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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 tomatoes 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 (Figure 1).

Figure 1. Tomato plants stressed by flooding during the rainy season. Grafted plants (right row) are vigorously growing while non-grafted plants (left row) are dying.

Selecting rootstocks

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. The lines should also be resistant to bacterial wilt *(Ralstonia solanacearum)* and other soil-borne diseases.

Currently, AVRDC recommends the eggplant variety Surya (EG203) from India. It is resistant to damage caused by flooding, bacterial wilt, rootknot nematode, and tomato fusarium wilt; with some tolerance to southern blight.

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. Currently, 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 needed to produce grafted seedlings. A ***screenhouse*** (Figure 2) is used to grow seedlings in preparation for grafting and for hardening of grafted plants prior to transplanting. Immediately after grafting, a ***grafting chamber*** (Figures 3 and 4) is used for about one week to provide high humidity and reduced light during development of the graft union. The tunnel-type chamber (Figure 3) can be built at low cost and is recommended for small-scale farmers. The controlled environment chamber (Figure 4) uses greater automation to maintain ideal conditions for healing. This chamber is recommended for growers interested in raising grafted seedlings as a business.

Figure 2.
Screenhouse

Figure 3.
Tunnel-type grafting chamber

Photo of exterior of chamber

Figure 4.
Controlled environment grafting chamber

Screenhouse

The screenhouse (Figures 2 and 5) should be constructed of 60-mesh nylon netting to exclude virus-transmitting insects such as aphids and whiteflies (standard 32-mesh is not adequate for 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 with chemical sprays.

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 2-3 days after being returned from the tunnel-type 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.

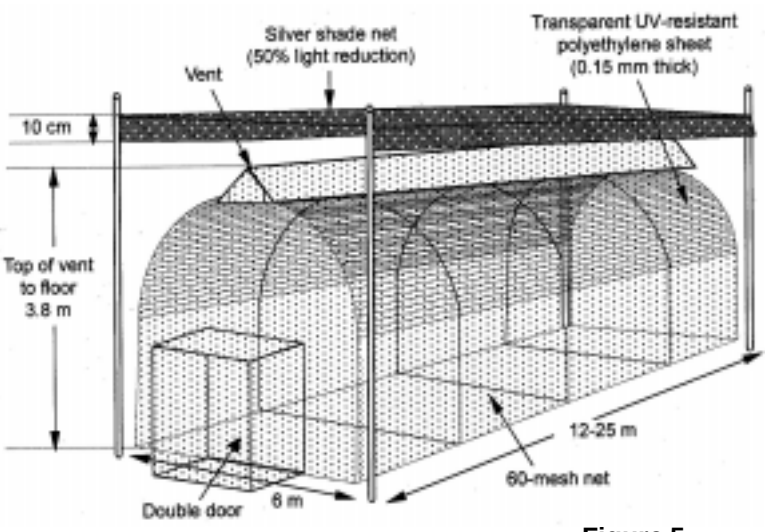

Figure 5.
Screenhouse

Tunnel-Type Grafting Chamber

This inexpensive facility (Figures 3 and 6) is designed to maintain high humidity and reduced 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 net further reduces light penetration and allows good air circulation to minimize heat build-up. Light intensity can be controlled as needed by addition or removal of shade nets.

Select a flat site that is elevated and not subject to flooding. Bamboo stakes or pipes (30 cm in length, inside 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 net. The outer door is covered with transparent polyethylene.

The use of this tunnel as a grafting chamber is illustrated on page 7 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.

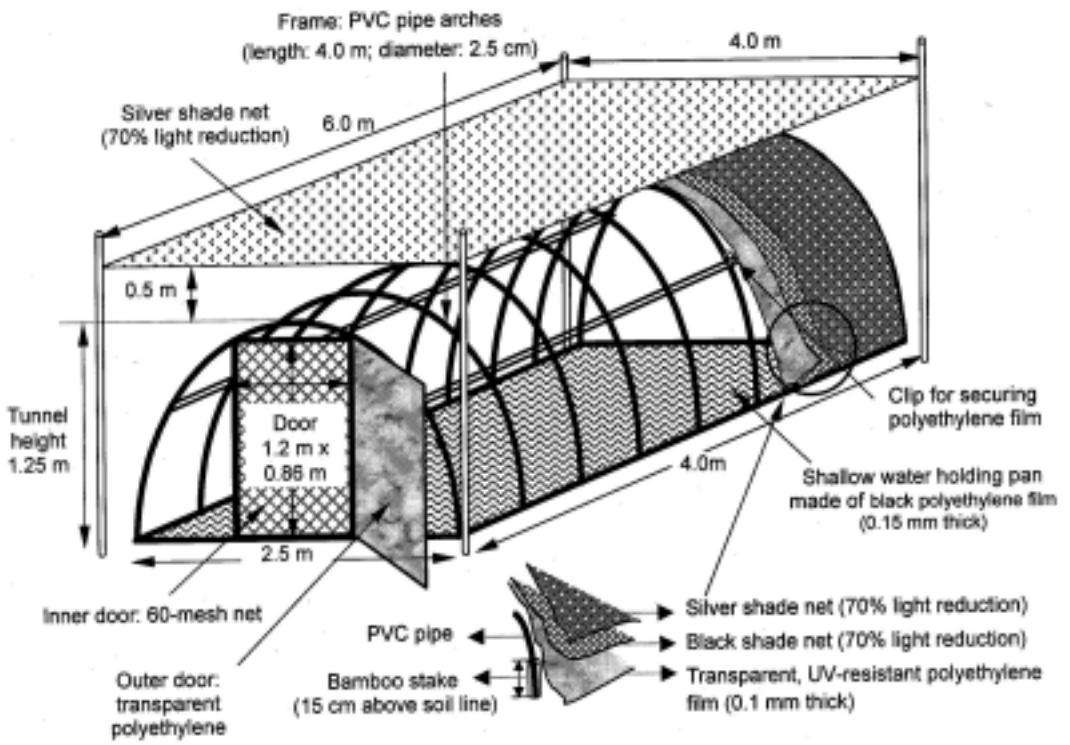

Figure 6. Tunnel-type grafting chamber

Controlled Environment Grafting Chamber

This specialized grafting chamber is a permanent structure built of cement blocks (Figures 4 and 7). The chamber uses an electric automated system to achieve optimal conditions during the healing period of the graft union. Relative humidity, light intensity, and temperature can be controlled.

The key advantage of this chamber is that it maintains constant light, temperature, and humidity regardless of the outside weather conditions. This, in turn, maximizes the rate of successful graft unions. Success rates exceeding 95% are regularly achieved. This level of success is important for businesses seeking to become reliable sources of grafted seedlings for farmers.

The 2.6 x 4.5 m pilot model illustrated can conveniently accommodate 60 trays (40 x 60 cm), each holding 40 plants in 6.0 cm diameter pots. Thus, the chamber capacity is 2,400 seedlings. Seedlings are kept 5 days after grafting, therefore about 12,000 seedlings per month could be produced in this size of chamber.

Detailed blueprints of this chamber are available on request or from the AVRDC web site: <http://www.avrdc.org.tw>

Figure 4. Interior of chamber. Features include fluorescent and incandescent lighting, mist blower, and air conditioner.

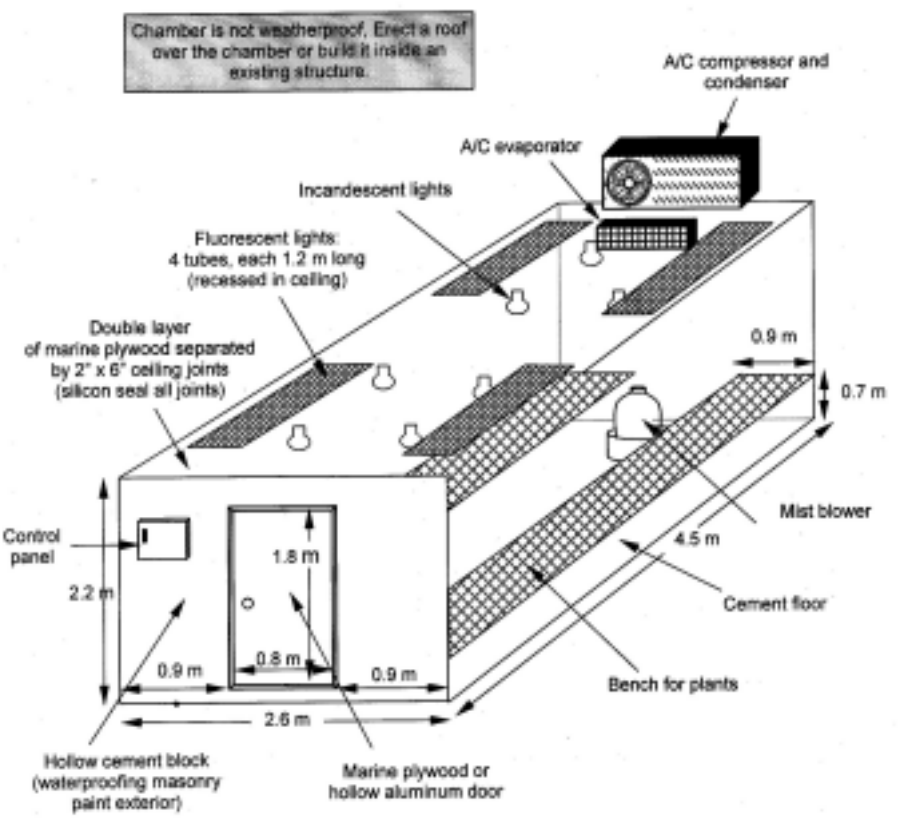

Figure 7. Controlled environment grafting chamber

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 2-3 days. Eggplant is more sensitive to temperature, requiring 3 days to germinate at 28-32ºC and 6 days to germinate at 21-24ºC.

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

Taking all factors into account, AVRDC generally sows eggplant seeds 3 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 and consistency allows for the development of uniform, healthy seedlings.

If commercial mixes are not available, prepare a lightweight, well-drained soil mix. One example is the AVRDC standard mix consisting of field soil (from a paddy field), compost (from sugar mill residue or mushroom production waste), 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 46-0-0 urea) 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 diameter). Sow two seeds per pot and thin to one seedling.

Scion seedlings. These seedlings may be 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 2-3 true leaves. Their stem diameter should be 1-6-1.8 mm at the point of excision. This stage of development typically requires 14-16 days.

Should I always grow grafted tomatoes?

No! Grafted tomatoes should be grown **only** when there is a risk of either flooding, rootknot nematode, or soil-borne diseases such as bacterial wilt or fursarium wilt. Consider the following advantages and disadvantages to using grafted or non-grafted plants:

Tomato grafted onto eggplant rootstock:
Advantages: Resistance to flooding, rootknot nematode and soil-borne diseases.
Disadvantages: Reduced yield potential. Later maturity. Higher risk of blossom end rot.

Tomato grafted onto tomato rootstock:
Advantages: Resistance to rootknot nematode and soil-borne diseases. No loss in yield potential or delay in maturity.
Disadvantages: No resistance to flooding.

Nongrafted tomato:
Advantages: Lower costs in transplant production. Larger fruits.
Disadvantages: No resistance to flooding. Variety may not have resistance to rootknot nematode or soil-borne diseases.

Grafting Procedure

The following photos illustrate the grafting of tomato scions onto eggplant rootstocks. Similar procedures are used when grafting tomato onto tomato. *For your convenience, this page has been developed into a waterproof laminated sheet. The sheet can be posted wherever grafting procedures are done. If not included with this guide, please contact AVRDC for a copy.*

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 3 days before the tomato. For more information, see section on Sowing Schedule.

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

3. Cut the tomato stem at a 30º angle, either slightly above or below the cotyledons. 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 length of latex tube (2.0 mm inner diameter) 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.

Management of Grafted Seedlings

Tunnel-Type Grafting Chamber

1. Move the grafted seedlings immediately into the shaded chamber. Recommended temperatures are 25-32ºC. Fill the floor with water and keep the doors closed to maintain high humidity (>85%). The trays are placed on bricks to support the plants above the water line. The grafted seedlings may wilt initially, but will become upright again within 3 days.

2. Six days after grafting, begin the hardening process by peeling away the top 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 3 days.

3. Nine days after grafting, apply a foliar application of 0.3-0.4% urea solution, or 1 gram per liter of BASF foliar Nitrophoska (20-19-19), or the equivalent of a similar soluble fertilizer. Move the grafted plants out of the chamber and place them into a screenhouse. Provide supplemental shading for the first two days. Hold the plants in the screenhouse for 7-8 days for further development and hardening. The entire process takes 30-33 days from sowing.

Controlled-Environment Grafting Chamber

Photo of moving plants into chamber

1. Move the newly-grafted seedlings immediately into the chamber. Grow the plants under continuous lighting and at 28ºC. During the first 24 hours, reduce the light intensity 50% by turning off half the bulbs; then return to full lighting. Maintain relative humidity at 90% for the first 3 days, then drop to 80% for the 4th day, then to 70% for the 5th day.

2. On the 6th day, move the grafted seedlings into the screenhouse. No supplemental shading is necessary. Apply a foliar fertilizer and hold the seedlings 7-8 days before transplanting. The entire process takes 26-29 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

Grafted plants are recommended for the hot, wet season, therefore raised beds are highly recommended to minimize flooding. Additionally, the use of protective plastic-covered shelters to reduce direct impact of heavy rainfall and to provide some shading have been shown to increase summer yields when used in combination with grafted plants (Figure 8).

Photo

Figure 8. Tomato crop grown under shelter.

Transplanting depth

The graft union must be kept above the soil line (Figure 9). 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.

Figure 9. 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 2-3 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, and bacterial spot. The 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.*