

Healing Chamber for Grafted Vegetable Seedlings in Florida¹

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Grafting is a horticultural technology that combines two plants, the scion and the rootstock, to create a plant with desirable features from both parts (Ozores-Hampton, Vavrina, and Frasca 2012; Zhao and Simonne 2008). While the scion will produce fruit with the desired characteristics, the rootstock will provide resistance against soil-borne diseases and/or nematodes. In the 1920s, Japan and Korea started the commercial use of vegetable grafting to enable watermelon production in areas with high-Fusarium wilt pressure (Kubota et al. 2008; Zhao and Simonne 2008). In addition to providing disease and nematode resistance, grafting can improve the plant's ability to tolerate environmental stress and increase its fruit quality and yield (Kubota et al. 2008; Lee et al. 2010). Vegetable grafting has been successfully performed in crops such as eggplants, tomatoes, peppers, watermelons, cucumbers, and melons (Zhao and Simonne 2008). In the United States, however, the use of vegetable grafting in field production remains limited. According to Lee et al. (2010), very little or no grafting has been reported for field-cultivated tomatoes in the United States, whereas 70% of the nation's total hydroponic greenhouse tomato area (approximately 815 acres) uses grafted seedlings.

Several factors may contribute to the success of grafting, such as genetic compatibility, similar stem diameters of the scion and the rootstock, and the healing of newly grafted plants in proper environmental conditions (Kleinhenz

2011). During the healing process, the scion and the rootstock must establish vascular connection, which is considered the most critical process in the production of vegetable grafted transplants. The complete vascular connection establishment takes approximately five to eight days, during which the scion is unable to uptake water through the rootstock (Johnson, Kreider, and Miles 2011a). Therefore, reducing scion transpiration is crucial for the grafting survival (Johnson and Miles 2011). In order to reduce scion water loss to the surrounding environment, the air relative humidity (RH) should be high, ranging from 85% to 100%. Large, commercial grafting operations use controlled-environment growth chambers to maintain high RH; however, the high cost limits their use in most small-scale grafting operations (Hassell, Memmot, and Liere 2008; Johnson and Miles 2011). As an alternative solution that provides proper healing at a lower cost, growers and researchers have been using small- to medium-sized covered structures called healing chambers (Johnson and Miles 2011).

Healing Chamber Environmental Conditions

The size and design of healing chambers will vary depending on the production scale. Healing chambers can be small, such as plastic bags that wrap a few potted seedlings at a time for a home gardener, or they can be larger

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structures within a commercial greenhouse. Regardless of the chambers' size, they must provide suitable environmental conditions to ensure a fast and successful graft union.

Relative humidity: Relative humidity must be maintained between 85% and 100%. However, several studies reported the optimum to be 95% or higher (Lee 2007; Oda 2007). High RH decreases the scion's transpiration rate, which prevents it from drying out (Johnson, Kreider, and Miles 2011a). Humidifiers may be used in climates where the air RH is not very high to ensure the humidity inside the chamber will not decrease because of evaporation to the outside environment. In Florida, however, monthly average RH ranges from 72% to 84% throughout the year, making the use of a humidifier not required (Figure 1). Furthermore, under Florida conditions constant humidification may lead to disease occurrence because of excess free water and consequent loss of the grafted plants. Instead, misting on the healing chamber's surfaces is more preferred than constant humidification (Hassel, Memmot, and Liere 2008). It is critical for the grafting success that the RH inside the healing chamber is 95% throughout the entire healing process, with special attention to the first hours after the grafted plants are placed inside.

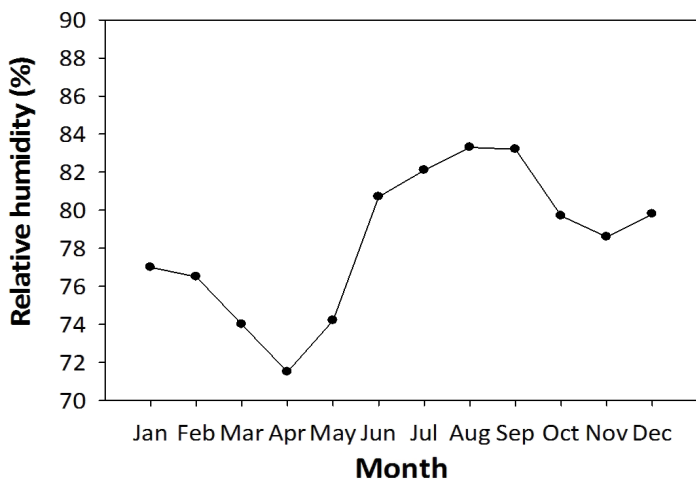


Figure 1. Monthly average air relative humidity during a 10-year period (2002–2012) for southwest Florida
Credits: Florida Automated Weather Network (FAWN)

Temperature: The temperature inside the healing chamber should range between 77°F to 86°F (Lee 2007; Oda 2007). Cell division is stimulated under this temperature range, which is fundamental for the healing process (Lee 2007). Note that temperature inside the healing chamber may be a few degrees higher than outside.

Light intensity: Within the first 24 to 48 hours, grafted plants should be under low-light intensity conditions (Johnson, Kreider, and Miles 2011b). Low-light intensity aids in minimizing temperature increase (Black et al. 2003).

For warm climates, such as Florida, reducing the light intensity during the entire healing process may be necessary, especially during summer months (Hassel, Memmot, and Liere 2008).

Building a Healing Chamber

Home Gardener

MODEL 1: PLASTIC BAG

One day before the grafting is performed, mist water on the inside surfaces of an appropriate-sized plastic bag, using a hand sprayer, and close it. This practice ensures the RH will reach 95% before the grafted plants are placed inside the bags. After grafting, open the plastic bag, place the potted, grafted seedlings inside, and then immediately close the bag to avoid RH loss (Figure 2). If needed, mist more water inside the bag before placing the plants inside. In order to avoid humidity loss to the outside air, there must be enough space to tighten the bag. Resealable bags can be a convenient option, since they can be tightly closed.



Figure 2. A grafted plant placed inside a resealable bag.
Credits: Monica Ozores-Hampton, UF/IFAS

MODEL 2: PLASTIC CONTAINERS

A plastic container with a lid, such as an empty salad container or a storage box, can be used as a healing chamber (Figure 3). One day before placing the grafted seedlings inside the container, mist water on the container walls, and close the lid to raise the RH. If needed, reapply water before placing the grafted plants inside. Then, place the pots inside the container, and immediately close the lid to avoid loss of RH.



Figure 3. Grafted plants inside salad container.
Credits: Monica Ozores-Hampton, UF/IFAS

MODEL 3: GLASS AQUARIUM

An empty glass aquarium can provide the ideal environmental conditions for a healing chamber (Figure 4). One day before the grafting is performed, use a hand sprayer to mist water on the inside surfaces of the aquarium walls, and close it to raise the RH. Place the seedlings inside the aquarium, and close the lid. If an aquarium lid is not available, place the aquarium upside down over the seedlings.



Figure 4. An upside-down aquarium used as a healing chamber.
Credits: Monica Ozores-Hampton, UF/IFAS

Medium-Sized Grafting Propagators

MODEL 4: FRAMED AND COVERED STRUCTURES

A set of plastic storage boxes can be used if the box is large enough to hold a transplant tray. It may become expensive, however, to have a large quantity of boxes, as the number of graftings being produced at a time increases. Alternatively, a small chamber can be built using polyvinyl chloride (PVC) pipes as the frame, a plastic tray as the bottom, and a plastic cover to maintain high RH (Figure 5). To make the transplant tray's management and RH maintenance easier,

the structure's height should not be more than three feet and its width and length should not be more than five feet (Johnson, Kreider, and Miles 2011a). One day before the grafting is performed, use a hand sprayer to mist water on the inside surfaces, pour water in the bottom, and close it to increase RH. The trays must be placed above the water level to avoid water saturation in the media.

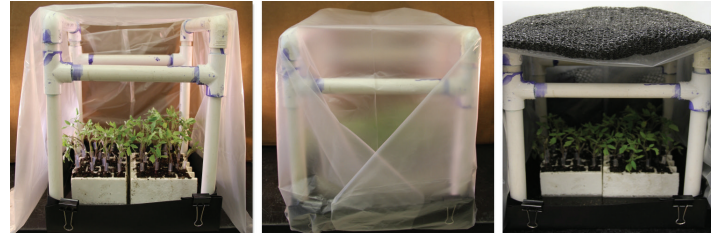


Figure 5. Healing chamber built with PVC pipes, plastic, and binder clips. From the left: open chamber, closed with plastic, and covered with shade cloth.
Credits: Monica Ozores-Hampton, UF/IFAS

Commercial Grafting Greenhouses

MODEL 5: TRANSPLANT TRAY BENCHES OR ELEVATED POOLS

For a large-scale grafting operation, healing chambers can be built inside a separate area of the greenhouse or over the transplant tray benches. Wood or PVC pipes can be used to build the chamber's frames and plastic can cover the structure (Figure 6). A pool of water can be maintained below the structure to provide high RH, eliminating the need to spray the surfaces of the chambers. The trays must be placed above the water level to avoid water saturation in the media. One day before grafting is performed, fill the water pool in the bottom of the chamber, and then close it to increase RH.



Figure 6. A wood-framed healing chamber, which would be found in a large-scale grafting operation.
Credits: Joel Mendez, UF/IFAS

The Grafting Union Healing Process

1. Approximately one day before grafting is performed, mist the surfaces of the healing chamber (side, top, and bottom) with water until they are wet (Johnson, Kreider, and Miles 2011b) or fill the bottom of the pool with water. Close the chamber tightly to avoid water evaporation to the outside environment.
2. Once grafting has been completed, open the chamber, and reapply water on the surfaces, if necessary.
3. Immediately place the grafted seedlings inside the healing chamber and tightly seal/close it to avoid water evaporation.
4. During the first 24 to 48 hours, use a shade cloth, dark-colored plastic, or newspaper to protect the graftings from direct sunlight. Provide shading for the entire healing period to minimize temperature increases during summer months in Florida.
5. For the next four days after grafting, avoid opening the healing chamber and/or disturbing the graftings. If misting or watering inside the chamber is necessary to replace evaporated water, open it, mist the walls or fill the pool, and close it again. Avoid spraying directly on the grafted plants to prevent disease development in the grafting union (Johnson, Kreider, and Miles 2011b).
6. On the fifth day, plants need to be acclimated to conditions outside the healing chamber. Thus on this day, open the healing chamber for about 30 minutes, mist the healing chamber surfaces, if necessary, and close it once again (Johnson, Kreider, and Miles 2011b).
7. On the sixth day, open the chamber for two to four hours, mist the healing chamber, if needed, and close it once again. Plants can be removed from the healing chamber on the seventh day. During the next two days, avoid direct sunlight on the grafted plants to acclimate them to the environment outside the chamber. If wilting occurs after the grafted plants are out of the healing chamber, place them back inside for one more day (Johnson, Kreider, and Miles 2011b).

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