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Grafting desirable fruiting varieties onto rootstocks with a vigorous, disease-resistant root system is a practical method for growers to further maximize their production potential. Not only can grafting help overcome many soilborne diseases, it can improve general plant health and environmental stress tolerance, lengthen harvest duration, and potentially increase the grower's net income. While it's possible to achieve top-grafting success in numerous ways, we offer the following general recommendations, technique, and guidelines to get you started.

### Required Materials

- Rootstock seed (*bottom or base variety*)
- Scion seed (*top or fruiting variety*)
- Growing medium and trays
- Disinfectant, such as Virkon® or a 1:10 bleach solution
- Razor blade or Miter-Cut Grafting Knife
- Silicone top-grafting clips
- Grafting stakes
- Spray bottle
- 7.5" Humidity Domes or healing chamber



The 4 sizes of silicone top-grafting clips Johnny's offers will accommodate stem diameters from as small as 1.5 mm to as large as 3.0 mm. Having various sizes of clips on hand will enable you to accommodate varying plant growth rates.

### CHOOSING THE ROOTSTOCK

Choosing the right rootstock depends on your primary objective for using grafted plants. Whether that is a specific soil disease resistance, a longer-lasting production, or just a general increase in vigor increase, you will want to think about your reasoning for planting grafted plants. They are not a plug-in solution for all situations and they may take extra attention in crop care, especially if you are targeting the second or third objective above. Some rootstocks, such as DRO141TX, have improved germination and seedling habits over others that aid in the efficiency of the actual grafting process, and a few are available as organically certified.

Growing environments and management strategies vary widely from one farm and season to the next, so we recommend experimenting with different rootstocks within your system over multiple years to identify combinations that produce the best, most consistent results.

Rootstocks are known to affect the plant habit of a scion variety. The goal is to choose a rootstock that complements your scion's natural habit and your growing methods. A well-balanced plant will put energy into setting and sizing fruits while continuing to grow a healthy vine for as long as your market demands. Rootstocks are broadly classified into two categories: 1) generative steering; and 2) vegetative steering. The more vigorous rootstocks tend to be more vegetatively steering but these two traits are not entirely linked.

- 1) **Generative rootstocks** are easier to steer generative, meaning they put growing energy into fruit sizing and ripening. They are helpful when over-vegetation is a concern, as is the case when growing
  - a) a highly vegetative scion variety (for example, many heirlooms and small-fruited tomatoes) under high fertility;
  - b) in a mixed-variety greenhouse; or
  - c) in shorter cropping cycles.

- 2) **Vegetative rootstocks** naturally put more of their energy into the leaves and stems, so it can be trickier to balance highly vegetative scions, compared to balancing them with more generative-type scions or even determinate varieties. Vegetative rootstocks are, however, are more likely to provide healthy plants for a longer duration, and are thought to have a higher yield potential, if properly managed.

## PLANT STEERING

A plant that is imbalanced toward a generative state may exhibit a thin, weak head (top of the plant), with developing flower trusses that appear small and curled. You may notice that the vegetative parts of the plant don't seem to be growing very fast. Internodes tend to be shorter, so the top flower cluster is closer to the head. Overly generative plants tend to peter out, as too much energy is going to fruits and not enough to build the vine for future growth and production.

A plant that is overbalanced toward vegetative vigor will tend to have a relatively thick stem at the head that may be oval in shape instead of round. The developing flower cluster stem may be thin and held nearly vertically, instead of arching out from the vine. Overly vegetative plants tend to grow very fast, with longer distances between nodes, so the head is far above the highest truss. Tomato crops tend to start out with high vegetative vigor at the beginning of the season, before there is any fruit load to balance the plant, but it is desirable to balance the crop as soon as possible. A plant that remains overly vegetative may grow large but produce relatively few fruits in proportion to the size of the plant, and the fruits may be slow to ripen. At the end of your season you may want to steer your tomatoes more generatively to finish ripening the last fruits.

Fruit size	Approximate wt. / fruit	Cropping cycle	Rootstock class	Rootstock variety
Large	> 4 oz (100 g)	Long, with hot conditions	Vegetative	#3195 DRO141TX #2700 Maxifort
Large	> 4 oz (100 g)	Short	Generative	#3088G Estamino OG
Small	< 4 oz (100 g)	Any	Generative	#3088G Estamino OG

## PLANTING

Sow seed about 6–8 weeks before your desired transplant date, depending on the temperature and amount of light in your growing and healing areas. The healing process adds 1–2 weeks to the seedling propagation phase compared to non-grafted tomatoes. You need the stem diameters of rootstock and scion to be as closely matched as possible for a strongly healed union, but many varieties germinate and grow at slightly different rates. Sowing multiple successions of both rootstock and scion and overseeding by about 25% of the number of plants you plan to transplant will give you higher chances of success with proper matching and hitting your targeted final plant number. A germination test can help you determine the most appropriate sowing times for each variety. (See right.)

All of our tomato rootstocks are *interspecific crosses*, meaning they are a cross between two different species (cultivated tomato or *Solanum lycopersicum* x a wild tomato species). This wide cross naturally increases hybrid vigor, but also tends to decrease germination rate and uniformity. Proper germination conditions (steady 74°F/23°C, 90% relative humidity, and dark location) can go a long way toward improving germination rate and uniformity of rootstocks. Using a germination chamber, soil probes, moderate moisture, and lukewarm water are additional measures that help. Good germination should occur within 3–5 days of primed rootstock seeds.

### Germination speed test

Prior to sowing your entire seed batch for grafting, sow 10 seeds of each variety you intend to graft, and grow them for 2–3 weeks.

Note the speed of germination and growth of the rootstocks compared to the scions.

You may also want to take note of light, day-night temperatures, relative humidity, and ventilation variables for your growing conditions, in case they require adjustment or replication.

To avoid leggy seedlings, provide adequate lighting shortly after germination, but keep constant temperature for next 7–10 days. Then, give the plants a day/night temperature differential (day 78°F/25°C and night 65°F/18°C), to encourage a stocky growth habit. Monitor plant growth rates and slow down varieties growing too fast by reducing water or temperature. Note that temperatures below 55°F/13°C can cause growth to shut-down temporarily.

## TOP-GRAFTING

Plants will be ready to graft approximately 18–25 days after sowing. The right size depends upon preference, but stem diameter anywhere in the range of 1.2–2.5mm is ideal.

You will need to prepare a clean area that is out of direct sunlight to do the cutting. An indoor area works well because the climate is more controllable, but an area in a greenhouse that is shaded and not too hot (70–74°F/21–23°C) or dry will work. Do not graft near a fan or draft.

Hygiene is very important during grafting because if you pick up a pathogen on your hands or equipment, you may transfer it to all of your plants. Do not use tobacco during grafting or near recently grafted plants, to avoid inoculating the plants with tobacco mosaic virus. Wash your work area down with a disinfectant before grafting. Always start with new or sanitized blades and grafting clips.

You will need a healing chamber to protect the newly grafted plants until the graft has taken. Any setup that maintains the plants in a humid environment (80–95% relative humidity), out of direct sunlight, at 80–85°F/26–29°C, will work. This environment keeps respiration rates low until vascular tissues are reconnected, but not so humid that adventitious roots begin to grow. On a small scale, 7.5"-tall humidity domes placed over individual flats work well, but for larger operations, a plastic tent set up to house a group of plants may be more efficient. Ideally the healing chamber is nearby the grafting work bench so the plants are moved around as little as possible.

Give your plants a deep watering 8–12 hours before grafting. If the roots are too wet, the excess moisture will be drawn up the stem, which can in turn push the scion off, reducing the percentage of successful grafts. The plants do, however, need enough water to survive the 5–7-day critical healing process without being watered in the interim.

Select a plant of your rootstock variety with a stem diameter that matches your clips. Sever the top just below the cotyledons at a 60° angle, and discard the top. A cut of this angle creates sufficient surface area to reconnect with the rootstock without being too steep to fit nicely within the silicon grafting clip. Next, find a scion with similar stem diameter to the rootstock, and sever the top above or below the cotyledons at a matching angle. Discard the root ball from the scion. (See below.)

### Practicing

If you have never grafted tomatoes before or setup a new chamber, you can start some old tomato seeds to practice on and also to learn how to best manage your healing chamber. That way you can analyze your technique and make improvements if need be without as high of a loss or setback.

Alternatively, you can self-graft some extra scion plants back onto themselves, just to get a feel for or demonstrate the motions to new grafters.



**Miter-Cut Grafting Knife (#7172)**

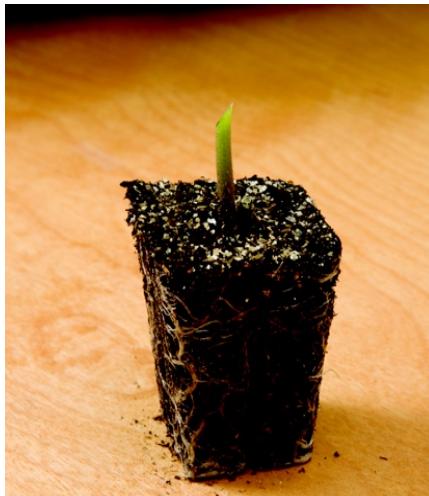
This tool is fitted with a preset blade to reduce human error in consistency. It has two precut grooves to accommodate the stem, enabling it to be cut automatically at the correct angle every time. A blank stem guide is also provided to make cuts at other angles. It can be used in place of a razor blade.



A plant ready to graft



Cutting



With the top severed

At this point, some people like to prune some leaves from the scion, leaving the growing point intact. This reduces respiration during healing, makes the scions easier to work with, and lightens the weight of a large or leafy scion so it doesn't lean as heavily on the clip. While the process is faster without this extra step, it is worth experimenting to see what works best for you. (See below.)



Defoliating



Defoliated

Place a grafting clip half-way over one of the cut stems; then insert the other stem so the cuts perfectly match up. One advantage of the silicone clip is that you can see through it, to make sure the cut surfaces match up. Air or dirt between the cut surfaces will prevent the graft from healing. Be sure the grafting clip is facing perpendicular to the angled cut, so that the scion is held in more tightly. (See below.)



Making the connection with a defoliated scion



View of finished graft with defoliated scion

If the scion has grown larger than the rootstock, you can move up above the cotyledon on the scion to acquire a smaller, matching cut surface. Likewise, if the rootstock is larger than the scion, you can move up above the cotyledons on the rootstock for a smaller stem diameter. If you have to move up above the cotyledons on the rootstock, the rootstock will resprout from axillary buds, which will have to be pruned off throughout the growing season.

Once you feel confident, the fastest way to graft is to cut many plants of rootstocks and put grafting clips on all the rootstock stubs. Then cut and match scions one-by-one to each rootstock.

## HEALING

For days 1–4 after grafting, maintain 85–95% humidity, 70–80°F/21–26°C, and nearly complete darkness. During days 4–10, gradually acclimate the plants back to full light and lower humidity by making small, incremental changes every day or two. There are many ways to accomplish this, depending on your system, but we've provided a flowchart (below) for general guidance.

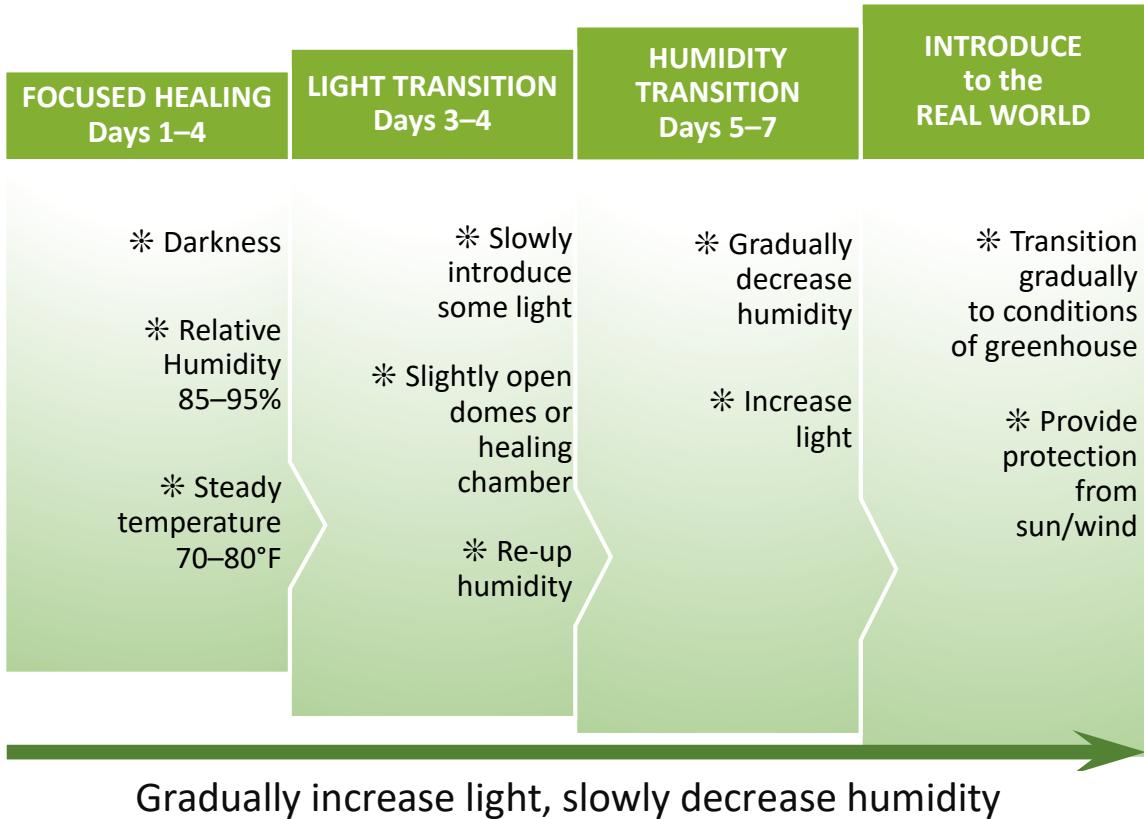
Monitor for wilting, which is a sign that the humidity has fallen too low too quickly, and for stretching, which is a sign that healing has proceeded well enough for the plants to begin growing again and more light would be beneficial.

If moving the plants from indoors to a greenhouse setting, extra care during acclimation may be necessary to reduce shock; the plants can also be moved out during a stretch of cloudy weather or under partial shade. Once the plants have reacclimated to greenhouse conditions for a few days they will be ready for normal handling and watering.

Silicon clips will expand with the growth of the plant and eventually fall off by themselves. They can be collected and disinfected for reuse. Boiling may help restore their elastic strength.

## TRANSPLANTING

At transplanting, make sure the plant's graft union lies above the soil line, or the scion variety may root into the ground, which would negate some of the grafting effects, primarily soil disease resistance. Prune off any suckers that develop at or below the graft union, as these derive from the rootstock and will quickly overwhelm the scion. In addition, consider planting at wider spacing than you might use with nongrafted plants, permitting more leaders to grow per plant, and other modifications in fertility and crop care to maximize the benefits and economics of your grafted tomatoes.



A photo taken in one of Johnny's trialing greenhouses. There are two tomato plants grafted to Maxifort on the left, and two ungrafted plants of the same variety on the right. It is easy to see that the vigor of the grafted plants is far greater.

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