



### Grafting Techniques for Tomato and Pepper Production

Somchit Pruangwitayaun 17 October 2017

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### Outline

- Introduction
- Grafting options
- eggplant/tomato rootstocks
- Facilities
- Growing seedlings
- Grafting and managing seedlings
- Field management
- Practical
- Field visit



#### Introduction

- Tomatoes and peppers 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.
- Likewise, grafting resistant chili rootstocks onto sweet pepper scions can also reduce similar problems.



### Why Grafting

- Control soil-borne disease.
- Provide flood-sensitive vegetable crops ability to tolerate water logging.
- Increase plant survival after flooding due to heavy rainfall.
- Extend harvest period after high rainfall.



#### **Grafting options**

 Grafted tomatoes are more expensive than non-grafted tomatoes and should be grown only when there is a risk of either flooding, root-knot nematode, or soilborne 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.



### Eggplant rootstocks

- WorldVeg 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 observation 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.
- WorldVeg Center recommends tomato line Hawaii 7996 because it has a high level of resistance to bacterial wilt and fusarium wilt.



#### **Facilities**

Two types of facilities are generally needed to produce grafted seedlings.

- A screenhouse is used for growing seedlings prior to grafting and for hardening of grafted plants prior to transplanting.
- Immediately after grafting, a grafting chamber is used for about one week to provide high humidity (>85%),reduced light intensity and Temperature 25-30°C during development of the graft union.
- The chamber can be built at low cost and is recommended for small scale farmers or community nurseries.



### **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.









## Healing of grafted plant By "VNR - method" covering of tunnel with cotton cloth, instead of plastic sheet.





#### Picture from vnrseeds.com



# Grafting chamber for healing process at Yu chia Nursery, Taiwan





#### **Simple Grafting Chambers**



High Moisture Incubation Conditions Are Highly Recommended for Post-Graft Care (a) in the Field and (B) in the Greenhouse.





Mr. Santika, the owner of a vegetable nursery in Tabanan district, Bali, Indonesia utilized a glass display case as his first modified grafting chamber to facilitate the healing process of grafted tomato seedlings.

Picture and information from FEEDBACK from the field (issue 25)



Mr. Santika's second innovation was to build a walk-in chamber with larger capacity (left); grafted tomato plants are placed in the plastic grafting chamber during the healing process (right)



Picture and information from FEEDBACK from the field (issue 25)



#### **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.



#### Sowing schedule

- WorldVeg Center 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 WorldVeg 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.



### **Raising seedlings**

- **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.



#### How to graft tomato to eggplant





#### Field management

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



#### **Raised beds and shelters**

- 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.
- Rain shelters have been shown to increase summer yields when used in combination with grafted plants.



#### Tomato crop grown under shelter





#### 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.



#### Suckers on the eggplant rootstocks





## Remove adventitious roots that develop on the scion before they reach 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 and 4-CPA (Chlorophenoxy acetic acid) 25 -50 ppm are recommended.

#### Comparison of grafting techniques using chili scion and wild eggplant rootstock

Mohamad Zahirudin Abu Bakar, Junizawati Mohd Zin (Malaysia), Thong Tri Nguyen, Linh Thi Mong Lam (Vietnam), Hazrat Gulab and Sediqullah Roghman (Afghanistan) and Aung Myo Thant (Myanmar)

#### Introduction

Chili (*Capsicum annuum* L.) is an economically important vegetable crop. It is cultivated in wide areas throughout the world. A major constraint limiting yield and production of pepper during the hot-wet season in the lowland tropics is the high incidence of soil-borne diseases such as bacterial wilt (*Ralstonia solanacearum*) and phytophthora blight (*Phythopthora capsici*). Thus, there is a need to reduce the damaging effects of soil borne diseases on the yield of chili during the hot-wet season.

Grafting presents is a sustainable means of reducing loss from soil borne diseases as well as flooding. Grafting allows for the use of resistant rootstocks, where the main crop is grafted onto. A key factor in the success of grafting requires that the vascular cambium tissues of the stock and scion must be contact with each other.



**Fig 1**. Wild eggplant rootstocks, a) the climbing type, and b) straight type.



#### **Objectives**

To determine a suitable grafting technique for chili (scion) and eggplant (rootstock) by comparing cleft, approach and tube grafting techniques.

#### Materials and methods

The experiment was conducted at the AVRDC – Asian Regional Center from November to December, 2009. Two types (climbing stem and straight stem as shown in Fig. 1) of wild eggplant rootstocks (*Solanum trilobatum Linn, common Thai name Ma-Waeng*), and a commercial chili variety were used in the study. They were sown on September 7' 2009 and October 2' 2009 respectively. Three different grafting techniques namely 1) cleft grafting, 2) approach grafting and 3) tube grafting were compared (Fig. 2). Data on plant height (cm) and percentage of seedling survival (%) were gathered.

Fig 2. Grafting methods, 1)cleft, 2) approach and 3) tube grafting



Percentage survival rate (%) and plant height (cm) of chili scion grafted onto the wild climbing and straight eggplant (Solanum trilobatum L.) rootstock.

Root- stocks	Treatments	% survival <sup>1</sup>	Plant height <sup>1</sup> (cm)	% survival <sup>2</sup>	Plant height <sup>2</sup> (cm)
Climbing stem	Cleft grafting	100	8.3	20	9.5
	Approach grafting	20	10.5	20	11.5
	Tube grafting	100	11.9	60	12.5
Straight stem	Cleft grafting	100	6.7	0	0
	Approach grafting	20	13.8	20	14.0
	Tube grafting	100	7.7	60	6.7

1= percent survival at transplanting date, 2= percent survival one week after transplanting

#### **Results and discussion**

At transplanting date, the grafted plants shown 100% survival for cleft and tube grafting, and for both climbing and straight stems. A low survival rate (20%) was observed was the plants where approach technique was used. However, after one weeks, the number of surviving plants under both cleft and approach grafting drastically decreased (0-20% survival rate). The low survival rate is attributed to the poor contact of the cambium tissues between the scions and the root stocks. This has led to the poor translocation of nutrients to the scions. Out of the three methods compared, the best results were recorded from tube grafted plants. The higher survival rate is also attributed to the ease of employing tube method as it is relatively easier to execute compared to approach and cleft grafting. It only requires a single cut on the scion and rootstock, at the same angle of the stem, and are locked securely with a flexible rubber tube. On the other hand, although poor survival was observed under approach method, plant height was observed to be better than the other methods. This can be attributed to the least disruption of the vascular system of both scion and rootstock.

#### **Conclusion and recommendation**

Results of study indicate that higher survival rate can be achieved via tube method in grafting chili onto eggplant. The higher survival rate is attributed to the ease of using the technique as well as the efficiency of "locking" the scion and rootstock using the flexible rubber tube. It is recommended that the effect of the three grafting methods on the yield of chili, as well as their resilience or susceptibility to soil borne diseases be further evaluated.

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#### http://www.vegetablegrafting.org/



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