AVRDC – The World Vegetable Center

International Cooperators' Guide

AVRDC The World Vegetable Center

AVRDC Publication Number: 03-551

# Grafting Tomatoes for Production in the Hot-Wet Season

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## Introduction

Tomatoes are difficult to grow during the hot-wet season. Flooding, waterlogged soils, diseases, and high temperatures can significantly reduce yields.

Grafting tomato scions onto selected rootstocks of eggplant and tomato can minimize problems caused by flooding and soil-borne diseases. Sometimes the use of grafted tomato plants can be the difference between harvesting a good crop and harvesting no crop at all (Fig. 1).

*Fig. 1. Grafted tomato plants (right row) are vigorously growing while non-grafted plants (left row) are dead.*

## Grafting options

Grafted tomatoes are more expensive than nongrafted tomatoes and should be grown only when there is a risk of either flooding, root-knot nematode, or soil-borne diseases such as bacterial wilt or fusarium wilt.

### *Eggplant rootstocks*

Use eggplant rootstocks when flooding or waterlogged soils are expected. Eggplant roots can survive for days under water.

Most eggplant lines will graft successfully with tomato lines. The key is to identify eggplant rootstocks that will maintain high yields and fruit quality of the scion variety. The lines should be resistant to bacterial wilt (caused by *Ralstonia solanacearum*) and other soil-borne diseases. AVRDC recommends eggplant accessions EG195 and EG203. They are resistant to damage caused by flooding, bacterial wilt, root-knot nematode (caused by *Meloidogyne incognita*), and tomato fusarium wilt (caused by *Fusarium oxysporum* f.sp. *lycopersici*). Field observations indicate the lines show tolerance to southern blight (caused by *Sclerotium rolfsii*).

### *Tomato rootstocks*

Use tomato as a rootstock only if flooding and waterlogged soils are not expected. Select rootstocks that resist bacterial wilt and other soil-borne diseases. AVRDC recommends tomato line Hawaii 7996 because it has a high level of resistance to bacterial wilt and fusarium wilt.

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# Facilities

Two types of facilities are generally needed to produce grafted seedlings. A ***screenhouse*** (Figs. 2, 3) is used for growing seedlings prior to grafting and for hardening of grafted plants prior to transplanting.

Immediately after grafting, a ***grafting chamber*** (Figs. 4, 5) is used for about one week to provide high humidity and reduced light intensity during development of the graft union. The chamber can be built at low cost and is recommended for small-scale farmers or community nurseries.

If necessary, the grafting chamber by itself can be used to raise grafted seedlings. The shade net layers of the chamber are removed to grow seedlings prior to grafting. Immediately after grafting, shade nets are layered over the chamber to facilitate healing. Plants are cared for in a similar manner as stated in steps 7 and 8 on page 5. Then rather than moving plants back into the screenhouse (as stated in step 9), simply peel off the remaining (black) shade net layer on the chamber and harden the plants until ready for transplanting.

### *Screenhouse*

The screenhouse should be constructed of 60-mesh nylon netting to exclude virus-transmitting insects such as aphids and whiteflies (standard 32-mesh will not exclude whiteflies). The double door reduces the chance for entry of insects with workers. If insects are detected in the screenhouse, they should be immediately killed.

The upper half of the structure should be covered with a separate layer of transparent, UV-resistant polyethylene to prevent rain penetration. A 50% shade net should be placed about 30 cm above the highest point of the house to reduce light intensity and temperature. Additional shading inside the screenhouse may be needed for plants during the first two or three days after being returned from the grafting chamber for hardening. A screened ventilation ridge along the top of the house is recommended for houses 6 m or more in width. This vent reduces the heat that accumulates in large screenhouses.

*Fig. 2. Photo of screenhouse*

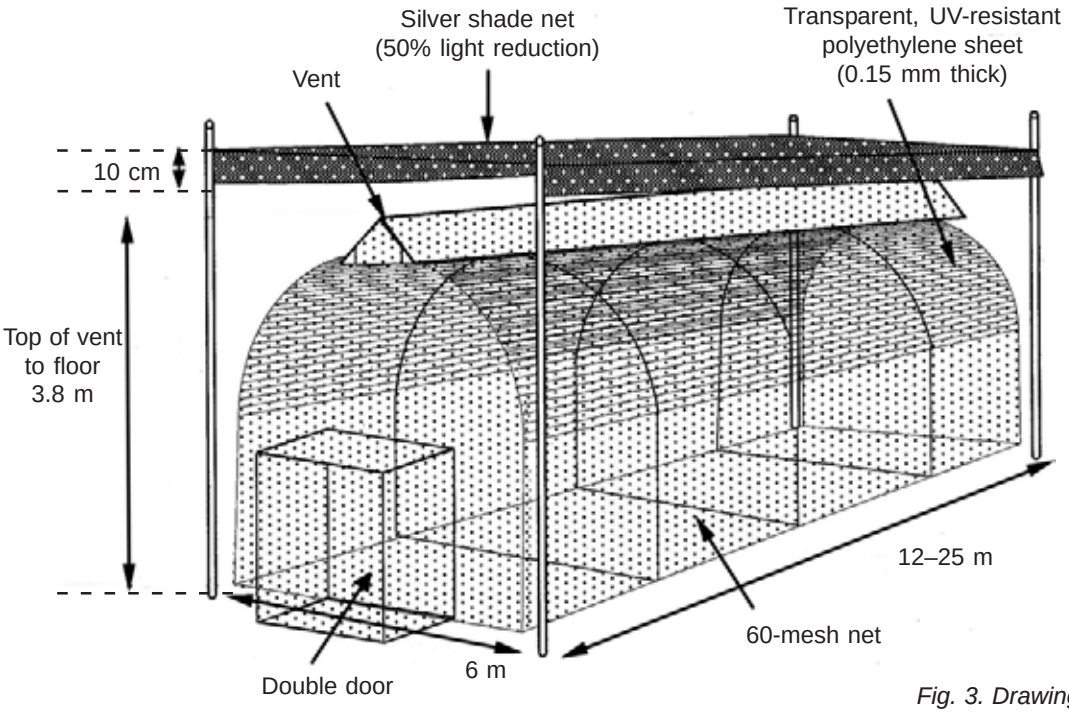


*Fig. 3. Drawing of screenhouse*

### *Grafting chamber*

This facility is designed to maintain high humidity and reduce light intensity to minimize heat build-up. The polyethylene covering retains moisture that evaporates from a water-filled floor pan. The chamber is covered with shade nets to reduce light penetration. The over-the-top shade nets further reduce light penetration and allow good air circulation to minimize heat build-up. Light intensity can be controlled as needed by addition or removal of shade nets. The structure, as shown, is suited for open air, full sun conditions. Placing the shelter under natural shade can reduce the need for shade netting.

Select a flat site that is elevated and not subject to flooding. Bamboo stakes or pipes (30 cm in length, inner diameter of 1.5–1.8 cm) are driven 15 cm into the ground. Space the stakes every 50 cm along the length of the chamber. To construct the arched frame of the chamber, bend PVC pipes and insert each end into the bamboo stakes on either side. The tunnel floor is covered with a black polyethylene film (0.15 mm thickness). The edges of the film are turned up and fastened to the tunnel skeleton so it will hold water. Bricks are placed in rows on the floor to hold plant trays above the water line.

A transparent, 0.1-mm-thick, UV-resistant polyethylene sheet is used as the first covering. This serves to maintain a high level of humidity inside the house and to prevent rainwater penetration. Two layers of shade nets, with the silver reflective net being the outermost covering, are placed over this sheet during the healing phase. Fasten the sheet and nets onto the skeleton using plastic clips. The inner door is covered with 60-mesh nylon netting. The outer door is covered with transparent polyethylene.

The use of this tunnel as a grafting chamber is illustrated on page 5 of this guide. The 2.5 x 4.0 m tunnel chamber shown below will accommodate 30 trays (40 x 60 cm), each holding 40 plants using 6.0-cm-diameter pots. Thus, the tunnel chamber capacity is 1,200 seedlings.

*Fig. 4. Photo of grafting chamber*

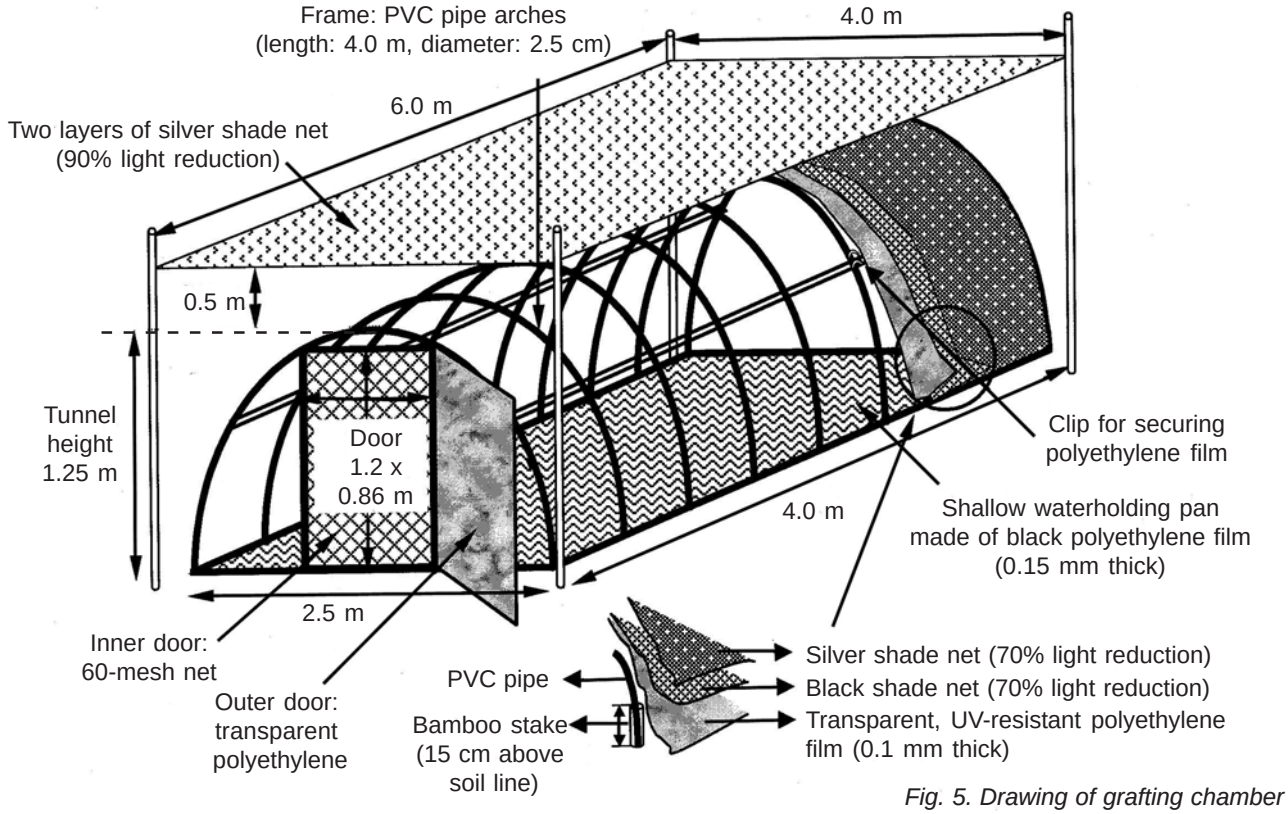


*Fig. 5. Drawing of grafting chamber*

# Growing seedlings for grafting

### *Sowing schedule*

The stem diameters of the rootstock and scion must be similar for successful grafting. The first factor to consider when deciding sowing dates is the germination period. Most fresh market tomato lines germinate in two to three days. Eggplant is more sensitive to temperature, requiring three days to germinate at 28–32°C and six days to germinate at 21–24°C.

The second factor to consider is the growth rate. Seedlings of large-fruited tomato varieties grow faster than eggplant and cherry tomato seedlings.

Taking all factors into account, AVRDC generally sows eggplant seeds three days before sowing seeds of large-fruited tomato scions, and on the same day when sowing seeds of cherry tomato scions. If tomatoes are to be grafted onto tomato rootstocks, seed of the scions and rootstocks are sown on the same day.

Growth rates vary from season to season and variety to variety. Every grower must adjust their sowing dates according to their own specific conditions.

### *Raising seedlings*

Commercial potting mixes are recommended. Their quality, consistency, and freedom from plant pathogens allow for the development of uniform, healthy seedlings.

If commercial mixes are not available, prepare a lightweight, well-drained, pasteurized soil mix. One example is the AVRDC standard mix consisting of field soil, well-decomposed compost, rice husk, and river sand in a 2:3:1:1 ratio. If compost is not available, add 30 g of nitrogen (*e.g.,* 65 g of urea [46% N]) per 100 liters of soil mix for tomato seedlings, or 50 g of nitrogen for eggplant seedlings. Cover seeds with a fine compost to prevent crusting if a field soil mix is used.

Rootstock seedlings. These are grown in individual pots (6 cm in diameter). Sow two seeds per pot and thin to one seedling.

Scion seedlings. These are raised in individual pots or in open flats. If using open flats, space seeds at least 4 cm apart to prevent seedlings from becoming tall and spindly.

Seedlings may be grafted after developing 2 to 3 true leaves. Their stem diameter should be 1.6–1.8 mm at the point of excision. This stage of development typically requires 14 to16 days.

# Grafting and managing seedlings

This section illustrates how to graft tomato scions onto eggplant rootstocks. Similar procedures are used to graft tomato scions onto tomato rootstocks.

1. Your tomato scion and eggplant rootstock stems must be the same diameter, 1.6–1.8 mm. To achieve this, sow the eggplant approximately three days before the tomato. For more information, see section on Sowing Schedule.

2. Cut the eggplant above the cotyledons at a 30° angle. Start the cut as high on the stem as possible.

3. Cut the tomato stem at a 30° angle, slightly above the cotyledons or first true leaf. It is critical that the tomato scion diameter matches the eggplant stem diameter. Select a place on the stem to cut the tomato scion to achieve the proper diameter.

4. Slide a 10-mm-long latex tube (2.0-mm-inner diameter and cut at a 30° angle) over the scion stem. Make sure that the cut angles of the tube and scion are parallel. Push the scion about halfway into the tube (you must leave room in the tube for the rootstock stem).

5. Slide the scion (now fitted with the latex tube) over the eggplant seedling stem. Again, make sure that the cut angles of the tube and rootstock stem are parallel.

6. Gently push the scion and rootstock together. If you have kept all of the cuts parallel, then you can be certain that the scion and rootstock are in complete contact with one another. The tube will stay on the seedling until it naturally hardens, splits, and falls off in the field.

7. Move the grafted seedlings immediately into the shaded chamber. Recommended temperatures are 25–32°C. Keep a shallow layer of water in the polyethylene floor liner and keep the doors closed to maintain high humidity (>85% RH). Place seedling trays on bricks to support the plants above the water line. The grafted seedlings may wilt initially but will become upright within three days.

8. Four to five days after grafting, begin the hardening process by peeling away the top (silver) layer of shade net material. Drain the water out of the floor pan. Open the chamber's plastic-covered door, but keep the screen door closed to prevent insect infestation. Maintain these conditions for two to three days.

9. Move the grafted plants out of the chamber and place them into a screenhouse. Nine days after grafting, apply a foliar application of 0.3–0.4% urea solution, or 1 g per liter of BASF foliar Nitrophoska (20N–19$P_2O_5$–19$K_2O$), or the equivalent of a similar soluble fertilizer. Hold the plants in the screenhouse for seven to eight days for further development and hardening. The entire process takes 30 to 33 days from sowing.

# Field management

The field management of grafted plants is generally similar to the management of non-grafted plants. However, a few specific practices for off-season production should be noted:

### *Raised beds and shelters*

Since grafted plants are recommended only during the hot-wet season, raised beds are highly recommended to minimize flooding. Clear polyethylene-covered rain shelters can be used to shield plants from direct impact of heavy rainfall and provide some shading (Fig. 6). Rain shelters have been shown to increase summer yields when used in combination with grafted plants.

*Fig. 6. Tomato crop grown under shelter.*

### *Transplanting depth*

The graft union must be kept above the soil line (Fig. 7). The closer the graft union is to the soil line, the more likely adventitious roots from the scion will develop and grow into the soil. If this occurs, disease can bypass the resistant rootstock and may lead to infection and death of the entire plant.

*Fig. 7. Transplant set with graft union above soil.*

### *Sucker and adventitious root removal*

Remove suckers that develop on the eggplant rootstocks near the cotyledons. Remove adventitious roots that develop on the scion before they reach the soil. To prevent infection from soil-borne diseases, the scion tissue must not come into contact with the soil.

### *Staking and pruning*

Grafted plants should be staked two to three weeks after transplanting. Indeterminate tomatoes should be pruned so as to allow two main stems to develop. It is very important that plants be tied securely to stakes. This will prevent vines from sliding down and the scion stem contacting the soil.

### *Pest management*

Diseases and insects can ruin a crop. Common diseases during the hot-wet season include early blight, southern blight, black leaf mold, gray leaf spot, bacterial spot, and tomato leaf curl virus. Commonly observed insects are tomato fruitworm, tobacco cutworm, beet armyworm, and leaf miner. Monitor your crops closely and take appropriate control measures.

### *Water management*

Plants with eggplant rootstocks require higher soil moisture than non-grafted tomato plants. Adjust your irrigation accordingly. Tomatoes on eggplant rootstocks are more likely to develop blossom end rot; this can be minimized by maintaining high soil moisture.

### *Fruit setting*

High temperatures during the off-season can reduce fruit yields. The use of heat-tolerant varieties plus applications of a commercial fruit-set hormone such as Tomatotone or Tomatolan are recommended.

For more information on growing tomatoes, consult AVRDC International Cooperators' Guides: *Suggested Cultural Practices for Tomato*, and *Pruning and Staking Tomatoes.*