

Grafting vigorous, disease-resistant tomato rootstocks to desirable fruiting varieties has become a cost effective method for growers to overcome many disease and production related issues. Grafting tomatoes can improve production, overall crop health and vigor, reduce or eliminate the need for pesticide use, lengthen harvest duration, and significantly increase net income. The entire process from sowing of rootstock and scion varieties to final transplanting of grafted plants into greenhouse soil or soilless media normally takes about 6-8 weeks.

If you have never grafted tomatoes before, or need to get back in practice, the best way to succeed is to plant some old tomato seeds and practice the following techniques with expendable plants. That way if the grafts don't take, you can analyze your technique and make improvements without setback. If you have never grafted before, even grafting the top back on to the stalk it came from is good practice and will show you what the perfect graft would look like.

Materials

In addition to rootstock and scion seedlings of matching stem size, you will need old-fashioned, double-edged razor blades, grafting clips, and a spray bottle or humidifier.

Planting

Do a germination test on each variety you plan to graft, to observe the speed of germination and growth of the rootstock compared to the top variety (scion) in your particular growing environment. Sometimes the rate of growth varies between rootstock and scion depending on growing conditions. The stems of rootstock and scion need to be as close as possible to the same diameter for successful grafting.

If you test the varieties you will be growing for germination and growth rate, slower germinating or slow-growing varieties can be planted earlier, and faster growing varieties can be planted a day or two later so the diameter of the stalks match up at grafting time. If this is not possible, most rootstock and scion varieties can be planted on the same day. Plan on starting seed for grafted tomatoes 6-8 weeks before the transplant date. Grafted tomato plants take 1-2 weeks longer to reach the transplant stage because they stop growing during the healing process.

Over-seeding is very important. Since most tomato rootstocks are interspecific crosses (the product of traditional plant breeding crossing a *Solanum lycopersicum* domesticated tomato with one of its wild cousins), this wide cross increases hybrid vigor but decreases germination percentage and uniformity. Your goal is to match the stem size of rootstock to scion variety so you want plenty of plants to choose from when it comes time to graft. Over-seed by at least 25% more than the number of plants you need to put in the ground.

The best germination is ensured by creating an environment with a steady 80°F (27°C) temperature. Use a germination chamber or heat mats with a soil probe to achieve this. Water the flats, cover them to conserve moisture, and germination should begin to occur within 3-4 days. To avoid leggy seedlings, move the trays to an environment with the same temperature and good light as soon as germination begins.

Once the seeds have germinated, after about 10 days, you can reduce the temperature to 64-66°F (18-19°C) to encourage a stocky growth habit. Make sure plants have plenty of direct light and keep close track of their progress because they are growing quickly and will exceed optimal size to graft in a very short time.

Plants will be ready to graft approximately 17-21 days after sowing. The easiest way to tell when they are ready is to take one of the 2.0 mm grafting clips (#9847) and compare it to your seedlings. When the stem below the cotyledon fits snugly in a grafting clip, the plants are ready to graft. Smaller plants can be done with the 1.5 mm grafting clips (#9844), or larger plants with the larger spring loaded grafting clips (#9031 or #9032), but 2.0 mm is the ideal size.

Grafting

You will need to prepare a clean area, such as a work bench, with no 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) 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 smoke during grafting or near recently grafted plants. Wash your work area down before grafting with a disinfectant such as Vircon or a 1:10 bleach solution. Always start with new razor blades and grafting clips.

You will need a healing chamber to protect the plants until the graft has taken. A healing chamber keeps newly grafted plants in a high humidity, low light environment so they do not respire too much and dry out before the vascular structure is reconnected. This can be as simple as plastic domes placed over individual flats to keep the humidity high, a plastic tent or tunnel suspended over a group of plants, or any structure to keep the humidity at 80-90% during the healing process. A healing chamber near the grafting area is ideal, so the plants are moved around as little as possible. Any setup that maintains the plants in a humid environment, out of direct sunlight, at 71-74°F (22-23°C) will work.

Give your plants a normal watering the day before, but not the day of grafting. Roots that are really wet will have too much moisture going up the stem, which can push the scion off and reduce the percentage of successful grafts. On the other hand, if you realize that the rootstocks are really dry as you are grafting them, stop grafting, water them, and resume grafting the next day because dry rootstocks will not survive.

The best way to tell if your plants are the right size is to put a grafting clip on the stem of a seedling. When it fits snugly it is time. When you are ready to graft, take an old-fashioned double-edged razor blade and snap it in half lengthwise while it is still in its paper cover, being very careful not to cut yourself. It is important to use this type of blade because they are thinner and sharper than the other types of razors.



Take a plant of your rootstock variety with stem diameter that matches your clips and sever the top just below the cotyledons at a 45° angle. Discard the top. Find a scion whose stem matches the rootstock you cut, and sever the top below the cotyledons in the same manner, at a 45° angle. Discard the root ball.



A plant ready to graft,



cutting



and with the top severed

At this point, many people like to cut all the leaves off the scion except the leaf at the growing point. This is to reduce respiration and the amount of leaf area for the healing plant to support. Some people prefer not to defoliate, and it's certainly faster without this extra step. Experiment and see which method you prefer but either method can work well. Defoliated plants can be easier to handle if the scion seedling is very leafy.



defoliating



defoliated

Place a grafting clip half way over one of the cut stems, then join to the other stem so the cuts match up. One advantage of the silicon 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.



making the connection



finished graft

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 may re-sprout from latent buds, which will have to be pruned off later.

Once you feel proficient at this, the fastest way to graft many plants is to have the plants graded by size, so you have whole flats of rootstocks and scions that match each other. Cut an entire flat of rootstocks and put grafting clips on all the rootstock stubs. Then cut an entire flat of scions, putting them in a small container of sterile water to keep them moist while you are cutting, and then attach all the tops to the prepared rootstocks at once. Change blades each time you begin a new session, or when they become dull.

If it is hotter or dryer than ideal in your grafting environment, you may want to mist the plants with a spray bottle. Be gentle - a powerful spray can knock the tops of the grafted plants off. As soon as you are done grafting a tray, you can either mist the plants and the inside of the healing chamber with a spray bottle to raise the humidity, or use a cool mist humidifier to put humidity right into your chamber. The humidifier is ideal because it is gentle and keeps the humidity constantly replenished.

Healing

Once you have put the plants in the healing chamber, keep the tunnel closed for three days and maintain it at 80-95% humidity, with no direct sunlight, at 71-74°F (22-23°C). Indirect sunlight (light shining in a window of the same room, as long as it does not fall directly on the plants) or artificial lighting is fine. Check the plants from the outside of the tunnel. If they are wilting, raise the humidity level and reclose the chamber.

On the fourth day, open the tunnel and check to see if the plants are still moist. The plants will not use much water during this time and should not need watering yet. Close the tunnel once you are done. On the fifth day, make a small opening in the tunnel so that some of the humidity can start to escape, and check the plants frequently. If they wilt, close the tunnel back up, re-elevate the humidity, and try ventilating again the next day. If the plants did not wilt when ventilated on day 5, make the opening a little larger on day 6. Gradually increase ventilation until you can take the plastic off completely without the plants wilting.

The key is to gradually bring the grafted plants to normal greenhouse temperature and humidity, but return to the previous conditions if they start to wilt. High humidity conditions cannot be maintained indefinitely, or the scion may grow adventitious roots of its own and not fuse with the rootstock.

If flats need to be watered during the healing process, use bottom water. Flood the bench they are on for a few minutes, or place flats in an inch of water so they can absorb it from the bottom. Top watering before the plants are healed may knock the tops off. Eventually, the seedlings will be strong enough to top water again. After the plants have re-acclimated to greenhouse conditions for a few days they are ready for normal handling.

Silicone clips will expand with the growth of the plant and eventually fall off by themselves. The spring-loaded grafting clips have more of a potential to restrict the plant's growth and should be taken off when the plants are healed.

At transplanting, make sure the graft union is above the soil line, or the scion variety may root into the ground and negate the benefits of the rootstock. Prune off any suckers that develop below the graft union, as these are from the rootstock. Otherwise, manage the plant as you would normally.



A photo from the Johnny's trial greenhouse. Two tomato plants grafted to Maxifort are on the left, two ungrafted plants of the same variety are on the right. It is easy to see that the vigor of the grafted plants is much greater.