



Vegetable Grafting: An Old Technology with a New Technique

The belowground portion of a plant—the rootstock—is chosen for its genetic ability to resist or tolerate soilborne disease. The above-ground portion of the plant—the scion—is chosen based on fruit quality.



Benefits of Grafting

- Disease resistance against soilborne pathogens
- Grafting effective overcome abiotic stresses
- Water and nutrient uptake
- Increase productivity

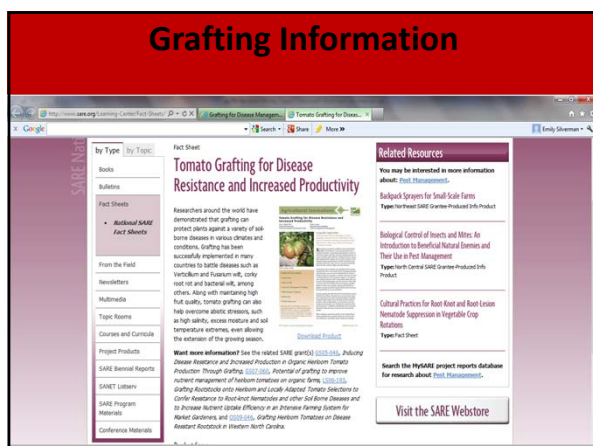
Vegetable Grafting

- ❖ Cucurbits (cucumber, watermelon and other melons)
 - ❖ Hole-insertion grafting, One cotyledon grafting, and Approach grafting
 - ❖ http://cals.arizona.edu/grafting/howto/cucurbits/grafting_methods
- ❖ Solanaceous (Tomato, eggplant and pepper etc.)

Grafting Information



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Grafting for Disease Resistance in Heirloom Tomatoes



Grafting is a simple technique that growers can use to increase soilborne disease resistance in tomatoes without chemical fumigants or pesticides.

Heirloom tomato cultivars lack genetic disease resistance and are particularly susceptible to epidemics in the field. Growers interested in this niche market, however, are not willing to give up the high-quality fruit that they desire. Grafting can be used to unite the soilborne disease resistance and enhanced vigor of hybrid tomato cultivars with the high fruit quality of heirloom varieties.

Grafting: An Old Technology with a New Technique

Grafting vegetables to manage soilborne disease is a similar process. The heur-

Grafting has been used in the horticultural industry for woody species, such as apples and grapes, for centuries. The first use of vegetable grafting to reduce soilborne disease occurred in the early 1900s to diminish fusarium wilt on watermelons. More recently, this technique has been used in plant production systems when the genetic trait for disease resistance in a crop is closely linked to a negative quality, such as small fruit size. For example, grafting is often used to reduce bacterial wilt caused by *Ralstonia solanaceae* in tomatoes. This disease complex is particularly difficult to manage due to its wide range of

<http://www4.ncsu.edu/~clivard/TubeGraftingTechnique.pdf>

Disclaimer

- No Recipe for Success
- Principles
 - Production
 - Uniformity
 - Water Stress
 - Sanitation
 - Re-acclimation



Disease and Variety

- Disease Diagnosis
- Variety selection
 - Scion
 - Wanted fruit characteristics
 - Rootstock
 - Disease resistance

What diseases do I have?

What characteristics do I want in my tomatoes?

What diseases do I want to have resistance in?

Commercial Rootstock Selection

Rootstock	TMV	Corky	Fusarium Wilt		Verticillium	Bacterial Wilt	Nematodes
			Race 1	Race 2			
Maxifort *	HR	HR	HR	HR	HR	S	MR
Beaufort *	HR	HR	HR	HR	HR	S	MR
Anchor-T **	HR	S	HR	HR	HR	MR	HR
Survivor **	HR	S	HR	HR	HR	MR	HR
Asahi ***	HR	HR	HR	S	HR	MR	HR
RST-04-105 ****	HR	HR	HR	HR	HR	MR	HR
Big Power *****	HR	HR	HR	HR	HR	S	MR
Robusta *****	HR	HR	S	HR	HR	S	S

HR = Highly Resistant, MR = Moderately Resistant, S = Susceptible

* = De Ruiter Seed Co. ** = Takii Seed Co. *** = Dai Honmei

**** = D Palmer Seed Co. ***** = Rijk Zwaan ***** = Bruinsma Seed Co.

Supplies and Space

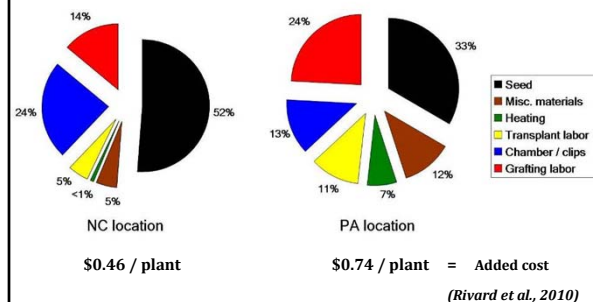


- Clean Space
- Razor blades
- Alcohol or other disinfectant
- Grafting Clips
- Healing Chamber

Propagation Costs

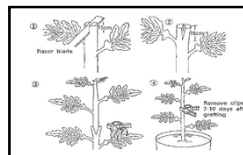
- Proportion of added costs

— e.g. seed costs (%) = $(SEED_{\text{graft}} - SEED_{\text{non}}) / (TOTAL_{\text{graft}} - TOTAL_{\text{non}})$

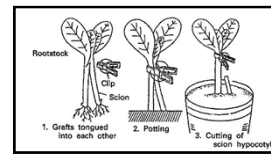


Tomato Grafting Techniques

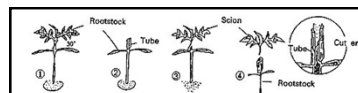
Cleft Grafting



Tongue Approach Grafting



Tube-grafting



Tube Grafting

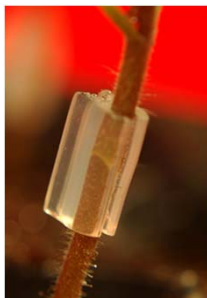
- The advent of “tube-grafting” or “Japanese top-grafting” has become the most popular for tomato.

— Seedlings are grafted at 2-4 leaf stage.

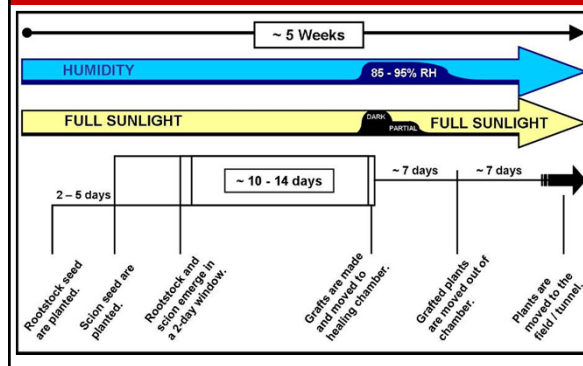
— High Throughput

- A person can make ~ 1000 grafts/day

- Grafting robots can make 700 grafts/hr.



Timeline



Seeding / Transplant Production

- Uniformity is key
 - Germination period
 - Substrate
 - Transplanting / Sowing
- Rootstock and scion
- Numbers
- Plastic trays



Tube Grafting Technique

- Size:
 - 2-4 leaves
 - 1.5-2.0 mm stem diameter
 - Sorting
- Temperature can be manipulated to compensate for size differences.
- Timing is critical.



Tube Grafting Technique

- Preparing for surgery...
 - Make sure plants are not water or nutrient stressed.
 - Have a clean working area.
 - Disinfect hands, tools, and grafting clips
 - Carry out grafting indoors
 - Be in close proximity to healing chamber.



Tube Grafting Technique



- Angle of cut
- Clip attachment
- Scion insertion
- Provide good contact between the rootstock and the scion.

Tube Grafting Technique



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Tube Grafting Technique



- Angle of cut to rootstock
- Clip attachment
- Angle of cut to scion
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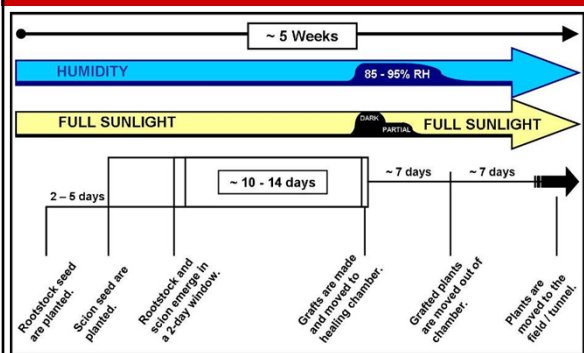
Tube Grafting Technique



Tube Grafting Technique



Timeline



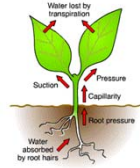
Life in the Chamber



- During the healing process, the plant has to form callus tissue and reconnect vascular bundles within the stem.

Life in the Chamber

- Objectives of the healing chamber
 - Reducing water stress by slowing the transpirational stream.
- Humidity
- Light
- Temperature
- Keep temperature fairly constant and between 75 and 80 degrees F.



Life in the Chamber



Small cool-mist vaporizer (~\$40).

Note: 1.5" PVC connectors to direct water vapor

- Regulate humidity
 - Cool-water vaporizers
 - Humidifiers
 - Passive humidifiers
 - No warm-water vaporizers
 - Overhead watering



- Regulate light & humidity in the chamber





Life in the Greenhouse



- 7-10 days in the Greenhouse
 - Hardening off
 - Overhead Watering
 - The Clip
 - Transportation

Life on the Farm



Planting Depth



Suckering

Life on the Farm



NON-GRAFTED

MAXIFORT

Life on the Farm



Twin leader for European string trellis



Twin leader for stake-and-weave

Reason for Graft Failure

- Seedlings are unhealthy and improperly matched in diameter
- Small seedling grafting
- Insufficient sanitation
- Improper management of post-grafting environment
 - High temperature
 - High humidity
 - Direct overhead watering
 - Excessive light
 - Insufficient light

Young et. al. 2009

Sanitation

During Grafting and Healing

- Contamination is common during grafting- vulnerable plants
- Use alcohol to wipe down grafting area before and after use
- Dip or wipe cutting utensils in alcohol often
- Bleach grafting area after use
- Bleach humidifiers in between uses to reduce algae build up
- Clean healing chamber between uses
- Soak used grafting clips in bleach solution and rinse repeatedly
- Bleach and rinse propagation trays if reusing trays

Other Areas of Concern:

- Saving seeds?
 - Sanitize seeds in bleach to prevent seed borne pathogens after seed extraction
- Organic production- soil with damping off pathogens- *Rhizoctonia* and *Phythium* sp.
 - Steam soil if possible
 - Monitor and remove infected plants
- Extended periods of leaf wetness can lead to fungal problems such as leaf mold or powdery mildew
 - Adjust leaf wetness- monitor humidity and look out for water droplets on foliage

Review

- Uniformity of seedlings
- Timing
- Patience
- Sanitation
- Careful observation
- Water management
- Cultural Management



Important links for Grafting Information:

Informational Resources:

1. <http://loghouseplants.com/plants/library/grafting/>
2. <http://www.hort.uconn.edu/ipm/greenhs/htms/Tomgraft.htm>
3. <http://www.deruiterusa.com/products/rootstock/root2.html>
4. <http://oardc.osu.edu/graftingtomato/graft.htm>
5. <http://cals.arizona.edu/grafting/home>

Grafting Supplies Resources:

1. <http://www.johnnyseeds.com/c-278-grafting-clips.aspx>
2. <http://www.dpalmersseed.com/>
3. <http://www.rijkwaaanusa.com/>
4. <http://www.neseed.com/>

Questions???

