

A Guide to GRAFTING TOMATOES: CORNELL'S TIPS FOR SUCCESS

Grafting can benefit your production in many ways, such as improving yields and increasing disease resistance. Follow these guidelines, which have been achieved through years of trial and error, and see your profits grow.

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Grafting is an age-old process of connecting the vascular tissues of two distinct plants. The aim of grafting is to combine and utilize beneficial traits of both the rootstock plant and the scion plant (the top plant that yields fruit). While the grafting of woody plants and vines such as apples and grapes has been common for years, grafting of herbaceous plants such as tomatoes and melons has only recently become popular. Today, grafting of herbaceous vegetable plants is widely used in intensive greenhouse and tunnel production systems.

In the United States, tomatoes are the most common crop grown under protection in greenhouses and high tunnels and their production in these systems has benefited enormously from grafting. The grafting of tomato rootstocks — which are chosen for their disease resistance, stress tolerance or root system characteristics such as vigorous vegetative growth — with tomato scions — which are chosen for their desirable fruit characteristics — has many benefits to tomato growers. Grafted tomatoes typically have higher yields, produce for a longer time, have increased disease resistance and may require less pesticides.

For large commercial growers, rootstock and scion seed will be selected and sent to a propagation company who will grow the seedlings, complete the grafting process, and then send the grafted plants to the grower. Although this is an expensive process, it is ultimately much cheaper than the time, labor, space and equipment it would take to graft the plants needed for their operation. However, for smaller operations, home growers or research facilities, it can be useful to graft your own plants to save money and allow for more control (such as limiting potential pests, diseases or viruses that could enter from an outside facility).

If a grower decides to graft their own tomato plants, it is first critical that they have a good understanding of the grafting process. It takes time and practice to become skilled at grafting. The following guide details the tomato grafting process developed over years of trial and error from researchers and students in Cornell University's Controlled Environment Agriculture group. Included are also a few helpful tips that the Cornell team has learned along the way.

To begin, the grafting process can be split into three distinct phases:

1. Pre-grafting/seedling growth
2. Grafting
3. Post-grafting/healing

PHASE 1: PRE-GRAFT/SEEDLING GROWTH

The first step in the pre-graft/seedling growth phase is choosing the rootstock and scion cultivars. The most common rootstock cultivar used in commercial tomato production is 'Maxifort.' While some growers may choose to use one rootstock cultivar for large fruit scions and another for small fruit scions, in commercial practice 'Maxifort', or one of its many genetic successors, is used with practically all scion cultivars. 'Maxifort' is so widely used because it has vigorous vegetative growth and has resistance to many common diseases. However, other rootstock varieties such as 'Estamino' or 'Beaufort' are also popular among growers. For scion cultivars, 'Merlice' is a common tomato-on-vine (TOV) variety, as it has consistent fruit and growth, high yields and resistance to powdery mildew. 'Sweetelle', a popular and flavorful grape tomato variety, is another commonly used scion.

Once the cultivars are selected, the seeds should be sown into a 98-cube rockwool sheet (alternatively seeds can be sown in other soilless media cells) that has first been soaked with tap water for 10 minutes. The rockwool sheet should then be placed in a growth chamber or a different climate-controlled room. Temperature in the chamber should be maintained at 73° F/68° F (day/night) and light should be provided at 260 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ for 16 hours/day leading to a daily light integral of 15 $\text{mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$. Plants should be watered every two days with a complete nutrient solution at

100-ppm nitrogen, until the grafting date which is about 20 days after sowing the scion cultivar (Figure 1).



Figure 1. A tray of rootstock (left) and scion (right) seedlings before the grafting process has begun.

Tip #1: Start with good seed. Poor quality seed can lead to bad germination, increased risk of disease and inconsistent seedling growth — all of which will make grafting much more difficult.

Tip #2: Always run a small trial before using a cultivar for the first time. Sowing a few seeds and growing them to grafting size can help to determine the cultivar's germination rate, growth rate and consistency.

Tip #3: Seed the rootstock variety two days after the scion variety. Rootstock cultivars have vigorous growth and, therefore, grow faster and reach sufficient stem diameter for grafting earlier than scion varieties.

PHASE 2: GRAFTING

Twenty days after sowing the scion cultivar the seedlings of both the scion plants and rootstock plants should have a stem diameter of approximately 2 mm (although there will likely be some variation) and are now ready to graft. While it is possible to graft older plants, younger plants heal faster and have a higher likelihood of surviving.

The first step in the grafting phase is to choose a scion plant and a rootstock plant with compatible stem diameters (Figure 2). It is important to graft plants with very similar stem diameters to achieve the best success. Stem diameter measurements should be taken below the cotyledons for both the scion and rootstock plants.

Figure 2. A rootstock (left) and scion (right) seedling with compatible stem diameters for grafting.

The next step is to cut the rootstock below the cotyledons (Figure 3). Cutting below the cotyledons eliminates advantageous shoots from growing out of the rootstock. The cut can be done using a razor blade at a 45- to 60-degree angle with a deeper angle allowing

for greater surface for the graft to take hold. Then, a transparent silicon channel grafting clip should be slipped onto the freshly cut rootstock stem so that the top half of the channel is left empty (Figure 4). Next, the scion seedling should be cut at the same angle as the

rootstock seedling was cut (Figure 5). The top part of the grafting clip should then be pulled open slightly so the scion stem can slip in. The cut surfaces of the two stems should now be in perfect contact with each other with no gap between them (Figure 6).



Figure 3. A rootstock seedling cut below the cotyledon.

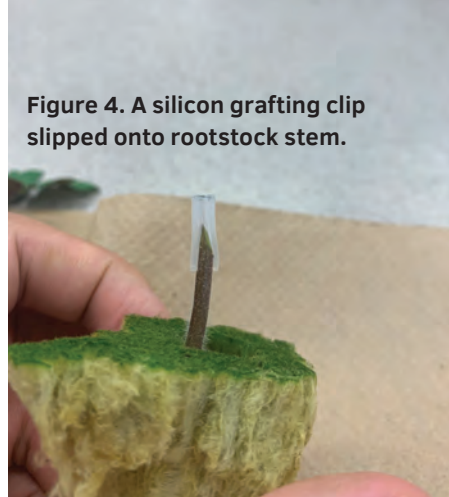


Figure 4. A silicon grafting clip slipped onto rootstock stem.



Figure 5. A cut scion seedling before it is slipped into grafting clip.



Figure 6. A rootstock and scion stem in perfect contact.

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Tip #4: Choosing a transparent grafting clip that is slightly smaller than the seedling stem diameter will allow for the union to be tight and will give more visibility to the grafted area.

Tip #5: When making the cuts, it is important to use a sharp surface such as a new razor blade, recently sharpened knife, or new grafting blade placed on a grafting tool. Grafting tools are commercially available and help to ensure perfectly uniform cut angles.

PHASE 3: POST-GRAFTING/ HEALING

With the graft operation complete, the next steps are to prepare the plants for healing. The goal is to at first keep the newly grafted plants at near 100% humidity with low light. As the union heals, the plants will slowly be acclimated to lower humidity and higher light conditions.

To begin, the grafted plants should be placed onto a tray with drainage holes (Figure 7). A second tray, without drainage holes, should have a small amount of water poured into it, but not enough to go above the ridges in the bottom of the tray (Figure 8). The small amount of water in this tray will be a source of humidity and will allow the grafted plants to have nearly 100% humidity during the healing process. If the water does reach the rockwool cubes then the water will be wicked up, transpiration will occur in the newly grafted plants, and the grafting union will break.

Then, the tray of grafted plants should be placed on top of the

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Figure 7. A tray with drainage holes and grafted plants.



Figure 8. A tray without drainage holes with a small amount of water poured into it.



Figure 9. Grafted plants in trays with humidity domes and plastic wrap placed beneath a bench (and raised off of the floor).

second tray, making sure the water does not reach the bottom of the tray with plants. Next, a clear, plastic humidity dome should be placed over the trays and the dome and trays should be wrapped in plastic wrap to prevent any humidity from escaping. The sealed dome should then be placed under a bench in the same growth chamber where the seedlings were grown (Figure 9).

It is important for the healing plants to have some light, but if the light is too strong it can heat up the leaf surface causing transpiration



Figure 10. Trays of grafted plants post-healing.

GRAFTING PHASE	DAY	ACTION
Pre-grafting/seedling growth phase	Day 1	Seed the scion cultivar
	Day 3	Seed the rootstock cultivar
Grafting phase	Day 21	Graft
Post-grafting/healing phase	Day 25	Cut lateral slits into plastic wrap
	Day 26	Remove the plastic wrap
	Day 27	Crack the humidity dome open
	Day 28	Remove dome, place on bench Transplant into rockwool block or pot
	Day 42	Transplant onto rockwool slab in greenhouse

Table 1. A typical grafting timeline.

and thus breaking the grafting union. By placing the plants under a bench, a portion of the light is filtered out so the healing plants get approximately $60 \mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ for 16 hours/day leading to a daily light integral of $3.5 \text{ mol}\cdot\text{m}^{-2}\cdot\text{d}^{-1}$. A shade cloth could also be hung in the chamber to the same effect.

After the plants have been kept under these conditions for four days, it is time to start acclimating the plants to the outside environment. Four days after grafting, two large lateral slits should be cut into the plastic wrap where the dome and the trays meet to start letting some of the humidity out. One day later, the plastic wrap should be removed and on the next day the humidity dome should be cracked open slightly to continue to acclimate the plants to the outside conditions. On the seventh day after grafting, the humidity dome can be removed and the plants can be moved onto the benches to expose them to higher light levels (Figure 10). The grafting clip will most likely have fallen off by this point, but if it hasn't it should be removed manually.

At this point, the plants should be acclimated to the growth chamber conditions and can now be transplanted into rockwool blocks

or larger pots. Two weeks later, the tomato plants will be ready to be transplanted onto rockwool slabs (or into other soilless media) and brought into the greenhouse or high tunnel.

Tip #6: For larger-scale grafting projects, a climate-controlled chamber with a fogging system that can achieve nearly 100% humidity can be used in place of the humidity domes.

Tip #7: The trays and humidity domes can be reused multiple times; however, it is crucial to thoroughly wash and sanitize them before reusing.

Although the grafting process can take some time and effort to perfect, the team at Cornell reports 95 to 100% success when using these steps. In general, growers can save a lot of money, greatly increase the quality control, and learn a very useful skill by grafting their own tomatoes. [gpn](#)

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