UF UNIVERSITY of FLORIDA
IFAS Extension

Chapter 5.
Transplant Production

B.M. Santos

Vegetable transplants are affected by many factors, but the most important are water, temperature, fertilization, sunlight, cell size, and length of stay in the house (Fig. 5-1). These factors must be managed to produce a product that is acceptable to the customer (Fig. 5-2).

Management of transplant production depends on knowledge and experience. The ideal transplant technique would be to raise a plant from start to finish by slow, steady, uninterrupted growth without undue stress to the plant. However, plant growth may need to be altered through the manipulation of the growing environment (water, temperature, fertilization, etc.) because ideal conditions rarely exist.

Some of the main factors involved in transplant production are summarized in Table 1.

THE TRAY OR FLAT

Composition

There are a vast variety of production trays composed of materials ranging from molded polystyrene to vacuum formed plastic. Expended polystyrene (EPS) trays are generally considered the standard in the Florida industry (Fig. 5-3). However, age cracks, from extensive use, may result in fertilizer penetration and uneven growth, or to root penetration leading to root damage upon pulling. Plastic inserts for styofoam trays are presently available that alleviate the fertilizer and root penetration effects and can extend tray life.

A change from EPS trays to plastic trays will necessitate a change in water management as plastic trays generally allow for greater water availability, resulting in a reduced ability for height control.

Drainage

The hole in the bottom of the cell should be sufficiently large to allow good drainage when watering from overhead and provide for good capillarity (upward movement of water through the spaces within the medium) when utilizing ebb and flow irrigation.

Table 1. Requirements for vegetable transplant production.

Crop[1]	Cell size (inches)	Seed required for 10,000 transplants	Seeding depth (inches)	Optimum germination temperature (°F)	Germination (days)[2]	pH tolerance[3]	Time required (weeks)
Broccoli	0.8 - 1.0	2 oz	1/4	85	4	6.0 - 6.8	5 - 7
Brussels sprouts	0.8 - 1.0	2 oz	1/4	80	5	5.5 - 6.8	5 - 7
Cabbage	0.8 - 1.0	2 oz	1/4	85	4	6.0 - 6.8	5 - 7
Cauliflower	0.8 - 1.0	2 oz	1/4	80	5	6.0 - 6.8	5 - 7
Celery	0.5 - 0.8	1 oz	1/8 - 1/4	70	7	6.0 - 6.8	10 - 12
Collards	0.8 - 1.0	2 oz	1/4	85	5	5.5 - 6.8	5 - 7
Cucumber	1.0	1.5 lb	1/2	90	3	5.5 - 6.8	2 - 3
Eggplant	1.0	4 oz	1/4	85	5	6.0 - 6.8	5 - 7
Lettuce	0.5 - 0.8	1 oz	1/8	75	2	6.0 - 6.8	4
Muskmelon	1.0	1.5 lb	1/2	90	3	6.0 - 6.8	4 - 5
Onion	0.5 - 0.8	3 oz	1/4	75	4	6.0 - 6.8	10 - 12
Pepper	0.5 - 0.8	7 oz	1/4	85	8	5.5 - 6.8	5 - 7
Squash	0.5 - 0.8	3.5 lb	1/2	90	3	5.5 - 6.8	3 - 4
Tomato	1.0	3 oz	1/4	85	5	5.5 - 6.8	5 - 7
Watermelon	1.0	3.5 lb	1/2	90	3	5.0 - 6.8	3 - 4

[1] Other crops can be grown as transplants by matching seed types and growing according to the above specifications (example: endive = lettuce). Sweet corn can be transplanted, but the tap root is susceptible to breakage.
[2] Under optimum germination temperatures.
[3] Plug pH will increase over time with alkaline irrigation water.

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The Cell

Cell shapes include the inverted pyramid, cylinder, rectangle, and hexagon. While no research exists to indicate which shape will produce the best plant, cell size does affect field performance.

Larger cell sizes, especially for longer cycle crops (>5 weeks), often result in earlier and larger yields in the field. Therefore, smaller growers who produce their own plants may wish to use large cell sizes if greenhouse space is not a consideration.

The standard cell size in the industry is 1 inch by 1 inch, or approximately 240 plants per tray; however, economics and duration of stay in the house may often dictate cell size. For example, an onion crop mandates about 100,000 plants per acre or a 400 tray requirement, but if grown in a tray containing 500 cells, only 200 trays would be needed, leaving more space available for other production. Furthermore, for short cycle crops (leafy greens, cucurbits), smaller cells may be necessary as root growth may not completely fill a large cell. Transplants with insufficient root growth almost always pull from the cell with a minimum of medium and many broken roots reducing their ability to establish well in the field.

Cleaning

Once used, trays should be cleaned and sterilized to avoid a buildup of soil-borne diseases, especially those introduced from the field. All organic matter should be thoroughly rinsed from the trays prior to any chemical sterilization process. A washing procedure with soap and water should be followed by either an ammonium (2 to 5%) or a bleach (5 to 10%) soak for at least 5 minutes. Most commercial operations further steam sterilize trays at 160°F for 45 minutes. University of Florida has shown that steam sterilization is the most effective method of tray sanitation.

MEDIA

All but the largest transplant production facilities in Florida utilize a readily available commercial soilless medium product. Self-prepared media often results in uneven distribution of the component materials. This will affect germination and plant growth and as a consequence lead to plant variability. Most mixes will include phosphorus, lime, micronutrients and a surfactant to improve wetting capabilities of the mix. Wetting agents degrade rapidly (3 to 6 months), so do not order more media than can be used within this time frame. Changing media may necessitate changing growing practices.

SEED

Good seed doesn't cost, it pays. This old adage especially applies in greenhouse transplant production. Poor germination and vigor result in lost uniformity, revenue, and productivity (see Chapter 4).

Coated seed (pelletized) often makes seeding easier due to uniformity of size. Pelletizing may also reduce the chances of more than one seed per cell. However, coated seed can result in slower germination should water availability be a problem and it may reduce oxygen availability to the seed with extended storage.

Once seeded, the cell is generally top-dressed with vermiculite. Vermiculite holds water in, thereby reducing losses to evaporation, and it resists large shifts in temperature, providing for a more uniform germination environment. For uniformity of germination, provide a controlled temperature room or at least a shaded environment in the fall and a heated environment in the spring.

FERTILIZER

The goal in transplant production is to produce a sturdy, compact plant that when transplanted will grow rapidly and yield well. Too much fertilizer in general and especially early in transplant growth will result in a leggy plant that may not establish rapidly in the field. Too little fertilizer will result in stunted plants which are slow to grow when field planted. Therefore, proper fertilization directly impacts field performance.

No generalized fertilizer program is available for all transplant crops or all environmental conditions. Growers develop their own blends and application schedules based on experience. Liquid fertilization is preferred to provide for greater height control (i.e., can be washed out).

Fertilizers used for liquid feeding of transplant crops should be 100% soluble in water. In general, 75-100 ppm N applied twice weekly in the spring should be sufficient to adequately satisfy crop nutrient demand. Some growers prefer to reduce the strength of the charge and supply a smaller amount (30 ppm N) on a daily basis. University of Florida research has shown that lower N rates (20-30ppm) under ebb and flow irrigation applied during fall tomato production results in greater early and overall yields. The multiple irrigations required during this time of year may preclude use of this low fertilizer rate under overhead irrigation technique.

The nutrient charge is to be delivered on demand. Growers must learn to "play the weather" and not simply fertilize by routine. For example, fertilizations should be suspended or at least reduced during conditions of extended cloudiness.

Fertilization, watering, temperature and sunlight interact in plant height control. Flexibility in fertilizer application scheduling will result in plants of greater acceptability for commercial use.

WATER

Water management is the dominant factor in the control of plant height. Therefore, water only when needed and allow the plug to dry sufficiently before additional watering. The media should be kept moist but not continually wet.

When watering, gauge application of overhead irrigation to allow for water leachate to occur throughout the tray. Overhead irrigate during the day and allow for sufficient time for the foliage to dry as wet foliage at night encourages disease. With ebb and flow irrigation allow for contact with the trays for at least 30 minutes. Continuous flotation of vegetable transplants will result in total loss of height control under Florida conditions.

Water quality should include a pH of 6.0 to 7.0, adequate filtration to reduce organic particulate, low conductivity (dissolved salts), and possibly chlorination (1 to 2 ppm Cl^-) to reduce bacterial contamination. High carbonates and bicarbonates in the water will result in rapid upward pH swings in the plug and often result in micronutrient deficiencies (particularly Fe and B).

HARDENING

Most Florida transplants will be sufficiently hardened for field setting by control of factors employed to maintain plant height. However, should additional hardening be required, reductions in the amount of water and/or fertilizer applied during the last week or two of production, or lowering greenhouse temperature 5 to 10°F at daybreak in north Florida can accomplish the hardening process.

TRANSPLANTING DEPTH

Sufficient research has been conducted in Florida to confirm that setting tomato, pepper and watermelon plants to the depth of the first true leaf when transplanting results in earlier yields and larger fruit size. These attributes are the outcome of greatly improved plant growth over the first 30 days of establishment in the field imparted by the depth of planting effect. Additional studies have confirmed a reduction in lodging also associated with deeper planting.

ORGANIC TRANSPLANT PRODUCTION

As with organic seed, recordkeeping and certification are required for all organic producers that sell products, such as transplants, labeled "certified organic". Production of organic transplants involves more than using organic fertilizers and rooting media or avoiding the use of non-approved pesticides, regulations also extend to greenhouse building materials and methods of phytosanitation. Some circumstances exist in which conventionally produced transplants can be used in organic production. See Chapter 24 for further details.

GRAFTED TRANSPLANTS

Tomato, eggplant, watermelon, and other crops can be grafted onto disease-resistant rootstocks. This is a common practice used in other countries in place of soil fumigation. Some companies that sell seed in these countries have active breeding programs to improve rootstock characteristics, and named cultivars are available. Grafted plants also are increasingly used in greenhouse vegetable production. Plants (scions) are grafted onto rootstocks to gain disease resistance, but added advantages can include improved cold hardiness, higher early yields, increased plant vigor, fewer plants per acre, and improved postharvest quality. Grafting occurs at the seedling stage and the primary disadvantage is greater cost per transplant. Currently, university and USDA research is studying the use of grafted

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