Transplant Production for Market Gardens

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Advantages of Transplants

- Can select the strongest seedlings for increased crop vitality in field
- Can better manage environmental conditions (temperature, moisture, air, soil)
- Earlier marketing and season extension
- Can manage large numbers of plants in small area
- Can achieve perfect plant spacing, save time thinning
- Can provide more reliable harvests and predictable harvest dates
- Advantage over weeds and diseases

Disadvantages of transplants?

- Infrastructure required ($$)
- Additional labor, skill, management
- Not best for every crop
- More resources (plastic, fertilizer, etc.)
- Often results in more total days of growth

Should you buy transplants or grow them yourself?

Buying considerations:

1. Can save time/labor
2. Can save on GH costs: heat, water, etc (or if you don't even have a GH!)
3. If purchasing, make sure your source is reliable
4. Quarantine plants for a few days to prevent spreading any potential pests

Growing considerations:

1. Less costly
2. Allows flexibility, variety selection
3. Control over quality
4. Make your own schedule
5. Potential to generate income

Considerations for growing your own transplants

- **Materials:** Potting media, Containers, & Seeders
- **In the Greenhouse:** Growing Conditions, Nutrition, Pests & Disease
- **Ready for the Field:** Hardening off & Planting out
- **Record Keeping**

Materials

Potting Media

- Four important qualities:
    1. Drainage
    2. Aeration
    3. Nutrient availability
    4. Water-holding capacity

- Can be achieved by mixing or purchasing a pre-mixed media with a combination of ingredients: perlite, sand, soil, leaf mulch, peat, compost, coir...
- Organic operations need organic media, approved and added to OSP

Potting Media

Mixing yourself

- Less expensive
- Can be time consuming
- More variable
- Can create a custom mix to suit your needs
- Potential problems with diseases, weeds

Buying pre-made

- More expensive
- Easier, Less time consuming
- More uniform
- Sterile

Don’t use field soil to start seeds! It is not sterile or seed free, often too heavy, and does not drain well.

Potting media: Compost

- Adding to potting mix can increase fertility & water holding capacity
- Can be made from animal manures (herbicide residue caution!) and bedding, farm and garden wastes, grass and alfalfa hay etc.
- Make sure you are using high quality, finished compost

Potting Media: Peat Moss

- Partly decayed plant residue that's been submerged under water in bogs & broken down to form a type of soil called "peat"
- Thousands of years old when harvested
- Acidic, pH of 4.0
- Provides organic matter, holds nutrients
- Exceptional water holding capacity, naturally weed free

Potting media: Sand, Vermiculite, Perlite

All can be used to adjust drainage and aeration

Sand: Coarse sand @ 1/8 - 1/16" is best; improves drainage when added to heavy soil mixes

Vermiculite: mined mica-like mineral, lightweight, better for holding moisture (seeds)

Perlite: volcanic glass that is expanded with heat, lightweight; better for adding aeration/improving drainage (cuttings)

Potting media: Coir

- Coconut fiber
- Lasts 2-4 times longer and is easier to wet than peat moss
- Good water holding capacity
- Not as nutrient rich: may need to adjust nitrogen, potassium
- Salinity may be an issue
- Good alternative to peat, renewable

Containers: Plug trays, cell trays, flats...

- The standard for many growers
- Available in a wide selection of sizes (50 to 500), size used will depend on:
  - Seed size
  - Desired transplant size
  - Length of time in GH
- The larger the cell in the tray, the longer the plant can stay in the GH, and the bigger it can get without being root bound.
- Usually around $1 each and can be purchased in cases 100+
- Most used plug trays can be sterilized and reused (but...)

Containers: biodegradable pots, paper pots

- Planting seeds in container made of paper pulp, etc.

- Benefits:
  - Little to no transplant shock-- minimal root disturbance
  - Less worker labor
  - Less plastic waste

- Cons:
  - May not be organically approved
  - May need special equipment (paperpot transplanter)
  - Not reusable
  - Root blockage? Must provide moisture.

Containers: Soil blocks

- Planting seeds in lightly compressed cubes of potting media.

- Benefits:
  - No root bound plugs, less transplant shock
  - Available in different sizes (1 ½ , 2, 3”)
  - Less plastic waste
  - No cost of pots

- Cons:
  - Can have less integrity
  - More labor to shape
  - May dry out quicker
  - May still have some plastic waste (support tray)

Seeders

- Vacuum Wand/Plate Seeders
- Vibration seeders
- Handheld Seeders
- Magnetic (or other) Plates


Precision Vacuum Seeder $540+


Gro*Mor Wand Seeder $450+


Mini Wand Seeder ~$30


Vibro Hand Seeder $80+


Hand Seed Sower $5


Bootstrap Farmer Drop Seeder ~$50+

Seeders

- Or use your hands!
- Consider the amount of time it takes to seed large quantities

In the Greenhouse

Growing Conditions

To produce healthy transplants, 4 main environmental factors must be met:

1. Light
2. Temperature
3. Moisture
4. Air

Light

Light intensity:

- Impacts the rate at which a plant undergoes photosynthesis
- As light intensity increases, so does the rate of photosynthesis up until a certain point (saturation point). Different plants have different saturation points.
- Low intensity light during germination & high intensity light after emergence to avoid seedling elongation

Light

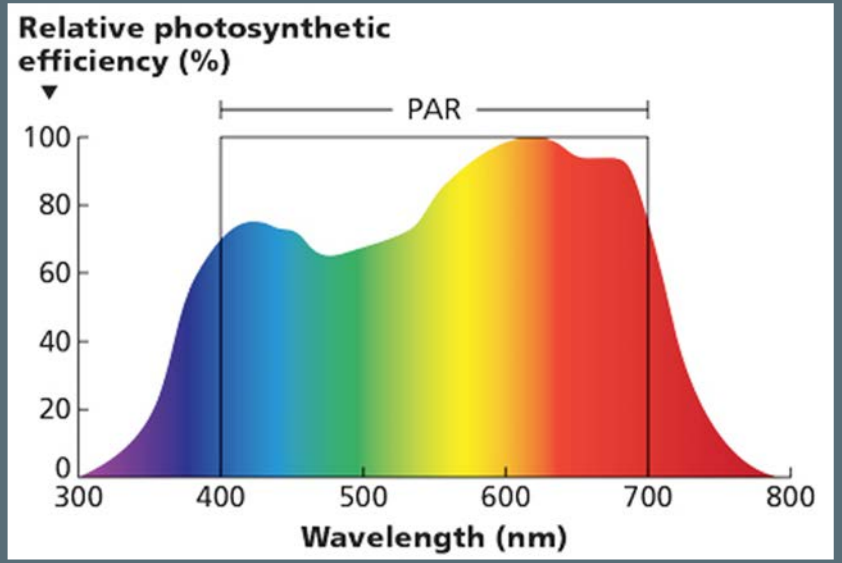
Light Duration:

- Also referred to as photoperiod or daylength
- 12-16 hours of “daylight” each day is optimal for young plant growth
- Adjusting light duration can affect flowering, fruiting, bulbing, etc.
  -Ex: Long day onions need 14-16 hours of daylight to initiate bulb formation, Short day onions need 10-12 hours daylight
- Increasing the time plants are exposed to light can be used to compensate for low light intensity.
- However, plants require some period of darkness to properly develop (no more 16 hours/day in general). Excessive light can be as harmful as too little.

Light

Light Quality:

- Aka. wavelength
- Certain wavelengths are more useful to plants for photosynthesis and other plant growth processes
- Light in the 400 to 700 nm range is used for photosynthesis. This range is known Photosynthetically Active Radiation (PAR).
- Red and blue wavelengths within the PAR range are most effective.
- Important if artificial light is the primary source of light for growing plants. Can alter light quality by using LEDs, etc.



Temperature

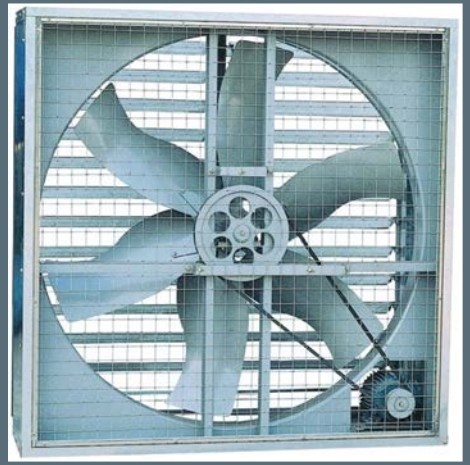
- Average Daily Temperature (ADT) will have the greatest influence on the rate of plant growth
- Most grow very little at temperatures less than 45 °F
- Most will increase their growth rate to ~77 °F, then level off or decrease
- Optimal ADT= 65-85 °F.
- Minimum nighttime temp ideally wouldn't be below about 55 °F
- Prolonged extremes on either end are not good for growth!
- Uniform adequate temps=uniformly grown transplants

Moisture

- GH watering requires attention to detail!
- Potting mixes should be moist before seeds are planted
- Avoid over-watering of seeds and small seedlings → disease, rot, damping off
- Mixes can dry out quickly and be tough to re-moisten
- Trays dry out at different rates depending on a variety of factors → size of tray, size of plant, temperature, etc.

Air

- Good ventilation and air circulation is important
- Results in drier foliage + lower humidity which reduces bacterial and fungal disease risk.
- Can reduce spikes in greenhouse temperature on sunny days & maintain optimal ADT



Seedling Nutrition

Plant Nutrients

Seeds contain all the nutrients they need to germinate and grow their first pair of leaves, but after that you may need to provide supplemental nutrition.

Macronutrients (The big 3):

- **Nitrogen (N)** needed for chlorophyll, proteins, enzymes and for general growth, leafy growth
- **Phosphorus (P)** needed to produce fruit, roots, seeds and blooms
- **Potassium (K)** needed to build roots and stems, involved in photosynthesis, and is important in disease suppression

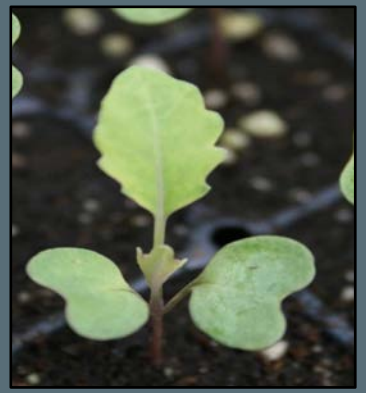
Micronutrients:

- **Ca, Mg, S, B, Cu, Cl, Fe, Mn, Mo, Zn**
- Needed in smaller amounts for growth, vigor, photosynthesis, protein, sugar and enzyme production; reproduction and seed formation, metabolism and respiration

Macronutrient Deficiencies

- **Nitrogen:** Uniform chlorosis (pale yellowing) on older leaves, chlorotic leaves can fall off, overall stunted.
- **Phosphorus:** Plant is stunted, foliage becomes deeper green or purple
- **Potassium:** Margins of older leaves become chlorotic followed by immediate necrosis

Nitrogen deficiency on kale



Phosphorus deficiency on cauliflower

Potassium deficiency on cabbage

Fertilization

- Many pre-mixed medias will contain some form of nutrition.
- Supplemental nutrition may be needed to:

  -Compensate for poor quality or nutrient deficient potting mix ingredients

  -Alleviate plant stress, especially in old, root-bound TPs where nutrition is exhausted

Fertilization

- Amount of fertilizer depends on:
  - Kind of vegetable grown
  - application frequency
  - stage of growth
  - growing environment
  - amount of fertilizer in the media

- Can begin fertilizing when true leaves appear, but if media contains fertilizer, delay 2 weeks.
- Use higher rates when temps are high and lower rates when temps are low
- Use higher rates if fertilizing less frequently, and lower rates when applied more frequently
- More nutrients/ higher fertilizer rate does not = better results

Fertilizer Application Methods

- Blend inputs into potting mixture (or buy it that way). Most useful with medium or slow release ingredients

- Apply inputs as a top dress to containers. Most useful with fast or medium release ingredients: powdered, granular, or pelletized.

- Apply water soluble inputs to root zone through irrigation water (Aka. fertigation). If using readily available nutrients: immediately addresses nutrient issues and increases plant growth.

GH Pests & Diseases

Preventing Pests

- Inspect new plants thoroughly
- Keep doors, screens and ventilators in good repair
- Use clean or sterile soils or ground media, sterilize tools, flats and other equipment
- Maintain a clean, trash-free, mowed area around the greenhouse to reduce invasion by pests that develop outdoors
- Avoid overwatering and promote good ventilation to minimize wet areas & eliminate pools of standing water on floors
- Remove all weeds, plants, and debris, clean the greenhouse after each production cycle

Monitoring for Pests

- Early detection will allow you to make decisions before the problem gets out of hand

- Use yellow sticky cards (1-3 cards per 1,000 sq ft) and change out weekly

- Keep records and notes from year to year

Controlling Pests

- Before treating, ensure you have correctly ID'ed the pest. Contact county extension offices if needed.
- **Chemical controls:**
  -Insecticidal soaps (aphids, spider mites, thrips, whiteflies)
  -Pyrethrins (aphids, thrips, spider mites, whiteflies)
  -Bt (Gnatrol) for fungus gnat larvae

- **Biological controls:**
  - Parasitic Wasps, many spp. & many hosts
  - Nematodes, many spp. & many hosts
  - Lady bugs, Lacewings, Damsel bugs, Pirate bugs, Aphid Midge...

Disease Prevention

Good greenhouse practices during production cycle:

- Maintain a weed-free greenhouse
- Obtain seed, media, etc. from reliable sources
- Avoid bringing non-sterile soil into the greenhouse on shoes, tools, and supplies
- Avoid wetting foliage and overwatering plants during irrigation
- Avoid standing water and allowing watering wand to touch floor

After a production cycle, sanitize the greenhouse by:

- Removing all plant material and roots from the greenhouse
- Hosing down with water all surfaces of the greenhouse structure, tools, and equipment
- Disposing of or sanitizing (with bleach or other sanitizer) plug trays, tools, surfaces, etc.

Controlling GH Diseases

- Prevention is best, some chemical and bio-control sprays/products exist for fungal issues
- Copper- and sulfur-based fungicides are inexpensive, widely available, affect many pathogens, but overuse may result in development of pathogen resistance
- Horticultural oils are less effective
- Efficacy depends on timing and level of infestation- Start spray schedule early!
- Little commercial control for viruses and bacteria

Common GH disease: Damping-off Disease

- Soil-borne fungal pathogens *Pythium* and *Rhizoctonia* can be destructive
- Common, often due to overwatering and poor sanitation.
- Results in the rotting, collapse and death of seedlings just before or after they emerge
- **Prevent/manage by**: avoiding overwatering, sanitizing flats, keeping watering wand off the ground, using sterile soil, don't crowd plants
- Heating mats can help

Ready for the Field

Transplant shock

- Refers to the setback in growth that plants experience when moving from one environment to another.

Reduce shock at planting by:

- Ensuring your transplants are full sized
- Hardening off for at least 3 days
- Watering thoroughly within an hour before planting

Transplant Size

- Generally need 4-6 true leaves, 2 okay for quick greens
- Roots should be well developed and branched
- If in trays, the roots should be knitted together in a unit that holds when removed from the cell

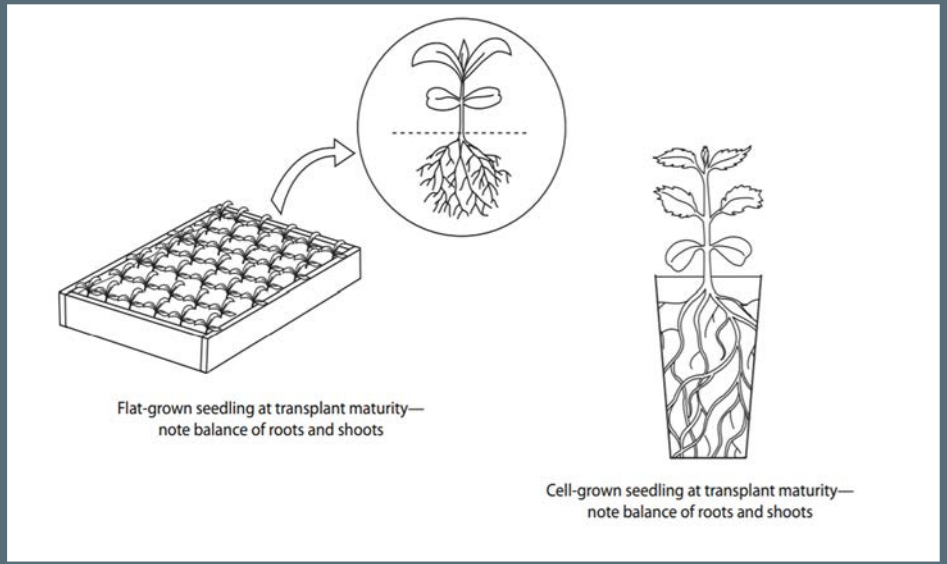


Image: CENTER FOR AGROECOLOGY & SUSTAINABLE FOOD SYSTEMS, University of California, Santa Cruz. "Teaching Organic Farming & Gardening Publication, Unit 1.4.

Hardening Off

- Allows TPs to acclimate to the environmental conditions in the field to promote success and reduce transplant shock in field

Can achieve by:

1. Gradually reducing temp., water, and fertilizer application in the greenhouse

2. Moving the flats outdoors or to another transitional environment several hours a day

Outdoor conditions for transplanting

Most favorable environmental conditions:

- **Low light:** foggy, cloudy, sunset, etc.
- **Mild temperatures:** plant in AM or early PM to reduce transpiration, heat stress on sensitive roots/leaves
- **Low wind**
- **High humidity**
- **Moist planting area**: irrigate bed before, during, immediately after...

Not always going to be perfect. But take steps to hit at least a few of the right conditions to increase success

Recordkeeping

Record Keeping

What to Record:

- What was seeded
- Date seeded
- Amount seeded
- Date transplanted
- Amount transplanted
- Where transplanted

Good to know regardless, but organic growers are REQUIRED to have these records during inspection, must be easy to follow

	B	C	D	E	F	G	H
1	Crop	Variety/ Varieties	Seeding Date	Transplant Date (indicate if DS)	Amount Seeded (tray size or row feet)	Amount Transplanted or Direct Seeded (rounded)	Location
192	Summer squash	Dunja, Smooth Operator	6/9	7/14	2x 50-cell each (about 200 total)	1x row @ 170' of each, about 85 plants of each ;about 170 plants total.	Upper Zone 2
200	Summer squash	Early bush patty pan and Tempest	7/28	7/28 DS	about 150 seeds/plants	about 150 seeds/plants	HT 5
201	Tomato- Cherries	Mix of: Pink BB, Sunrise BB, Citrine, Esterina, Sakura, Black Cherry	3/17	5/5	36 of ea variety for 3x 72-cell trays, about 220 total	2x rows @ 170' each (about 170 plants total)	Mid Zone 1
202	Tomato- Cherries	Mix of Sunrise, Peacevine, Esterina, Black Cherry, White cherry, & Citrine	4/20	6/18	varying #'s of seeds per variety, about 150 total	1 row @ 250' long or about 125 plants. The rest were tossed.	Quad 2A
203	Tomato- Heirloom/Specialty	Mix of: Tie-Dye, Cherokee Carbon, Pruden's Purple	3/17	5/18, 5/19	72 of ea variety, about 220 total	About 80 plants of each (overseeded 72-cells) plus about 15-20 of the Copia tomatoes seeded on 3/17. **Total number of Heirlooms TP'd this succession: about 250**	Upper & Mid Zone 1
204	Tomato- Heriloom/Specialty	Tie-dye, Cherokee Purple, Striped German	4/20	6/18	Varying #'s of seeds per variety, about 125 total	1 row @ 250' long or about 125 plants. The rest were tossed.	Quad 2A

Thank you!

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