late blight suppression. Decree, Scala and Endura are labeled for Botrytis management in greenhouse tomatoes. Some fungicides commonly used in open field tomato production, such as Bravo Weather Stik and Quadris, are not allowed in greenhouse or high tunnel systems.

## Late Blight Control in Greenhouse Tomatoes

Late blight may occur in greenhouses at any time of the year, but in Ohio the disease occurs most often beginning in September/October. At this time of year, greenhouses heat up during the warm sunny days and may get very cool at night as temperatures drop. This results in condensation, providing moisture, and cool conditions, which are ideal for late blight.

### To prevent this disease:

Maintain temperatures of at least 65°F in the greenhouse. Water plants early so that foliage is not wet after sunset. Scout plants regularly. Look for distinctive symptoms (black lesions on stems and leaves, fuzzy mycelial growth on undersides of leaves, on stems and on fruit, copper-colored lesions on fruit). Pay special attention to areas where condensation or other sources of moisture are heaviest. Also watch out for and repair leaks in the greenhouse (e.g., slipped panes, tears in the plastic, etc.) that will allow the cool night air to enter the greenhouse. Maintain proper ventilation and air movement in the greenhouse.

Use a protectant fungicide. Dithane formulations (mancozeb) and Exotherm Termil (a fog of chlorothalanil) are labeled for late blight control in the greenhouse. Be sure to follow label instructions and be aware of restrictions.

## Blossom-end Rot (BER)

BER usually is associated with water stress within the plant. Water stress can be caused by over-fertilization, especially with nitrogen; high salt concentrations in the soil; over-watering; irregular watering; or high plant temperatures following several days of cooler temperatures under low light conditions.

## Fruit Burst and Cracking

Sudden increases in amounts of water applied during irrigation may promote these disorders. They have been observed when conditions exist that are conducive to water condensation on the fruit (i.e., low fruit temperature and humidity, high air temperature). Also, high levels of nitrogen application and low levels of potassium may cause these disorders.

Fruit burst and cracking generally can be prevented by frequent picking so that ripe fruit are not left on plants.

## Puffiness

Many factors appear to be associated with puffiness, but the exact cause is not known. Conditions that cause poor pollen development or inadequate pollination or fertilization of the ovules likely will result in puffy fruit. These conditions include excessive nitrogen and/or low potassium levels within the plant; insufficient light; inadequate vibration with pollinators; low daytime temperatures; and over-watering.

## Stylar Scars and Catface

Stylar scars and catface usually are caused by low growing temperatures. They also can be aggravated by high levels of nitrogen in the plant.

Improper uses of the vibrator used for pollinating, tying and picking scars, pesticide applications and other operations can result in fruit scarring.

## Blotching, Ripening, Graywall, Internal Browning

Rather than uniform ripening, fruit affected by these disorders have irregular patches that do not ripen normally and remain hard. The color of the afflicted areas can vary from a dull brown or light gray to a glossy green or yellow.

Often, blotchy ripening occurs when an extended period of dull and humid weather is followed by bright sunny weather. Succulent plants seem more susceptible. Low temperature, low light intensity, high soil mixture, low potassium and high nitrogen all contribute to ripening problems.

To overcome these disorders, use proper management of fertilization, watering, temperature control and varieties with demonstrated resistance.