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College of Tropical Agriculture & Human Resources – University of Hawaii at Manoa[1]

Transplant & Seedling Diseases

Articles on transplant diseases and related topics from IL, IN, PA, TX, FL, CA,& HA extension newsletters and publications.

WARNING: Information on pesticides in this document may be quite dated or specific only to certain states so please be sure to read the label before purchasing. Note that most articles provided here were written for growers in northern climates. Thus, not all the information is directly applicable to warmer climates. For specific questions and clarifications contact your local county extension agent.

Comment: The information contained herein is quite valuable and provides helpful guidelines on keeping vegetable transplants healthy and disease free; our thanks to the University of Hawaii. I have added a few comments and made a few edits along the way hopefully in clarification of the material – C.S. Vavrina, Vegetable Extension Specialist, University of Florida.

Sterilization and Sanitation of Flats

Alan A. MacNab, Penn State, Vegetable Newsletter Diseases, March, 1996, Volume 25, Number 3

Old flats may be contaminated with fungi capable of causing damping-off of seedlings when grown in such flats; therefore, steam sterilize all flats before re-use. Flats can be stacked on a bench or on the floor and covered with a tarpaulin beneath which steam is released. Minimum treatment should be 180 degrees Fahrenheit for 30 minutes. Flats should be separated horizontally by 0.75-inch strips of wood or stacked in a staggared manner with vertical spaces of about 1-inch. Treated flats can be used immediately.

If steam is not available, and chemicals must be used, chlorine solutions (1 part laundry bleach to 9 parts of water) are probably the most effective sanitizers. Dip the flats; then drain the solution back into the tank. Stack the flats under a tarpaulin for 24-hours; then uncover, but keep flats wet by spraying with water until odor is gone (4 to 6 days). To be sure flats are safe for use, put a wet treated flat into a plastic bag for 24 hours and then check the closed bag for chlorine odor as soon as the bag is opened. Two other kinds of chemical disinfestants are available:

1) Phenolics: Phenol-type disinfestant such as Amphyl LF-10, effective at 1 ounce in 2 gal water.
2) Quaternary ammonium salt compounds such as Physan-20, used at 1 oz in 2 gal of water.

Both the phenolic and quaternary ammonium salt disinfestants are reactive and break down quickly upon contact with air and organic matter. Effectiveness is enhanced by precleaning surfaces before disinfestation. As with most chemicals, disinfestants should be used promptly. **Precaution:** Use rubber gloves when dipping, do not use formaldehyde or chlorine in a house with living plants, and be sure flats are kept wet until all odor is gone. Disposal of all waste solutions can be problematic especially with large volumes and regulations may be in place that govern both use and disposal.

Effect of Transplant Tray Type & Tomato Cultivar on Incidence of Fusarium Crown and Root Rot in Transplants

R. S. McGovern and C. S. Vavrina, UF-SWFREC, Immokalee, Florida - *Proc. Fla. State Hort. Soc.* 106:173-175. 1993

The effect of transplant tray type and tomato cultivar on the incidence of Fusarium crown and root rot caused by the fungus *Fusarium oxysporum F. sp. Radicis-lycopersici* (FORL) was examined in a commercial transplant house. Four common south Florida tomato cultivars, Agriset-76 1, PAP-34283, Sunbeam, and Sunny, were seeded in a peat-based medium in five different transplant trays, two polystyrene and three styrofoam trays with respective cell volumes of 19 and 28 cm3, and 6, 20, and 32 cm^3. Six weeks after seeding, the roots and crowns of eight randomly selected transplants from each tray type were surface disinfected and plated on Komada's selective medium for *Fusarium oxysporum.* Following removal of all transplants and surface disinfestation, cotton tipped applicators dipped in sterile water were used to swab ten cells of each tray and to streak plates of Komada's. Isolation of FORL was assessed 5 days following incubation of plates at 28 C/82 F. No significant differences in varietal susceptibility to FORL were detected. Crown rot incidence was significantly highest in transplants from styrofoam trays with the largest cell sizes (20 and 32 cm3), and FORL was most frequently recovered from styrofoam trays. The greater recovery of the fungus from styrofoam vs. plastic trays may be related to the presence of larger pores in the former which become more numerous as the styrofoam ages, making styrofoam trays more difficult to disinfest. Steam disinfestation of styrofoam at 71 C/160 F for 45 min eliminated FORL. Steam disinfestation of

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transplant trays should be a routine sanitary operation in tomato transplant production to reduce crown rot occurrence. However, care must be taken when steam-treating trays so as not to exceed the temperature recommendations of the manufacturer or damage to the trays may result.

SEED HEALTH IMPORTANT TO A GOOD START

Frank Killebrew, Extension Plant Pathologist

Vegetable crop producers are fully aware that trying to figure out what type of early season growing conditions to expect is most often a "best guess." So the best rule-of-thumb is to get started right in the hope that the weather will cooperate. One of the best ways to reduce the chances for early season disease problems is to use healthy seeds.

Seed selection is an important consideration for producers for several reasons. One of the most important has to do with plant diseases, since our southern climate, with its frequent periods of humid conditions during the growing season, favors the development of many fungal, bacterial, and viral problems that may be carried on infected seeds. Thus, it is generally unwise to save seeds from season to season.

Vegetable producers should purchase seed each year from dealers who have a reputation for selling high quality, disease-free seed. Certified seed should be used when ever available. Examples of seed-borne diseases that can cause severe damage when conditions are favorable are anthracnose of lima beans, early blight of tomatoes, mosaic virus of southern peas, bacterial blights of beans, black rot of cabbage, leaf spots of turnip and mustard greens, an watermelon fruit blotch.

To help prevent diseases of this type, your seedsman will have seeds available that have been produced under stringent guidelines to insure that seeds are free from diseases. Often seeds originate from dry regions, such as the western United States, where diseases are less common.

After selecting good seed, the next step is to make sure the seeds are properly treated with fungicides. Seeds from dealers are often pre-treated (denoted by a reddish or green color) with fungicides such as Captan or Thiram for control of seed decay and damping-off diseases. The use of treated seeds is especially worthwhile when seeds are to be planted in the early season in cool, wet soils, conditions which are favorable for development of seedling diseases. Fungicides applied to seeds reduce seed rot and give some protection from seedling disease during early stages of seedling development.

Growers who have "homegrown" untreated seeds can easily carry out their own fungicide seed treatment. Large seeded crops such as corn or beans can be treated by placing seed and fungicide in a gallon container (use a pint container for smaller seeds) and gently shaking or rotating the container until all seeds are evenly coated with fungicide. As little as 1/2 to 1 teaspoonful of Captan or Thiram per pound of seed may be all that is needed to accomplish this, but the label is you best guideline. Be sure to wash equipment and hands after handling fungicide and treated seeds. Treated seeds should be planted promptly.

Michael D. Orzolek, Peter A. Ferretti, Penn St. Horticulture Vegetable Newsletter, Vol. 8, No. 5, May 1996 adds:

Growers who are interested in a "chemical-free" alternative to fungicide treatment might want to try a hot-water soak. This technique may be used on tomato seeds and cabbage seeds just before planting to destroy many diseases causing microorganisms carried on and within seeds. Seeds should be soaked at 122 degrees F for 25 minutes. Use a large quantity of water with some type of agitator to keep the water temperature as uniform as possible. Note: water temperatures and treatment times in excess of that recommended may kill the embryo or reduce the percentage of seed germination. Lower temperatures will not kill the disease microorganisms. Immediately after this heat treatment, seed should be plunged into cold water to reduce the post treatment “cooking effect”, then removed and planted promptly.

Seed Treatments

Randy Hamasaki, Univ. Hawaii Oahu Vegetable Growers’ Newsletter, Vol. 6 No. 1, March 1994

Starting off with clean seed is a basic and sound step in crop production which is often overlooked by growers. Seed treatments can help prevent early infection by seedborne diseases and help reduce risk of a poor crop stand or crop failure. You have probably read many articles about improvements in seed treatment technology being offered by commercial seed producers. Seed treatment can be broadly grouped into two categories: 1) eradication treatments which kill disease causing agents on or within the seed and 2) protective treatments which are applied to the surface of the seed to protect against decay, damping-off, and soil insects. Seeds of beans, cucumbers, and sweet corn, when planted in unfavorable soil conditions (cold and wet soils), should be treated with Thiram or Captan. The hot water seed treatment is the major means of eradication. Vegetable growers should become familiar with the advantages, limitations and procedures of seed treatments. When using hot-water seed treatment, it is important to precisely follow the temperature and time directions. Use a good thermomoter and a system which provides uniform temperature (no hot or cold spots).

Hot water seed treatment guidelines

Crop	Temperature (^{o}F)	Time (minutes)	Seedborne Diseases Controlled
Broccoli	122	20	Alternaria, blackleg, black rot
Cabbage	122	25	Alternaria, blackleg, black rot
Eggplant	122	30	Phomopsis blight, anthracnose, rhizoctonia
Pepper	122	25	Bacterial spot, Rhizoctonia
Tomato	122	25	Bacterial canker/spot/speck, anthracnose

Reference: Lorenz and Maynard. 1988. Knott’s Handbook for Vegetable Growers, 3rd Ed.

GERMINATION AND CARE OF OUR SEEDLINGS

M. Mirza and M. Younus, Alberta Agriculture, Food and Rural Development CDC, North Edmonton.

It is important to get the maximum germination from the seeds. This can be tough especially when trying to germinate seeds when it is very cold. Here are some reminders:

***Temperature** - Seeds require proper temperatures for germination which is generally higher than what is required once the seed is germinated. The growing medium temperature for tomatoes and peppers is around 75 degrees F and cucumbers, 81 degrees F. Lower temperatures delay seedling emergence, higher temperatures may inhibit germination. Many growers who do not have bottom heat and use over-head heated air to maintain the temperature, may find it difficult to maintain adequate temperature in the plug around the seed. Focus on temperature in the growing medium using a thermometer to check. Rockwool and peat moss growing mediums can show a lower temperature due to evaporative cooling from the surface of the plugs or cubes or pots.

***Moisture** - Saturate the rockwool cubes with pH adjusted water before putting the seeds in cavities. When using bedding plant trays, thoroughly soak them before seeding. It is important to maintain adequate moisture in the germinating media. Remember the seed has to take up water to begin the process. If there is not enough free water available, the seed cannot swell and emergence is inhibited. If media is too wet, oxygen availabilitiy could be a problem.

***Oxygen** - *A* good germination medium can absorb water to its maximum water-holding capacity (it's saturated). Most water held by the growing media is available to the seed. Once saturated, most air in the growing medium has been expelled. After a few hours of drainage, evaporation, and uptake by the seed, air begins to refill the pore space previously occupied by water and this helps the germination process. If the media is too compacted or very fine in nature (i.e., less pore space) reduced oxygen levels can hamper germination.

***Relative Humidity** - Relative humidity is very important for seed germination and is the most neglected factor in forced air heated greenhouses. Erecting a plastic tent over the germination bench helps to maintain close to 100 percent relative humidity. Using intermittent mist also helps to achieve higher relative humidity.

When using a germination chamber, remove trays from the chamber when 60 to 75 percent emergence has occurred. The timing is very critical, done too early and the late emerging seeds are further delayed and if done too late, the seedlings that have already emerged become stretched and leggy. Uniform emergence is often a function of seed quality.

***Early Care** - *Proper* care of the young seedlings is essential to grow good quality plants. Quality plants are the foundation of a productive crop. The focus is on growing a healthy and strong seedling. After germination the temperature is dropped several degrees below the germination temperature so the plants can be hardened off to better handle stress. A complete fertilizer feed has to start early, especially when growing in an inert media like rockwool. Vegetable seedling growers are familiar with the use of higher electrical conductivities or salty conditions (E.C.) to slow down the growth of plants, especially tomatoes. This technique is not advisable for every grower. The goal is to avoid the stretching of the plants by slightly stressing the them by making it harder to take up water, a prime ingredient for growth. Growers can use potassium sulfate or sodium chloride (most commonly used in tomato seedling management) to raise the E.C. of the standard fertilizer solution. The E.C. of seedless cucumbers can be raised as high as 4.0 millimhos, while tomatoes can tolerate an E.C. of up to 7.0 millimhos until the first cluster of flowers are set (flower development actually occurs around the time the tomato shows 4 – 5 leaves in the greenhouse). Calciumnutrition is important. Most fertilizers with N, P, and K do not contain calcium and generally not enough calcium is available in the water. Greenhouse grade calcium nitrate contains about 19 percent calcium, while ready-made 15-0-15 contains about 12 percent calcium. Liquid calcium nitrate may contain even less calcium, 11 percent in one formulation. It is important to know the source of the fertilizer and the amounts of nutritional elements they contain. Spacing is vital! When growing bigger plants, make sure they don't get crowded since crowding results in weak and stretched plants. Often these plants do not recover. – from Michael D. Orzolek, Peter A. Ferretti, Penn St. Horticulture Vegetable Newsletter, Vol. 8, No. 12, December 1996.

POSSIBLE CAUSES OF TRANSPLANT DISEASES

Dan Egel - Purdue Univ. Vegetable Crops Hotline No. 312, Apr. 4, 1996

In greenhouses around Indiana vegetable seeds are being sown, transplants are beginning to emerge and growers are beginning to worry about plant diseases. Diseases may be infectious or non-infectious. Infectious diseases are caused by fungi or bacteria that may be introduced on seed. Such diseases include watermelon fruit blotch, anthracnose of muskmelon, bacterial spot of tomatoes and black rot of cabbage. Other infectious diseases are caused by fungi that survive in the soil. These diseases include rhizoctonia and pythium damping-off diseases which affect a wide variety of plants. Infectious diseases can be eliminated or their spread limited by proper greenhouse sanitation.

Non-infectious diseases are sometimes known as the "too much" diseases. They may be caused by too much or too little water, sunlight, fertilizer, heat, etc. It is important to note that while the bacterium that causes watermelon fruit blotch may spread from one plant to many, a single transplant with fertilizer burn will not affect any of the plants around it. If a grower recognizes an infectious problem, it is best to remove the transplants involved as soon as possible. In addition, healthy trays of transplants next to diseased trays may be contaminated and should also be removed.

Infectious diseases usually start on one plant and spread to nearby plants. Therefore, infectious diseases often occur in clumps of plants with similar symptoms. In contrast, brown spots that occur on every plant in the greenhouse are more likely fertilizer burn than an infectious disease. Similarly, stunted or yellow plants that occur near a heater or along a walk way are probably NOT due to an infectious disease. Problems that start as transplants can end up as problems in the field. Pay close attention to transplant health.

POSSIBLE SYMPTOMS OF TRANSPLANT DISEASES

Rick Latin & Dan Egel –Purdue Univ. Vegetable Crops Hotline No. 314, May 2, 1996.

In previous issues, we have discussed the difference between infectious/ non-infectious disorders and greenhouse sanitation. Now we would like to talk about some of the common seedling problems seen about this time of year.

Damping off: Seedlings may collapse at the soil line. Often, the stem has a brown color at or just below the soil line. Damping off may be caused by soil fungi such as Pythium or Rhizoctonia. Water soaked or shrunken stem lesions (tan or brown) may be an infectious problem even though the stems do not collapse.

Wilting/yellowing: Root diseases can result in wilted and yellowed seedlings. The roots may be brown. These problems may be caused by the soil fungi mentioned above.

Leaf spots: There are many problems that can result in what we call leaf spots. More than 90% are non-infectious. If the spots are located only on the edge of the leaf or between the veins, it is likely that the spots are non-infectious. Seedlings with infectious leaf spots will occur in a clustered pattern (i.e, next to or close by other plants with the same symptoms) within the greenhouse.

Leaf yellowing: In most cases, yellowed leaves are not symptomatic of infectious problems. If the yellowing occurs only on the leaf margins and/or between the veins, the disorder is non-infectious.

Stunting: Sometimes growers complain that their seedlings are just not growing. Often, this can be blamed on poor growing conditions. For example, seedlings that are grown too cold and/or too wet may end up stunted.

DISEASES OF VEGETABLE TRANSPLANTS

Darin Eastburn, Illinois Fruit and Vegetable News, Vol. 2, No. 1, Feb. 21,1996

GREAT TIPS ON GENERAL DISEASE MANAGEMENT: Managing diseases is an important aspect of transplant production, but one that is often overlooked until a problem develops. Diseases that develop during transplant production can be divided into two general types. There are diseases such as Botrytis gray mold and Pythium seedling blight that are usually only problems in the greenhouse. These diseases generally become less important once transplants are placed in the field. There are also diseases that get started on seedlings in the greenhouse, but cause most of their damage after plants are set in the field. The pathogens that cause this second class of diseases usually survive on or in the seed and infect as the seeds germinate. This week's focus will be **Botrytis and Pythium**, other diseases will be covered in the next few issues.

Both Botrytis gray mold and Pythium seedling blight are common on greenhouse-grown plants. They infect a large number of plant species, and develop as a result of environmental conditions in the greenhouse. Both of these diseases are favored by conditions that are common in greenhouses, including: high moisture levels, low light levels, and dense plantings. Once established, these diseases can be difficult to control. Botrytis causes leaf and stem blights on greenhouse grown plants. Relative humidity levels above 90% are required for infection, and temperatures between 68 and 76F are ideal for disease development. Short periods (8 to 12 hours) when the plants are wet are also required for spore germination and infection to occur. Such conditions often develop in the late afternoon and evening as the air within the greenhouse begins to cool. As the air cools, relative humidity levels increase and water condenses on plant surfaces.

Adjustments to heating and ventilation systems can help keep humidity levels down, and increasing air flow within the greenhouse, especially at plant level, can reduce the amount of condensation on plants. To discourage infection by Botrytis, temperatures should not drop below 70F and relative humidity should not rise above 90%. Bottom watering or drip irrigation systems, instead of watering with an overhead spray, also helps keep the foliage drier and reduces problems with Botrytis. Water plants early in the day so that they will dry quickly. Never water in the late afternoon or evening. Fungicides that are registered for use in greenhouses, such as Botran on tomatoes, also may be used to help control Botrytis blights. Pythium can be introduced into greenhouse plantings in the irrigation water or in soil brought in on shoes and tools. It also can be present in planting mixes. Even though most of these mixes have been steamed or treated to kill pathogens, they may be recontaminated between treatment and use. Pythium causes both pre- and post-emergence damping-off by attacking the roots and lower stems of seedlings. The development of Pythium seedling blight is favored by overly wet soils and high humidity levels.

Pythium produces swimming spores (called zoospores) that can easily move in films of water and can spread quickly from plant to plant during periods of irrigation. If Pythium problems develop, remove affected plants and isolate neighboring plants. Attempt to determine and eliminate the source of contamination. Make sure that irrigation water is "clean". If it is coming from an irrigation pond, or some other source that is exposed to contamination, the water should be filtered and possibly treated before use. Well water and city water should be free of Pythium. Manage irrigation water carefully. Do not let soils get too dry, or stay overly wet for extended periods of time. Consider treating the planting mix or switching to a different brand if another source of contamination cannot be identified. Use fungicide-treated seed. Most commercially produced seed is treated with Captan and Thiram, which are broad spectrum fungicides that will provide some control of Pythium.

Ridomil 2E (metalaxyl) is effective for controlling Pythium on many vegetable crops in the field. However, this product is not registered for use in the greenhouse and thus may not be used to control Pythium on vegetable transplants. Another formulation of metalaxyl, Subdue, may be used as a soil drench on certain vegetables including tomatoes and cucurbits. Simple sanitation practices eliminate some sources of inoculum and help control seedling diseases in the green-house. Floors, benches, walls, and equipment should be dis-infected with a 10% bleach solution or other disinfectant. Remove any plant debris and weeds which may serve as a source of disease inoculum. Transplant trays should be dipped or soaked in a disinfectant solution and rinsed before use. Limit access to the greenhouse to essential personnel only, and institute procedures to minimize the amount of soil and other possible contaminants on shoes, clothing, or tools.

PART 2: CRUCIFERS [Illinois Fruit and Vegetable News, Vol. 2, No. 2, March 8, 1996]

There are several diseases of cruciferous crops that are either seed-born or attack the plant primarily in the seedling stage. The most common of these is black rot. **Black rot** is caused by a bacterium that can overwinter on and in seed or on infested plant debris in the field. Once this bacterium is introduced into a seed-bed or greenhouse transplant operation, crowded conditions from high plant densities and high humidity levels favor its rapid spread to neighboring plants. Wetness on leaves or other plant parts is required for infection, and the disease develops most rapidly at temperatures from 80 to 86 F. The margins of infected cotyledons turn black, and eventually the cotyledons shrivel and drop off. Small, yellow, v-shaped lesions are the initial symptoms on the margins of true leaves. These lesions continue to expand and the affected tissues turn brown. Crop rotation and the use of disease free seed are the most effective ways to control this disease. A hot-water-soak seed treatment can eliminate both internal and external bacterial contamination. Cabbage and Brussels sprouts should be soaked for 25 minutes at 122 F, while cauliflower and broccoli should be soaked for 20 minutes at the same temperature Chemical treatments, such as a soak in dilute sodium hypochlorite, are effective only for eliminating bacteria on the outside of the seed. **Blackleg** is another disease that can be carried on and in seed. This disease is caused by a fungus, and infection of the cotyledons usually results in plant death. Circular, light brown lesions develop on true leaves, and circular to elongated forms can develop on stems of infected plants. As with black rot, the most effective means for controlling blackleg is a combination of disease free seed and crop rotation. Fortunately, the seed production industry has done a good job of producing clean seed and treating seeds with fungicides, so that this disease is not as great a problem as it once was. The fungus that causes **Alternaria leaf spot** can also be carried on seed. Infection can occur shortly after germination, resulting in a small dark spot on the stem of the seedling. This often leads to damping-off or stunting of the seedling. Hot-water or fungicide seed treatments will also help control this disease. For all of the above diseases, disease development and spread during transplant production in the greenhouse can be minimized by avoiding high humidity levels and by proper watering techniques that reduce the amount of time the plants are wet. Wire-stem, or **Rhizoctonia** damping-off, is not a seed-born disease, thus not normally a problem in greenhouse transplant production. But it can be a problem in seed-beds or in the field shortly after transplanting. The disease is favored by wet soils with temperatures at or above 75 F. Rhizoctonia attacks the stem of the plant near the soil line. The infected tissue shrivels and turns dark brown. Infected plants may die or be moderately to severely stunted. Neither seed treatment nor crop rotation is effective for controlling wirestem. Seed beds can be fumigated to eliminate the pathogen. After planting, a mixture of 4 oz. of PCNB (75WP) and 4 oz. of Captan (50 WP) in 50 gal. of water can be used to drench 1000 sq ft. of soil.

PART 3: TOMATOES AND PEPPERS [Illinois Fruit and Vegetable News, Vol. 2, No. 4, Apr. 10,1996]

Some of the most important diseases of tomatoes and peppers are seed-born and brought into the field on infected transplants. These include bacterial canker and bacterial speck of tomato, and bacterial spot, which affects both tomato and pepper. As the names indicate, these three diseases are caused by bacteria, and the pathogens survive both on and under the seed coat. Bacterial canker has been an infrequent but serious disease of tomatoes in Illinois. Unlike bacterial spot and speck, **bacterial canker** is a systemic disease that disrupts the vascular system, causing stunting and wilting of the plant. This disease can be difficult to detect in seedlings because it can take 30 days or more from the time of infection to the first expression of symptoms. Infected transplants can look perfectly healthy at the time of planting, but start showing symptoms a few weeks after they have been set in the field. The disease is especially severe on transplants that have been clipped or pruned, as the wounds created during this process provide an easy way for the pathogen to enter the vascular system of the plant. The symptoms of **bacterial spot and speck** on leaves of tomato seedlings are similar, and appear as small, dark brown to black specks or lesions which may or may not be surrounded by a yellow halo. Bacterial spot is also one of the most important diseases on peppers in Illinois. If it is established early and weather conditions are favorable, yield reductions can be dramatic. Initial symptoms on leaves of seedlings are similar to those on tomato, but usually lighter brown in color. All of these bacterial diseases are readily spread by splashing water and through handling (or clipping in the case of tomatoes). One way to reduce the spread of these diseases during transplant production is to repeatedly clean hands and tools before working with a new flat or tray when attending the seedlings. Also, make sure that used transplant trays are thoroughly washed and soaked in dilute bleach or another disinfectant before they are used again. Seed treatments also reduce problems with these bacterial disease. Many seed companies treat tomato and pepper seeds with chlorine or acid based chemicals. Such treatments do a good job of eliminating any contamination on the outside of the seed. However, these treatments do not eliminate any bacteria that are under the seed coat. Hot water seed treatment is more difficult to do, but it eliminates both internal and external contamination. Soaking seeds in water at 122 F for 25 minutes will usually be sufficient for these pathogens. For bacterial canker on tomato it may be necessary to go to 132 F for 30 minutes.

Because seed contamination may be associated with a particular variety or seed lot, it is a good idea to keep different varieties somewhat separated while in the greenhouse. Monitor the seedlings closely, and remove or isolate any flats or trays containing seedlings showing symptoms of bacterial infection. If purchasing planting stock, buy certified disease free seedlings from a reputable supplier. Remember, you rarely come out ahead by purchasing bargain priced transplants. Also, inspect them carefully prior to planting, and remove any trays or flats that contain seedlings with symptoms of disease.

Phomopsis Blight of Eggplant

Randy Hamasaki, Univ. Hawaii Oahu Vegetable Growers' Newsletter, Vol. 6 No. 1, March 1994

Phomopsis blight has caused significant losses to some eggplant fields on Oahu. Phomopsis blight is caused by the fungal organism *Phomopsis vexans* (Sacc. and Syd.) Harter. This disease ranks second only to bacterial wilt in destructiveness to eggplant in the tropics. Phomopsis blight affects the main stems, branches, fruit, and leaves of eggplant. Only eggplant is affected by this disease.

Other names that describe the symptoms expressed in eggplant include: damping off, seedling stem blight, collar rot, canker, leaf spot, leaf blight, stem blight, eggplant blight, tip-over, fall-over, and fruit rot. This disease has been reported in Hawaii since 1925.

Seedling Symptoms. Phomopsis blight can spread very rapidly in fields when seedlings become infected and are later transplanted. The seedlings may show the stem canker (girdling) symptom which can be easily confused with other common damping off organisms. Other diseases in Hawaii such as verticillium wilt and bacterial wilt also cause wilting in eggplant. Growers should learn to diagnose these important eggplant diseases. Laboratory analyses (such as those available through the Extension Service) can be used to confirm greenhouse diagnoses by growers. Pycnidia and pycnospore production are promoted by growth of the fungus on 4 to 7% oatmeal agar, at 68 to 89F and in light.

Disease cycle. The fungus can live within seeds or as spores on seeds and in soil and crop residue. The fungus remains alive for more than one year in fields after eggplant has been grown and cleared away, but completely dies out by the third year. Fungal conidia are spread through splashing rain, insects and tools. Wet weather and high temperatures promote disease development.

Phomopsis blight management. It is important that growers start with clean seed, preferrable certified. Seed batches which have dark or shriveled seeds are suspect. Seeds can be treated for 30 minutes in water at 122F (see accompanying article on seed treatments). Seed beds or nurseries should be kept free of disease or entire fields can become contaminated through infected transplants. Avoid wet conditions in the seed bed or nursery which can promote the spread of the disease. To help keep fields free of inocolum, follow a 3-year or longer rotation. Diseased plants should be plowed under and affected fruit should be picked quickly and disposed of properly. Resistance is available in some foreign varieties and related species. Varieties grown locally are apparently susceptible.

PART 4: VINE CROPS [Illinois Fruit and Vegetable News, Vol. 2, No. 5, Apr. 24, 1996]

As with crucifers, tomatoes, and peppers, some of the diseases of cucurbits that cause problems in the field can start on seedlings in the greenhouse. Gummy stem blight and anthracnose are probably the most common field diseases to develop during transplant production. Bacterial fruit blotch of watermelon and angular leaf spot can also get started on seedlings. Symptoms of **gummy stem blight**, also called black rot on pumpkins, vary somewhat depending on the host crop. Small, green, water-soaked spots often appear first on the undersides of cotyledons. These spots can expand to kill the entire cotyledon, and eventually move to the stem, killing the seedling. Small black specks (called pycnidia) form in infected tissues, and are useful in the proper identification of the disease. On seedlings infected with anthracnose, the cotyledons droop and wilt. Lesions may also form on the stem near the soil-line. **Angular leaf spot and watermelon fruit blotch** also initially appear as dark, water-soaked lesions on the lower surfaces of the cotyledons. All of these diseases can be seed-borne, surviving on or under the seed coat. Thus, the use of disease free seed is important. During transplant production, watch for wilting or dying seedlings and spots or lesions on leaves and stems. If you do notice plants with symptoms, try to determine if there is a pattern to the problem. For instance, are the affected plants scattered randomly among apparently healthy plants, or are there groups (clusters) of affected plants? Try to determine if the problem appears to be spreading. Are there severely affected plants in the middle and mildly affected plants near the edges of the group? These patterns of development can help you determine if the problem is the result of an infectious disease. Diseases such as gummy stem blight and anthracnose often start on a few plants, and gradually spread to neighboring plants, forming groups or clusters of affected plants. Isolate trays containing plants that you suspect may be diseased, and watch the plants in neighboring trays carefully. Overhead watering, handling the plants, and warm, humid greenhouse conditions promote the spread and development of diseases. So take steps to keep foliage dry an to minimize handling of the plants. Fortunately, the most common virus diseases of vine crops, including cucumber mosaic (CMV), watermelon mosaic (WMV), and zucchini yellows mosaic (ZYMV), are not thought to be seed-borne, thus they do not usually show up on seedling in the greenhouse. Squash mosaic (SqMV) is seed-borne, but instances of this disease on vine crops in Illinois have been rare.

CARE OF TRANSPLANTS AND SEEDLINGS IN THE FIELD

TREATING TRANSPLANTS RIGTH

Liz Maynard - Purdue Univ. Vegetable Crops Hotline No. 314, May 2,1996

With the transplant season well underway for cole crops and beginning for the warm season crops in the southern part of the state, here are some reminders on how to "do the right thing" for your transplants. Getting them off to a good start in the field will pay off down the road.

- Harden the seedlings before transplanting. Reduce water and fertilizer applications, and lower temperature by 5 to 10 degrees (but not below 50-55 for warm season crops). If possible, increase light levels by moving them outside. Hardened seedlings will withstand the shock of transplanting better. The object of hardening is to slow growth (not stop it entirely) and promote storage of carbohydrates.
- Set transplanting equipment to plant at the proper depth and cover root ball well.
- Water transplants in after setting. If you use a starter fertilizer make sure it is well-dissolved and evenly mixed in the tank. Be careful not to increase your fertilizer concentration over time as you refill that partial tank over and over again!
- If your transplants did not grow as well as you would have liked this year, try to find out why now. Transplant growing media and irrigation water can be analyzed for pH and nutrients and help diagnosing transplant diseases can all be obtained through you County Extension Agent. Temperature gradients in the greenhouse can be identified by using a thermometer at several locations throughout the house.

Diseases of Vegetables Transmitted by Infected Transplants

J.D. Johnson and G. Philley, Disease Management. In: Vegetable Growers' Hamdbook, 2nd ed. Texas Ag. Extension Service

Crop	Symptoms	Cause
Cole Crops	Yellow "V" shaped lesion at margin of leaf Small galls or swellings on roots	Black Rot (bacterium) Root Knot (nematode)
Eggplant	Yellow foliage frequently with ringspot	Yellows (virus)
Onions	Roots are pink and shriveled	Pink Root (fungus)
Pepper	Plants die rapidly, stems are dark & often woody Angular leaf spots on margin & tips of leaves have ragged appearance Leaves are distored and may have a mosaic appearance, plants are sometimes stunted	Phytophthora Root Rot (fungus) Bacterial Leaf Spot (bacterium) Virus (several viruses).
Irish Potatoes (seed pieces)	Rough, scabby lesions on tubers Brown ring just inside of peeling Small raised areas on surface of potato	Scab (bacterium) Ring Rot (bacterium) Root knot (nematode)
Tomato	Woody dark stems, plants wilt and die Foliage has small angular shaded spots Leaves distored and may have a mosaic pattern, & leaves sometimes curl downward and turn purple & leaves may develop necrotic ringspots Root have small swellings or galls	Collar Rot (fungus) Bacterial Leafspot (bacterium) Virus Leafspots (Viruses) Root knot (nematodes)

DISEASES THAT AFFECT VEGETABLES AFTER TRANSPLANTING

Alan A. MacNab, Penn State, Vegetable Newsletter: Diseases, March, 1996, Volume 25, Number 3

Control programs for the following field diseases should begin in the greenhouse:

Asparagus: Rust.	*Melons:* Fusariurn wilts, powdery mildew, anthracnose, and mosaic viruses.
Crucifers: Blackrot, black-leg, clubroot, Fusariurn yellows, and downy mildew.	*Onion:* Smut.
Eggplant: Fruit rot, and Verticillium wilt.	*Pepper:* Bacterial spot, and mosaic viruses.
Lettuce: Botrytis gray mold, and mosaic virus.	*Tomato:* Bacterial spot, speck, and canker; Fusarium and Verticillium wilts; and mosaic viruses.

Control: Controls include use of pathogen-free seed, various seed treatments, use of disease-resistant varieties, use of pathogen-free media, control of weeds that are sources of viruses, control of insects that transmit viruses, isolation of seedlings from diseased plants, inspectoin of field plantings from transplants with a history of infection you believed you controlled, application of specific bactericides and fungicides, and minimizing contact with seedlings.

RHIZOCTONIA SEEDLING BLIGHT

T. Kucharek, Univ. Florida, Coop. Ext. Serv. Pl. Path. Fact-Sheet, PP—I

Rhizoctonia, a soil inhabiting fungus affects a number of vegetables including beans, cabbage, carrot, celery, cowpea, cucumber, lettuce, okra, peas, pepper, potato, soybean, strawberry, and tomato. Rhizoctonia is capable of causing plant diseases over a broad range of soil temperatures, soil pH, soil types, fertilizer levels, and soil moistures. The versatile nature of Rhizoctonia results from its broad genetic potential. Individual isolates of Rhizoctonia can cause plant disease on numerous plant species and under varied environmental conditions. For practical reasons, Rhizoctonia is becoming known as "Rhizoctonia complex" as compared to its old name Rhizoctonia solani. Even though soil fumigation is highly effective against Rhizoctonia, recontamination of fumigated areas should be avoided. Any method that reduces movement of soil from nonfumigated areas to fumigated areas will achieve this goal. For example, minimize stepping in fumigated areas from nonfumigated areas. Avoid soil wash due to rain or irrigation from nonfumigated to fumigated areas.

The following control measures used collectively will reduce seedling blights caused by Rhizoctonia and other fungi. The major objective with this group of control measures is Rhizoctonia control on seedlings and stems of young plants by establishing a fast growing seedling, which essentially reduces the "hazard time" as young tender plants are more susceptible than older plants.

l) Use only healthy disease-free seed, seed pieces, or transplants. Although Rhizoctonia is not notorious for being seed transmitted, poor quality seed will germinate slowly, if at all, which offers a distinct advantage to Rhizoctonia.

2) Avoid deep seeding, if moisture permits, as deep planting is advantageous for Rhizoctonia infection. Likewise, deep setting of transplants should be avoided, despite several publications showing marked advantages for deeper planting of transplants (Mangan et al., 2000, HortScience, 35(4):593-595; Vavrina et al., 1996, HortScience, 31(2):190-192; Vavrina et al., 1994, HortScience, 29(10):1133-1135)

3) Especially in fields where fumigation was not used, plant when the soil temperature is suitable for rapid germination;

4) Seed should be treated with fungicide for protection against infection from Rhizoctonia in the soil. Seed treatment fungicides such as Captan and Thiram are nonsystemic in the plant, but they are labeled for use on numerous plant species...

5) Use crop rotation;

6) Prepare land so that a minimum amount of old plant debris is on the soil surface;

7) When double cropping, allow green matter to decompose for 30 days after bottom plowing the old crop. Undecomposed green matter has been a major source of Rhizoctonia inocolum on green beans and soybeans in Florida;

8) Control soil insects and nematodes. These organisms weaken the plant, thereby predisposing the plant to infection;

9) Avoid over seeding and close transplanting as Rhizoctonia can grow from an infected plant to adjacent healthy plants;

10) When cultivating, avoid moving the soil onto stems.

TOMATO SEEDLING DISEASES IN THE FIELD

Rick Latin - Purdue Univ. Vegetable Crops Hotline No. 315, May 16,1996

The general health and vigor of our pepper and tomato transplant crops appear to be very good, despite the lack of sunshine and preponderance of cool, dark, wet days. There are, however, a few problems out there that growers should be aware of. For the first time in many years, we isolated the bacterial speck pathogen from tomato transplants raised in an Indiana production facility. As you may recall, we've had problems with bacterial spot and bacterial canker in the past. Symptoms of bacterial speck are nearly identical to those of bacterial spot on young seedlings. You should be alerted if you observe a cluster or clusters of small (1/16" diameter), round, dark brown-black spots on true leaves. The cluster pattern of distribution is an important sign of an infectious problem. The spots will appear on otherwise healthy leaflets, and are often surrounded by a yellow halo. Unlike noninfectious spots on seedlings, bacterial speck symptoms will not occur only between the veins and also will occur on petioles.

I advise discarding plants with symptoms, and at least all plants (symptomatic or not) in plastic trays bordering those with spots. It would be wise to isolate other plants from the same seed lot and observe them closely for additional outbreaks. Treatment with copper hydroxide may reduce spread in the field. Also, the onset of warmer and drier weather conditions will dramatically slow the increase of symptoms in the field.

I have also observed a case of black root rot on tomato seedlings. The disease is caused by a common soil fungus that takes advantage of plants that are stressed due to growth in small-celled trays during unfavorable weather periods. The seedlings will appear somewhat stunted, and show uneven growth over a single tray or within a given area. Removal of the seedling from its cell will reveal a layer of darkened roots near the top of the cell. This disease can be outgrown by the plant if it is placed in more favorable conditions. The general rule of thumb is that if the plant is not wilted and has a fairly extensive root system with plenty of white roots at the margins of the cell, they will survive and produce in the field.

CULTURE & MANAGEMENT IN A WET YEAR

Michael D. Orzolek, Peter A. Ferretti, Penn State Horticulture Vegetable Newsletter, Vol. 8, No. 7, July 1996

Growers may be noticing yellowing, purpling, or interveinal chlorosis in their crop plants after so many weeks of rain. The diagnosis may be infectious so look closely for disease symptoms, but most likely it is a non-infectious situation you are observing. With so much rain in the last 6 weeks, leaching of nitrates from soils has occurred. Addition of modest amounts of fertilizer (20 to 40 lbs/A of actual N) may help ensure maximum yields at harvest time. Potassium levels may be low too because potassium is moderately water soluble and would have been leached this last 6 weeks with above normal rainfall in most counties of the state. Loss of phosphorus is quite likely not the problem as P doesn't leach readily, so choose a fertilizer without P, such as a 8-0-8, for your sidedressing.

DISEASE TO WATCH FOR IN WET WEATHER

Darin Eastburn, Illinois Fruit and Vegetable News Vo l. 2. No. 9, May 30,19961

Although weather conditions have varied somewhat over the state, most areas have had an over-abundance of rain. The wet and warm conditions of the south and the wet and cool conditions of the north may result in the development of particular disease problems on vegetable crops. The hard, driving rains that occurred in many areas not only helped spread pathogens from plant to plant and soil to plant, they also created small wounds on leaves and stems that can serve as sites of infection. In areas receiving heavy rains, growers should be especially watchful for bacterial diseases. Not only do bacterial pathogens need splashing rain and films of water on plant surfaces to spread and infect, many of them can only enter plants through wounds or other openings in the plant. The prevalence of bacterial spot on peppers and tomatoes, bacterial speck on tomatoes, angular leaf spot on cucurbits, black rot on crucifers, bacterial blights of snap beans, and other bacterial diseases may increase following heavy rains. For these diseases it is important to recognize the problem early and begin applications of copper based fungicides/bactericides as soon as symptoms appear. Other diseases to watch for over the next few weeks include early blight and Septoria leaf spot on tomatoes, especially in the south. On vine crops watch for the initial symptoms of Alternaria leaf spot, gummy stem blight, and anthracnose. Phytophthora blight may become a problem on peppers and vine crops in low areas or where soils remain saturated for an extended period of time. On sweet corn, symptoms of northern leaf blight, gray leaf spot, anthracnose, and other foliar diseases may begin to appear in the near future. Many of these diseases are particularly damaging to young plants, so it is important to identify problems early and initiate the appropriate management strategy.

COOL/WET SOILS AND PROBLEMS WITH DAMPING OFF, ROOT ROTS, AND SEED DECAY

Darin Eastburn, Illinois Fruit and Vegetable News Vol. 2, No. 6, (Part 2), May 8, 1996.

Much of Illinois has received healthy doses of rain (and more) over the past few weeks. The combination of wet soils and the continuing cool temperatures means that conditions are favorable for some of the pathogens that cause root rots, damping-off, and seed decay diseases. Root rots and damping-off caused by species of Fusarium, Pythium, and Rhizoctonia are usually more severe in cool wet soil because the plants grow slowly and remain in the susceptible seedling stage for a longer period of time. This gives the pathogens more time to infect and damage roots and lower stems. Green beans are particularly susceptible to these seedling and root rot diseases.

Cabbage and other crucifers may develop "wire-stem" as a result of infection by Rhizoctonia solani at or just below the soil line. Dark sunken lesions girdle the stem, leaving the wiry inner tissues of the lower stem. Plants with wire-stem usually do not fall over, but they do stop growing and develop an unhealthy stunted appearance. Captan and Thirarn seed treatments will be of some help in protecting the seed, but they may not be enough when conditions are extremely favorable for disease development. PCNB (Terraclor) can be used on green and dry beans and some direct-seeded crucifers to help control Rhizoctonia root rots and wirestem. PCNB is available in several formulations and is applied to the seedbed at the time of planting. It is not registered for use after seeding or transplanting.

Products containing the fungicide metalaxyl will help control damping-off, root rots, and seed rots caused by Pythium. Metalaxyl (Ridomil) can be applied as a seed treatment (Apron) on legumes, beets, carrots, and corn. Ridomil may also be applied to the soil as a pre-plant incorporated treatment or to the soil surface after planting on several vegetable crop species. Ridomil PC 11G contains a combination of metalaxyl for the control of Pythiurn and PCNB for the control of Rhizoctonia on beans. Unfortunately, there are no fungicides that are very effective for controlling seedling problems caused by Fusarium. From a diseases prevention standpoint, it is always best to plant into a warm, well drained soil, but other factors may require that seeds or transplants be planted in a less than ideal environment. By being aware of the problems associated with seedling or transplanting in cool, wet soils, growers will be better able to assess the risks and benefits of planting early.

DAMPING OFF OF COLE CROPS

Darin Eastburn, Illinois Fruit and Vegetable News Vol. 1, No. 5. May 17, 1995

The cool, wet conditions of the past few weeks have been very favorable for pathogens that attack seedlings of cabbage and other crucifers. The soilborne fungi Rhizoctonia solani and several species of Pythiurn are the most common causes of damping-off in crucifers. These fungi usually attack the lower stem just below the soil-line. The infected tissue becomes dark and shrivels, resulting in a condition called wirestem. Plants with wirestern can remain alive, although stunted, for some time, but eventually the plants fall over and die. Plants that have reached the 3 to 4 leaf stage are much less susceptible to damping off. Infection by Pythium is favored by low soil temperatures, whereas Rhizoctonia usually prefers warmer conditions. Damping-off is usually most severe in fields with high levels of green organic matter, poor drainage, or soil compaction problems. The best way to avoid damping-off is to plant in a warm, well drained planting bed.

RAIN AND PLANT DISEASE

Dan Egel & Rick Latin - Purdue Univ. Vegetable Crops Hotline No. 320, July 25, 1996

The microorganisms such as fungi and bacteria that cause plant diseases usually need water to cause and spread disease. So the down pour of rain that has occurred recently in Northern Indiana is bound to result in more plant disease. Phytophthora diseases in particular may become more severe. Since we had such a wet spring, Phytophthora diseases may have already gotten a good start. In addition, some plants remained under water for several hours. Such conditions may weaken the roots as well as other plant parts. When plants become weakened, they more easily become diseased. Phytophthora. blight usually first appears in low areas of the field. If the disease is diagnosed when there are only a few clusters of plants, fungicide sprays may help. Plants already infected with Phytophthora can not be cured. Symptoms on pepper plants can be varied. Growers may notice a general wilt, dark brown-black lesions that girdle roots, stems and branches, rapidly expanding brown-tan spots on leaves, and a rapid rot of affected fruit. The Phytophthora fungus also affects winter squash and pumpkin. Turban and acorn squash appear to be the most severely affected.

To control Phytophthora diseases, many vegetable crops are labeled to permit the application of chemicals such as Ridomil 2E at planting. A few vegetables, such as pepper and tomato, may be sprayed twice after emergence. For tomatoes, a second post planting application may be made up to 4 weeks before harvest. Peppers may be sprayed up to until 7 days before harvest. Read the labels for important information about applying these chemicals. Ridomil, however, will not control the disease on above ground parts. Remember, the purpose of chemicals such as Ridomil is to prevent additional plants from being infected.

Fields that are severely affected by Phytophthora. this year should be rotated out of susceptible crops for at least 3-4 years. Using raised beds with peppers also may provide some relief. Some pepper varieties may have partial resistance. Avoid tank mixes of "try this one too". Frantic application of chemicals at this point is not going to help. Pay special attention to post harvest intervals.

SEEDLING DISEASES OF DIRECT SEEDED VEGETABLE CROPS IN THE FIELD

Darin Eastburn, Illinois Fruit and Vegetable News, Vol. 1, No. 4, May 3, 1995

Soilborne fungi belonging to the genera Pythium, Fusarium, and Rhizoctonia are responsible for many of the seedling, disease problems of vegetable crops. These diseases are usually most severe under conditions that slow the growth of the young plants, such

as cool soil temperatures, overly wet soils, or poor seed quality. The control of seedling diseases involves three areas: the seed, the site of planting, and the environment. Always use high quality seed that will germinate and establish quickly. If possible buy seeds or transplants that are certified as disease free. Many commercially produced seeds are treated with broad spectrum fungicides, such as Captan or Thiram, that will help protect the seeds and young seedlings from seed and soilborne fungi for a week or two after planting. Choose a planting site that is well drained and does not have a history of seed disease problems. Plant at a time when soil temperature and moisture conditions favor rapid germination and growth. The use of raised beds can help improve soil drainage and increase soil temperatures. Fungicides, applied at the time of planting or transplanting, are registered for controlling seedling diseases on some crops such as snap beans and peppers.

Snap Beans: Seedling diseases can severely reduce stands of snap beans. Infection by Pythium, Fusarium, and Rhizoctonia can cause both pre-emergence and post-emergence damping off. Control options include avoiding sites with a history of disease problems; planting in warm, well drained soil, and the use of seed treatment or soil applied fungicides. Most commercially produced snap bean seed comes already treated with Captan and/or Thiram, both of which are broad-spectrum protectant fungicides. Apron, a seed treatment form of metalaxyl, can also be applied to help control infection by Pythium. Ridomil 2E also contains metalaxyl, and is applied to the soil at or before the time of planting. PCNB (sold as Terraclor) can be used to help control Rhizoctonia. Ridomil PC 11G contains both metalaxyl and PCNB, and thus will be useful for controlling both Pythium and Rhizoctonia. None of the fungicides mentioned here are particularly effective for controlling seedling diseases caused by Fusarium.

Sweet Corn: The fungi *Fusariurn moniliforme*, *Penicillium oxalicum*, and several species of Pythium are the most common causes of damping-off and seedling blights of sweet corn. Both Fusarium and Penicillium can survive on infected kernels or in the soil, while Pythium is strictly soilborne. Seedling diseases can be especially serious on shrunken-2 sweet corn hybrids. The production of shrunken-2, or super sweet, sweet corn is hampered by poor emergence, irregular stands, reduced vigor of seedlings, and a high incidence of seedling wilt, when compared to the standard sugary hybrids. One of the reasons for this is that most of the shrunken-2 hybrids were originally developed from lines that were fairly susceptible to some of these pathogens.

Resistant breeding lines are available, and the development of resistant hybrids will help control this problem in the future. Some seed companies treat their seed with several different fungicides to try to eliminate any external seed contamination, and to help protect the seed against soilborne pathogens. At this point the most effective means of managing the problem are those practices which promote rapid germination and emergence of seedlings. Proper preparation of the seed beds and placement of the seed are very important, and techniques like seed priming may help increase germination rates. Those growing shrunken-2 hybrids for the early market may be forced to plant when soil temperatures are too cool, but delaying planting until temperatures are more favorable will help reduce these seedling disease problems.

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