Producing Transplants

Growers transplant vegetables to permit earlier harvest of crops that require long growing seasons. This overcomes adverse weather conditions early in the spring that can preclude field seeding. Sources for vegetable transplants for Ohio are local greenhouses and the southern United States.

It is important to have transplants that are free of insect and disease problems. Therefore, it is necessary to conduct a good pest control program during transplant production. Areas of plant production should be rotated so as not to increase or carry over disease and insect problems. Also, disease-free seed should be obtained from suppliers. Seed sources must be reputable and should provide information on seed treatment for disease and insect control.

Vegetable growers can select between soil mixes or artificial mixes when producing vegetable transplants. Selected soils should be light and well drained, with a desirable level of organic matter and no herbicide residues.

If herbicide residues are suspected, the soil can be tested by germinating sensitive plants such as lettuce, tomatoes or marigolds. However, a control must be used; use soil from another source, or the same soil mixed with 2-3 tablespoons of activated charcoal per volume of soil, to fill a standard 6-cell tray pack. After germination, compare the growth and plant appearance in each container to determine if there is any difference.

It is important to have a soil test performed in order to correct soil pH and fertility prior to planting. Submit a soil sample with the exact amendments in the proportion to be used in the final mix.

Artificial mixes are popular because they are sterile, contain fertilizer, are easier to handle and provide uniform, rapid growth. A soil test also is a good idea, because experience has shown that some mixes have little fertilizer, while some are high in soluble salts or deficient in important elements.

Transplant Feeding

Fertigation, or the use of water-soluble fertilizers at the time of each watering, is one method of feeding young vegetable transplants. The usual concentration is 100-220 ppm per feeding. An alternative method is fertilization at 7- to 10-day intervals at a nitrogen concentration of 300 ppm. Adjust fertilization according to temperature and light conditions. Some soluble fertilizers are:

Fertilizer	Rate
20-20-20	0.75-1.0 lb/50 gal of water
15-15-15	1.0-1.5 lb/50 gal of water
15-30-15	1.0-1.25 lb/50 gal of water

Apply fertilizer per 200 sq ft. Also, rinse leaves slightly after feeding. Vegetables sensitive to high levels of ammonium sources of nitrogen should be fertilized with 15-15-15, which has at least 50% of its nitrogen in nitrate form.

Transplant Condition

It is important to use transplants that are in good condition. Plants should not be too large or too hardened and should not have a large number of the roots removed by pulling the plants. Severely wilted plants can be soaked in water, or in some cases, merely placed between water-soaked cloth for a short time to revive them prior to transplanting.

Plants should be planted 1-2 inches deeper than in the plant bed, and the soil should be well-firmed around the roots. Most mechanical transplanters permit the addition of water or starter fertilizer. However, if weather conditions are dry and windy, wait for better transplanting conditions.

Hardening Transplants

Plants should be acclimated to the shock and stress of transplanting into the field by slowly removing the optimum growing conditions of the greenhouse. This is accomplished by a process known as "hardening-off," which is the reduction of water, temperature and fertilizer. Care must be taken to not "overharden" young transplants. With cool-season crops exposed to very low temperatures, bolting (in biennials such as cabbage) or buttoning (in broccoli or cauliflower) can be induced. Warm-season crops generally are hardened at temperatures higher than those of cool-season crops. Cold temperatures set back warm-season crops and can induce disorders such as catfacing in tomatoes.

Hardening Temperatures	
Cool-season crops	50-60°F (for 5 days)
Tomatoes, peppers, eggplant, vine crops	Not below 55°F

Vegetable crops differ in their ease of transplanting. The degree of difficulty in transplanting follows:

Easy to transplant: efficient in water absorption and rapid formation of new roots, beets, broccoli, cabbage, greens, lettuce and tomatoes.

Moderate: young plants do not absorb water as efficiently, but new roots form quickly; cauliflower, eggplant, leeks, onion and pepper.

Difficult to transplant: root system is easily injured during transplanting; plants cannot be stored easily, especially if they become too large: muskmelon, cucumber and squash.

Starter Solutions

Starter solutions are water-soluble, high-phosphorus fertilizers applied to young plants at the time of transplanting. They are used commonly with tomatoes, peppers, eggplant, melons and cole crops. The use of starters should be considered standard procedure for transplanting operations. Starter fertilizers supply phosphorus in an available form even when cold soil temperatures restrict phosphorus uptake. However, at soil temperatures below 56°F, phosphorus uptake is restricted. The use of starters promotes root development, early flowering and increased yield in tomatoes.

Common starter fertilizers include:

9-45-15
10-52-0
15-30-15
10-55-10
10-34-0
16-32-16

The usual rate is to mix 3 lb of the dry material per 50 gal of water. Then, 1/2 pt is applied per plant. Label directions should be followed. Excess starter can severely burn roots and reduce plant stand; applications at twice the recommended rate can reduce stands by 50%. Therefore, it is important to read all labels. Starters can be applied to the transplants in the plant containers, but more benefit is obtained if starters are applied in the transplant water.

Disease Management in Plant Beds

Plant beds can have special disease problems because of the close spacing of plants and the succulence of young seedlings. Exclusion of disease organisms often is the best method of disease management.

Soil sterilization is used in plant beds to eliminate soil-borne pathogens responsible for damping-off or other root diseases. Soil "sterilization" denotes disinfestation of soil. The disinfesting agent either is a chemical or heat. Sterilization implies the complete killing of all living organisms, but this is a misnomer, because the practices used are insufficient to kill all living organisms.

Heat is the only disinfesting agent that can be relied upon to destroy bacteria, fungi, nematodes, mites and insects. The goal is to increase the soil temperature to approximately 180°F and maintain this level for 1-4 hours to ensure that all pathogenic organisms are destroyed. Soil to be treated should be moist, because heat does not penetrate dry soil well. Fortunately, most pathogenic soil organisms are destroyed at relatively low temperatures.

If growers are unable to steam-treat soil, they must consider treatment with fumigating chemicals. Fumigants can be applied by growers if licensed by the state to do so. However, because special equipment is required to inject fumigants into soil, many growers either rent equipment or hire commercial applicators. Although fumigation is less costly than steaming, fumigants do not kill plant viruses and often are marginal in controlling pathogenic bacteria. They generally are satisfactory for the control of weeds, fungi, insects and nematodes.

The fumes of chemical soil fumigants are toxic and should not be inhaled. Applicators must use respirators. Never allow these liquids to remain in contact with skin; wash them off immediately. If the liquids are spilled on clothing, change the clothing at once.

Do not use these materials when living plants are growing in the area, because the fumigants are phytotoxic. Growers should take precautions that fumes do not travel to adjacent greenhouses through electrical conduits or steam or drain lines.

Whether producing plants in plant beds or flats or purchasing them from a supplier, the important factor is pest-free plants. The earlier that plants become infested, the more severe the effect on yields. The most important time of pest

exclusion is during the transplant stage. Therefore, clean the hands and all tools used in the production of transplants. Freeing hands of virus contamination requires long, hard scrubbing with soap and water.

Disease Management in the Greenhouse

Management of diseases during transplant production in the greenhouse is a vital first step toward producing a healthy crop. The best strategy is to prevent disease by using clean seed, proper sanitation and appropriate environmental conditions.

Ideally seed that has been tested for the presence of pathogens should be used. If testing has not been done, seed treatment may be considered (see page 24). Planting mixes, flats, benches, tools, etc., must be clean and free of pathogen propagules. Benches should be raised and watering hoses and nozzles should be kept off the floor or ground. Plants should not be overwatered and greenhouses should be well ventilated.

A few chemicals are labeled for disease control on greenhouse vegetable crops. Botran may be used for control of white mold (sclerotinia) and Botrytis (gray mold, leaf rot or stem canker) on cucumber, lettuce rhubarb and tomato. Apply according to labeled rates and timing.

Mancozeb may be applied to cucumbers, melons, squash, tomatoes and watermelons in the greenhouse for the control of various diseases (see label). *Note that mancozeb, as an EBDC fungicide, may not be acceptable to vegetable processors and some other markets (see page 58)*.

Disinfectants for Use in and Around Plant Beds and Greenhouses

Bleach (sodium hypochlorite, calcium hypochlorite) (5.25%, diluted 1:9).

- Use: surface disinfectant. Effective against small microbes such as viruses, bacteria and fungus spores. Surfaces should be visibly clean before they are wiped or dipped in solutions. Has good penetration activity.
- Disadvantages: no residual action, corrosive to iron. Solutions rapidly lose activity, especially in light or in the presence of organic matter. Not effective in killing fungus sclerotia or other resting structures.

Phenols (Amphyl, Lysol, CM-19); usually contain surfactants and alcohol (1-3 oz/5 gal of water).

- Use: surface disinfectant. Effective against bacteria and fungus spores. Solutions retain activity for some time.
- Disadvantage: not effective against fungus sclerotia or viruses. Poor penetration. Rapidly broken down when in contact with organic matter.

Quaternary ammonium compounds (Physan-20) (1 oz/2 gal water).

- Use: surface disinfectant. Good algicide.
- Disadvantages: not effective against viruses or fungus sclerotia. Very reactive and breaks down quickly on contact with air and organic matter. Poor penetration. Compounds should be used promptly after mixing.

Damping-off of Seedlings

Vegetable seedlings often germinate poorly under humid conditions, particularly if soils are cold and wet. Damage usually is caused by one or more soil-borne fungi that attack under conditions unfavorable for rapid seed germination and growth.

Seeds may rot or seedlings may decay before emerging (pre-emergence damping-off). Young plants that do emerge are weak and often wilt from infection at or below the soil line (postemergence damping-off). The bases of infected stems generally are water-soaked at first, turn gray to brown or black, then rot. Seedlings of cabbage, cauliflower, radish, tomato and beans may be girdled by brown or black sunken cankers. Stems of these plants may shrivel and become dark and woody (wirestem or collar rot), but the plants normally do not collapse. These transplants grow slowly.

Control measures for damping-off primarily are preventive, because the disease usually is quite difficult to stop once symptoms are seen. The strategy is to eliminate the fungi that cause damping-off or to provide chemical barriers that prevent the fungi from growing. Suggested practices are:

- Use only certified disease-free seed from reputable seed producers.
- Use fungicide-treated seed. Some fungicides are labeled for application to certain vegetable crops for control of damping-off. See specific crop recommendations and the following section, "Seed Treatments."
- Sterilize plant beds if practical, or use a commercial, disease-free, soil-less mix in flats or pots.

Plant Growing					
Germination and Growing Guide for Vegetable Plants and Herbs					
Crop	**Opt. No. of Seeds per Oz**	**Opt. Germination Temp. (°F)**	**Usual Day Temp. (°F)**	**Min. Night Temp. (°F)**	**Time for Uniform Germination (days)**
Asparagus	700	75			10-21
Broccoli	9,000	68-86	65-70	60	5-10
Brussels sprouts	9,000	68-86			5-10
Cabbage	9,000	85	65	60	5-10
Chinese cabbage	18,000	85			3-7
Cauliflower	9,000	80	65-70	60	5-10
Celery	72,000	70	65-70	60	10-21
Collards	9,000	68-86			3-10
Cucumber	1,100	68-86	70-75	65	3-7
Dandelion (for greens)	35,000	68-86			7-21
Eggplant	6,500	85	70-85	65	7-14
Endive	27,000	68-86	70-75	70	5-14
Kale	9,000	68-86			3-10
Leek	11,000	68			6-14
Lettuce	25,000	75	60-65	40	7
Okra	500	68-86			5-14
Pak-choi	18,000	68-86			3-7
Parsley	18,500	75			11-28
Pepper	4,500	85	70-75	60	6-14
Sweet potato plants (from tuberous roots bedded in sand)		77	75-85		14-21
Squash	400	80-90	70-75	65	4-7
Tomato	11,500	85	65-75	60	5-14
Herbs					
Anise	9,600	70			5
Basil					
dark opal	20,000	70			10
Basil					
lettuce					
leaves	9,600	70			10
Borage	2,100	70			8
Chives	22,000	60			10
Coriander	1,240	70			10
Dill	6,300	60			10
Fennel, sweet	4,000	65			10
Marjoram, sweet	100,000	70			8
Rosemary	30,000	60			15
Sage	3,250	70			15
Thyme	96,000	75			10

- Disinfest all flats, cold frames, pots and tools.
- Plant in a light, well-drained, well-prepared, fertile seedbed under conditions that will ensure rapid emergence.
- Avoid heavy soils, overcrowding, poor air circulation, careless handling, too-deep planting and overfertilization (especially of nitrogen).
- Apply a soil insecticide if needed.
- Do not over-irrigate. Do not use pond water or other surface water.
- Provide adequate light for rapid growth.

Seed Treatments

Seed treatments are useful for many vegetable crops for the prevention of damping-off and some other root diseases, as well as eliminating certain diseases carried on the seed.

There are two general types of seed treatment: eradicative and protective. Eradicative seed treatments kill disease-causing agents on or within seed and are useful in controlling certain seed-borne diseases. Protective seed treatments are applied to the seed surface and protect the seed against decay and damping-off caused by soil-borne organisms.

Hot water treatment: Properly used, this treatment kills most disease-causing organisms on or within seed. This treatment is suggested for seeds of eggplant, pepper, tomato, cucumber, carrot, spinach, lettuce, celery, cabbage, turnip, radish and other crucifers. Improper treatment can cause seed injury. Seed of cucurbits can be severely damaged by hot-water treatment.

Pre-warm seed in a loosely woven cotton bag (not over one-half full) for 10 minutes in 100°F water. Place pre-warmed seed in a water bath that will constantly hold the water at the recommended temperature (see table below). Length of treatment and temperature of water must be exact. After treatment, dip bags in cold water to stop heating action. Spread seed out to dry. Always apply a protective seed treatment fungicide to hot-water-treated seed.

Caution: Old seed can be severely injured by this treatment. A small sample of any seed lot over 1 year old should be treated and tested for germination to determine the amount of injury, if any, that might occur.

Fungicide seed treatment: Thiram is the most frequently suggested seed-protectant fungicide. Other fungicides are recommended for specific crops. These fungicides are often combined with insecticides, and these combinations may be superior to fungicide treatment alone. Dust seeds lightly with fungicide in accordance with label directions or purchase seeds already treated.

Do not use treated seed for food or feed.
The following water bath temperatures and treatment lengths should be followed exactly.

Seed	Temp. (°F)	Minutes
Brussels sprouts, cabbage, eggplant, spinach and tomato	122	25
Broccoli, cauliflower, cucumber, carrot, collard, kale, kohlrabi, rutabaga and turnip	122	20
Mustard, cress and radish	122	15
Pepper	125	30
Lettuce, celery and celeriac	118	30

Bleach treatment: Bleach treatment effectively removes bacterial pathogens on the seed surface. Bleach treatment is recommended for peppers, tomatoes, cucurbits and other vegetables if the seeds have not been treated by another method.

Agitate seeds in a solution of 1 qt household bleach in 4 qt water with one teaspoon surfactant for 1 minute. Use 1 gallon of disinfectant solution per pound of seed and prepare a fresh solution for each batch. Rinse seed thoroughly in running tap water for five minutes; then spread out seed to dry. Dust seed with Thiram 75 WP (1 teaspoon/lb seed). Carry out seed treatment near planting time, as viability may be reduced over time. It is recommended that a small sample (e.g., 50-100 seeds) of each seed lot to be treated is treated then tested for seed germination before the entire seed lot is treated.

If coated seed or seed treated with fungicide are further treated with hot water or bleach, waste water should be disposed of in an environmentally sound manner.