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Florida Plant Disease Management Guide
Volume 3: Vegetables

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Preface

This document is composed of two parts. The first part contains information describing specific diseases for specific crops such as rust on beans. Symptoms and cultural controls are discussed in this first section. Additional information may be obtained in Fact Sheets where listed. Fact Sheets are available online at <http://edis.ifas.ufl.edu/>. Chemical controls are listed as "See PPP-6."

The second part of this document, starting at page 94, is Plant Protection Pointer No. 6, also known as "Extension Plant Pathology Report No. 6, Chemical Control Guide for Diseases of Vegetables." In order to obtain the information on control for rust on beans (example above) or other diseases, the user can read about the symptoms, pathogen biology, and cultural control information in the first section and then refer to the tables in the second section (PPP-6) to obtain chemical control information if needed.

The use of trade names in this Guide is solely for the purpose of providing information. It is not a guarantee or warranty of the products named, and does not signify approval to the exclusion of other products of suitable composition.

In all cases, check the label before using any pesticides. The user is responsible for determining that the intended use is consistent with the label of the product being used. **Read the complete label** for specific instruction as to proper product use. Use pesticides safely.

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PPP6 must be
accessed using
the above link

Beans

Disease Management in Beans: Bush, Lima, Pole, Wax (*Phaseolus* spp.) and Southern Peas (*Vigna* spp.)

Ken Pernezny

Alternaria Leaf and Pod Spot (*Alternaria* spp.)

Symptoms: Symptoms are generally confined to older leaves. Lesions tend to become circular, dark-brown and zonate with advanced age and size. Centers of older spots may appear gray and often fall out, leaving a dark-brown, lesion border and a shot hole effect on the leaf. Petioles and stalks may also become infected, developing dark-brown elongated spots. The most conspicuous symptom is small, raised black pimples on pods that throw produce out of grade.

Alternaria infections of bean plants occur throughout the season in the winter vegetable areas of southern Florida. This disease is often found on plants that have been injured by spider mites or nutrient stress.

Cultural Controls: Avoid nutrient stress that can weaken bean plants. Control insect problems.

Chemical Controls: See fungicides listed for anthracnose control in PPP-6.

Anthracnose (*Colletotrichum lindemuthianum*)

Symptoms: Anthracnose affects all above-ground portions of the bean plant. The most noticeable symptoms are on the pods, especially on lima or butter beans, where the fungus causes yellowish-brown or purple-colored, irregular, sunken spots with dark reddish-brown borders. These spots vary in size and often coalesce. Infections may occur on the under side of the leaf veins, causing a dark, brick-red to purplish color which later turns to dark brown. Elongated dark-red or blackened lesions also may be found on the stems.

Under moist conditions, masses of flesh-colored spores are borne on the surface of the lesions. These small spores are easily spread to other plants by rain or mechanical means. Fields of anthracnose-affected beans should not be cultivated or worked while plants are wet. The spores of the anthracnose fungus bear a sticky substance causing them to adhere to hands and clothing of farm workers and to the bodies of insects and other animals. Disease development is favored by cool, wet weather.

Cultural Controls: Purchase anthracnose-free seed or seed grown in arid regions of the country as the causal fungus can be seedborne. Rotate fields out of beans for at least three years where disease has been a problem. The pathogen can survive in soil for two years.

Chemical Controls: See PPP-6.

Ashy Stem Blight (*Macrophomina phaseolina*)

Symptoms: Seedling infection may occur before or after emergence and appears as small, dark sunken lesions at the base of the cotyledon. The disease progresses quickly into the petioles of primary leaves and then into the shoot tip. Strong winds or cultivation result in the breakage of many infected plants at the soil line. Older plants develop a root and stem rot with sunken lesions. Plants exhibit a one-sided wilt and leaf yellowing prior to plant death. A diagnostic sign is the presence of small, black sclerotia in or on stem and root tissue.

This disease is most severe under very hot growing conditions or when adverse soil moisture or fertility shortens the normal maturity of the crop. The fungus survives as sclerotia and/or mycelium on debris and in the soil. Avoid depositing soil on stems during cultivation.

Cultural Controls: Plant only certified, disease-free seed. Maintain adequate nematode control so plants are not prematurely stressed. Balanced soil fertility and moisture will lessen disease incidence. Rotation is not a satisfactory control measure due to the wide host range of this fungus. Do not deposit soil or stems during cultivation.

Bacterial Blights (*Xanthomonas campestris* pv. *phaseoli*, *Pseudomonas syringae* pv. *phaseolicola*)

Symptoms: There are two bacterial blights occurring in Florida, halo blight caused by *Pseudomonas syringae* pv. *phaseolicola* and common blight caused by *Xanthomonas campestris* pv. *phaseoli*. The symptoms and controls for each are similar.

These diseases may attack the seed, seedlings, leaves and pods. Many seedlings from infected seed may die before or soon after they emerge, but some may continue to live. In either case, they serve as a source of inoculum for nearby plants. During wet weather, lesions on these infected plants produce slimy masses of bacteria that are spread by wind-blown rain or mechanical means. On older plants, the first evidence of infection of the leaves appears in the form of water-soaked spots; and in the case of halo blight, these are often surrounded by a yellow halo. Later, the spotted leaf tissue turns brown and dies. The spots on the pods start as water-soaked (greasy) areas and later become surrounded by a brick-red border.

Cultural Controls: The most effective control is to plant certified blight-free seed. If the disease appears, pickers and cultivators should be kept out of the field while the plants are wet to reduce the amount of spread in the field. Common blight has been found to survive in the soil from one growing season until the next. Beans should not be planted in infested fields for at least three years.

Chemical Controls: See PPP-6.

Cercospora Leaf Blights (*Cercospora canescens*, *C. cruenta*)

Symptoms: These diseases occur on *Phaseolus*, *Dolichus*, and *Vigna* species of beans, with the fungus surviving in crop debris and on or in seed. The disease is fairly uncommon in beans in Florida, but they occur on southern peas commonly. *Cercospora canescens* produces a circular to slightly angular leaf spot with a gray center and a reddish border. Lesions are smaller on lima beans than other species and have more intense red borders.

Cercospora cruenta infects stems, leaves, and pods of mature and senescent plants. Brown to rust-colored lesions (irregular in size and shape) develop on the leaves. These lesions are patch-like in appearance, angular, and form a checkerboard pattern. The leaf undersurface characteristically exhibits the dark, fuzzy growth of the causal fungus. The lesion centers often drop from the dried, necrotic tissue giving a shot-hole appearance.

Cultural Controls: Plant only disease-free, certified seed. Plow up and bury all infested crop debris to reduce the survival of the causal fungi in the field.

Chemical Controls: See PPP-6.

Cladosporium Pod Spot (*Cladosporium vigna*)

Symptoms: Pod lesions start as small, narrow, brown-black spots with a slight yellow halo. Spots enlarge irregularly, turning purplish-black in color. Young pod infection results in pod distortion and some pod drop. Older pod lesions develop a dark border and a light brown center of dead tissue. Leaf infection is less common and is characterized by a brownish-purple mold growth on the undersides of leaves. This is primarily a disease of southern pea.

Cultural Controls: Plant only disease-free seed since this disease is commonly seedborne. Black-eye varieties of Southern peas are more susceptible than purple-hull varieties.

Damping-off and Root Rots (*Pythium* spp., *Rhizoctonia solani*)

Symptoms: Several soilborne fungi will rot bean seed and seedlings from planting time through emergence. This condition is aggravated by deep planting, excess moisture and by the presence of newly incorporated green plant material such as weeds or cover crops. Later stages of infection by these fungi often produce root rots.

Cultural Controls: Control of root rots and damping-off can be aided by preventing saturation of the soil and by chopping all cover crops and allowing them to dry thoroughly before disking or plowing under. Green cover crops should be turned under 6 to 8 weeks before planting time, and the land should be kept disked in order to prevent a new grass/weed cover from developing.

Chemical Controls: Seeds should be treated with a fungicide. See PPP-6.

Fusarium Root Rot (*Fusarium solani* f. sp. *phaseoli*)

Symptoms: Symptoms of infection appear as a reddish discoloration on the taproot as early as 1-2 weeks after plant emergence. Root lesions enlarge and turn dark brown in color. Clusters of roots develop above the lesion and below the soil line as the main taproot becomes riddled with longitudinal cracks, then hollows and dries. In dry seasons, plants will be stunted with poor pod and seed set. Disease symptoms in wet years may be limited to some leaf yellowing due to compensatory surface root development. This common soil fungus, *Fusarium solani*, produces a dry root rot in green beans, limas, southern peas and English peas. This disease is most prevalent in hot weather, in acidic, low nutrient soils.

Cultural Controls: Practice crop rotation and maintain adequate nematode control. Insure the complete decomposition of crop debris or the cover crop by land preparation at least 4-6 weeks prior to planting.

Mosaic (*Bean Common Virus, Bean Golden Virus*)

Symptoms: These diseases are caused by viruses. The leaves of diseased plants become mottled with light and dark green areas, the greener portion of the pattern often becomes decidedly puckered. *Bean golden mosaic* is now the most common and destructive virus of the snap bean. A striking yellow mottling of leaves occurs with this disease. Plants are severely stunted and little yield is obtained. The virus may cause a downward curling of the leaf margins, and in some varieties extreme malformation of the leaves occurs. The whole plant may become stunted and have a pale yellow appearance. Flowers may shed freely, resulting in late and irregular setting of the pods. Usually the earlier the plants become infected, the greater will be the reduction in yields. Bean common mosaic of bean and are spread via seed and aphids. *Bean golden mosaic virus* is spread by whiteflies.

Cultural Controls: Purchase virus-free seed. The best seed is produced in the dry areas of the United States (Idaho, Oklahoma, Wyoming, Colorado, etc.). The use of resistant varieties offers the only other practical means of control. Seed treatment or eradication of the aphid or whitefly populations has not been successful on a commercial scale. However, control of the virus-bearing weeds in and around the field and the vectors that spread the virus will help in reducing infection.

Powdery Mildew (*Oidium* sp.)

Symptoms: The first evidence of the disease is the presence of small, dark-green areas in a mottled pattern over the leaf. These develop into white talcum-like spots that increase in size and run together to form a whitish, powdery growth, primarily over the upper surface of the plant. If infection is severe, the diseased leaves curl downward and become distorted and pale yellow. The pods become mottled or blotched with purple and have little direct evidence of mildew growth.

This disease is usually most severe during cool, humid weather or following application of irrigation water during cool weather. In Florida, these conditions normally occur during late fall and early spring.

Cultural Controls: Avoid late spring plantings.

Chemical Controls: See PPP-6.

Red node (*Tobacco streak virus*)

Symptoms: Red node is caused by a strain of the *tobacco streak virus* (TSV). It is a sporadic problem, but has occurred in several seasons in the Belle Glade, FL farming region. The initial symptom is usually a characteristic reddening of the node of bean stems. Veins of leaves may also be reddish and turn necrotic. Sunken, reddish lesions may form on pods.

Cultural Controls: Plant disease-free seed. Control leguminous weeds that may be source of TSV.

Rhizoctonia Root, Stem, and Pod Rot (*Rhizoctonia solani*)

Symptoms: Rhizoctonia is a soilborne fungus that can rot bean seeds prior to emergence from the soil. Young seedlings develop brick-red to brown, sunken lesions on the tap root and basal stem. When the disease is severe, the tips of branch and tap roots may rot off leaving reddish-brown stubs. Such plants are weakened and may not survive. Above ground symptoms appear as lower leaf chlorosis with leaf marginal and tip burn and stunting. Older plants are affected similarly to seedlings.

In addition, leaves and pods can be affected. Leaves become irregularly blighted with reddish-brown spots. During moist, warm weather, the tan strands of the causal fungus can be seen matting leaves together or spanning the distance from the soil to the lowest leaves. Pods develop typical sunken, brick-red lesions both in the field and during shipment, especially near tips close to the ground.

This disease is so common on beans in Florida that 100% field infections are not rare in spring or fall. Stand losses up to 75% have been reported.

Cultural Controls: Turn under summer vegetation 3-4 weeks before planting, practice rotation, plant disease-free seed, maintain good drainage and plant not deeper than 1-1.5 inches. At harvest, cull out all pods showing the disease to prevent its spread in transit.

Chemical Controls: Use Chloroneb, Demosam or Vitavax seed treatments.

Rust (*Uromyces appendiculatus*)

Symptoms: Occurs on the leaves and rarely on the pods in Florida. The first evidence of the disease is the presence of small, pale-yellow spots on the upper side of the affected

leaves. Usually, 2-3 days later, cinnamon-brown pustules about 1/16 inches in diameter appear in the yellow spots and break open, exposing the spores. Under severe conditions, the rust pustules may be so numerous that the whole leaf becomes yellow, withers and dies. This loss of foliage can greatly reduce the yield. Conditions most favorable for severe rust infections in South Florida usually occur during the late winter-spring months, beginning in February or March. Crop losses are greater when rust pustules are numerous before blossoming, rather than when the disease appears after the blossoms have formed. Traditionally, this disease has been most severe on pole beans in South Florida.

Cultural Controls: For bush and pole beans, plant resistant or tolerant varieties where they are adapted. Avoid late spring plantings.

Chemical Controls: See PPP-6.

White Mold (*Sclerotinia sclerotiorum*)

Symptoms: Most infections begin on flower petals that have fallen onto plants. Young plants diseased by this fungus have a watery soft rot of the stem beginning near the soil line and extending up to the primary leaves. Older plants may be invaded on any growing part, including the pods. A day or two after infection, a white fungal growth appears over the diseased parts. Later, black sclerotia (irregularly shaped, hard bodies) ranging from 1/4 to 1/2 inch in length are produced by the fungus. The presence of these sclerotia is an identifying characteristic that is unmistakable. Most of the infections occur when the plants are at or near blossoming time.

In addition to being called white mold, this disease is known as watery soft rot, sclerotinose, and sclerotinia rot of beans. During periods of cool weather accompanied by frequent rains, fogs or heavy dews, epidemics of white mold can be expected. The disease will develop after 20 or more days, with a mean temperature of 70° F or below, in an area in which the soil is infested with the sclerotia of the fungus. The lower temperatures stimulate the production of small mushroom-like, spore-bearing, fruiting bodies. The spores (ascospores) from these are discharged into the air and are disseminated by wind and splashing rain. Virtually all inoculum in Florida is ascosporic.

Cultural Controls: Turn soil at least 6 inches deep where possible. Flooding fields for 5-6 weeks during summer months will effectively reduce the number of sclerotia in the soil. Before using flooding as a control measure, find out from local authorities if drainage into a given body of water after flooding of agricultural fields is permissible. Plant seed farther apart (2-3 in) within bean rows to allow for adequate air circulation when plants mature.

Chemical Controls: See PPP-6.

Southern Blight (*Sclerotium rolfsii*)

Symptoms: Infection by the southern blight fungus usually produces a sudden wilting as the first symptom, followed by the appearance of a collar of fan-like, white fungal

mycelium. This band of white fungus threads is attached to the stem at the soil line and may spread over and into the soil for a radius of one or more inches. Death of the plant follows soon thereafter. If an infected plant is pulled, it brings with it soil which adheres to the mycelium around the stem.

In the white mycelium, numerous sclerotia are produced both on the plant and on the mycelial threads on the soil. The sclerotia first appear as white nodules, but later turn tan and are about the size of cabbage seed. Under favorable conditions, the sclerotia germinate by producing mycelial threads, which can live for long periods on organic material in the soil. It occurs throughout Florida and is especially prevalent in soils that have been cultivated for many years. Southern blight is a warm weather disease and occurs on beans in early fall and late spring plantings. The fungus is preserved over periods of unfavorable environmental conditions in the form of sclerotia and is disseminated in water, in soil, and on farm machinery.

Cultural Controls: Long crop rotations with grass crops are best. Turn under cover crops and weed cover at least 6 inches deep as far ahead of planting as possible to allow decomposition of the plant material before bean seeds are planted. A minimum of a week or 10 days for lower Florida east coast, to several weeks further north should elapse between turning under weeds (or cover crops) and planting. The ground should be kept clean of subsequent grass/weed growth until planting.

Wet Rot (*Choanephora cucurbitarum*)

Symptoms: This disease has been reported throughout Florida on beans and southern peas. It is found on bean foliage, blossoms and pods. On the foliage, symptoms begin as water-soaked areas without external white mycelium; these lesions then enlarge, darken and dry with age. Signs of the fungus become evident on both surfaces of the leaf as well as on blossoms and pods. These consist of whitish fungal growth tipped with numerous black spore-bearing structures, giving the appearance of “whiskers”. It can be expected during periods of excessive rainfall and high temperatures.

Cultural Controls: Avoid excessively high plant populations that may favor disease incidence. Some data exists to indicate that disease severity is correlated with high populations of cowpea cuculio on southern pea plants.

Chemical Controls: The fungicides such as Botran when used to control other diseases will provide control of this disease.

Cantaloupe

Disease Management in Cantaloupe (*Cucumis melo*)

Pam Roberts and Tom Kucharek

Alternaria Leaf Spot (*Alternaria cucumerina*)

Symptoms: Small circular spots (may appear water-soaked) develop on leaves and enlarge to 1/2 inch or more across. Concentric rings appear in the spots as they enlarge, giving a "target spot" appearance. Fruit is seldom attacked unless plants are nutrient deficient. The pathogen over-seasons on infected plant debris and spores are wind-borne and rain-splash dispersed. See Plant Pathology Fact Sheet PP-32.

Chemical Controls: See PPP-6.

Angular Leaf Spot (*Pseudomonas syringae* pv. *lachrymans*)

Symptoms: Symptoms occur on the leaves, stems, and fruit. Spots on the leaves are irregular in shape, angular, and water-soaked. Free moisture allows the bacteria to ooze from the spots, which, upon drying, leave a white residue. These spots of dead tissue will occasionally drop away from the healthy tissue leaving irregular holes in the leaves. Bacterium is seedborne and rain-splash dispersed. This bacterial disease occurs during cool weather.

Cultural Controls: Use pathogen-free seed. Rotate land. Avoid handling plants when wet.

Chemical Controls: See PPP-6

Anthracnose (*Colletotrichum lagenarium*)

Symptoms: This disease has not been a common disease in Florida. The disease symptoms first appear on the foliage as small, yellow, water-spots that enlarge rapidly and turn brown. The dead tissue dries and may crack and fall out. On the stems, the lesions are elongated. On the fruits, dark, circular, sunken lesions appear, varying in size with the age. During wet weather the center of the spots often show a pinkish color due to production of spores.

Cultural Controls: Choose resistant varieties. Deep plow plant residue and practice crop rotation.

Chemical Controls: See PPP-6.

Bacterial Fruit Blotch (*Acidovorax avenae* subsp. *citrulli*)

Symptoms: Angular, water-soaked leaf spots that are restricted by leaf veins occur in an aggregated pattern on leaves. Lesions may appear as pin-striping aside of veins. During dry conditions these spots become light brown and have a papery thin consistency. Sunken spots that are slightly water-soaked, and green occur in fruit. These sunken spots can be 1" or greater in diameter and may occur anywhere on the fruit, but they are most common on the top and sides of the fruit.

Cultural Controls: Purchase seed that are indexed to be free of bacterium. Purchase transplants that are disease-free. Use crop rotation with non-cucurbit crops. Destroy cucurbit weeds and cucurbit crop volunteers.

Chemical Controls: See PPP-6. Use copper-containing fungicides if necessary.

Cercospora Leaf Spot (*Cercospora citrullina*.)

Symptoms: Leaf spots are small (ranging from 1/8"-1/4" in diameter), circular and often are surrounded by a slight yellow halo. The lesion centers typically develop a white color. Spores are air-borne and rain-splash dispersed. Fungus over-seasons on plant debris and weed hosts

Cultural Controls: Destroy infected plant material.

Chemical Controls: See PPP-6.

Damping-Off (*Pythium spp.*, *Fusarium spp.*, *Rhizoctonia spp.*)

Symptoms: This disease on seedling cantaloupes is caused by several soil-inhabiting fungi that are almost universal in occurrence. These fungi infect portions of the plant at or below the soil level, resulting in collapse and death of the seedling. Conditions unfavorable for rapid emergence of cantaloupes (cool, wet weather) are usually most favorable for this disease. Plant in well-tilled soil where old crop and weed debris has been plowed down 30 days previously. See Plant Pathology Fact Sheets PP-1 and PP-53.

Chemical Controls: Plant only fungicide-treated seed (most seed is purchased pre-treated). See PPP-6.

Downy Mildew (*Pseudoperonospora cubensis*)

Symptoms: This disease first appears on the foliage as pale areas separated by islands of darker green tissue. These spots develop into an angular, yellowish lesion. Older lesions become brown and necrotic. Severely affected leaves may become chlorotic, brown and shrivel. During moist periods, a grayish spore mass may be observed on the lower leaf surface under these spots. Spores are dispersed by wind. See Plant Pathology Fact Sheet PP-2.

Cultural Controls: Choose resistant varieties.

Chemical Controls: See PPP-6.

Gummy Stem Blight (*Didymella bryoniae/Phoma cucurbitacearum*)

Symptoms: On young seedlings, lesions on the cotyledons and true leaves are round or irregular, brown, with faint concentric rings. Lesions on the crown and stem are brown and usually turn white with age. The causal fungus can often be observed to reproduce on the crowns or stem lesions and will produce small black specks (pycnidia) in the plant tissue. The fungus over-seasons on old plant debris and can be seedborne. The pathogen is spread by splashing rain from plant to plant, or be carried long distances on wind currents. See Plant Pathology Fact Sheet PP-27.

Cultural Controls: Avoid planting in fields with residual cucurbit crop debris still present. Purchase disease-free transplants.

Chemical Controls: Use treated seed. See PPP-6 for foliar fungicides.

Powdery Mildew (*Erysiphe* sp./*Sphaerotheca fulginea*)

Symptoms: The fungus affects the leaves and stems. Symptoms first appear as round whitish spots on the under side of the older leaves. The spots increase in number and size and coalesce. These appear on the upper surface with a white powdery growth. Severely affected leaves lose their normal dark color, become pale yellow green, then brown, and shrivel. The young stems may also be killed. Fruits of infected vines ripen prematurely, are of poor quality and often become sunburn. Spores are readily wind-dispersed.

Cultural Controls: Purchase disease-free transplants.

Chemical Controls: See PPP-6.

Viruses (*Cucumber mosaic virus*, *Papaya ringspot virus*, *Watermelon mosaic virus 2*, *Zucchini Yellow mosaic virus*)

Symptoms: Leaves show varying degrees of mottling, distortion and stunting. Growth habit may altered as infected vine tips appear more erect. Fruits may occasionally be mottled and deformed. These are the most common viruses in cantaloupe in Florida. They may also occur naturally on many weed hosts throughout the state and is moved into cantaloupes by aphid feeding.

Cultural Controls: Control weeds in and around plantings. This will aid in virus control. Treating fields repeatedly for aphid control is not recommended because of the short time period needed by aphids to transmit the virus while feeding. JMS Stylet Oil can be sprayed in a rigorous program to delay the onset of the epidemic.

Carrot

Disease Management in Carrot (*Daucus carota*)

Tom Kucharek

Alternaria Leaf Spot (*Alternaria dauci*)

Symptoms: The disease usually starts on older leaf margins causing dark-brown to black spots with yellow borders. Numerous spots causing death of interveinal tissue can kill an entire leaflet. Spots on leaf petioles (stems) elongate and can kill an entire leaf. The fungus may also cause a shallow, firm, black decay of the roots. The disease favors the cooler portions of the production season.

Chemical Controls: See PPP-6.

Bacterial Blights (*Xanthomonas campestris* pv. *carotae*)

Symptoms: Irregular brown spots are produced on the leaves, and dark brown streaks and spots on the petioles. The spots start as small yellow areas with an irregular halo. Brown to reddish spots are produced by root infections. These sunken or raised areas may crack open.

Seed Treatment: Treat seed 25 minutes in water at 126° F if seed is contaminated. Use pathogen-free seed. Use crop rotation. Indexing of seed for this bacterium can be done with PCR.

Chemical Controls: See PPP-6.

Cavity Spot: (*Pythium* spp.)

Symptoms: Lens-shaped cavities form on the root with the longer portion of the cavity oriented perpendicular to the length of the roots. The spots may be up to ½ inch in length and generally less than 1/8 to ¼ inches deep. They may or may not have a dark color. Often the depression occurs and the spot remains orange.

Cultural Controls: Flooding of soil where allowed is helpful. Resistant cultivars may be available. Use crop rotation. Use fields not prone to flooding during cropping season, used raised beds. Avoid fields with a known history of this problem if possible. Early harvests will allow for less disease.

Chemical Controls: Use Ridomil at planting. See PPP-6. Some seed treatments may be helpful.

Cercospora Leaf Spot (*Cercospora carotae*)

Symptoms: This disease affects all foliar plant parts but not the root. Young leaves are affected first with marginal leaf lesions. Spots are small, round with a tannish-gray to black center and an indefinite yellow halo. Several spots on the same leaf may cause withering and death. Lesions that develop on leaf stalks are pale centered, elliptical, tan spots. Warmer, more humid weather favors this disease.

Chemical Controls: See PPP-6.

Damping-Off (*Rhizoctonia* spp., *Pythium* spp., *Sclerotinia rolfii*, *Fusarium* spp. and *Sclerotinia sclerotiorum*)

Symptoms: Seedlings may damp-off at random or in rapidly enlarging circular areas. In the latter case, lesions may be observed well up on the petioles as well as at the soil line. Entire plantings may be lost unless adequate control measures are practiced.

Cultural Controls: Prepare a seed bed that is raised and free of non-decomposed plant debris from previous weeds and crops.

Chemical Controls: Use a fungicide seed treatment. See PPP-6.

Pythium Brown Root (*Pythium spp.*)

Symptoms: Early infection causes a seedling blight. Somewhat later, infection causes a dying of the root tip resulting in excessive branching of the root above that point. Foliage symptoms are wilting, stunting and often yellowing of lower leaves. Harvested carrots give a low yield with many rough and "hairy-root" type roots.

Cultural Controls: No satisfactory control at the present time, but circumstantial evidence suggests that flooding fields, as done for pink rot of celery, may reduce this problem. Also, minimize damage to raised beds with tractor tires and implements. Use field not prone to flooding.

Rhizoctonia Cavity Spot (*Rhizoctonia solani*)

Symptoms: Infection can cause seedling damping-off as well as a crown rot of mature plants. Foliage will wilt and die leaving only a few viable inner leaves. Affected crowns are dark brown to black. A dry, sunken spot develops where lateral roots emerge.

Cultural Controls: There is presently no effective control. Avoid successive carrot cropping in infested fields.

Sclerotinia Rot/White Mold (*Sclerotinia sclerotiorum*)

Symptoms: The causal fungus can cause a damping-off disease but mostly typically infects the crown where it continues to develop as a storage rot. The fungus infects the base of the leaf stalk causing a brown tissue rot. Individual leaves wilt and die, followed by the formation of small black sclerotia on these dead leaves. The fungus spreads rapidly from the leaf base to the crown and upper root surface. Here the fungus produces the characteristic white cottony mycelium and black, irregularly shaped sclerotia. Infected roots appear darker than normal and develop a soft, watery rot either in the field or in storage. There is no sliminess with this rot as there is with bacterial soft rot. This disease can spread rapidly by root contact in storage.

Cultural Controls: A number of actions will contribute to disease control. In disease favorable weather, all strategies will be needed for satisfactory control.

- 1) Rotate to a non-susceptible crop like sweet corn. Avoid susceptible crops like lettuce or celery.
- 2) Turn soil 6 inches deep to bury sclerotia and old crop debris.
- 3) Flood the soil either completely or intermittently for 6 weeks during the summer if the situation allows.

Chemical Controls: See PPP-6.

Southern Blight (*Sclerotium rolfsii*)

Symptoms: Infection typically begins near or at the soil surface. Rotting begins at the top of the taproot and the base of the leaf petioles. These tissues turn brown. Leaves eventually turn brown and they may wilt. The rot in the root progresses downward. Commonly, sclerotia (fungal resting bodies) of the fungus form on white mycelial growth on the soil surface. The sclerotia began as white tufts and turn to various shades of brown. They are about the size of a cabbage seed.

Cultural Controls: Use crop rotation with grass crops and use a mold board plow to aid in burial of sclerotia after planting a susceptible crop like carrots, pepper, tomato, beans, peanut, etc.

Chemical Controls: See PPP-6. Amistar is effective but this disease is not listed on the label.

Celery

Disease Control in Celery (*Apium graveolens* var. *dulce*)**Richard Raid and Tom Kucharek****Bacterial Blight and Brown Stem (*Pseudomonas cichorii*)**

Symptoms: While bacterial blight often occurs in the seedbeds, it occasionally causes extensive damage in the field. Bacterial blight leaf lesions may be easily confused with those caused by *Cercospora*, but characteristically bacterial blight lesions are smaller, more angular (frequently being delineated by the veins), have a deeper reddish-brown color, and have a water-soaked appearance. Additionally, chlorosis does not develop as rapidly with bacterial blight and lesion margins are much more defined than those incited by *Cercospora*, the cause of early blight. Brown stem is characterized by elongated, water soaked lesions on the petiole. The discoloration is more evident on the inside of the petiole close to the crown, but streaks may occur anywhere along the petiole. Vascular bundles appear healthy, yet are surrounded by diseased pith. On plants cut for whole stalks, brown stem may render the entire plant unmarketable, resulting in substantial yield losses where incidence is heavy. See Plant Pathology Fact Sheet PP-8.

Cultural Controls: Control of bacterial blight is difficult. The disease is favored by warm, wet conditions. In seedbeds, mechanical transmission can be minimized by trimming when foliage is dry. Do not apply foliar nitrogen during warm, wet periods which are favorable for blight and avoid over-fertilization with soil-applied nitrogen. Minimizing mechanical contact with the plants once set in the field may also prove helpful. Use seepage irrigation rather than overhead irrigation.

Chemical Control: Fixed copper sprays remain the mainstay of chemical management of bacterial blight. See PPP-6.

Cucumber Mosaic (*Cucumber mosaic virus*)

Symptoms: *Cucumber mosaic virus* (CMV) causes a mosaic and mottling of foliage (light green and dark green areas intermingled on the leaf). CMV may also cause stalk pitting. Severe plant stunting may result from infection.

Cultural Controls: Weeds can harbor the virus as well as the aphid vector, therefore proper weed management in and around seedbeds and fields is essential. The dayflower weeds, *Commelina spp.*, are frequent CMV weed hosts in Florida.

Damping-off (*Rhizoctonia spp.*, *Pythium spp.*, *Fusarium spp.*, and *Sclerotinia spp.*)

Symptoms: Seedlings may damp-off at random or in rapidly enlarging circular areas in the seedbeds. In the latter case, lesions may be observed well up the petioles as well as at the soil line. Entire plantings may be lost unless adequate control measures are practiced.

Cultural Controls: Damping-off is favored by excessive soil moisture. Avoid over-saturation of seedbeds and do not transplant obviously diseased plants to the field. Transplants should be grown in sterilized soil or fumigated soil. Use raised beds.

Early Blight (*Cercospora apii*)

Symptoms: Early blight is the most serious fungal disease of celery in Florida. It starts as small circular spots on the leaves or petioles. These rapidly enlarge and may encompass the entire leaflet and even the stalk. Petiole lesions are more elongated than circular due to the heavy veination. Under humid conditions, lesions may take on a gray appearance due to the presence of spores on the leaf surface. Large chlorotic areas often surround the circular lesions.

Cultural Controls: Celery varieties with demonstrated resistance to early blight should be planted, particularly during periods that are most favorable (warm and humid). Early Belle and June Belle are two varieties with good early blight resistance. Florida 683 and 2-14 are most susceptible and should not be planted except for the cooler months. See Plant Pathology Fact Sheet PP-8.

Chemical Control: Fungicides should be applied at the first sign of disease incidence. Broad spectrum protectants (chlorothalonil) should be applied in sufficient volume to obtain thorough coverage. Sterol inhibitor and strobilurin fungicides, exhibiting some systemic properties, should be applied in a program with a broad-spectrum protectant to minimize the risk of fungicide insensitivity developing. See PPP-6.

Late Blight (*Septoria apiicola*)

Symptoms: Late blight is typically of minor importance but outbreaks do occasionally occur. The chief diagnostic feature of late blight is the occurrence of small black fungal fruiting bodies (pycnidia) near the center of the circular brown lesions. These black specks may be observed with the naked eye or under low magnification. See Plant Pathology Fact Sheet PP-8.

Cultural Controls: Late blight spores are rain-splash disseminated. Therefore, the disease is promoted by extended rainy periods, particularly during cool to moderate temperatures. The pathogen is capable of surviving on seed for periods of up to 2 years, but no longer. Therefore, the most economical control is to plant seed that is three-years-old or older. Movement of equipment and personnel through dew-laden fields infested with late blight should also be minimized as this also spreads the pathogen.

Chemical Control: The same fungicides used to control early blight may be used to manage late blight. See PPP-6.

Pink Rot (*Sclerotinia sclerotiorum*)

Symptoms: This fungal disease is characterized by a sudden wilting and collapse of the plants in the field. A soft watery decay of tissues near the soil line usually is present. Rotting tissues often take on a pinkish cast and black fungal resting bodies (sclerotia) develop within the cottony white mycelium covering the rotting mass. Sclerotia are variable in size from 1/8 to 1/2 inch and are usually somewhat irregular in shape.

Cultural Controls: Where possible, flooding of celery fields during the summertime in Florida is extremely effective in controlling this disease. Flood the soil completely, partially, or intermittently for a 6-week period. If flooding is not possible, turn the soil 6-8 inches deep to bury the sclerotia and old plant debris. Crop rotation with a crop not susceptible to the pathogen (i.e. corn) may be useful, however, sclerotia may survive for years in the soil.

Chemical Control: Fungicides should be first applied at the first sign of disease. Broad spectrum protectants (chlorothalonil) should be applied in sufficient volume to obtain thorough coverage. Sterol inhibitor and strobilurin fungicides, exhibiting some systemic properties, should be applied in a program with a broad spectrum protectant to minimize the risk of fungicide insensitivity development in the fungus. See PPP-6.

Red Root (*Fusarium sp.*)

Symptoms: Red to brownish bands on the roots and death of root tips characterize this disease. Red root is primarily a seedbed problem but occasionally severe field problems may arise.

Cultural Controls: Fumigation of seedbeds usually gives initial control of redroot. Avoid recontamination of seedbeds by not stepping onto the bed after fumigation. The judicious use of fertilizer and water often allows plants to make a nearly complete recovery.

Rhizoctonia Stalk Rot (*Rhizoctonia solani*)

Symptoms: Stalk rot is characterized by sunken, orange to brown brick-red lesions on the stalks, particularly at the base of plants. Severe infection may necessitate extreme trimming of affected petioles from infected plants.

Cultural Controls: Transplants should be raised in fumigated beds to provide disease-free planting material. Care should be taken not to set transplants excessively deep, as this increases exposure of the susceptible lower petiole and crown area to the fungal pathogen. Use raised beds in field.

Chemical Control: Fungicides directed toward the base of the plant and adjacent soil may aid in the control of stalk rot. See PPP-6

Celery Mosaic (*Celery mosaic virus*; formerly *Western Celery Mosaic Virus*)

Symptoms: This virus causes mosaic or mottling of foliage, similar to *cucumber mosaic virus*. Severe leaf distortion and twisting as well as general plant stunting are additional symptoms of this viral disease. Aphids and leaf miners are common vectors of this virus and may they may transmit the virus to celery after feeding on infected volunteer celery or other umbelliferous weed hosts.

Cultural Controls: Eradicate potential weed reservoirs around seedbeds and celery fields. Mockinishopweed is susceptible as are other umbelliferous weeds. Have a celery-free period during the year.

Crucifers

Disease Management in Crucifers: Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Chinese Broccoli, Chinese Cabbage, Chinese Mustard, Collards, Kale, Mustard, Radish, Rutabaga, Turnip (*Brassica* and *Raphanus* spp.)

Tom Kucharek

Alternaria Leaf Spot (*Alternaria brassicicola*, *Alternaria brassicae*, and *A. raphani*)

Symptoms: The disease first appears as small dark brown or black spots on the leaves. As the spots enlarge a definite zonation, or target spot, becomes evident. As spores are produced, the spots, especially in the center, become darker than other areas of the spots. With development of numerous spots, the leaves may turn yellow and die. Spots on stems and leaf petioles are elongate and purple to brown. The fungus produces numerous small brown sunken spots on cauliflower heads. See Plant Pathology Fact Sheet PP-34.

Cultural Controls: Use crop rotation. Plow down old plant beds and harvested fields. Use a fungicide seed treatment. Employ fungicide sprays starting in the seed production

system. Ship produce at a 40-45° F. Purchase disease-free transplants. See Plant Pathology Fact Sheet No. 34.

Chemical Controls: See PPP-6.

Anthracnose (*Colletotrichum higginsianum*)

Symptoms: This disease occurs primarily on turnip, mustard, and Chinese cabbage. Small dry circular, gray to straw-colored leaf spots are produced. On leaf petioles and stalks the spots are sunken, elongated and gray to brown with black border. Gray or light tan spots, somewhat sunken, are produced on turnip roots.

Cultural Controls: Use crop rotation.

Chemical Controls: Apply fungicides if needed. The use of fungicides to control *Alternaria* leaf spot will also confer a measure of control on this disease. See PPP-6.

Bacterial Leaf Spot (*Pseudomonas cichorii*)

Symptoms: Slightly sunken gray-brown to dark-brown, round or oval spots up to about 1/4 inch across. Spots may show concentric (target spot) rings; these spots usually larger than plain spots. Spots may coalesce into large ones. Disease occurs mainly on the wrapper leaves, but under favorable conditions, may cause injury to inside leaves.

Cultural Controls: Practice crop rotation. Disease is favored by overhead irrigation and poor field drainage. Purchase disease-free transplants.

Black Rot (*Xanthomonas campestris* pv. *campestris*)

Symptoms: Areas of yellow and light brown with a network of black veins develop in leaves of affected plants. Often there are "V" shaped areas at the edges of the leaves. Movement of the bacteria down the leaf veins into the vascular tissue of the stem produces the systemic stage of the disease. A cross section of a diseased stem shows the damaged vascular system in a circle around the central pith. Bacteria move from this area into upper, uninjured leaves.

Cultural Controls: To obtain control of black rot disease, a complete package approach to control must be followed. Omission of any one step in the control procedure may result in negation of disease control efforts.

1. Purchase certified, disease-free transplants.
2. Upon receipt of transplants, examine plants for early black rot symptoms **before**, not after, planting. Refuse payment on shipments with potential transplant-borne black rot. Infested shipments can be legally refused.
3. Do not locate seedbeds or field plantings on land planted to any crucifer during the preceding 12 months.
4. The use of tolerant varieties can decrease disease losses in the field especially when proper rotation is impossible.

5. Hot water treatment of all cabbage seed is suggested regardless of source. Hot water treatment is as follows:
 - a) Treat seed at 122° F.
 - b) Cabbage and brussels sprouts seed should be treated for 25-35 minutes.
 - c) Broccoli, cauliflower, collards, Chinese cabbage, kale, kohlrabi, rutabaga and turnips should be treated for 18 minutes.
 - d) Retreat seed with a seed treatment fungicide prior to planting.
6. Use strict sanitation in the transplant production areas and in production fields.
7. Plow down old crop debris in field as soon as possible after harvesting.
8. Do not establish cull piles on the farm.
9. See Plant Pathology Fact Sheet No. PP-13 for total disease control program.

Black Speck (unknown cause)

Symptoms: On cabbage harvested during the winter months, numerous pin head-sized black specks may appear on the leaves extending all the way to the core. Usually they appear approximately one week after harvest. These specks may occur on cabbage in the field, particularly if harvest is delayed,.

Cultural Controls: The exact cause of these black specks is not fully understood, however, some varieties and hybrids are much more susceptible than others.

Cercospora Leaf Spot (*Cercospora* sp.)

Symptoms: Definite spots, which are circular to angular, pale-green to light-brown, are found commonly on turnips in Florida. This disease also occurs in cabbage within transplant production greenhouses.

Chemical Controls: See PPP-6.

Damping-Off (*Fusarium* spp., *Pythium* spp., and *Rhizoctonia* spp.)

Symptoms: Failure of plants to emerge often indicates pre-emergence damping-off. Post-emergence symptoms show a water-soaked, collapsed area in the stem below or near the soil surface. Later the darkened, shrunken stem cannot support the seedling and it wilts, falls over and dies. Damped-off plants often are in circular areas or extend some distance in rows.

Cultural Controls: Use seed treated with an approved fungicide. Use healthy transplants. The field should be free of old crop and weed debris in the soil surface. See Plant Pathology Fact Sheets No. 1 and 53, and Circular 1025.

Chemical Controls: See PPP-6.

Downy Mildew (*Peronospora parasitica*)

Symptoms: All plant parts of crucifers can become infected with this fungus. Leaf symptoms are most commonly observed in Florida. Black or dark specks appear on young leaves, usually on the underside of the leaf first. Such spots are often irregular in shape and may appear net-like. The upper side of the leaf will also develop dark spots similar in shape and may be accompanied by leaf yellowing. On older leaves, coalescence of these spots can occur, resulting in larger areas of the leaf blade having large, sunken, paper tan-colored spots. Leaf yellowing, again, may accompany these symptoms. Early infection on young plants can cause stunting.

On the underside of the leaf spots, a gray-white downy growth can be observed with or without the aid of a hand lens, especially when leaves are wet. On mature cabbage, downy mildew can appear as dark sunken spots on the head or wrapper leaves. Often infections on the cabbage head will result in a purplish tinge. Infections predispose the plant to soft rot bacteria or Sclerotinose, which can further rot tissue in the field or after harvest.

Cauliflower curds and broccoli heads can become infected with blackened areas on the outside of the tissue. The infection can become systemic and turn inner curd and stem tissue dark. Radish and turnip “roots” can become infected from spores that are washed down to the soil from the leaves. Symptoms might predominate on the upper part of the root but the entire root is susceptible. Black spotting or a netted appearance can be observed on the outside of the root but an internal, firm rot can occur as well in some situations. Some root distortion could occur, especially, if infection occurred early in relation to root swelling. Flowers and weed stalks of cruciferous crops, especially mustard, are also infected.

Cultural Controls: Plow under abandoned seedbeds and harvested fields to prevent diseases from spreading to new plantings. Eradicate all crucifers and weeds in vicinity of seedbed or transplant production area. See Plant Pathology Fact Sheet No. 33.

Chemical Controls: See PPP-6.

Sclerotinose (*Sclerotinia sclerotiorum*)

Symptoms: All parts of the plants are susceptible. Infection occurs on leaves and stems nearest the ground, or on the wrapper leaves in cabbage. A small water-soaked spot appears and as it enlarges, a growth of white mycelium is produced. As the fungus grows upward on a maturing plant, it often spreads over the head, darkening the leaves into a soft, water-soaked mass. At this stage, numerous black sclerotia 1/8 - 1 inch in length are produced on the dead and dying parts. Where stems are heavily infected, the plant wilts, falls over and dies. This disease can follow cold temperature damage or other injuries.

Cultural Controls: The following control methods are recommended:

1. Rotate with a crop not susceptible to *Sclerotinia* such as sweet corn.
2. Turn soil at least 6 inches deep when plowing.
3. Where possible, flood the soil either completely, partially or intermittently for a period of 6 weeks during the summer. Before using flooding as a control measure, find out from local authorities if drainage into a given body of water after flooding fields is permissible.
4. The use of overhead irrigation may favor severe disease incidence.

Chemical Controls: See PPP-6.

Turnip Mosaic (*Turnip mosaic virus*)

Symptoms: This disease (also known as black ringspot) infects crucifers, beets, spinach, tobacco and other plants and is transmitted by aphids. Plants develop conspicuous symptoms between 75-85° F and appear stunted with mottled leaves. The typical mosaic symptom often develops first on the leaf under surface as dark green spots which turn necrotic forming a ring spot pattern. Symptoms on apparently normal heads may develop in a post-harvest storage situation.

Cultural Controls: Eliminate the natural weed hosts of this virus (such as mustard type weeds) in both seedbed and field situations. Early, rigorous aphid control, especially in the seedbed, will reduce subsequent virus incidence.

Wirestem (*Rhizoctonia solani*)

Symptoms: Roots (root rot), stems (damping-off, wirestem), and leaves (bottom rot, head rot) may be damaged by this fungus. One of the most common types of damage is wirestem where the outer tissues of the seedling stem shrivel, turn yellow to orange to brown to black, and become tough and woody. These tissues may slough off or, depending on weather conditions, the seedling may recover. If growth of the fungus continues up the stem, the bottom rot and head rot conditions may develop.

Cultural Controls: Use treated seed, rotate seedbeds and fields, give as good drainage as possible, and cultivate soon after heavy rains to aerate and dry soil. Avoid planting in crop debris or in a recently incorporated green manure crop. See Plant Pathology Fact Sheet No.1.

Chemical Controls: See PPP-6.

Yellows (*Fusarium oxysporum f. conglutinans*)

Symptoms: A characteristic yellow-green color first appears in one or more of the lower leaves and may progress upward to the top leaves. In some cases, only one side may be infected and a resultant bending and curling usually occurs. As the yellow tissue ages, it turns brown, dies and leaves shed prematurely. A cross section of the stem shows the vascular tissue area to be blackened. Vascular tissues in the infected leaf petioles also show this dark discoloration.

Cultural Controls: The primary control after soil is infested is use of resistant varieties. Growers should take every possible precaution to secure disease-free transplants. Use crop rotation.

Cucumber

Disease Management in Cucumber (*Cucumis sativus*)

Pam Roberts and Tom Kucharek

Angular Leaf Spot (*Pseudomonas syringae* pv. *lachrymans*)

Symptoms: Infections are found on the leaves, stems, and fruit. Spots on the leaves are typically angular and water-soaked. Free moisture allows the bacteria to ooze from the spots which, upon drying, leaves a white residue. These spots of dead tissue will occasionally drop away from the healthy tissue leaving irregular holes in the leaves.

The spots on the fruit are generally smaller, nearly circular and slightly depressed. Early external fruit infections may be so small as to be impossible to cull out during packing. Internal symptoms, however, are quite obvious. The internal flesh discolors (brown) from below the skin lesion down to the seed layer within the fruit and may run the entire length of the fruit. Older fruit lesions turn white with an obvious tissue cracking. This disease is apt to be severe during wet springs and is rain-splash dispersed. The causal bacterium can infect watermelons as well and can survive in infected crop debris. The bacterium is seedborne.

Cultural Controls: Use disease-free seed and rotate crops to avoid this pathogen surviving in crop debris. Avoid working or harvesting fields while foliage is wet. Mechanical spread of the bacterial pathogen is likely. Rotate crops with non-hosts.

Chemical Controls: See PPP-6.

Anthracnose (*Colletotrichum lagenarium*/*Glomerella cingulata*)

Symptoms: The disease first appears on the foliage as small, yellow or reddish-brown, water-soaked spots often on veins, which enlarge rapidly and turn brown. The dead tissue dries and may crack and fall out. On the stems, the lesions are elongated and light brown to black in color. In fruit, circular, water-soaked, sunken lesions appear, varying in size with the age. Lesions turn dark green to brown. During wet weather, the centers of the spots often show a pinkish color due to production of spores of the causal fungus.

This disease is particularly severe during wet seasons where temperatures remain between 70 and 80 F. The causal fungus can survive in old crop debris and on weed hosts. This fungus is known to infect balsam pear (*Momordica* sp.), bottle-gourd

(*Lagenaria* sp.), cantaloupe, chayote (*Sechium* sp.), mock cucumber (*Echinocystis* sp.), and watermelon.

Cultural Controls: Choose resistant varieties. Avoid working fields when plant foliage is wet. Deep plow plant residue and practice crop rotation. Use disease-free seed.

Chemical Controls: See PPP-6.

Belly Rot (*Rhizoctonia solani*)

Symptoms: This disease is caused by a common soilborne fungus which infects the ground (belly) side of fruit. Young cucumbers exhibit a yellow reddish-brown, superficial discoloration which develops into a sunken, irregular lesion or pit in the fruit underside. Mature fruits develop a large, water-soaked decay. This disease proceeds rapidly above 82° F and in periods of high humidity, a dense, light brown mold growth develops from the lesions on the fruit.

Cultural Controls: Incorporate the previous crop or weed debris at least 4-6 weeks prior to planting. The use of full bed plastic mulch will greatly reduce disease incidence where fruit is produced on the plastic. See Plant Pathology Fact Sheet PP-41.

Chemical Controls: See PPP-6

Cottony Leak (*Pythium* spp.)

Symptoms: This disease is primarily a fruit rot but the causal fungus can cause a damping-off of seedlings or produce vine cankers during unusually wet growing seasons. In the field, the fungus can enter the fruit through old floral parts or directly from the soil. The fungus produces dark green, water-soaked lesions. The fruit become soft and mushy very rapidly and may be completely covered with white, cottony mycelium during warm, wet weather. Fruit rot can occur rapidly in transit when conditions are moist since the fungus spreads by fruit-to-fruit contact.

Cultural Controls: Plant only in well-drained fields. Avoid picking fruits from infested areas of the field. Infected fruits will contaminate adjacent fruits in buckets or hampers or other picking containers.

Chemical Controls: See PPP-6.

Damping-off (*Pythium* spp., *Fusarium* sp., *Rhizoctonia solani*)

Symptoms: Seed fails to germinate due to rapid colonization of seed by soilborne fungi. Excavated seed will be rotted and soft, often with evidence of fungal mycelium. Young, newly emerged seedlings often collapse at soil line and topple over. The stems may exhibit an obvious discoloration ranging in color from a reddish-brown to black and may be dry or mushy to the touch depending on the soil fungus involved.

Cultural Controls: Avoid planting seed when soil moisture, soil preparation, temperature or planting depth do not favor rapid emergence. Plant in well tilled soil where old crop and weed residue has been plowed down 30 days previously. Plant fungicide-treated seeds. See Plant Pathology Fact Sheet No. 1.

Chemical Controls: See PPP-6.

Downy Mildew (*Pseudoperonospora cubensis*)

Symptoms: The disease first shows as angular, yellow spots on the upper leaf surface. If the weather is humid and warm, a gray mold growth is evident on the under surface. As the spots enlarge, a general leaf yellowing develops followed by browning and death of leaf tissue. Usually the first symptoms are on older leaves and they gradually move outward. Periods of wet weather, heavy dews or fog are favorable for severe disease occurrence. Spores are dispersed by the wind. See Plant Pathology Fact Sheet PP-2.

Cultural Controls: Choose downy mildew resistant varieties. Avoid working fields when plant foliage is wet. Maintain a fungicide control program during wet, humid weather.

Chemical Controls: See PPP-6.

Fusarium Wilt (*Fusarium oxysporum* f. sp. *cucumerinum*)

Symptoms: This is not a common disease in Florida. The causal fungus is soilborne and may infect the cucumber at any stage of growth. Freshly seeded cucumbers may damp-off below ground or as newly emerged seedlings. If older plants are infected prior to vine elongation, the entire plant will exhibit a mid-day wilt. After several days of wilting, leaves will tip burn followed closely by a complete wilt and plant death. Plants infected in the vining stage of growth will often wilt in only one or two runners.

Diagnostic field symptoms are the wilting syndrome and the brown discoloration of the vascular tissue within the lower stem when split open. In moist weather, the whitish-pink fungal mycelium may be observed on the outside of the lower stems. See Plant Pathology Circular 1025.

Cultural Controls: Rotate with other crops such as crucifers, legumes or solanaceous plants. Occurrence of this disease in commercial greenhouses should be controlled through sanitation of infected plants and soil fumigation. Raising the soil pH reduces this disease.

Gummy Stem Blight (*Didymella bryoniae*/*Phoma cucurbitacearum*)

Symptoms: This has not been a common problem on cucumbers in Florida. Lesions in the cotyledons and leaves are round or irregular, brown and with a faint zonation. Lesions in the crown and stems are brown, usually turn white with age and often exhibit a sap flow. The disease will usually begin at the crown and progress outward on the vines.

The causal fungus is seedborne and can survive on crop and weed host debris. Secondary spread is by rain-splashed spores. The fungal pathogen is known to infect cantaloupe, chayote, pumpkin, squash and watermelon. The black, speck-like fruiting structures (pycnidia) can often be found in lesions. See Plant Pathology Fact Sheet PP-27.

Cultural Controls: Use resistant varieties. Use fungicide-treated seed and initiate a fungicide spray program at first disease appearance. Avoid planting in fields with residual crop debris. Use healthy transplants.

Chemical Controls: See PPP-6.

Powdery Mildew (*Erysiphe* sp./*Sphaerotheca fulginea*)

Symptoms: These fungi infect leaves and stems. Round whitish spots on the underside of the older leaves appear. The spots increase in size, coalesce, appear on the upper surface with a white powdery growth. Severely affected leaves lose their normal dark-green color and become pale yellow-green, then brown and shriveled. The young stems may also be killed. Fruits may sunscald as a result of loss of foliage. Spores are readily wind-dispersed over long distances.

Cultural Controls: Plant resistant varieties. Excellent resistance is available.

Chemical Controls: See PPP-6.

Scab (*Cladosporium cucumerinum*)

Symptoms: On the leaves, the fungus produces small brown spots with yellow margins. The brown center may fall out leaving a ragged hole. Young leaves at the vine tips may become distorted. The greatest damage is to the fruit. Here small sunken dark gray spots appear, and a sticky material oozes from the spots. As the spots enlarge, they often run together forming large scab-like diseased areas. In humid periods, spores are produced giving the spots an olive-green color.

This disease is most severe in cool weather. The causal fungus can be seedborne or survive on old cucumber crop debris. Spores can be carried by air currents or spread by water splashing, clothing, or tools.

Cultural Controls: Exercise crop rotation for at least three years where this disease is a problem. Plant resistant varieties and achieve additional control through the use of fungicides.

Chemical Controls: See PPP-6.

Target Spot (*Corynespora cassiicola*)

Symptoms: Symptoms often look the same as downy mildew. Target spot begins on leaves as yellow to white leaf flecks, becoming angular with a definite outline. Later, the spots become circular with light brown centers surrounded by dark-brown margins.

Individual lesions are 1/8 to 3/8 inch in diameter. Lesions coalesce and produce larger dead areas with drying and shredding of leaves. Fungus survives on infested plant material and conidia are readily airborne dispersed

Cultural Controls: Avoid working infested fields when they are wet. Remove and destroy infected plant debris. Apply fungicides as needed to control this disease.

Chemical Controls: See PPP-6.

Viruses (*Papaya Ringspot Virus Type W*, *Cucumber mosaic virus*, *Zucchini Yellow mosaic virus*, *Watermelon mosaic virus 2*)

Symptoms: Leaves show varying degrees of mosaic, distortion, and stunting. Fruits may also be mottled and deformed. These viruses are aphid-transmitted and can infect cantaloupe, squash, watermelon and a number of common weeds including balsam pear (*Momordica* sp.), bur cucumber (*Sicyos* sp.), citron (*Citrullus vulgaris* var. *citroides*), creeping cucumber (*Melothria* sp.) plantain (*Plantago major*), *Sesbania* sp., showy croton (*Crotalaria spectabilis*), sweet clover (*Melilotus indicus*), alyceclover (*Alysicarpus* sp.) and many other plant species. See Plant Pathology Circular 1184.

Cultural Controls: Maintain weed control in and around cucumber plantings. Insecticide control of the aphid vector is not recommended because of the rapid transmission of the virus during aphid feeding.

Chemical Controls: See PPP-6 for use of JMS Stylet Oil.

Eggplant

Disease Management in Eggplant (*Solanum melongena* var. *esculentum*)

Ken Pernezny

Bacterial Wilt (*Ralstonia solanacearum*)

Symptoms: Plants wilt and die rapidly with slight or no leaf yellowing prior to death. Plants cut at the soil line will exhibit brown, slimy pith in cross-section. Bacterial streaming can be observed from the vascular tissue when the lower several inches of stem section are suspended in a jar of water.

Cultural Controls: No economical controls are available. Avoid land with a previous history of this disease. Rotate out of susceptible solanaceous crops into grass, legume or cucurbit crops.

Damping-Off (*Fusarium* spp., *Pythium* spp., *Rhizoctonia solani*)

Symptoms: Soil fungi such as *Fusarium*, *Pythium* and *Rhizoctonia* species will infect newly planted seed through the seedling stage. These fungi will prune off lateral roots and may rot the hypocotyl above or below ground causing seedling death.

Cultural Controls: Plant in well-drained sites when soil moisture and temperature are conducive to rapid germination and emergence. Do not plant in soil with a high percentage of recently incorporated, undecomposed plant debris. Employ a seed treatment fungicide and consider soil fumigation of seedbeds.

Chemical Controls: See PPP-6.

Early Blight (*Alternaria solani*)

Symptoms: Small, light-colored lesions will occur on leaves, with little of the concentric ringing characteristics of early blight on potato or tomato. Very occasionally, leathery spots may be seen on fruit.

Cultural Controls: Plant as far from tomato and potato fields as possible.

Chemical Controls: See PPP-6.

Phomopsis Blight (*Phomopsis vexans*)

Symptoms: Seedlings exhibit dark brown lesions that become gray in the center and form on the stem slightly above the soil line. The stem soon becomes girdled and the plant topples over and dies. On established plants, brown, round or oval spots may develop on the leaf and stem becoming irregular in shape as they enlarge. The center becomes gray and contains small black dots (pycnidia) while the margin is a narrow, dark brown zone. Foliar infection is minor compared to fruit infection. Fruit are infected while on the plant. The spots are pale, sunken areas and may finally cover the entire fruit. The small black pycnidia are present in abundance in the fruit spots.

Cultural Controls: Florida Market and Florida Beauty are resistant to the "tip over" stage of seedling blight, but the leaf and stem blight and fruit rot stages are still serious problems. Maintain a fungicide program in the transplant bed. Only disease-free plants should be set into the field.

Chemical Controls: See PPP-6.

Phytophthora Blight (*Phytophthora parasitica* and other *Phytophthora* spp.)

Symptoms: Severe losses from this disease have been recorded in Southern Florida during wet winter vegetable seasons. Symptoms include damping-off of young seedlings, spotting of lower leaves, and decay at the base of older stems. Advanced stem infection leads to wilting and collapse of plants. Fruits may become infected at any time in their development. Individual fruit spots enlarge rapidly and significant portions of the fruit may become decayed and soft. Premature fruit drop often results.

Cultural Controls: Plastic mulch substantially reduces infection caused by spores of the fungus splashed up onto fruit surfaces. Avoid planting eggplant behind pepper, especially if the pepper crop has had a confirmed outbreak or a history of *Phytophthora* blight.

Chemical Controls: Use a pre-plant soil fumigant.

Pythium Fruit Rot (*Pythium* spp.)

Symptoms: The blossom end bleaches white, and then turns tan and wrinkled. The flesh becomes watery and light brown in color. The white, cottony mycelium of the fungus eventually covers the surface of the fruit-especially during moist periods.

Cultural Controls: Discard all fruits that show brown discoloration at harvest. The causal fungus can spread by fruit-to-fruit contact and can contaminate harvesting containers.

Southern Blight (*Sclerotium rolfsii*)

Symptoms: This disease occurs during hot, moist weather. Plants exhibit a progressive wilt with leaf chlorosis and necrosis beginning with the lower foliage. The causal fungus infects the root system and stem at the soil line until the plant is killed. Fruit borne low on the plant may become infected.

The causal fungus becomes obvious as a coarse web of white mycelium on the stem at the soil line during humid and wet weather. Small mustard-seed-sized fruiting structures (sclerotia) form on the mycelium. These are initially white, maturing to a tan color. These overseasoning structures fall to the soil and can survive for years under Florida conditions.

Cultural Controls: No economical control exists for this disease under Florida conditions. Deep plowing infested land will reduce disease severity by burying sclerotia. Crop rotation with a non-host such as a grass crop is advised.

Verticillium Wilt (*Verticillium albo-atrum*)

Symptoms: This wilt disease progresses slowly on eggplant. Plant vigor is affected to the point of stunting. Lower foliage will exhibit slight yellowing while plants exhibit progressive daily wilt until death. Slight vascular discoloration will be evident when lower stems are slit lengthwise. The degree of browning is slight compared to bacterial wilt while the pith is not affected.

Cultural Controls: Do not crop land with a history of this soilborne fungal disease. Choose non-susceptible rotation crops such as cucurbits, beans or grasses. The plants of the Solanaceae are quite susceptible to this fungus.

Lettuce and Endive

Disease Management in Lettuce (*Lactuca sativa*) and Endive (*Cichorium endiva*)

Ken Pernezny and Richard Raid

Alternaria Leaf Spot (*Alternaria sonchi*, *Alternaria* spp.)

Symptoms: Small circular spots are formed, the centers of which gradually dry and turn black. Production of spores increases the black appearance of the spots. Leaf lesions often exhibit a zonate appearance.

Chemical Controls: Rarely an economic problem in Florida, the use of maneb fungicides to control downy mildew on lettuce or endive will aid in control of this disease.

Bacterial Blight (*Pseudomonas marginalis* pv. *marginalis*)

Symptoms: This disease begins on older, outer leaves. First water-soaked begins usually towards the leaf base. Then brown-to-red or black decay appears and later infected areas become slimy and foul smelling. During shipment, a pink rib symptom may appear.

Cultural Controls: Avoid mechanical injuries during harvesting. The use of rapid pre-cooling and the avoidance of crushing and free water in shipping containers will aid in the reduction in postharvest loss.

Bacterial Leaf Spot (*Xanthomonas campestris* pv. *vitians*)

Symptoms: This has been one of the most widespread and serious diseases of lettuce to appear in Florida in recent years. Lesions begin as small water-soaked spots on outer leaves. As the lesions mature, they become brown to black and greasy-looking. Even mature lesions may remain water-soaked on the underside of leaves. In some cases, especially on romaine-type lettuces, a "peppery" look will develop among lesions. So far the disease has not been observed on endive.

Cultural Controls: Use only disease-free seed. Avoid movement in fields where plants are wet. Some differences in susceptibility exist among cultivars. Romaine-type lettuces generally are most susceptible and butterheads are least susceptible. Growers should not follow lettuce with lettuce in the same season, especially if the first crop as had a confirmed outbreak of bacterial leaf spot.

Chemical Controls: Treat seed with bleach or other disinfectant before pelletization. Copper sprays in the field applied for other disease may provide some control of bacterial leaf spot, especially since most strains recovered to date are fairly sensitive to copper.

Botrytis Blight (*Botrytis cinerea*)

Symptoms: The fungus can invade in the seedling stage through maturity as well as cause a post-harvest decay. Young plants or seedlings may damp-off as a result of *Botrytis* infection. Invasion normally begins on lower leaf margins and progresses throughout the head until it is a rotted slimy mess. The fungus produces a light-brown to ashen-gray layer of sporulation on diseased tissue. Spores are easily blown by wind, air movement, agitation or water splash. The disease may occur over a wide range of temperatures but is strongly favored by fog, light rain or high humidity periods, and moderate temperatures.

Cultural Controls: Prevent condensation and late day waterings in greenhouse production sites. Sanitize infected tissue carefully and destroy. Prevent tissue damage in the field caused by other diseases, pesticide or soluble salts burn.

Chemical Controls: See PPP-6.

Corky Root Rot (*Rhizomonas suberifaciens*)

Symptoms: This disease is characterized by corkiness of the outer portions of the taproot, necrosis of the tip of the taproot, and reduced fibrous root mass. Vascular tissue of the taproot may be discolored and, in advanced cases, the taproot may disintegrate internally and become hollow. In the field, infected plants range from exhibiting little evidence of any disease to wilting, stunting, and death, depending on the degree of root damage. The bacterium causing this disease has only recently been isolated and characterized.

Cultural Controls: Differences in cultivar susceptibility to corky root rot exists. Avoid planting in fields with a history of corky root rot.

Damping-off (*Pythium* spp., *Rhizoctonia solani*)

Symptoms: Seed fails to germinate due to rapid colonization of seed by soilborne fungi. Excavated seed will be rotted and soft, often with evidence of fungal mycelium. Young, newly emerged seedlings often collapse at soil line and topple over. The stems may exhibit an obvious discoloration ranging in color from a reddish-brown to black and may be dry or mushy to the touch depending on the soil fungus involved.

Cultural Controls: Avoid planting seed when soil moisture, soil preparation, temperature or planting depth do not favor rapid emergence.

Chemical Controls: See PPP-6.

Downy Mildew (*Bremia lactucae*)

Symptoms: Older leaves are the main ones infected by this fungus, but it may appear on any above-ground parts. It produces a yellow area on the upper surface of leaves, and usually a white or grayish fluffy growth on the underside of the same leaf areas. The spots often coalesce into large areas. The causal fungus survives on a number of native weeds including: chicory, cudweed, sowthistle, and wild lettuce. It may also arrive from other states on shipments of lettuce.

Cultural Controls: Infection will necessitate leaf trimming or stripping at harvest.

Chemical Controls: See PPP-6.

Drop (*Sclerotinia sclerotiorum*)

Symptoms: The first symptom is a progressive wilt of older and then younger leaves; outer leaves collapse around plants in a fan pattern. The inner leaves become soft, dry rapidly and turn dark in color. The fungus usually produces a heavy mycelial growth around the main stem and in cavities in the plant. As the plant dies, numerous black, irregular bodies (sclerotia) develop on and in the diseased tissue. Sclerotia range in size from 1/4-3/4 inch in length. These survival structures of the causal fungus will fall to the soil surface where they persist for a number of years.

Cultural Controls: Since the disease is not serious every year, it is difficult to suggest a definite control program. Each of the following control measures has reduced drop, but when conditions become favorable for the development of the disease, it may be necessary to combine all of them in order to obtain satisfactory control.

1. Rotate with a crop not susceptible to this disease, such as sweet corn.
2. Turn soil at least 6 inches deep when plowing.
3. Flood the soil either completely, partially or intermittently for a period of six weeks during the summer. Before flooding, find out from local authorities if drainage into a given body of water is permissible.
4. Apply a fungicide for severe disease situations.

Chemical Controls: See PPP-6.

Erwinia Soft Rot (*Erwinia carotovora* pv. *carotovora*)

Symptoms: This is a typical soft rot disease characterized by a wet, slimy decay with extensive brownish discoloration. Affected plants decompose rapidly in a loose, wet mass in the field. Although this soft rot is correlated with mechanical injuries on many crops, it can affect internal leaves within a head of lettuce and not be apparent from the external surface.

Cultural Controls: Avoid harvesting from field areas affected by this disease. Handling infected heads can result in spread of the soft rot bacterium by workers, harvesting equipment etc.

Mosaic [*Bidens mottle virus* (BMV), *Lettuce mosaic virus* (LMV)]

Symptoms: Field differentiation of BMV from LMV cannot be reliably done without laboratory verification. Typical symptoms of BMV on lettuce include vein clearing, some mottling, veinal necrosis as well as an increase in leaf serration. Young infected plants may exhibit severe stunting. Symptoms on endive are a more subtle leaf mottling with or without plant stunting. Escarole demonstrates a more pronounced leaf mottling due to the greater leaf surface.

Symptoms of LMV are similar on these leafy crops. Infected crisphead lettuce types may exhibit vein clearing, mosaic and stunting. Wrapper leaves are duller in appearance, typically fold backward and exhibit more leaf margin serration. Romaine types exhibit similar symptoms to crisphead types plus a characteristic leaf blistering. Affected butterhead types often are stunted and quite chlorotic. Endive and escarole plants affected with LMV exhibit chlorotic dots against the green leaf background.

Both viruses are vectored by aphids-especially the green peach aphid (*Myzus persicae*). LMV is known to be seedborne in most lettuce varieties but not escarole or endive. BMV is not known to be seedborne. Survival of BMV in Florida is strongly dependent on weed hosts, such as hairy beggar ticks (*Bidens pilosa*), Virginia pepperweed (*Lepidium virginicum*), horse weed (*Erigeron canadensis*), butterweed (*Senecio glabellus*), American burnweed (*Erechtites hieracifolia*) and Mexican prickly poppy (*Argemone mexicana*).

Cultural Controls: Strong weed control efforts directed toward old crop land and ditch banks will reduce surviving virus inoculum. Weed control is especially important to minimize BMV. State regulations for a 0 tolerance of LMV infected lettuce seed in a 30,000 seed test lot reduces LMV incidence in Florida. Avoid planting lettuce, endive or escarole crops near old plantings or crops such as carrots, Chinese cabbage, or radish that are favored feeding sites for aphids.

Rhizoctonia Bottom Rot (*Rhizoctonia solani*)

Symptoms: Disease first occurs as soon as outer or lower leaves touch the soil surface, trapping moisture. Leaf petioles and midribs become rust colored and slightly sunken prior to leaf decay. Infection may spread upward through the head or leaf canopy destroying the entire plant. Obvious brown strands of the causal fungus can be observed on severely affected heads. Sclerotia (dormant survival structures) of *Rhizoctonia* often form on the lower leaf tissue close to the soil.

Cultural Controls: Severely infested fields should be plowed deeply and allowed to fallow until all crop debris has rotted.

Chemical Controls: See PPP-6.

Tipburn

Symptoms: This is a physiological (abiotic) problem. Disease incidence increases as plants approach marketable stage. Symptoms first appear as small, translucent spots near the margin of inner leaves. These spots discolor and the margins die. Injury can occur with no external signs unless soft-rotting organisms invade the tipburn areas causing a soft rot. Tipburn severity is greatest on butterhead and Romaine (cos) types. Environmental conditions that favor disease seem to be those where the greatest difference exists between soil temperatures and air temperature. This occurs when a dry, sunny period follows cool, moist weather.

Cultural Controls: Choose tipburn resistant or tolerant varieties where this disease has been a problem.

Okra

Disease Management in Okra (*Hibiscus esculentus*)

Tom Kucharek

Cercospora Leaf Blight (*Cercospora abelmoschi*)

Symptoms: Leaf spots have no definite shape, size or margin. The causal fungus appears as an olivaceous to sooty-colored growth on the lower leaf surface. Injured leaves will often roll, wilt and abscise. This is usually not of economic importance in commercial plantings.

Cultural Controls: There are no cultural or chemical controls available for this problem under present growing conditions in Florida.

Damping-Off (*Pythium* spp., *Rhizoctonia* spp.)

Symptoms: This disease can affect plantings by the fungi reducing seed germination or infecting emerged seedlings. Cultural or environmental conditions that delay the rapid germination of seed, such as cool soil, may result in pre-emergence damping-off. The soilborne fungi responsible for seed decay can also infect young seedlings at or below the soil line causing them to topple over and die. Affected plants will exhibit soft, mushy roots and stems or discolored areas on these plant parts. See Plant Pathology Fact Sheet PP-1.

Cultural Controls: Plant only when soil moisture and temperature favor rapid germination. Apply a seed treatment fungicide to protect seed during germination.

Chemical Controls: Use a fungicidal seed treatment. See PPP-6.

Powdery Mildew (*Oidium* sp.)

Symptoms: This disease is characterized by the obvious white coating of fungal mycelium on lower and upper leaf surfaces. Severe infection will cause the leaves to roll upward and result in leaf scorching. This disease can be particularly severe during the winter cropping season in south Florida.

Chemical Controls: See PPP-6.

Southern Blight (*Sclerotium rolfsii*)

Symptoms: This disease occurs during warm, humid weather. Okra plants exhibit a progressive wilt symptom as the causal fungus infects the roots and lower stem. During moist weather a coarse white fungal mycelium can be observed at the soil line around and on the stem. In a few days, numerous white nodules form on this mycelium. These structures (sclerotia) turn brown with age and are the size of a mustard seed. These sclerotia survive in the soil and serve as survival structures for this fungus over a number of years. Any movement of infested soil will spread this disease problem. See Plant Pathology Fact Sheet PP-4.

Cultural Controls: Rotate to a grass crop in fields with a high infestation of this fungus. Deep plow infected crop debris to place most of these sclerotia below the root zone of the next crop. Amistar fungicide would suppress this disease when applied to the soil by the stem prior to occurrence of this disease. This disease is not listed on the Amistar label.

Verticillium Wilt (*Verticillium albo-atrum*)

Symptoms: This is a fungal wilt disease of okra. A slight leaf yellowing will be noted (usually on lower, older leaves). Plants begin to exhibit an increasing period of wilt around mid-day. Wilt progresses from the lower to the upper foliage for longer periods until the plant dies. Slight vascular discoloration can be observed when the lower stem is slit lengthwise. This disease is most likely to occur on soil with a high pH such as in the Homestead/Florida city area of Southeast Florida.

Cultural Control: Plant okra crops onto new land or on land rotated away from such susceptible crops as the solanaceous vegetables or strawberries. Good rotation crops are grasses, cucurbits, and legumes. Soil fumigants applied prior to planting can shorten rotation time. Avoid over liming of the soil.

Wet Rot (*Choanephora cucurbitarum*)

Symptoms: Young and old blossoms, young fruit and wounded leaf tissue may become infected. Newly opened blooms will wilt and collapse. Fruit may become infected from the blossom and affected plant parts become covered with a dense white growth of fungus that is whisker-like in appearance. These whiskers (sporangiophores) develop purple-black heads at maturity. Affected plant parts will soften, rot and fall to the soil surface.

Cultural Controls: Improve air circulation by avoiding dense planting rates. In garden situations, dislodge the flower from the fruit as soon as fruit set had occurred. See Plant Pathology Fact Sheet PP-11.

Onion

Disease Management in Onion (*Allium cepa*)

Tom Kucharek

Botrytis Leaf Blight/Blast (*Botrytis* spp./*Botrytis squamosa*)

Symptoms: Botrytis leaf blight (BLB), sometimes called blast, is caused by the fungus *B. squamosa*. While other species of *Botrytis* have been associated with disease of leaves and bulbs of onions, *B. squamosa* is generally regarded as the usual cause of leaf spots in onion foliage and sometimes in the outer scales of the bulb.

Botrytis neck rot, typically a post harvest disease, is likely to be caused by *B. allii* or *B. cinerea*. *B. cinerea*, a common pathogen of many other crops, also may produce leaf symptoms slightly similar to those caused by *B. squamosa* but such infections are more superficial and generally regarded as rare.

The generic name *Botrytis* refers to the portion of the cycle of *Botrytis* spp. during which the spores (conidia) are produced asexually. In addition, *Botrytis* spp. are capable of producing sexually derived spores (ascospores) in the portion of the life cycle called *Botryotinia*.

The sources of spores that cause BLB in onions grown in Florida have not been determined. However, nearby onion plantings, volunteers, and old onion debris in fields or cull piles are probable sources of inocula. Asexually produced conidia are likely to be the principal type of inoculum. Conidia, dispersed mainly by wind, are produced abundantly, during cool, wet conditions on blighted leaves, onion debris, or sclerotia of the fungus.

Sclerotia are embedded in bulb or leaf tissues on onions or may exist in soil after the onion tissue has completely decomposed. They provide a mechanism for long-term survival of this fungus. Sclerotia are somewhat elongated structures of compacted masses of fungal hyphae with a black outer rind and a white to gray interior that may be as large as several conidia, sclerotia can produce sexually derived spores called ascospores. Ascospores are produced in microscopic sacs within mushroom-like structures (apothecia) that grow on the outside of sclerotia. Although ascospores can serve as inoculum for disease, they are probably more important as sources of new genetic variants for this fungus.

Botrytis leaf blight has been seen most commonly south of Gainesville in Florida. It is regarded as a cool, wet-weather disease. Some infection can occur with only seven hours

of leaf wetness if temperatures are near the optimum range of 59°F to 68°F. As temperatures deviate from this optimum range, longer periods of leaf wetness are required for infection. For example, temperatures at 48°F and 79°F are conducive to infection, provided that leaf wetness periods increase to 10 hours. Levels of infection should be regarded as being most severe if leaf wetness periods approach 14 hours, provided that temperatures are in the optimum range. Severe levels of infection can also occur at 48°F and 79°F if leaf wetness periods last for nearly 20 hours.

Symptoms of BLB include whitish flecks on onion leaves. *Botrytis cinerea* can cause similar, but more superficial symptoms. This latter fungus, common in Florida, causes diseases in many broadleaf plants but is not known to cause disease in onions in Florida. Herbicides, thrips and ozone can induce symptoms that appear somewhat similar to those of BLB in onions. However, lesions of BLB often begin as distinct watersoaked areas that persist around mature lesions. With increasing severity of BLB, onion fields appear progressively more yellow in color.

Older (outer) leaves tend to be more susceptible to BLB than younger leaves. Conidial production is greatest on blighted and dead leaves. Conidial production is greatest on blighted and dead leaves. Small lesions in green leaves may not produce conidia. Because larger, more numerous lesions occur on older leaves, BLB appears more as a blight than as distinct spots on older leaves, particularly near the leaf tips. See Plant Pathology Fact Sheet PP-124.

Chemical Controls: See PPP-6.

Damping-off (*Fusarium* spp., *Pythium* spp.)

Symptoms: The seedlings are infected at or slightly below the soil line. When this occurs the tissue shrinks rapidly at or near the point of infection causing the above-ground parts of the plant to topple over. These areas of infection usually result in more-or-less circular spots of various sizes in the field.

Cultural Controls: Consists of preventing infection by cultural and other methods and by seed and soil treatment. Cover crops, grasses, and weeds should be turned under in sufficient time for the plant material to decay prior to planting the onion seeds. Good drainage to prevent the seedlings standing in saturated or extremely wet soil, and the encouragement of favorable growing conditions all help in prevention of damping-off. See Plant Pathology Fact Sheet No. 1.

Chemical Controls: Use seeds with a seed treatment. See PPP-6.

Downy Mildew (*Peronospora destructor*)

Symptoms: This disease has not occurred frequently in Florida. Downy mildew is favored by humid weather conditions. The first symptoms are found by examining onion leaves early in the morning while the dew is still on the plants. The somewhat violet-colored furry growth on the surface of the leaf or seed stem is characteristic of the downy

mildew disease. The affected leaves gradually become pale green and later yellowish, and the diseased parts collapse.

The furry growth, which is the causal fungus, becomes widespread under conditions of high humidity. The disease usually starts in spots in the field that are most humid and where the dew remains longest and then spreads to surrounding areas. If the weather becomes dry with little or no dew and relatively low humidity after an outbreak of downy mildew starts, such conditions tend to inhibit growth and spread of the disease.

Infected plants often send out new leaves and partially recover. Downy mildew lesions on seed stems are circular and elongated and often affect only one side of the leaf. This weakening of one side of the leaf frequently causes it to break over.

Chemical Controls: See PPP-6.

Purple Blotch (*Alternaria porri*)

Symptoms: Bulbing onions, green onions, and leeks have been infected frequently in Florida, but other types are also susceptible. As disease severity increases, leaf size, bulb size, and bulb weight decrease drastically. Purple blotch (PB) occurs throughout the state and yield losses due to PB have been measured at more than 50 percent in Florida.

Symptoms induced by the fungus causing PB are of two types. Initially, flecks similar to those induced by the BLB fungus may occur in leaves. Later oval to football-shaped lesions appear, sometimes accompanied by linear yellow to brown streaks that progress from the main lesion. Individual lesions may be two or more inches long, light brown throughout or have a dark brown to purple central area surrounded by a light brown area. Lesions may contain alternating, concentric zones of dark and lighter tissue. The concentration of asexually produced spores (conidia) is greatest in the darker portions of the lesions. With increasing severity of PB, leaves become generally yellow to brown and lose erectness.

Conidial inoculum for initiating an epidemic can originate in nearby planting, volunteers, old, infected onion debris, and possibly other debris in the field. These spores are dispersed primarily by wind. Upon landing on a leaf, a spore germinates and then penetrates the leaf when the next leaf wetness period occurs. From such infections, new lesions may form in seven days or less.

Temperatures below 55°F are not conducive for infection by the fungus causing PB, but temperatures above 55°F contribute to the development of this disease. Because the PB fungus is active across a wide range of temperatures about 55°F, increasing leaf wetness and relative humidities about 90 percent generate higher probabilities for infection and disease occurrence. Leaf wetness periods of nine to eleven hours are adequate to promote spore production and infection. As periods of leaf wetness become longer, conditions for development of PB are improved.

Onion leaves become more susceptible to PB as they age. Emerging leaves become increasingly more susceptible to PB as the bulbs approach maturity. See Plant Pathology Fact Sheet PP-124.

Cultural Controls: Control of PB includes rotating crops with non-susceptible crops, accelerating decomposition of old onion debris in the field, destroying volunteers, and using healthy transplants.

Chemical Controls: Spraying with approved fungicides is often necessary. A sequence of spray treatments, delivered at five-to-seven day intervals, should be initiated when symptoms of PB first appear in leaf wetness periods exceed 11 hours. Spray intervals can be lengthened during extended dry periods, when leaf wetness lasts for less than nine hours. Thoroughly covering onion leaves with the spray is essential to achieve control. With proper use of nozzle arrangements and spreader-stick adjuvants, excellent control of PB and Botrytis Blight can be achieved. See PPP-6.

Parsley

Disease Management in Parsley (*Petroselinum crispum*)

Richard Raid and Pam Roberts

Alternaria Leaf Spot (*Alternaria radicina*)

Symptoms: Infections begin with the appearance of small brown flecks on parsley leaflets. Lesions may develop yellow halos as they expand in size and number. The disease is usually most prevalent on the oldest leaves and lesions attacking the petiole may render the entire leaflet brown and appearing scorched.

Cultural Controls: Controls for Alternaria leaf spot should include planting in fields where parsley or carrots have not been planted for several years. The pathogen is sometimes associated with infected seed, so purchase high quality seed from a reputable source. Old plantings should be destroyed and disked in to avoid spread of inoculum to younger plantings.

Chemical Controls: Early buildup of Alternaria leaf spot may preclude multiple cuttings of this crop. In such cases, fungicidal sprays may be effective and economical. Scout fields regularly for early detection. Strobilurin fungicides offer the best efficacy in controlling this disease. See PPP-6.

Damping-off (*Pythium* spp. and *Rhizoctonia* spp.)

Symptoms: Seedlings may die at random or in rapidly lengthening sections of freshly seeded rows. Lesions may be observed well up on the petioles as well as at the soil line. Entire plantings may be lost unless adequate control measures are practiced.

Cultural Controls: Plant parsley on raised beds in well-drained soil.

Chemical Control: Ridomil Gold, applied as a band over seeded rows at the time of planting, may assist in the control of diseases incited by *Pythium* spp. This compound does not control *Rhizoctonia*. See PPP-6.

Root Rots (*Fusarium* spp. and *Rhizoctonia solani*)

Symptoms: Initial symptoms of root decay are the progressive yellowing and browning of older, lower leaves. Plants may wilt during mid-day. Ultimately, the entire plant may turn yellow, then necrotic, and die. Inspections of root systems may reveal a reddish discoloration and deterioration of small feeder roots. Longitudinal, reddish cankers frequently develop on the taproots. Exterior cortical tissues appear dry and rotted. With *Fusarium*, a reddish discoloration of the internal vascular system may also be observed, extending well up into the crown. On an annual basis, this is easily the most devastating disease of parsley in Florida.

Cultural Controls: Avoid planting parsley in fields previously planted to this crop. Crop rotations should exceed five years to be effective. Fallow flooding during the offseason may assist in reducing the impact of this disease, but cannot be relied on solely if parsley is planted in consecutive years. Excessive seeding densities should be avoided, as this has been observed to increase disease incidence.

Chemical Controls: Soil fumigation may assist in reducing the effects of these organisms but is seldom economical.

Septoria Leaf Spot (*Septoria petroselinii*)

Symptoms: Lesions appear as sunken brown foliar spots with gray centers. As lesions age, minute black specks (fungal pycnidia embedded in the leaf tissues) may be observed under low magnification. These black specks distinguish *Septoria* leaf spot from the leaf spot caused by *Alternaria radicina*.

Cultural Controls: *Septoria* may survive for up to 2 years on infected seed. Plant seed that has been certified as being free of *Septoria* or store seed suspected as being infected for a period of two or more years. This reduces the viability of the pycnidia, rendering the pathogen incapable of infection. Avoid the use of overhead irrigation, as the pathogen is rain splash disseminated. Also, if an outbreak has been detected, the movement of equipment or workers through the field while the canopy is wet should be minimized.

Chemical Controls: Scout fields for early detection. The use of recently registered strobilurin fungicides should assist in reducing the impact of this disease. See PPP-6.

Peas, English and Snow

Disease Management in English and Snow Pea (*Pisum sativum*)

Tom Kucharek

Damping-off (*Pythium* spp., *Rhizoctonia* spp., *Fusarium* spp.)

Symptoms: Several soilborne fungi will rot pea seed and seedlings from planting time through emergence. This condition is aggravated by deep planting, excess moisture and by the presence of newly incorporated green plant material such as weeds or cover crops. Later stages of infection by these fungi often produce root rots.

Cultural Controls: Control of root rots and damping-off can be aided by preventing saturation of the soil and by chopping all cover crops and allowing them to dry thoroughly before disking or plowing under. Green cover crops should be turned under 6 to 8 weeks before planting time, and the land should be kept disked in order to prevent a new grass/weed cover from developing. See Plant Pathology Fact Sheet PP-1.

Chemical Controls: See PPP-6.

Powdery Mildew (*Oidium* sp.)

Symptoms: The characteristic symptom is the white, powdery-like fungal mycelium that covers portions of leaves, stems and pods. Heavy infection can result in leaf death. Occasionally, small black dot-like fruiting structures (cleistothecia) may form on the older areas of white fungal mycelium. This disease can be serious during the cool winter months when peas are grown.

Chemical Controls: See PPP-6.

Pythium Root Rot (*Pythium* spp.)

Symptoms: This disease is worse in wet seasons, on low, poorly drained fields. This fungus can cause a pre-emergent and post-emergent damping-off problem. Older plants become infected through small feeder roots. The infection proceeds into the taproot producing a soft, gray to brownish-black surface rot up to the soil surface or slightly beyond. A diagnostic field symptom is the way the outer root tissue "sloughs off" leaving the central core, when the root is slipped between two fingers. Infected plants appear stunted and pale yellow-green above ground. In very moist weather, a foliar blight may occur as the *Pythium* fungus infects the apical or axillary buds. Affected foliage appears watersoaked, dying and desiccating rapidly. The disease progresses down the plant canopy, girdling stems and killing all foliar parts beyond the point of girdling.

Cultural Controls: Avoid low-lying, wet fields. Do not plant too deep. See Plant Pathology Fact Sheet No. 53.

Chemical Controls: The damping-off phase may be controlled by seed treatment fungicides.

Rhizoctonia Stem Canker (*Rhizoctonia solani*)

Symptoms: *Rhizoctonia solani* may infect peas in the seed, seedling or mature plant stage. Seed may fail to germinate or young seedlings may fall over at soil line due to fungal invasion. Seedlings as well as mature plants exhibit a reddish-brown lesion or canker on the lower stem that will enlarge to a point of girdling the plant causing plant death.

Cultural Controls: Avoid planting in soil containing plant debris that has not fully decomposed. Plant seed properly to encourage rapid germination and establishment.

Chemical Control: Use a seed treatment fungicide.

Pepper

Disease Control in Pepper (*Capsicum annuum*)

Ken Pernezny and Tim Momol

Anthracnose (*Colletotrichum capsici*, *C. gloeosporioides*, *Colletotrichum* spp.)

Symptoms: Anthracnose or ripe rot is an increasingly important disease of pepper. Damage appears primarily on fruit. Fruit may be infected by spores of the fungus at any time of development, but symptoms are expressed only on mature fruit. Symptoms first appear as small, water-soaked lesions on mature fruit. These can rapidly develop into larger sunken areas. A dark growth of the fungus may be visible in these lesions, with tan to pink concentric circles of spores evident in some cases. Occasionally, leaf spots and stem dieback may occur.

Cultural Controls: Use pathogen-free seed. Avoid overhead irrigation whenever possible. Avoid injury to fruit. Crop rotation may be important in reducing primary inoculum.

Chemical Controls: See PPP-6.

Bacterial Spot (*Xanthomonas campestris* pv. *vesicatoria*)

Symptoms: Symptoms begin on leaves as small, water-soaked spots. These become up to 1/4 inch in diameter, turn dark brown and appear greasy. Scabby lesions may appear on the fruit. During periods of high rainfall or humidity, spots on leaves may coalesce causing "blight" symptoms and abscission. Bacterial spot can be a seedborne disease and can spread rapidly in the transplant bed.

Cultural Controls: Transplant production should be carefully monitored for disease occurrence. Do not use infected plants for field planting and do not work transplants when they are wet. Maintain a preventative bactericide schedule in the transplant bed as well as the field. Use cultivars with resistance to specific races of *Xanthomonas campestris* pv. *vesicatoria* known to occur in the production area. Avoid unnecessary foliar or soil applications of magnesium. See Plant Pathology Fact Sheet No. 3.

Chemical Controls: Maintain a preventative bactericide schedule in transplant production as well as the field. See PPP-6.

Damping-Off (*Pythium* spp. and *Rhizoctonia solani*)

Symptoms: Pre-emergence damping-off or seedling death may occur as a result of soilborne fungal pathogens. Seedling plants will exhibit a necrotic collapse of the hypocotyl and root system when infected. Irregular areas of seedlings may be affected in the transplant bed corresponding to inadequate soil fumigation or subsequent contamination of fumigated soil by run-off water or soil. In our experience, damping-off problems commonly occurring in early fall crops in southern Florida are almost exclusively caused by *Pythium* spp.

Cultural Controls: In the transplant bed, avoid planting in low, poorly drained areas or into land previously in peppers. Employ multi-purpose soil fumigation for vigorous transplant production. In the field, avoid setting into land with residual, undecomposed plant debris. Do not set unthrifty plants. See Plant Pathology Fact Sheet No. 1.

Chemical Controls: See PPP-6.

Bacterial Soft Rot (*Erwinia carotovora* pv. *carotovora*)

Symptoms: This disease is characterized by soft, often "mushy" rot of the pepper fruit that occurs primarily after harvest and during shipment. The rot often occurs on the stem of the fruit, and advances from that point into the stem end of the fruit. This decay can progress quickly in transit. Field symptoms are quite obvious as fruit soften and sag from the pedicel like a balloon filled with water. Softened areas usually are gray in color. The invasion by numerous organisms will confer a characteristically foul odor to infected fruit.

Cultural Controls: In the field, maintain adequate insect and disease control. Insects can move the soft rot bacteria fruit to fruit during feeding. Severe outbreaks of foliar diseases can expose fruit to sunscald injury and to subsequent soft rot. Avoid harvesting while plants are wet. Do not let harvested fruit set in the sun. Avoid fruit bruising and wounding. Do not harvest within 2 days after a rain.

In the packinghouse, avoid washing fruit whenever possible. When fruit must be washed, use chlorinated water. All fruit should be dried (forced air) prior to packing to lessen

likelihood of soft rot. Maintain good quality control in the culling lines. See Plant Pathology Fact Sheet No. 12.

Chemical Controls: See PPP-6.

Frogeye Spot (*Cercospora capsici*)

Symptoms: Lesions are roughly circular leaf spots (approximately 1/4 inch in diameter) with light tan to white centers and narrow dark borders. Leaf lesions may often appear zonate. Heavy infection may cause abscission of leaves and subsequently reduce yield. See Plant Pathology Circular No. 946.

Chemical Controls: Apply fungicide in the transplant bed at first disease appearance and in the field as disease severity warrants. This disease is more important in northern Florida. See PPP-6.

Gray Leaf Spot (*Stemphylium solani*)

Symptoms: More or less circular spots on leaves, the spots are at first brown, later turning light tan to white with sunken centers, and reddish-brown margins. Spots can also appear on stems, petioles and fruit pedicels, but have not been observed on fruit or flower petals. This disease is a rare occurrence in Florida.

Chemical Controls: See PPP-6.

Phytophthora Blight (*Phytophthora capsici*)

Symptoms: This is one of the most common and serious diseases of pepper in Florida. This disease can affect all parts of the pepper plant. It causes a seedling death as well as a root rot, stem canker, leaf blight and fruit rot in older plants. Stem infection at the soil line is common. Affected plants exhibit sudden wilting and death. The initial canker is dark green and water-soaked but turns brown as the plant dies.

When mature plants are affected, individual branches become infected at forks killing whole branches. Individually infected leaves exhibit small circular to irregular leaf spots that appear scalded. The affected areas are dry and bleached to a light tan color with a papery consistency.

Fruit are usually infected from the stem end first. A progressive margin of water-soaked tissue proceeds from the pedicel into the fruit. The fruit surface will shrivel and during moist conditions may exhibit the white fungal growth of the causal fungus.

Cultural Controls: Avoid low, wet fields for pepper planting. Pump down fields rapidly after heavy rains. Practice crop rotation.

Chemical Controls: See PPP-6.

Sclerotinia Stem Rot (*Sclerotinia sclerotiorum*)

Symptoms: This disease can be damaging some years, especially in cool, damp winters in fields near or following susceptible crops. The causal fungus infects the stem at soil line, individual petioles of leaves and occasionally fruit close to the soil surface. Stem infections frequently girdle the stem causing plant wilt and death. When weather is moist, the white mycelium will often grow up the stem surface several inches above ground.

Petiole or bud infections proceed rapidly downward in the plant. Entire branches may be girdled in this manner. Fruit infected directly from the soil surface or downward through the pedicel, rot quickly into a watery mass. The fungus survives as sclerotia formed in stems and lesions associated with diseased fruit. These sclerotia are black, irregular in size (1/8"-3/4"), and highly resistant to environmental conditions when in plant debris or soil.

Cultural Controls: Avoid rotations involving susceptible crops such as cabbage, celery, lettuce, potatoes or tomatoes. Deep plow fields with a previous history of this fungus to bury fallen sclerotia. Fields may be flooded with several inches of water for six weeks in the off-season in order to kill sclerotia. As emerging exemption for use of this phomtemethyl is currently in effect for control of this disease. See Plant Pathology Fact Sheet No. 22.

Chemical Controls: See PPP-6.

Southern Blight (*Sclerotium rolfsii*)

Symptoms: This is a warm, humid weather disease. Infected plants exhibit a progressive wilt due to root and stem invasion prior to death. During moist weather, a white collar of coarse white fungal mycelium can be observed on the stem at the soil line. Numerous white nodules form on this mycelium. These structures (sclerotia) mature to a tan color, and are the size of mustard seed. They provide an overseasoning mechanism for this fungus as they are incorporated into the soil.

Cultural Controls: Rotate to a grass crop in fields with a high infestation of this fungus. Deep plow infested crop debris to place the sclerotia below the root zone of the next crop. Wind, water or equipment that can move soil can spread this fungus in the field. See Plant Pathology Fact Sheet No. 4.

Chemical Controls: See PPP-6.

Viruses (*Cucumber mosaic, Pepper mottle, Potato Y, Tobacco etch, Tobacco mosaic, Tomato Spotted Wilt*)

Symptoms: It is difficult to distinguish single or multiple virus infections in the field. Most of these viruses induce degrees of mosaic, mottle, vein banding, and plant stunting. Malformation, leaf cupping, and fruit distortion may also be encountered. Accurate diagnosis is dependent on laboratory tests involving serology or viral inclusion examination.

Tobacco mosaic virus is commonly mechanically transmitted during transplant production, harvesting, and setting. Pepper mottle, potato Y, and tobacco etch are primarily transmitted by aphids during feeding.

Tomato spotted wilt virus (TSWV) is transmitted by thrips. Western flower thrips is the important vector in north Florida for TSWV. Minute pirate bug (*Orius insidiosus*) is an effective predator that suppressed populations of western flower thrips in north Florida.

These viruses are known to survive in numerous weed hosts such as ground cherries (*Physalis* spp.), nightshades (*Solanum* spp.) common groundsel (*Senecio* sp.), wild tobacco (*Nicotiana* sp.), toadflax (*Linaria* sp.), sicklepod (*Cassia* sp.), and jimson weed (*Datura* sp.).

Cultural Controls For:

Tobacco Mosaic Virus

Use resistant varieties. Workers handling pepper plants should wash hands with strong soap and water or 70% alcohol before handling plants. This is most important for workers who use tobacco. This will assist in controlling tobacco mosaic virus.

Pepper Mottle, Potato Y, Tobacco Etch

To reduce insect transmission of viruses (*tobacco etch virus*, *potato Y virus*, and *cucumber mosaic virus* from wild host plants (nightshade, ground cherry and others) several practices are suggested.

1. Eradicate wild host plants in fence rows and on ditch banks during season when crops are not growing.
2. Destroy old infected crops well before planting subsequent crops along side them.
3. Plant barrier crops around pepper fields. A 50-foot strip of a non-susceptible crop (corn, sugarcane, etc.) tends to trap insects flying in until they become non-infective.
4. Spray barrier crop with suitable insecticide at least weekly to reduce population of insect vectors.
5. JMS Stylet Oil has received a Florida state label for control of *tobacco etch*, *potato Y*, and *cucumber mosaic viruses* on pepper. This product interferes with the acquisition and/or transmission of a virus by the aphid in the field. Application requirements are highly specific and must be followed precisely to achieve control. See section on chemical control.

Tomato spotted wilt

1. Monitor crops for thrips, especially vector thrips to time insecticide applications.

2. Locate fields as far away as possible from very susceptible crops such as tomato, peanut and tobacco.

Chemical Controls: See PPP-6. For TSW management, use insecticides specific to vector thrips and not effective on the thrips predator *Orius* sp.

Wet Rot (*Choanephora cucurbitarum*)

Symptoms: This disease produces a blossom blight as well as a fruit rot stage and occasionally a leaf blight. Blossoms exhibit a lack of turgidity as petals begin to wilt. Stiff whisker-like strands of the causal fungus, topped with black heads (sporangia) grow off the infected blossoms causing a blossom drop. Young fruit may become infected, soften and abort with the same fungal growth apparent on the fruit.

Cultural Controls: Plant crop to the proper spacing to maintain adequate air circulation. Use of fungicides to control other disease will aid in control of wet rot.

Chemical Controls: There are materials labeled for this disease on this crop at this time.

Potato, Irish

Disease Management in Irish Potato (*Solanum tuberosum*)

Pete Weingartner and Tom Kucharek

Management Strategies

Potato is vegetatively propagated by planting tubers which can carry many different pathogens. Thus it is especially important to include both preplant and post harvest strategies in controlling diseases in this crop. Many potato diseases during the cropping season and in the harvested crops are initiated as inoculum in seed tubers. For this reason utilization of certified inspected seed tubers is imperative for effective disease management in potatoes and a Florida Seed Law is in place to help ensure high quality seed tubers for Florida growers.

Bacterial Ring Rot

(*Clavibacter michiganensis* subsp. *sepidonicus*)

Symptoms: Leaves and stems of affected plants can wilt anytime after midseason. At first, lower leaves wilt during the heat of the day and then recover at night. As symptoms progress, leaves first become pale green and roll slightly at the margins, followed by more severe wilting, interveinal yellowing and necrosis of leaves. Often, one or two stems of a plant are severely diseased with the remainder remaining healthy. Stems cut and squeezed near the base often exude a milky white bacterial ooze.

Infection of tubers starts at the stem-end and proceeds through the vascular tissue. Tubers cut crosswise exhibit rings of a cheesy rot that can be gray, creamy yellow, or light to red-brown in the vascular tissue. Severely affected tubers may have dry, gray pockets of tissue around the vascular ring.

Control: Infected tubers are the most important source of inoculum. Seed certification is therefore the most effective means of controlling bacterial ring rot since there is a zero tolerance for the disease in all seed producing regions. Introduction of the bacterial ring rot pathogen into a field by using uncertified seed can result in severe crop losses. The disease can spread during the season and infected tubers are difficult to cull at harvest. The pathogen does not overseason in soil.

Bacterial Soft Rot, Black Leg, and Aerial Stem Rot (Aerial Black Leg)
(*Erwinia carotovora* pv *carotovora* and *E. carotovora* pv *atroseptica*)

Symptoms: These diseases are closely related. Soft rot affects the tubers as seed piece decay or as rots of daughter tubers. Black leg and aerial stem rot symptoms develop on potato stems during the season.

The causal bacteria are carried on and in tubers. Seed piece decay is favored by wet weather and temperatures exceeding 68°F. Rotting of seed tubers in Florida is especially severe in warm humid weather when condensation develops on cold seed tubers prior to or during cutting. Bacteria from rotting seed pieces infect daughter tubers by entering lenticels or wounds.

Black leg can develop at anytime during the season and stems may rot at any point from the seed piece to several inches above ground. During humid weather, affected stems are soft and water-soaked. Lesions shrivel and harden when dry weather prevails. The color of lesions varies from light brown to black. Often the pith above the lesions is decayed. Infected plants often are stunted and have rolled terminal leaflets which turn yellow and wilt. In advanced cases the entire plant dies.

Aerial stem rot is generally limited to above ground plant parts. It is distinguished from other rots as a soft rot of stems and petioles which does not start from the seed piece. Infection is often, but not always predisposed by plant injury. Symptoms start with a soft green decay which often turns brown in color.

Tuber rot symptoms vary from dark black decay emanating from the stolon end, to dark colored lesions at the lenticels. Rot can also initiate from wounds. Affected tissue is cream to tan in color and is soft and granular. Margins of decayed tissue often develop brown to black margins. Advanced stages of decay often become slimy and foul smelling due to secondary organisms. Some infections wall off and dry up as chalky white spots. See Plant Pathology Fact Sheet PP-12.

Cultural controls: Use certified seed derived from tissue culture or stem-cutting programs. Avoid moisture condensation on seed tubers by air stacking and maintaining air movement through seed piles. Sanitize seed cutting equipment between seed lots. Plant in well-drained soil, but also avoid planting under excessively dry conditions. During the season avoid cultural practices which wound stems and when possible remain out of fields when plants are excessively wet. To avoid post harvest losses, follow appropriate vine-killing procedures. Do not harvest after a rain. Minimize bruising and wounding of tubers and avoid exposure to excessive heat. Tubers harvested when soil temperatures exceed 70°F are more susceptible to rot and the decay is speeded up when tubers are warmed in sunlight. Dry all tubers of free surface moisture after washing. Clean flumes as frequently as possible to avoid buildup of organic matter and soft rot bacterial inoculum. Avoid packing in film bags. Assure ventilation and air flow (forced air flow is best) around potatoes held for two days or longer. Cool internal tuber pulp temperature to 60°F. See Plant Pathology Fact Sheet PP-12.

Chemical Control: See PPP-6 for specific recommendations for seed piece treatments.

Bacterial Wilt and Tuber Brown Rot (*Ralstonia solanacearum*)

Symptoms: Symptoms resemble those of bacterial ring rot. Initially terminal leaflets wilt on hot days. Wilt progresses rapidly during hot weather and individual branches or entire plants wilt. Leaves often turn yellow and leaf margins roll. Stem cross sections exhibit vascular browning and as wilt advances illustrate bacterial oozing which is more viscous than that of ring rot. Cut stems suspended in water will usually exude bacterial streams from the vascular system. Tuber symptoms progress from the stolon end and consist initially of mild browning which progresses to distinct vascular discoloration coupled with bacterial oozing when tubers are cut in cross section. Soil often adheres to bacterial oozing from the eyes of severely affected tubers. Complete disintegration of tubers often results from secondary invaders. Tubers from a single plant can vary from asymptomatic to complete rot.

Cultural Control: Maintaining a dense cover crop of sorghum/sudan grass or corn which crowd out broad-leaved weeds can reduce incidence of bacterial wilt. Avoid rotations with Solanaceous crops or planting highly susceptible cultivars such as Superior, Red LaSoda, LaRouge, or Pontiac. Do not move soil, water, or equipment from infested to non-infested fields. Incidence of tuber brown rot in the crop can be reduced by delaying harvest and allowing infected tubers to rot in the field.

Chemical controls: Incidence of bacterial wilt is reduced following control of root-knot nematodes with soil fumigants.

Soft rot caused by Clostridia (*Clostridia* spp.)

Symptoms: Clostridia were for many years considered to be solely secondary invaders of rotting tissue. Recent evidence, however, has shown some to be pathogens. Clostridial bacterial soft rots are slimy and have highly offensive odors which distinguishes them

from other the bacterial soft rots of potato. Clostridial rots are favored by anaerobic conditions and relatively high (86 to 99°F) temperatures. These bacteria are present in most soils and rots caused by them are favored by water films on tuber surfaces. Even though Clostridia are pathogens, tuber decay is more rapid in presence of other soft rotting bacteria such as Erwinias.

Cultural controls: Strategies for managing Clostridial rots are the same as those for other bacterial soft rots of potato.

Scab (*Streptomyces* spp., principally *S. scabies*)

Symptoms: Scab is a disease of tubers. New lesions are brown and at maturity may be circular or irregular in shape, rough-textured, and dark brown in color. These lesions may be superficial on the tuber surface, raised, or pitted. The pathogen strain, variety, or soil environmental conditions affect lesion type or severity. The lesions may be few or many, often covering the entire tuber surface.

Common scab is normally a disease of alkaline soils of pH = 7 or higher. Some strains cause scab in soils with pH below 5.0, but these are less common.

Cultural Controls: Plant certified seed. Planting infested seed not only results in diseased tubers at harvest, but also can introduce new more aggressive strains of the pathogen. When possible, increase the length of time between successive potato crops. Maintain optimum soil moisture levels during tuberization. Avoid soil treatments which raise pH. Seed treatments with fungicides can reduce incidence of the disease at harvest.

Powdery Scab (*Spongospora subterranea* f. sp. *subterranea*)

Symptoms: *Sponospora* is a cool weather pathogen and it was therefore long believed that powdery scab would not develop in Florida because of the subtropical conditions. The disease, however, has been observed during recent years in north Florida potatoes. Both tuber and root symptoms are seen. Initially symptoms on roots consist of light brown lesions that develop into wart-like galls. Without magnification early symptoms can be confused with galling caused by root-knot nematodes. The galls initially are white, but turn brown with age. Similar lesions and galls develop at tuber lenticels and eyes. As lesions mature, developing “spore balls” or cytosori develop in the tissue. Fully mature lesions filled with spore balls have not been observed in Florida, however, the pathogen has been shown to naturally survive for at least five years in north Florida commercial potato fields. This organism also carries and vectors the potato mop-top virus which has been recently (2001) found in potatoes shipped from north Florida.

Cultural Controls: Plant only certified seed tubers. Plant symptomless tubers to avoid introducing the disease to uninfested areas.

Rhizoctonia stem and stolon canker and tuber black scurf (*Rhizoctonia solani*)

Symptoms: Development of *Rhizoctonia* stem and stolon cankers is favored by cool, wet soil conditions between planting and emergence. Immature sprouts are more susceptible to attack than are green stems. Early season disease leads to increased tuber black scurf at harvest. Inoculum is tuber-borne, soilborne, or both. Amber brown to black lesions develop on stems, stolons, and roots. Severe cankers can girdle affected plant parts. Emergence can be delayed or reduced. In severe cases aerial plant symptoms develop including reddening and rolling of terminal leaflets and formation of aerial tubers. Tuber symptoms include scurf and cracking, but conspicuous dark black sclerotia (“dirt which won’t rub off”) on the tuber surface is the most recognized symptom.

Cultural controls: Rotate to other than crucifer or solanaceous crops for two to three years. Use certified, inspected seed to reduce levels of tuber-borne inoculum. *Rhizoctonia* is favored by heavy crop residue. Minimize amounts of cover crop residues by disking in cover crops several weeks before planting. Shallow planting can reduce stem cankering. Development of black scurf is enhanced by vine desiccation. Harvest as soon as possible after vine- killing or detach tubers from the mother plants.

Chemical controls: Treat cut seed with recommended fungicides. (See PPP-6).

Early Dying or Verticillium Wilt (*Verticillium albo-atrum* and *V. dahliae*)

Symptoms: Early dying is difficult to distinguish from other causes including natural plant maturity. Symptoms can develop when plants are small, but usually occur after blossoming. Early season infection can result in stunting. Initially, lower leaves turn yellow and wilt, eventually becoming necrotic. Sometimes symptoms are confined to one side of a plant. Leaf yellowing and necrosis progress up the plant which dies and often remains erect. Vascular browning is observed in stems and at the stolon end of tubers, however, these symptoms may be due to other causes. Although severity of early dying is known to be enhanced by root lesion nematodes, the species reported are not found in Florida.

Cultural Controls: Plant only certified seed. Rotate and plant summer cover crops to nonhost plants. Incidence and severity of the disease are reduced following use of some nematicides.

Chemical Controls: See Nematode Management Guide for specific nematode controls.

Early Blight (*Alternaria solani*)

Symptoms: Early blight is a disease of senescence and is most severe following blossoming. Lesions first appear as small dark brown spots, usually on the older lower leaves of the plant. The spots enlarge rapidly in wet weather and develop a series of rings resulting in a “target board” appearance. Plants can be rapidly defoliated when

conditions favor early blight development. Stems as well as leaves can be affected. Tuber infections occur and wounding of the periderm exacerbates infection. Small (1/16 to 1/8 inch), sunken round to irregular lesions develop on the tuber surface. Occurrence of tuber rot is not common in Florida. See Plant Pathology Fact Sheet PP-7.

Cultural controls: Employ adequate soil fertilization and moisture conditions. Utilize fungicides when disease occurs. After midseason consider using fungicides which prevent both early and late blight diseases.

Chemical controls: See PPP-6.

Brown Spot and Black Pit (*Alternaria alternata*)

Symptoms: Brown spot can appear on foliage at any time during the season and is easily confused with early blight. Initial lesions are dark brown circular necrotic spots up to ½ inch in diameter. Spots enlarge, can merge and have necrotic brown margins and concentric target board zonations similar to early blight lesions. Black pit symptoms on tubers are black sunken lesions with defined margins which can be 1/8 inch deep and up to ½ inch in diameter.

Cultural Controls: Provide adequate fertilization to the crop. Avoid bruising tuber at harvest.

Chemical Controls: Broad spectrum fungicides which control early blight are also effective for this disease. See PPP-6 for specific fungicides.

Late blight (*Phytophthora infestans*)

Symptoms: Lesions first appear as water-soaked spots on stems, petioles, or leaflets. The spots enlarge rapidly and on leaflets develop a brown center with a light green border or halo. When it is humid the fungus produces in the halo on the underside of the leaflet a white moldy growth that contains sporangia, spores or both. Frequently, elongate lesions that develop on stems under the crop canopy enable the disease to persist even during dry conditions.

Tuber rot first appears as a brown or purplish-black metallic discoloration of the skin. An amber brown discoloration of the flesh just below the skin develops, usually not penetrating more than ¼ inch. Soft rots often follow late blight in tubers resulting in complete decay. See Plant Pathology Fact Sheet PP 6.

Cultural Controls: Use certified seed. Plant tolerant cultivars. Avoid lifting tubers in wet weather which increases likelihood of tuber infection. If disease is severe, desiccate vines prior to harvest. Disease forecasts are available in the Hastings area.

Chemical Controls: FOR EFFECTIVE CONTROL OF LATE BLIGHT, ANY CURRENTLY REGISTERED FUNGICIDES MUST BE APPLIED BEFORE INFECTION OCCURS.

Use fungicides to control late blight. In south Florida, begin spraying after emergence and maintain a calendar schedule. Consult with local University of Florida, IFAS, extension personnel.

In the Hastings region spray advisories based on forecasting used to be available. Contact the University of Florida, IFAS, Hastings REC or area extension agents for additional information. If forecasting is not used, begin spraying before plants are six to eight inches tall if late blight fails to occur earlier. Follow a five to seven day spray interval or an alternative more economical method of blight control by spraying plants following eight consecutive days when the average daily temperatures range from 50 to 77° F and the 10 day rainfall total is 1.02 inches or greater. Weather data are available for the Hastings area by consulting the FAWN network. Intervals using this method may vary from five to 14 days or more. A MINIMUM OF A SEVEN DAY SPRAY SCHEDULE IS REQUIRED REGARDLESS OF WEATHER CONDITIONS ONCE LATE BLIGHT IS REPORTED IN THE REGION. More frequent sprays may be needed when weather conditions are favorable. Please consult PPP-6 for suggested fungicides.

White Mold (*Sclerotinia sclerotiorum*)

Symptoms: The disease is also known as *Sclerotinia* stalk rot. It is generally more severe in south Florida potatoes than in the north. Water-soaked lesions develop on the stems, beginning in the crotches or at points of injury. The spots enlarge and turn light to dark brown as they dry out. Infection can occur through old leaves, especially when in contact with the soil. Secondary infection often follows other diseases. Under favorable conditions, a white growth of mycelium may cover stems and foliage. Hard black resting bodies or sclerotia may form on the surface of infected stems or foliage, but are more common within the pith of the stems. The sclerotia are irregular in shape and range in size from 1/8 to 3/4 in. Aerial infections of leaves and stems may occur from ascospores produced from tiny mushroom-like structures emerging from soil-bore sclerotia during cool, moist weather. The ascospores may be dispersed some distance by wind.

Cultural Controls: Flooding of fields for several weeks has been suggested in the past, however, this is impractical in modern agriculture. Avoid injuring plant tissue when cultivating. Avoid irrigation practices such as overhead sprinkling which prolong wetting of foliage. Utilize cultural practices which enhance air flow within the canopy and speed up drying of the foliage. Avoid rotations with other susceptible crops such as snap beans or cole crops. Use crop rotation with grass crops and turn soil six inches to bury viable sclerotia. In fields with a history of white mold, application of protective fungicides may be advisable. See Plant Pathology Fact Sheet PP-22.

Chemical Controls: See PPP-6.

Southern Stem Rot or Southern Blight (*Sclerotium rolfsii*)

Symptoms: The disease generally occurs near harvest when higher soil temperatures prevail. Stem rot often appears rapidly near the end of the production season when rainy periods follow a prolonged period of drought. Most infections observed in the field are confined to the base and under ground portions of the stems and to tubers. Initially, wet lesions develop at the soil line. As lesions age, white mycelial growth and numerous white to amber brown spherical sclerotia, resembling mustard seeds when mature, are visible on affected stems. Sclerotial development and growth of mycelium is usually more profuse on subterranean plant parts. Tuber infections usually start at the stolon end. Lesions are brown to dark brown in color and threads of mycelium and sclerotia develop on the tuber surface. Tuber flesh beneath the lesion can rot. Occasionally, dark brown to black circular lesions develop beneath tuber lenticels. See Plant Pathology Fact Sheet PP-4.

Cultural Controls: Bury plant debris by deep plowing. Attempt to complete harvest before hot weather prevails.

Virus Diseases (Various viruses)

Symptoms: A number of viral diseases affect potato. Field diagnosis is difficult because symptoms are often similar for different viruses. Mosaic symptoms are often associated with strains of *Potato Virus Y*, however, accurate diagnosis depends upon laboratory tests. Fortunately, incidence of these viruses has generally been low due to effective control through seed certification programs. A noted exception is tobacco rattle virus which is soilborne and common in the Hastings region. See the discussion on corky ringspot for details on this disease.

Cultural Controls: Plant only certified seed. Plant resistant cultivars when possible.

Corky Ringspot (*Tobacco rattle virus*)

Symptoms: Foliar symptoms usually do not occur in the field and symptoms are limited to the tubers. Although diagnostic symptoms of necrotic rings and arcs occur on the tuber surface of many smooth-skinned cultivars, the tubers of many cultivars do not have distinguishing external symptoms. Typical internal tuber symptoms in most susceptible cultivars are seen as arcs and rings of necrosis and can occur in tubers of any age depending upon the time of infection. *Tobacco rattle virus* is vectored to potato tubers by stubby root (trichodorid) nematodes.

Cultural Controls: Plant resistant cultivars such as Superior. Crop rotations are generally ineffective, however, there is evidence from other regions of the U.S. that rotations with alfalfa provide effective control.

Chemical control: Consult the Nematode Control Guide for current suggestions.

Seed-Piece Rots (Various fungi and bacteria)

Symptoms: Symptoms are varied. Some pathogens such as *Fusarium* cause dry rot whereas other including soft rot bacteria result in soft, wet rots. Seed piece decay can result from the use of poor seed, improper handling and storing of seed prior to planting, or planting seed in an unfavorable environment.

Cultural Controls: Purchase only certified, low generation seed. For maximum protection, have seed inspected on arrival. Segregate truckloads or lots of seed. Avoid moisture condensation on incoming seed by air stacking (spacing) to maximize air flow around the tubers. Allow tubers to warm to 55 to 55 °F before handling. Avoid bruising of seed tubers. Sanitize cutters between seed lots or at least daily. Wound healing is favored by fresh air, 95 to 99% relative humidities, and temperatures of 55 to 60°F. Lower humidity or a film of water interferes with normal healing. In Florida, the most favorable conditions for wound healing are often in the soil. Many seedborne pathogens can be controlled with seed treatments applied at the time of cutting.

Chemical Controls: See PPP-6 for specific seed-piece treatments.

Post-harvest tuber rots (Bacterial soft rots, *Pythium* spp, *Sclerotium rolfsii*, *Fusarium* spp., *Rhizoctonia solani*)

Symptoms: Bacterial soft rots, Pythium leak, Sclerotium rot, Fusarium rots, and Rhizoctonia black scurf, and occasionally charcoal rot (*Macrophomina phaseolina*) are the most frequently observed post harvest rots in Florida. The symptoms of these rots vary. Pythium leak and Sclerotium rot are often initiated at the stolon end of the tuber, but they can also occur in wounds, or in the case of Sclerotium, at lenticels. Similarly, Fusarium can be associated with the stem end of tubers, but is also often seen emanating from wounds.

Cultural Controls: Although at harvest and post harvest handling of tubers can exacerbate soft post harvest rots, most of these diseases are most effectively managed through use of the previously described appropriate practices at planting and through the season coupled with practices which minimize tuber injury at harvest.

Chemical Controls: Pythium leak, Fusarium rots, and Rhizoctonia black scurf can be partially managed with appropriate fungicide programs. See PPP-6 for fungicide recommendations.

Pumpkin

Disease Management in Pumpkin (*Cucurbita pepo*)

Tom Kucharek

Alternaria Leaf Spot (*Alternaria cucumerina*)

Symptoms: This is not a common disease on pumpkin in Florida. Small, dark circular spots (may appear water-soaked) develop on leaves and enlarge to 1/2 inch or more across. Concentric rings appear in the brown spots as they enlarge, giving a "target spot" appearance. Fruit is seldom attacked unless plants are nutrient deficient. See Plant Pathology Fact Sheet PP-32.

Chemical Controls: See PPP-6.

Angular Leaf Spot (*Pseudomonas syringae* pv. *lachrymans*)

Symptoms: This is not a common disease in pumpkin in Florida. Infections are found in the leaves, stems, and fruit. Spots in the leaves are irregular in shape, angular, and water-soaked. Free moisture allows the bacteria to ooze from the spots, which, upon drying, leaves a white residue. These spots of dead tissue will occasionally drop away from the healthy tissue leaving irregular holes in the leaves.

Cultural Controls: Use disease-free transplants.

Anthracnose (*Colletotrichum lagenarium*)

Symptoms: This is not a common disease on pumpkin in Florida. The disease first appears in the foliage as small, yellow, water-soaked spots which enlarge rapidly and turn brown. The dead tissue dries and may crack and fall out. In the stems, the lesions are elongated. On the fruits, dark, circular, sunken lesions appear, varying in size with the age. During wet weather the center of the spots often show a pinkish color due to production of spores.

Cultural Controls: Choose resistant varieties.

Chemical Controls: See PPP-6. Fungicides listed for downy mildew and powdery mildew will be useful.

Damping-Off (*Pythium* spp., *Fusarium* spp., and *Rhizoctonia* spp.)

Symptoms: This disease affects seedlings and is caused by several soil-inhabiting fungi that are almost universal in occurrence. These fungi infect portions of the plant at or below the soil level, resulting in collapse and death of the seedling. Conditions unfavorable for rapid emergence of cantaloupes (cool, wet weather) are usually most favorable for this disease. See Plant Pathology Fact Sheet PP-1.

Chemical Controls: Plant only fungicide-treated seed (most seed is commercially pre-treated). See PPP-6.

Downy Mildew (*Pseudoperonospora cubensis*)

Symptoms: This disease first appears on the foliage as pale-green areas separated by islands of darker green tissues. These spots develop into angular, yellowish lesions. Older lesions become brown and necrotic. Severely affected leaves may become chlorotic, brown and shrivel. During moist periods, a grayish spore mass may be observed on the lower leaf surface on these spots. See Plant Pathology Fact Sheet PP-2.

Cultural Controls: Choose resistant varieties, if available.

Chemical Controls: See PPP-6.

Gummy Stem Blight (*Didymella bryoniae/Phoma cucurbitacearum*)

Symptoms: This is not a common disease on pumpkin in Florida. Lesions on the cotyledons and leaves are round or irregular, brown, with faint concentric rings. Lesions on the crown and stem are brown and usually turn white with age. The causal fungus can often be observed to reproduce on the crowns or stem lesions and will form small pycnidia (black specks). Asexual spores are produced within the pycnidia in the plant tissue. The pathogen can be spread by splashing rain from plant to plant, or be carried long distances on wind currents. The fungus "over-winters" on old plant debris and can be seedborne. See Plant Pathology Fact Sheet PP-27.

Cultural Controls: Avoid planting in fields with residual cucurbit crop debris still present.

Chemical Controls: See PPP-6.

Powdery Mildew (*Sphaerotheca* sp.)

Symptoms: The fungus affects the leaves and stems. It first appears as round whitish spots on the under side of the older leaves. The spots increase in number and size and coalesce. These appear on the upper surface with a white powdery growth. Severely affected leaves lose their normal dark-green color and become pale yellow green, then brown and shrivel. The young stems may also be killed. Fruits of infected vines ripen prematurely, are of poor quality and often sunburn.

Cultural Controls: Choose resistant varieties.

Chemical Controls: See PPP-6.

Viruses (*Cucumber mosaic*, *Papaya ringspot virus type W*, *Watermelon mosaic virus 2*, *Zucchini Yellow mosaic virus*)

Symptoms: Leaves show varying degrees of mottling, distortion and stunting. Growth habit may alter as infected vine tips appear more erect. Fruits may be mottled, have greenish lines or ring spots, and can be deformed. These viruses are spread by aphids. See Plant Pathology Circular 1184.

Cultural Controls: Control weeds in and around plantings. This will aid in virus control. Treating fields repeatedly for aphid control is not recommended because of the short time period needed by aphids to transmit the virus while feeding.

Chemical Controls: See PPP-6.

Spinach

Disease Management in Spinach (*Spinacia sp.*)

Richard Raid and Tom Kucharek

Damping-off (*Rhizoctonia solani* and *Pythium spp.*)

Symptoms: Damping-off disease affects young plants during or after emergence. The causal fungus invades the seed, emerging root, or stem and will rapidly rot the plant. Emerged plants are often invaded at the soil line where a maroon to reddish-brown lesion (*Rhizoctonia*) will develop that girdles the stem and causes a seedling to wilt to death. *Pythium* causes a soft lower stem decay that may be greasy-black in color. See Plant Pathology Fact Sheet PP-1.

Cultural Controls: Insure that all previous crop and weed debris has completely decomposed prior to planting.

Chemical Controls: PPP-6

Downy Mildew (*Peronospora effusa*)

Symptoms: Lesions begin as indefinite yellow blotches on the upper leaf surface. As infection proceeds, the lower surface of these spots becomes covered with a purplish mat of fungal sporulation. Infection and disease development can be rapid resulting in blackened leaves and/or dead plants, especially during wet weather periods. Under less favorable weather, infected plants exhibit stunting and creamy yellow leaves.

The pathogen is an obligate parasite that over seasons in spinach, spinach seed, and through sexual spores in the soil. At least three races of this pathogen are known to exist. Preferred weather for fungal reproduction is between 45-59° F. Infection requires a wet leaf surface.

Cultural Controls: Exercise crop rotation to avoid overlapping winter and spring spinach crops. Hot water treatment of seed at 122° F for 25 minutes will eradicate the seedborne presence of this fungus. Many varieties are resistant to two races of this fungus.

Chemical Controls: See PPP-6.

Mosaic (*Cucumber mosaic virus*)

Symptoms: Spinach infected with *Cucumber mosaic virus* (CMV) will exhibit mottling on new leaves. This mottling will develop into full leaf chlorosis that is accompanied by leaf curling and distortion. Leaf and plant death can occur. Stunting can be quite apparent if plants are infected at an early age.

This virus infects plants in at least 34 plant families that include such economically important crops as cucumber, squash, pepper, turnip, muskmelon, watermelon, eggplant, tobacco and carrot. Many weeds also host this virus, especially dayflower, *Commelina* spp. Aphids carry and spread CMV.

Cultural Controls: Plant varieties with tolerance or resistance to CMV. Pursue perennial weed control to prevent reservoirs of this virus near fields.

Stemphylium Leaf Spot (*Stemphylium botryosum*)

Symptoms: Stemphylium leaf spot was first reported in California in 1997, and appears to have become endemic. Foliar symptoms were first observed in Florida during the 2000-2001 growing season, although the fungus had been previously reported as a seed mold. Left uncontrolled, the disease may result in significant losses, particularly in spinach that is densely planted for the newly popular “spring salad mixtures”

The disease starts out as small circular, gray-green leaf spots, approximately 2-5 mm in diameter. Visual symptoms appear about one week following exposure to the pathogen. As the disorder progresses, lesions expand, and coalesce, covering larger portions of tissue. Seven to ten days after their initial appearance, diseased foliar tissues turn light tan to brown, and become papery in texture. Asexual spores (conidia) are dark brown, oblong with rounded ends, and have both longitudinal and transverse cross walls. Borne singly on typically unbranched conidiophores with a swollen tip, conidia may be viewed microscopically on the surface of older lesions. However, sporulation is not readily apparent to the naked eye, as with spinach downy mildew and white rust.

Although infection may take place over a relatively wide-range of temperatures, the disease is favored by moderate to warm temperatures (18 to 24° C) and prolonged periods of leaf wetness. Spores are disseminated by wind, rain splash, irrigation, and farm implements or workers. Primary inoculum is thought to originate from infested seed or crop debris in or near the field.

Cultural Controls: There does not appear to be a wide range in cultivar resistance to *Stemphylium botryosum* at the present time. California research showed only slightly less favorable lesion development on the savoy spinach cultivar “Vienna” than on other types

or varieties tested. Favored by free moisture, cultural practices that promote unnecessary periods of leaf wetness, i.e. overhead irrigation, should be avoided as much as possible.

Chemical Control: Fungicides may be useful in slowing or lessening the impact of the disease. Of the currently registered fungicides, strobilurin compounds appear to offer the most efficacious control. To avoid possible phytotoxicity, care should be exercised to read the specific label regarding their use or mixture with other pesticides or adjuvants, particularly during warmer weather. See PPP-6.

White Rust (*Albugo occidentalis*)

Symptoms: Infected plants exhibit white, blister-like pustules on the leaves, mostly on the lower surface and petioles. Pustules are about 1/8 inch in diameter and can be solitary or grouped. Leaves with numerous infections will discolor and brown. The fungus can survive in crop debris as sexual spores for about a year. The fungus is also hosted by the weed relative, *Chenopodium capitatum*, which is not known to occur in Florida at this time. Other close weed relatives of spinach can exhibit a similar white rust disease but the pathogen in these situations does not infect spinach.

Cultural Controls: Crop rotation is advised where the disease becomes established. All weed species of *Chenopodium* should be eradicated since their role in harboring the spinach white rust fungus is unknown. The varieties Wintergarden, Jewel, and Crystal have resistance to this disease.

Chemical Controls: See PPP-6.

Squash

Disease Management in Squash (*Cucurbita pepo*, *C. maxima*, and *C. moschata*)

Pam Roberts and Tom Kucharek

Angular Leaf Spot (*Pseudomonas syringae* pv. *lachrymans*)

Symptoms: This is not a common disease in squash in Florida. Infections are found in the leaves, stems, and fruit. Spots in the leaves are angular, and water-soaked. Free moisture allows bacteria to ooze from the spots which dry later leaving a white residue. These spots of dead tissue will occasionally drop away from the healthy tissue leaving holes in the leaves. This is a cool weather disease.

The spots on the fruit are generally smaller and nearly circular. The dead spots on the fruit turn white and the tissue may crack open. Wet, cool seasons favor this disease. The bacterium is seedborne and dispersed by rain or irrigation water.

Cultural Controls: Plant disease-free seed. Rotate land away from cucurbit crops. Do not work diseased plants when they are wet.

Chemical Controls: See PPP-6.

Damping-off (*Pythium* spp. and *Rhizoctonia solani*)

Symptoms: Seed fails to germinate due to rapid colonization of seed by soilborne fungi. Excavated seed will be rotted and soft often with evidence of fungal mycelium. Young, newly emerged seedlings often collapse at soil line and crown. The stems may exhibit an obvious discoloration ranging in color from a reddish-brown to black and may be dry or mushy to the touch depending on the soil fungus involved. See Plant Pathology Fact Sheet PP-1.

Cultural Controls: Avoid planting seed when soil moisture, soil preparation, temperature or planting depth do not favor rapid emergence. Plant in well tilled soil where old crop debris had been destroyed 30 days previously.

Chemical Controls: Use a fungicide seed treatment. See PPP-6.

Downy Mildew (*Pseudoperonospora cubensis*)

Symptoms: Symptoms appear on the foliage as pale-green to yellow, angular spots, with gray-tinged spore masses on the undersides of these spots. Severely infected leaves become chlorotic, turn brown, and shrivel. The fruits are rarely affected directly, but fail to color properly and are usually sunburned and tasteless. Spores are readily wind dispersed. See Plant Pathology Fact Sheet PP-2.

Chemical Controls: Initiate a fungicide spray program in advance of disease occurrence. See PPP-6.

Gummy Stem Blight (*Didymella bryoniae/Phoma cucubitarum*)

Symptoms: This fungus can cause damping-off, crown and stem rot, leaf spots and fruit rot on winter squash. Infection can begin on seed leaves but usually occurs on the older leaves close to the soil line. Lesions are round to irregular, brown and sometimes concentrically zoned. In Florida, this disease is found in fruit as black surface lesions.

Stem or vine lesions are brown, often splitting open and turning light colored with age. The black, speck-like fruiting structures (pycnidia) can often be seen in these stem or vine cankers. Lesion enlargement may girdle the stem or vine causing death.

The pathogen can be seedborne but often survives in previous crop debris. Spread is achieved by rain splashing and strong winds. See Plant Pathology Fact Sheet PP-27.

Chemical Controls: Plant only fungicide-treated seed. Avoid planting in field with residual crop debris still present. Apply fungicides as needed. See PPP-6

Phytophthora Blight (*Phytophthora capsici*)

Symptoms: The disease can occur on the plant at any stage causing damping-off, seedling blight, foliar blight, and plant death preceded by wilting. Symptoms on mature plants are seen as dark, water-soaked areas in the crown. Leaf spots are rapidly expanding, water-soaked lesions. Infection of the plant, particularly summer squash, leads to rapid death. Sunken, brown water-soaked areas appear in infected fruit. A white growth may cover the lesion and sporangia can be readily recovered. Sporangia are rain-splashed dispersed or by moving infested soil or contaminated equipment. Surface moisture is required by the swimming zoospores for infections. Standing water in fields is an ideal situation for occurrence of this disease if inoculum is present in the soil.

Cultural Controls: Plant in well-drained soils and avoid waterlogged conditions. Do not move plants or equipment from infected fields to non-infected fields. Avoid fields known to have had this disease because the pathogen can survive for many years in the soil.

Chemical Controls: Use a soil fumigant. See PPP-6

Powdery Mildew (*Oidium* sp.)

Symptoms: This disease affects the leaves and stems, first appearing as round whitish spots on the upper or lower leaf surfaces. The spots increase in number and size, coalesce, and appear on the upper surface as a white, powdery growth. Severely affected leaves lose their normal dark-green color and become pale yellow-green, then brown and shriveled. Also, the young stems are killed. Fruits on infected vines ripen prematurely, are of poor quality, and often sunburn. Spores are readily wind-dispersed over long distances.

Chemical Controls: Apply fungicides as needed. See PPP-6.

Viruses (*Cucumber mosaic virus*, *Papaya ringspot virus Type W*, *Watermelon mosaic virus 2*, and *Zucchini yellow mosaic virus*)

Symptoms: Young infected plants may exhibit prominent vein clearing, chlorotic spotting and a mosaic on leaves. Older plants may exhibit stunting with varying degrees of mottling, leaf blistering and malformation and vein extension along leaf borders depending on the strain of virus, age of infection and possibly other factors.

Yellow squash varieties will exhibit varying degrees of fruit greening in a striped or mottled pattern, sometimes with raised yellow blisters. Green-fruited squash may lighten or mottle in color as well as blister. Fruit distortion can be severe across squash types.

This virus is spread by aphids from weed hosts within Florida. Common weed hosts include the creeping cucumber or melonette (*Melothria pendula*) in south Florida and alyce clover (*Alysicarpus* sp.) farther north in the State. Dayflower (*Commelina* sp.) is a major host for cucumber mosaic virus. See Plant Pathology Circular 1184.

Cultural Controls: Do not grow squash behind or adjacent to other cucurbit crops since these viral diseases affect all cucurbits. Isolation of squash fields may limit aphid buildup from other crops and use of noncrops (solanaceous crops) as buffer fields should reduce field to field spread. Control weeds prior to cropping. Use of JMS Stylet Oil on a schedule can reduce losses to virus. See PPP-6 for use of JMS Stylet Oil. Certain varieties of yellow summer squash and zucchini squash have resistance to some of these viruses.

Wet Rot (Blossom Rot) (*Choanephora cucurbitarum*)

Symptoms: This disease affects the blossoms and fruit. The infected part rapidly becomes covered with a mass of whisker-like, white-stalked, black-headed fruiting bodies of the causal fungus. The tissue beneath this mass of fungus becomes water-soaked and rotted. During dry periods, fruit may rot back from the blossom-end without the characteristic fungus growth present. See Plant Pathology Fact Sheet PP-11.

Cultural Controls: Occurrence of blossom-end rot may predispose fruits to invasion by this weak pathogen. Use of fungicides in the control of other diseases may aid in the control of wet rot. Minimize crowding of plants and control weeds; these practices enhance air circulation. In gardens, removing the spent corolla (flower) after successful pollination will control this fungal disease on those fruit.

Strawberry

Disease Management in Strawberry (*Fragaria vesca*)

Pam Roberts

Angular Leaf Spot (*Xanthomonas fragariae*)

Symptoms: The first symptoms are dark green, water-soaked lesions on the under surfaces of leaves. These later become visible on the upper surfaces as reddish or brownish angular spots of variable size. Often the angular spots are aggregate in the leaves. Back lighting of infected leaves show a multicolored stained window glass effect that is diagnostic for this disease. With the onset of warmer weather, the disease disappears and the plants recover.

Cultural Controls: Buy disease-free plants. Limiting the use of overhead sprinklers as much as possible may decrease spread and severity of the disease.

Chemical Controls: The use of a copper fungicide will aid in control. Strawberry plants are very sensitive to copper, therefore use low rates with caution. See PPP-6.

Anthracnose fruit rot and Colletotrichum crown rot (*Colletotrichum fragariae*, *C. acutatum*, *C. gloeosporoides*)

Symptoms: Diseases caused by species of *Colletotrichum* can affect almost every plant part. Symptoms on the runner or petiole appear dark brown to black and are sunken lesions that sometimes girdle the runner or petiole. Girdling of the runner causes death of its distal portions with consequent death of any un-rooted daughter plants beyond the lesion. Observation of the older lesions with hand lens often reveals groups of black bristles (setae) that are formed by the acervuli. In this way, the fungus can be identified.

Plants in the field can suddenly wilt and die in the nursery or fruiting field. Wilt in the fruiting field usually occurs only during prolonged periods of hot weather. Pith in the crowns of *Colletotrichum*-infected plants is brown and firm. Since the fungus grows into the crown from runner or petiole lesions, control of this phase of the disease will also prevent wilting.

Ripe fruit may become infected, without any symptoms on the leaves or the crown. Dark brown, circular, sunken lesions may develop anywhere in the fruit. Lesions are firm and may take on a buff-colored appearance due to spore production on the fruit surface. Lesions in immature fruit are dark brown or black, sunken, and usually small. Several lesions may coalesce and cover most of the surface of a fruit. Infected flowers or very young immature fruit turn brown or black and remain attached to the pedicel.

Cultural Controls: Purchase disease-free, certified transplants. The variety 'Sweet Charlie' is resistant to Anthracnose fruit rot. Control of this disease is extremely difficult because it is most severe during periods of high temperature and rainfall. Incorporate plant debris into the soil. Use of fungicides will aid in control.

Chemical Controls: See PPP-6.

Leaf Spot (*Mycosphaerella fragariae*)

Symptoms: Spots are small, purplish-red lesions less than 1/8 inch in diameter. The final size of the lesion depends on the variety. On some, the lesions remain very small and numerous and the leaflets appear "rusty." On others, the lesions increase in size to 1/4 inch or larger and develop white or gray centers with reddish-purple to dark purple borders. Lesions may form on fruit, calyxes, petioles, and stolons. Severe infection can result in death of leaflets and defoliation of plants.

Cultural Controls: Buy disease-free plants. Use crop rotation.

Chemical Controls: See PPP-6.

Gray Mold or Brown Rot (*Botrytis cinerea*)

Symptoms: This rot occurs both in the field and during transportation. It is favored by cool, wet weather in the field, where it occurs in fruit at all stages of development.

Infection begins with the flowers but the symptoms are observed on unripe or maturing fruit. Lesions in fruit begin as small, light brown spots that quickly enlarge and become covered with white fungal mycelia and gray to brown spores. The fruit becomes soft at first, then hard, dry, and mummified. Under moist conditions the fruit becomes covered with 'gray mold', which consists of conidia and conidiophores. When diseased fruit are disturbed, large numbers of spores are often released and are visible as gray puffs.

Cultural Controls: Remove and discard infected fruit and plant debris.

Chemical Controls: See PPP-6.

Phomopsis Leaf Blight and Fruit Rot (*Phomopsis obscurans*)

Symptoms: Lesions in the foliage are initially circular and reddish-purple spots. Older lesions are zonate with a dark brown central area surrounded by a lighter brown or tan area which in turn is bordered by a purplish zone. These spots are frequently V-shaped with the widest part of the lesions at the leaf margin and the narrow base centered on a vein. Black specks, the protruding necks of pycnidia, dot the central areas of the older lesions.

Initial symptoms on fruit are round, light pink, and water-soaked lesions. Frequently, two or more lesions may coalesce, turn brown, and eventually entire fruit becomes infected. Infected fruit will mummify and appear dark brown to black due to the numerous fruiting structures (pycnidia) on the fruit surface. The disease may also cause dark, sunken, and elongated lesions in stolons and petioles, that are very similar in appearance to anthracnose.

Chemical Controls: See PPP-6.

Leaf Scorch (*Diplocarpon earlianum*)

Symptoms: Symptoms in leaves are numerous purplish blotches of irregular shape and are 1/16 to 3/16 inch in diameter. Clusters of the blotches turn brownish, but never white or gray as in the case of common leaf spot. Dark, glistening acervuli appear in the lesions on the upper surfaces of the leaves. In severe cases, the leaf margins curl upward and the leaves dry to a tan color, progressively from the margins to the midrib, giving a scorched appearance.

Chemical Controls: See PPP-6.

Phytophthora crown rot and Leather rot (*Phytophthora cactorum* and *P. citricola*)

Symptoms: Symptoms of the disease are sudden wilting of plants. Brown streaks are present in the crown. The wilt and crown rot symptoms of this disease are difficult to distinguish from the symptoms produced by other wilt pathogens so isolation and characterization of the pathogen is important for proper identification.

Cultural Controls: Use disease-free transplants.

Chemical Controls: See PPP-6.

Powdery Mildew (*Sphaerotheca macularis*)

Symptoms: The edges of the leaves roll upward, and a sparse white growth of conidia and conidiophores may be seen on the under surface of the leaves. Irregular-shaped yellow or black spots will develop initially on the lower surface of the leaf and eventually show on the upper surfaces. The edges of heavily infected leaflets curl upward. Leaf petioles, flowers and fruit can be infected. Seeds on the fruit can be colonized by the fungus which produces aerial mycelia and makes the seeds appear fuzzy. This can be a severe problem in greenhouses and tunnels.

Cultural Controls: Use disease-free transplants.

Chemical Controls: See PPP-6.

Rhizopus Rot or Leaks (*Rhizopus nigricans*)

Symptoms: This rot affects fruit and is most serious during transportation and marketing but can also occur in the field. Conditions of high temperature and moisture favor development. Infected fruits collapse and rapidly lose juice that leaks from the container. A loose, cottony growth of mycelium (whiskers) grows over the surface of the fruit. Fruiting bodies (sporangia) appear as black dots scattered throughout the mycelium.

Cultural Controls: Handle fruit carefully to avoid bruising, pick fruit during the morning and protect from the sun at all times, and cool rapidly to 35 to 40° F before shipping.

Sclerotium Rot (*Sclerotium rolfsii*)

Symptoms: This disease develops during hot, wet weather and is most severe in the nursery during the summer. The fungus attacks plants at the soil line and invades both crown and roots, causing sudden death. The roots and crowns, and often the soil surface around diseased plants, may become covered with white mycelium and/or many sclerotia. The sclerotia are about the size of mustard seed and vary in color from white through various shades of tan to dark brown depending upon age. The disease usually occurs in distinct spots in the field.

Cultural Controls: If possible avoid areas where this disease has been prevalent in previous crops, particularly where heavy legume cover crops have been grown. Cut and allow cover crops to dry thoroughly before turning under. Turn soil at least 6 inches deep. This disease is most prevalent during hot, wet weather.

Soilborne Diseases (including Black Root Rot Complex)

Symptoms: These are varied, depending on specific pathogen causing the trouble, but in general, poor growth, poor yield and dying of leaves of entire plants are typical.

Chemical Controls: Employ soil fumigation to reduce plant loss and improve plant vigor and quality. See PPP-6.

Tip Burn

Symptoms: This disease is of non-pathogenic origin. Though its cause is unknown, it frequently develops after sudden changes from low to high temperatures.

Although flower buds can be affected, the leaf symptoms are most noticeable. The terminal growing tissues of young unfolding leaves and flowers are killed. As the affected leaves expand, the tips appear to have been burned and the leaves may become irregularly shaped and puckered.

Cultural Controls: No control known. Recovery of the plants is almost a certainty, although the affected leaves are permanently disfigured.

Verticillium Wilt (*Verticillium albo-atrum* and *V. dahliae*)

Symptoms: Initial symptoms of the disease are wilting of the plant. Leaf margins and browning between veins appear on older leaves. Younger leaves may remain green and healthy, but develop slowly and the plant becomes stunted, decline and ultimately die. The crown of diseased plants develops necrotic streaking within the crown that appears similar to other crown rots. It is necessary to isolate the fungus to confirm its identity.

Cultural Controls: Use disease-free transplants. Avoid planting strawberry nurseries on ground previously used for potato or tomato production. Do not over lime the soil. This fungus is likely to be more severe a soil with a high pH.

Sweet Basil

Disease Management in Sweet Basil (*Ocimum basilicum*)

Pam Roberts

Leaf Spot (*Colletotrichum* sp.)

Symptoms: Dark spots form on leaves and the dead tissue within leaf spots may drop out to leave holes. The disease can cause defoliation, tip dieback, stem lesions, and sometimes loss of entire plants. Spores are water-splashed from diseased tissue.

Cultural Controls: Sow seeds in sterile containers in sterile soil. Since wet conditions favor disease development, reduce leaf wetness periods by reducing humidity and increase plant spacing to increase air movement. Avoid overhead irrigation. Remove disease plants to reduce inoculum levels.

Bacterial Leaf Spot (*Pseudomonas cichorii*)

Symptoms: Spots on leaves are water-soaked, dark, and may be both angular and delineated by small veins in the leaves or show as irregular leaf spots. A wet stem rot may occur. Bacterium is reported to be seed-borne. The disease is favored by wet, humid conditions and is disseminated by splashing water or by handling and spreading infected tissue.

Cultural Controls: Decrease moisture on plants with low humidity and sufficient plant spacing for adequate movement to reduce leaf wetness periods. Use disease-free seed and transplants. Remove diseased leaves and plants to reduce inoculum levels. Avoid overhead irrigation. Use clean, sterile equipment and do not move between infected and healthy plants.

Sweet Corn

Disease Management in Sweet Corn (*Zea mays*)

Richard Raid and Tom Kucharek

Also see Plant Pathology Circular 1130.

Bacterial Leaf Blight (*Pseudomonas avenae*)

Symptoms: Incited by a bacterium, bacterial leaf blight is characterized by sharply delineated dead spots and stripes on the leaf. These may measure about 1/16 inch wide and up to several inches long. The spots initially appear water-soaked, turn brown, and then white to gray. Newly-formed lesions typically occur on leaves as they emerge from the whorl, with little elongation once the leaf is fully expanded. Bacterial blight rarely advances once the corn has tasseled.

Cultural Controls: Since severe bacterial blight has been observed to follow heavy budworm infestations, good insect control may aid in lessening the disease. Additionally, since the bacterium may survive on grassy weeds, particularly Vasey grass, control of such weed hosts, particularly along ditch banks, is often beneficial. The disease is favored by warm, wet conditions. Some varieties are more resistant to bacterial blight than others and these should be considered in disease prone areas.

Bacterial Stripe (*Pseudomonas andropogonis*)

Symptoms: Primary lesions are typically amber- to olive-colored, with parallel sides. Lesions usually elongate, giving a stripe appearance, and may coalesce. Unlike bacterial leaf blight, bacterial stripe symptoms appear first on the lower leaves and spread upwards. Leaves superior to the ear are seldom affected and therefore bacterial stripe is seldom of economic importance.

Cultural Controls: Bacterial stripe, like bacterial blight, is most severe under warm wet conditions. It also survives on weed hosts such as Johnsongrass and Sudangrass. Resistant varieties and proper weed control will reduce disease incidence.

Common Rust (*Puccinia sorghi*)

Symptoms: Common rust is a fungal disease characterized by small, circular to elongate, reddish brown to dark brown pustules on the leaf surface. Common rust pustules are frequently erumpent on both the upper and lower leaf surface. Pustules give rise to tens of thousands of cinnamon brown spores which are easily dislodged during periods of reduced humidity. When severe, common rust may cause extensive yellowing and premature desiccation of corn foliage, resulting in leaf necrosis. In extreme cases, heavy rust infestations may result in stunting, incomplete ear tip fill, and pustules on ear husks, reducing marketability.

Cultural Controls: Common rust, because it is favored by cool to moderate temperatures (60-73° C), is most prevalent during Florida's spring growing season. It is seldom a problem during the fall in Southern Florida when southern rust is the more prevalent rust disease. During the late 1980s and throughout the 1990s, common rust was the most important disease of Florida sweet corn. New varieties, specifically bred for rust resistance, have proven to be very beneficial in the control of this disease.

Chemical Control: Early detection is extremely important in initiating a chemical control program for rust. Since the fungus produces millions of spores which are wind-disseminated over large areas, rust may build up to high levels in a very short time. The newer strobilurin and sterol-inhibiting fungicides, which have some systemic properties, are more effective in controlling rust than the broad spectrum protectants. However, they should be used in a program (either tank-mixed or alternated) with the protectants to minimize the development of resistant strains of the rust fungus and to maximize efficacy. See PPP-6.

Damping-Off (*Fusarium* spp., *Penicillium* spp., and *Pythium* spp., and *Rhizoctonia solani*)

Symptoms: A number of soilborne fungi may infect the seed or seedling, causing them to rot or to die shortly after germination. Affected seed kernels are soft, and deteriorate in the soil. Seedlings that do emerge may show chlorosis or tip burn of the seed leaf as well as the first true leaves. Many of these will die, falling over at the soil surface. Root systems of affected plants will show dark lesions on roots and/or the coleoptile. See Plant Pathology Fact Sheet PP-1.

Cultural Controls: Damping-off is most prevalent when soils are cold and wet. Any condition that delays emergence will enhance disease incidence and severity. Plant in warm, well-drained but moist soils when possible. Use quality seed of high germination and avoid mechanical injury to the seed when planting.

Chemical Controls: Seed-protectant fungicides, including some of the standard protectants (i.e. captan and thiram) and some of the newer systemics can provide excellent control of damping off. Planting only seed which has been commercially treated with combinations of these compounds greatly enhances the opportunity for excellent stand establishment, particularly during cool, moist soil conditions.

Maize Dwarf Mosaic (*Maize Dwarf Mosaic Virus*)

Symptoms: Although there are a number of viral diseases of sweet corn, *maize dwarf mosaic virus* (MDMV) is the most common in Florida. Symptoms are highly variable. Leaves may have irregular, light and dark green mottle or mosaic patterns. These may develop as narrow, light green or yellow streaks along the veins. Infected plants may become stunted with a resulting reduction in ear size and development.

Cultural Controls: MDMV is retained and transmitted in a non-persistent manner (up to 6 hrs) by over 20 species of aphids. There are also over 200 wild and cultivated grass hosts for this virus. It causes an economic problem in Northern Florida. Resistant varieties are currently under development. Because Johnson grass is a major host for this virus, Johnson grass must be eliminated around and in fields used for production of sweet corn.

Northern Corn Leaf Blight (*Exserohilum turcicum*)

Symptoms: Along with common rust, this is one of the most important diseases of sweet corn in Florida. This fungal disease is characterized by long, spindle-shaped lesions which are at first pale green, gradually turning gray-brown with age. Lesions may eventually be up to ½ inch wide by 4-6 inches long. Under favorable conditions, numerous lesions may coalesce to kill large amounts of foliage. The disease usually starts on the oldest leaves and works its way up the plant. The causal agent produces tiny stalks that emerge from the stomates located within the lesion area to give rise to long, multi-celled spores. These may be observed using a hand lens after periods of high humidity.

Cultural Controls: *Exserohilum turcicum* is favored by moderate temperatures (65-80° F) and periods of prolonged leaf wetness. It is slowed by periods of extended dryness. If the disease is well established prior to silking, economic losses may ensue. Lesions on ear husks also reduce marketability of sweet corn intended for the fresh market. Resistant hybrids are currently available to aid in the control of northern blight and are highly recommended, particularly for the spring growing season. Northern blight is

seldom a concern in the fall in southern Florida, when southern corn leaf blight is more prevalent.

Chemical Control: Fungicides can be effective in helping to control this disease. A forecasting system based upon leaf wetness and temperature is helpful in determining infection periods. While sterol-inhibitor and strobilurin fungicides are more effective than protectant fungicides in the control of northern blight, these should be utilized in a program with the broad-spectrum protectants to reduce the risk posed by the development of fungicide insensitivity. See PPP-6.

Smut (*Ustilago maydis*)

Symptoms: All plant parts above ground may be infected, especially actively growing meristematic tissue. The causal fungus produces spore-filled galls which are initially greenish to silvery white. The interior of the gall turns into a brown to black powdery mass, as the spores mature. Galls may range from ½ inch to 6 inches in diameter. Young plants may die but this is infrequent. Leaf galls usually remain small (1/4 to ½ inch in diam.) and become hard, but seldom rupture.

Cultural Controls: Unlike most fungal diseases, smut is favored by dry conditions. Favorable temperatures range from 78 and 94° F. Since the disease appears to be more severe when high nitrogen fertility or heavy manure amendments are used, maintain a balanced fertility program. Smut is also favored by injuries due to hail, blowing sand, and mechanical factors. Therefore, mechanical injuries caused by cultivation and spraying should be minimized. Where smut is a consistent problem, choose varieties with generalized or polygenic resistance to the causal fungus.

Southern Corn Leaf Blight (*Bipolaris maydis*)

Symptoms: Lesions caused by southern corn leaf blight are much smaller (up to ½ inch wide and 1 inch long) than those incited by northern corn leaf blight. Southern blight lesions are also lighter in color (light tan to brown), and have parallel sides rather than the tapering sides of lesions caused by *E. turcicum*. When severe, lesions may become so numerous that they coalesce and turn the entire leaf necrotic. Southern blight, like northern blight, moves from the lower canopy to the upper canopy. Fungal sporulation may be observed with a simple hand lens on foliar lesions following periods of high humidity.

Cultural Controls: Southern corn leaf blight is most prevalent during the fall growing season in south Florida, but may also appear at the end of the spring growing season, particularly if unseasonably warm. It is favored by warm to hot temperatures (68-90° F) and periods of extended leaf wetness. Resistant varieties are available and should be considered, particularly for fall plantings.

Chemical Control: Fungicides can be effective in helping to control this disease. These should be applied early, particularly if the forecast is for warm, humid weather. As with

northern corn leaf blight, the sterol inhibitors and strobilurin fungicides are most efficacious. However, these should be utilized in conjunction with a broad spectrum protectant to minimize development of fungal insensitivity. See PPP-6.

Southern Rust (*Puccinia polysora*)

Symptoms: Like common rust, southern rust is characterized by pustules which erupt on through the foliar epidermis. However, southern rust pustules are more orange than brown, more circular than elongate, and are more prevalent on the upper leaf surface than on the lower leaf surface. Given favorable conditions, southern rust may cause premature death and desiccation of corn leaves. In addition, plant photosynthates intended for ear fill are diverted to the pathogen for spore production, resulting in incomplete ear tip fill. Most prevalent in fall sweet corn in south Florida, southern rust is occasionally of economic importance and warrants control.

Cultural and Chemical Controls: Southern rust, in contrast to common rust, is favored by warm to hot temperatures (80-90° F). It too likes high humidities and long periods of leaf wetness. Hybrids resistant to southern rust are not as numerous as those resistant to common rust. Therefore, growers may have to rely more on fungicides for control if conditions are favorable. Growers should scout fields and begin fungicide applications during early stages of the disease. As with common rust, the newer strobilurin and sterol-inhibiting fungicides, which have some systemic properties, are more effective in controlling rust than the broad spectrum protectants. However, they should be used in a program (either tank-mixed or alternated) with the protectants to minimize the development of resistant strains of the rust fungus and to maximize efficacy. See PPP-6.

Sweet Potato

Disease Management in Sweet Potato (*Ipomoea batatas*)

Tom Kucharek

Black Rot (*Ceratocystis fimbriata*)

Symptoms: All underground plant portions are susceptible to this fungus. Disease spread usually occurs in the seedbed as the causal fungus grows from an infected potato into sprouts. Infected sprouts exhibit a small black lesion near the potato. This lesion will enlarge, often up to the soil surface, girdling the sprout and causing leaf yellowing, stunting and finally sprout death. Infected potatoes may or may not exhibit lesions at digging. Spots are blackish in color, slightly sunken and circular. Under favorable storage conditions, Lesions enlarge. The fungus can be observed as short, dark bristle-like structures within a ½ inch circle in the lesion center. The potato injury may extend to the potato center as black flesh. The fungus will cause the potato to develop a bitter flavor.

Cultural Controls: Plant seedbeds in areas that have not produced sweet potatoes for at least two years. Where permanent seedbeds are used, fumigate prior to setting potatoes.

Plant only the best, pathogen-free seed potatoes. Dip potatoes in a seed treatment fungicide before planting. After sprouting, clip sprouts about the soil line and reset in new ground or fumigated ground for rooting prior to setting these slips into the field.

Chemical Controls: See PPP-6

Pox or Soil Rot (*Streptomyces ipomoea*)

Symptoms: Infested plants appear stunted and chlorotic, often in spots in the field. Roots exhibit rotted tips with frequent black lesions. These lesions also occur on the stems. Harvested roots will have black, crusty lesions that will be sunken. Lesions may be in rows on the potatoes and often roots may be misshapen due to the one-sided occurrence of lesions on a root. These injuries do not enlarge in storage.

Cultural Controls: Select fields without a previous pox history. Choose disease-free seed potatoes and plant in a new or fumigated seedbed. Propagate clean slips as explained under Black Rot in a second, clean seedbed. Avoid contamination of clean fields with infested soil carried by equipment and machinery.

Slightly infested fields should not be limed. Aim for a pH of 5.2 or lower to minimize disease severity. Consider in-row fumigation to reduce disease incidence and severity. Severely infested fields should be rotated out of sweet potatoes for 3-4 years.

Chemical Controls: Same as for Black Rot. See PPP-6

Rhizopus Soft Rot (*Rhizopus spp.*)

Symptoms: The fungus causes a soft, spongy moist decay in storage or transit. An abundant growth of gray fuzzy mold is usually produced on the surface. When the rotting process is completed, or checked, the parts of the affected potato becomes shrunken, dry and hard.

Cultural Controls: Avoid injuring potatoes at harvest. Wash or dip with an appropriate fungicide. Store or cure under warm moist conditions of 85° F and 90% relative humidity and aeration for 5-7 days. Store potatoes at 55-60° F under aerated conditions of 80-85% relative humidity.

Chemical Controls: See PPP-6

Scurf (*Monilochaetes infuscans*)

Symptoms: This disease involves only the outer layer of the underground parts of the potato. It does not cause a rot or reduce yield, but it causes a superficial dark discoloration of the skin. The discoloration may be only a few spots, or may cover most

of the surface of the potato. The casual fungus can survive in the field or plant bed and usually is worse during wet seasons.

Cultural Controls: Plant only disease-free seed potatoes into new seedbeds or those previously fumigated. Take vine cuttings or cut sprouts above soil line as described for Black Rot to insure disease-free slips to set in the field. Treat both seed-piece and subsequent cuttings with fungicides. Practice crop rotation for 2-3 years where disease has been severe.

Chemical Controls: See PPP-6

Southern Stem Rot (*Sclerotium rolfsii*)

Symptoms: Plants in beds wilt suddenly and then turn yellow to brown and die. Stems of sprouts will have brown lesions. White fungal mycelia may be present on the lower stem, and surface of the soil or mother roots. Sclerotia that are about the size of cabbage seed form among the mycelia. They are white initially but later they become brown. This disease is likely to be the most severe when the canopy of the crop is dense in the bed.

Cultural Controls: Rotate the sites of the beds. Do not allow bed covers to remain over the bed after emergence.

Surface Rot (*Fusarium oxysporum*)

Symptoms: The fungus produces circular, slightly sunken spots that are lighter in color than the lesions caused by black rot. The lesions are quite shallow. Infection takes place around harvest time and is usually worse in years when harvesting follows a wet period. During storage, moisture escapes through the spots and results in considerable shrinkage and numerous, hard, mummified potatoes.

Cultural Controls: Do not harvest when soil is too wet. Avoid injuries to the potatoes that will provide entrance points for this soilborne fungus. Severely infested fields should be rotated out of sweet potatoes for at least 2-3 years.

Wilt/Stem Rot (*Fusarium oxysporum* f. sp. *batatas*)

Symptoms: The fungus in the vascular tissue causes the plant to wilt, yellow, and stunt. If the attack comes early in the season, the plant may die. The water-conducting tissues of the potato stem turn dark in color, often making the stem appear blue from the outside. Affected stems may crack open. This disease can be carried in or on the seed potatoes and is able to live for long periods in the soil once introduced.

Cultural Controls: Select disease-free seed potatoes for slip production. Use new land or fumigated land for seedbeds. Infested land should be rotated to other crops for 4-5 years. Use resistant varieties.

Tomato

Disease Management in Tomato (*Lycopersicon esculentum*)

Tim Momol and Ken Pernezny

Anthracnose (*Colletotrichum coccodes*, *C. gloeosporoides*, *C. dematium*)

Symptoms: This is primarily a disease of ripe to overripe fruit that can cause serious losses in home gardening but seldom in commercial fields due to the mature green harvest nature of Florida's industry.

Fruit infection may occur during green stages but disease development is linked to ripening. Small lesions are circular and depressed, but can enlarge to greater than 12 mm in diameter with zonate markings. The lesion surface may appear salmon-colored due to spore production and be dotted with black specks (microsclerotia). Infected fruit have a short shelf life.

Cultural Controls: Home growers should rotate the location of tomatoes in the garden whenever possible to avoid soil survival of the causal fungi. Avoid stress on tomatoes from nematodes, insects, and other diseases that will predispose plants to fruit rot. Collect and destroy infected fruit as they appear. Avoid overhead irrigation where possible. Staking plants and mulching helps to reduce losses to anthracnose.

Chemical Controls: Use of a fungicide to control other diseases will reduce incidence of anthracnose. Specific fungicides for anthracnose must be used **before** fruit ripen. See PPP-6.

Bacterial Soft Rot and Hollow Stem (*Erwinia carotovora* pv. *carotovora*)

Symptoms: The most important aspect of this disease is post-harvest infection of the fruit. Symptoms are soft watery decay of fruit, starting at one or more points, as very small spots. These spots enlarge, often very rapidly until the entire fruit may become a soft watery mass. Usually leakage occurs as the decay develops.

The causal bacterium may infect stems, petioles and pedicels producing a dark green-to-black, water-soaked canker. Affected stem areas become soft and hollow.

Cultural Controls: Tomato varieties differ in their resistance to bacterial soft rot disease of fruit. To reduce disease incidence and severity, avoid harvesting plants while they are wet. Avoid wounding fruit and avoid exposing harvested fruit to the sun. Use chlorine in the first water immersion in the packinghouse. Avoid deep or prolonged immersion of tomato fruit in water. Fruit should not be packed with wet stem ends nor should green fruit be chilled below 55° F. See Plant Pathology Fact Sheet PP-12.

Chemical Controls: See PPP-6.

Bacterial Speck (*Pseudomonas syringae* pv. *tomato*)

Symptoms: Foliar infection due to this disease is difficult to distinguish from leaf spots caused by bacterial spot. Fruit infection caused by bacterial speck appears as numerous, tiny, dark brown lesions less than one-sixteenth of an inch in diameter, and sunken. Speck lesions do not usually extend deeper than the epidermis of the fruit.

Large speck lesions may be mistaken for those of bacterial spot since both diseases can occur on the same fruit. Speck lesions are more restricted in size on the fruit and do not exhibit the raised, scab-like appearance or cause the epidermis to rupture as with bacterial spot-infected fruit. This bacterial pathogen is seedborne and is apt to be more severe during particularly cool, wet growing seasons that favor plant-to-plant spread. See Plant Pathology Fact Sheet PP-10.

Cultural Controls: Start with clean, disease-free seed or transplants. This disease, like bacterial spot, is very difficult to control once it is established in a field situation.

Chemical Controls: See PPP-6.

Bacterial Spot (*Xanthomonas campestris* pv. *vesicatoria*)

Symptoms: Spots on the leaves and fruit spurs are brown, water-soaked circular and rarely more than 1/8 inch in diameter. They can be confused with young early blight, gray leaf spot and Target spot lesions on the leaves. Later, spots may coalesce and large blighted areas appear. Lesions caused by the race T3 of the pathogen often tear out leaving a “shot hole” appearance. However, the bacterial spot lesions usually lack the concentric zones of early blight and usually they are darker and less uniformly distributed on a leaflet than gray leaf spot lesions. Often the lesions tend to be elongated on the leaf margins; occasionally, after a heavy rain during which the leaves have become saturated with water, entire interveinal areas will become infected.

On the fruit, the early symptom is a very minute black speck surrounded by a slightly lighter area. As the spot enlarges it becomes brownish in color, scab-like, slightly raised on the edges, and sunken in the center. The epidermis of the fruit finally ruptures and curls back from the center of the spot. This is the most characteristic symptom of the disease on the fruit. The bacterial spots are very seldom deeper than half way through the outer fleshy layer of the tomato.

Cultural Controls: Do not place seedbeds in the area of an abandoned field where bacterial spot was present the previous season. Set only disease-free transplants. This disease is difficult to control once it is established. Protect against mechanical transmission by frequent hand washing with a bactericidal soap.

Biological Controls: Bacteriophages (phages) have been found as an effective biocontrol agent for the management of bacterial spot on tomato. Phages are viruses that infect bacteria. Recently, protective formulations were developed to increase longevity of

phages on plant surfaces in the field conditions. A 'Powdered Skim milk' formulation may be recommended for field application because it is easy to prepare and apply. Evening (before sunset) application of phages resulted in better bacterial spot control compared to morning application. Formulated phages could be applied twice a week at sunset for the management of bacterial spot. As for any new product, first test on a limited acreage.

Chemical Controls: See PPP-6. Recently, alternative chemical control approaches have been investigated in which chemicals are applied that activate plant defense responses. Plants can activate protective mechanisms upon detection of invading pathogens. It is a similar concept to immunity in animals. If this protection is expressed locally at the site of primary inoculation and also systemically in tissues remote from the initial treatment, it is called systemic acquired resistance (SAR). Chemical SAR inducers are active against a broad range of pathogens, including fungi, bacteria, and viruses. Acibenzolar-S-methyl (Actigard 50WG, Syngenta), an SAR inducer, has now been registered for commercial use in Florida against bacterial spot of tomato.

Bacterial Wilt (*Ralstonia solanacearum*)

Symptoms: A diseased plant is characterized by rapid wilting with the foliage remaining green. Affected plants rapidly wilt and die without appreciable yellowing of the lower leaves. Plants that are attacked by this pathogen frequently appear stunted before wilting occurs. The pith near ground level is dark colored and has a water-soaked appearance. If the stem is cut near the base, a slimy, gray material may exude from the cut.

In later stages, the pith decays and the stem becomes hollow. The vascular tissue becomes brown, and adventitious root formation may be enhanced. The rapidity of wilting and death, the lack of foliage yellowing, and the pith decay and hollowness distinguish this wilt disease from the *Fusarium* and *Verticillium* wilts. This is a hot-weather and wet-soil disease.

Rapid diagnosis can be made in the field. Cut the lower three-inch stem section from soil line upwards. Suspend this section in water for 15-30 seconds. Observe immersed stem end for streams of bacteria that will be extruded into the water. Visibility of bacteria is enhanced when viewed in front of a strong source of light.

Cultural Controls: Bacterial wilt is a very difficult disease to control. The only way to totally control bacterial wilt is to not plant in fields infested with the pathogen. Do not plant seedbeds on land where this disease has been a problem. Infested fields should be rotated to non-susceptible crops (long term rotation might reduce pathogen populations). Avoid movement of water, equipment, or soil from infested fields to non-infested ones. In south Florida, late fall planting (October in the Ft. Pierce area) reduces the incidence of this disease. Fields should not be over-irrigated, because excess soil moisture favors disease build-up. Increase of soil pH and available calcium might reduce the disease incidence.

Chemical Controls: See PPP-6. Please note that these broad spectrum soil fumigants (chloropicrin) will contribute to the management of this disease either through reduced disease incidence or the delay of the initial disease onset.

Black Shoulder (Undetermined)

Symptoms: Fruit approaching maturity appear most susceptible. Dark gray to blue-black areas develop on the shoulders of fruit. Those areas are irregular in size and shape. The discolored areas may undergo tissue collapse with the subsequent production of sunken lesions. The affected tissue in these lesions will harden and shrivel but further lesion enlargement normally does not occur.

Cool, rainy weather that occurs, especially when fruit are mature, has been associated with the incidence of this problem.

Cultural Controls: Choose varieties that are more tolerant of this disorder.

Blossom-end Rot (Calcium deficiency)

Symptoms: The blossom ends of fruit turn pale green to brown. These affected areas enlarge into sunken spots. The discolored fruit portion will shrivel into a dry rot unless the tissue is invaded by secondary organisms that often extend the area of rot throughout the fruit.

This condition can result from a number of situations that limit available calcium to the plant. Poorly limed, sandy soils may suffer from a deficiency of calcium in the soil. Calcareous soils seldom have this problem. Extremes in soil moisture can limit calcium availability to roots regardless of the amount present in the soil. Since calcium is not freely mobile in the plant, short periods of calcium deficit will affect rapidly growing fruit tissues. Competition from other cations (e.g. Mg) can lead to and exacerbate blossom-end rot.

Cultural Controls: Follow a program of soil testing and liming according to soil test results. Soil should contain adequate calcium (\Rightarrow 300 ppm). Supplement erratic rainfall with irrigation during fruit development to avoid blossom-end rot problems.

Buckeye Rot (*Phytophthora nicotianae* var. *parasitica*)

Symptoms: On fruit that are touching soil, the fungus enters at the point of contact, causing a slight brownish spot. As the fungus develops and the spot enlarges, a series of irregular, brown-to-light-colored concentric bands are produced, forming a typical buckeye effect. Fruits decay very rapidly and break down in a soft-rot.

All stages in the growth of the tomato fruit can be infected by the fungus. In some instances when the fruit remain damp and moist for a day or two, the concentric zoning effect may be indistinct and invasion of the fruit by the fungus exceedingly rapid. Under these conditions the invaded areas become dull brown, and the fruit collapse without the

production of the marked concentric zones. In some cases where the epidermis is ruptured the mycelium of the fungus can be distinguished.

Cultural Controls: Good field drainage. Stake plants. Use of full-bed plastic mulch will limit fruit contact with the ground and therefore limit disease incidence.

Chemical Controls: See PPP-6.

Cucumber Mosaic (*Cucumber Mosaic Virus*)

Symptoms: This aphid-vectored virus has a wide host range within Florida that includes many plant species among agronomic, vegetable, ornamental crops as well as weeds. Plants in the Solanaceae and Cucurbitaceae are particularly susceptible. The virus is not seed-transmitted. Infection results in a 'shoestring' like symptom on leaves as the interveinal tissue is reduced. Infected plant appears stunted and bushy while fruits may exhibit ring or line patterns during ripening.

Cultural Controls: Sanitize surrounding crop fields to prevent over-seasoning of the virus and/or the aphid vector. Eliminate stands of dayflower in and around the tomato field.

Chemical Controls: Manage aphid population according to the latest recommendations in the Insect Management Guide.

Damping-off (Various fungi, species of *Pythium* and *Rhizoctonia* often implicated)

Symptoms: Dying or poor growth of seedlings in seedbed. Seedling death may also occur after plants are set in the field.

Chemical Controls: Plant only fungicide-treated seed.

Employ an appropriate soil fumigant for seedbed treatment as well as in-row treatment in the field depending on previous disease history and other production practices. See PPP-6.

Early Blight (*Alternaria solani*)

Symptoms: Early blight is first observed in the field as small brownish-black lesions on the older foliage. The spots enlarge rapidly, and by the time they are 1/4 inch in diameter or larger, concentric rings may be distinguished on the dark brownish portion of the spots. The tissue surrounding the spots may become yellow in color, and when spotting is abundant the entire leaf may yellow.

Stem lesions on seedlings are small, dark, and slightly sunken. These lesions enlarge, forming circular or elongated lesions with concentric rings and light centers. If stem-infected seedlings are set in the field, the lesions continue to enlarge at the ground line

and partially girdle the plants. These plants often die, but if they do survive, their growth and yields are reduced.

The fruit become infected, generally through the calyx or stem attachment, either in the green or ripe stage. The fruit lesions attain considerable size, often involving nearly the entire fruit, and usually show concentric ringing. The diseased areas appear leathery and may be covered by a velvety mass of black spores. Infected fruit frequently drop, and losses of 50% of the immature fruit may occur.

Chemical Controls: Pursue fungicide applications as needed in the transplant production system as well as in the field. See PPP-6.

Fusarium Crown Rot (*Fusarium oxysporum* f.sp. *radicis-lycopersici*)

Symptoms: Disease first appears during cool seasonal periods when fruit are setting or sizing. Symptoms indicate lower leaf marginal yellowing and a slow-to-rapid wilt syndrome that kills the plant. The lower stem at soil line exhibits vascular discoloration and pith necrosis for a variable distance upward in the stem.

Cultural Controls: As the pathogen is soilborne, incidence tends to increase with the direction of movement of infested soil. Several cultivars with resistance are now available.

Chemical Controls: Use of soil fumigation will aid in pathogen suppression.

Fusarium Wilt (*Fusarium oxysporum* f. sp. *lycopersici* races 1-3)

Symptoms: Infected seedling plants are stunted, the older leaves droop and curve downward, and the plants frequently wilt and die. Symptoms on older plants generally become apparent during the interval from blossoming to fruit maturation. The earliest symptom is the yellowing of the older, lower leaves. These yellow leaves often develop on only one side of the plant, and the leaflets on one side of the petiole frequently turn yellow before those on the other side. The yellowing process gradually includes more and more of the foliage and is accompanied by wilting of the plant during the hottest part of the day.

The wilting becomes more extensive from day to day until the plant collapses and dries up. The vascular tissue of a diseased plant is dark brown in color. This browning often extends far up the stem and is especially noticeable in a petiole scar. This browning of the vascular system is characteristic of the disease and generally can be used for its identification. Fruit infection occasionally occurs and can be detected by the vascular tissue discoloration within the fruit.

Cultural Controls: Use resistant varieties where available for Race 1 or 2. A 5-7 year crop rotation will greatly reduce losses on infested land.

Prevent the movement of infected plants and/or infested soil clinging to machinery, hand tools, vehicles, trellising and staking implements, and field crates into areas free of this pathogen.

Do not flood land, since this will spread fungus. Do not overhead irrigate with ditch water that may be contaminated with the fungus. Do not use infested land for seedbeds.

Chemical Controls: Use pre-plant soil fumigants.

Gray Leaf Spot (*Stemphylium solani*)

Symptoms: Gray leaf spot first appears as minute, brownish-black specks on the lower leaves. The spots are circular to oblong. Occasionally the spots are marginal and in such cases are somewhat elongated or irregular in outline. The spots enlarge to about 1/12 inch in diameter, turn in color from a brownish-black to a grayish-brown, and become somewhat shiny and glazed. By this time, a definite yellow area may be apparent around the spots.

Lesions rarely exceed 1/12 inch in diameter, although on the very oldest leaves near the base of the plant individual spots may obtain a diameter of 1/6 inch or more. On the older leaves the spots may coalesce, killing large areas of the leaf blade. As the centers of the spots dry out, they often crack with a yellowing of the entire leaf. The leaves then die rapidly, become brown and drop. Serious infections in the seedbeds result in marked defoliation without conspicuous yellowing. Most globe tomatoes developed for Florida are resistant to this disease. Commercially, most gray leaf spot outbreaks have been noted in cherry tomatoes. Homeowners may experience problems if older, "up-north" cultivars or heirlooms are planted.

Cultural Controls: Plant resistant varieties.

Chemical Controls: See PPP-6.

Gray Mold (*Botrytis cinerea*)

Symptoms: On the stems, gray mold is characterized by large, elliptically shaped, water-soaked lesions that during cool, wet weather soon become covered with the grayish-brown mycelium and spores of the fungus.

The lesion produced on the fruit is a watery area with a light brown or tan-colored central region. The decay develops rapidly, and the fruit is converted into a soft, watery mass within a few days. If the skin is broken, the grayish mycelium and spore clusters develop within a few hours.

Occasionally, following abortive infections, small whitish rings approximately 1/6 inch in diameter develop on young green fruit. These "ghost spots" are usually single rings but may be solid white spots; the center of which contain dark-brown specks. The spots are superficial on the pericarp of the fruit, do not increase in size, and do not affect fruit eating quality. Infected leaves, which develop gray lesions that are often wedge-shaped,

soon wither and die. During cool, wet weather the diseased leaves become covered with the gray mycelium and spores of the fungus.

Cultural Controls: To avoid gray mold, crop tomatoes on soil limed to pH = 6.5 or higher.

Chemical Controls: See PPP-6.

Gray Wall (undetermined)

Symptoms: Dark brown tissue develops around the vascular bundles of the outer fruit wall. Sometimes this browning also occurs in the middle column and septa of the fruit. Outward appearance of the fruit shows blotchy gray (sometimes yellow) areas with indistinct margins. Occasionally the tissue of the gray areas shrinks and sunken spots develop. On green immature fruit, symptoms are more difficult to see, but by careful examination the dark areas and streaks can be seen through the translucent skin. Plants infected with *Tobacco Mosaic Virus* (TMV) have higher incidence of gray wall. However, plants free of TMV and those resistant to the virus can also develop gray wall.

Cultural Controls: Use resistant varieties.

Late Blight (*Phytophthora infestans*)

Symptoms: The lesions produced on the leaves are rather large, irregular, greenish, water-soaked areas. These areas enlarge rapidly and become brown and paper-like. During moist weather or periods of heavy dew, a fine, white mold may develop near the margin of the diseased tissue on the lower surface of the leaf.

Stem lesions may occur anywhere on the stem, and appear as water-soaked brown to gray areas that may girdle and kill the plant. Severely diseased plants often appear to have been frozen.

Fruit lesions appear as large, green to mahogany colored, irregular water-soaked blotches. These lesions most commonly appear on the upper half of the fruit, are firm in texture, and may occasionally become zonate. Often soft rot organisms invade blighted fruit and cause rapid deterioration of the fruit.

Chemical Controls: Apply fungicides preventively. See PPP-6. See Plant Pathology Fact Sheet PPP-6.

Leaf Mold (*Fulvia fulvum*)

Symptoms: Leaf mold is usually first observed on the oldest leaves closest to the ground where ventilation is poorest and the period of excessive moisture is most uniform. It is detected on a leaf by the appearance of small, light-colored spots which turn to a distinct light yellow color followed by the browning, drying, and death of the cells in the area. Often when the infection is severe these spots coalesce, and the foliage is rapidly killed.

The causal fungus sporulates on the lower surface of the leaf but very rarely is found producing spores on the upper surface. Careful examination of a yellow-spotted leaf will reveal an olive-green mold on the lower surface almost exactly coinciding with the yellow area. Traditionally, this disease has been more of a problem on greenhouse crops.

Cultural Controls: Choose resistant varieties where possible. The practice of staking and pruning plants, along with proper plant spacing, will ensure adequate ventilation and discourage disease development.

Chemical Controls: Apply fungicides when needed. See PPP-6.

Phoma Rot (*Phoma destructiva*)

Symptoms: On the foliage, small black spots first appear on either surface of the leaf. These spots are round or irregular in shape, slightly sunken, and as they rapidly enlarge, become typically zonate as in early blight. They enlarge and often coalesce, causing the leaves to become yellow and curl upward. The pycnidia, or fruiting bodies, which are produced in these spots on the foliage, are imbedded or sunken in the leaf tissue with only a small opening to the outside. Thus, they are very difficult to observe, and without a hand lens it is almost impossible to make a definite diagnosis.

On the stems the lesions are black, elongate, and zonate. The damage to young seedlings may be extremely severe, since they are often completely girdled by the stem lesions. Plants are attacked from the seedling stage to maturity.

On the fruit, the spotting takes place only where the fruit have been injured, and in most cases the fungus enters through growth cracks, the stem scar, and other mechanical injuries around the stem end, although in some cases it enters through punctures made by insects. When it enters any skin rupture it produces a distinctly sunken spot almost black in color which enlarges rapidly and involves large portions of the fruit.

The disease is readily distinguished from other rots by the black color of this spot which is speckled with small, black, pimple-like eruptions. These specks are the pycnidia or fruiting bodies of the fungus.

Chemical Controls: Use only fungicide-treated seed. Apply fungicides in the seedbed or field as needed. Use of chlorothalonil to control other diseases will aid in control of Phoma rot. See PPP-6.

Potato Y Disease (*Potato virus Y*)

Symptoms: The young leaflets cup inward slightly and curl downward. The petioles also curl downward and give the plant a drooping appearance. The vein areas of the leaflets are banded with yellow. Dark-brown necrotic areas develop on the young leaves, especially on the terminal leaflets. The stem tips and petioles are usually streaked with purple. Entire shoots may be killed. Infected plants are stunted, unthrifty, and yield

poorly, but the fruit do not show symptoms. Laboratory assays are required to accurately diagnose this disease.

This virus is transmitted to tomato plants by aphids during feeding. A number of weed hosts of this virus occur in Florida and include the ground cherries and nightshades.

Cultural Controls: Eradicate wild host plants and volunteer tomato plants **before** the crop is planted. Avoid planting subsequent crops next to diseased early plantings until after the early plantings have been destroyed. Avoid tomatoes in close proximity to potatoes. Applications of JMS Stylet Oil, exactly as the label directs, will reduce virus spread by aphids in the field.

Chemical Controls: See PPP-6.

Pseudo-curly Top (*Pseudo-curly top virus*)

Symptoms: Primarily a disease of young plants, but fruiting-sized plants can become infected. The first symptom is severe upward rolling and curling of leaflets. Later the plant turns rather yellow and becomes brittle and often the veins of the leaflets turn purple. Branches and stems are stiff and erect and the entire plant stunted. After infection, little or no fruit is set.

Cultural Controls: Destroy nightshade and ragweed growing in and around the field before planting the crop. If the disease appears in the field, spray the margin of the field with an approved insecticide to kill the treehoppers that transmit the virus. Consult the Insect Control Guide for recommendations.

Sclerotinia Stem Rot (*Sclerotinia sclerotiorum*)

Symptoms: The seedling disease occasionally caused by this fungus is a typical damping-off, resulting in a quick, wilting death of the seedlings. The fungus usually attacks older plants at or slightly above the soil line.

The grayish-white mycelium covers the surface of infected tissues and the plant shows a marked wilted condition and eventually withers and dies. An examination at this time will show a large canker at the base of the plant, which girdles the stem and causes the softer tissue to disintegrate. Stems are generally quite soft, later turning to a white “dried bone” appearance. This disease is most prevalent in Miami-Dade County.

Splitting of the stem will reveal cavities filled with the black, large, hard sclerotia and the grayish-white fungal growth characteristic of this fungus. Infected fruit may develop a watery soft rot. Occasionally the leaves are affected; however, if petioles become infected the fungus generally grows into the stem. See Plant Pathology Fact Sheet PP-22.

Cultural Controls: Flooding fields for five to six weeks during summer months will reduce the number of sclerotia in the soil. However, flooding may spread other soilborne pathogens such as those causing Fusarium wilt and bacterial wilt. Adequate drainage,

sanitation and crop rotation are important in the control of this disease. Plant tomatoes in well-drained fields. Do not plant tomatoes immediately following *Sclerotinia*-diseased crops of beans, cabbage, celery, lettuce, potato, or any other susceptible crop.

Chemical Controls: Apply fungicides to the transplant production system or field as needed when disease occurs. See PPP-6.

Soil Rot (*Rhizoctonia solani*)

Symptoms: This fungus causes the fruit to decay in all stages of development. It penetrates the fruit through wounds or the unbroken epidermis and invades the tissue, causing numerous small, brown, sunken spots on the side of the fruit that is in contact with the soil.

Usually there is a single point of invasion by the fungus, and as this spot enlarges it becomes zonate with concentric brown rings, somewhat typical of buckeye rot. This marking may be distinguished from buckeye rot in most instances by the narrowness of the concentric zones. With this disease, the zoning is extremely definite and more pronounced than in buckeye rot. In most cases, the epidermis is ruptured at the center of the spot in soil rot, whereas in buckeye rot the epidermis is very seldom broken. See Plant Pathology Fact Sheet PP-41.

Cultural Controls: This disease is seldom of importance in fields where the plants are staked, pruned and/or grown on plastic mulch. Fruit losses in transit can be controlled by careful grading.

Chemical Controls: See PPP-6.

Southern Blight (*Sclerotium rolfsii*)

Symptoms: Mature plants are attacked just below the soil surface and are completely girdled. The tops wilt and die rapidly. The mycelium often grows over the diseased tissue and surrounding soil forming a white mat of mycelial threads with the typical tan-to-brown, mustard-seed-sized sclerotia. Often the entire root system is destroyed. This is a hot weather disease.

The fungus is exceedingly destructive on ground crops and attacks the fruit where they contact the soil. Slightly sunken, yellow spots develop on invaded fruit, which rapidly decay, collapse, and become covered by a white fungal mass with numerous sclerotia.

Seedling invasion occurs rapidly, and the seedlings die quickly. As the plants grow older they become more woody and more resistant to attack.

Cultural Controls: Sanitation will provide good protection against southern blight. Whenever diseased fruit or plants are found in a field they should be collected and disposed of, preferably by burying 2 or 3 feet deep or by burning. In this way, the

distribution of the sclerotia throughout the field will be prevented, and to a large extent the disease will be controlled.

Since these sclerotia are so large that they are not carried by the wind and since their numbers are comparatively small, sanitation is an effective control measure.

The careful regulation of water by means of a well-designed irrigation-drainage system to prevent excessive soil moisture will help prevent the occurrence of the disease.

Plants in a field where the disease has been prevalent should be staked. This will keep the fruit from touching the ground and thus prevent infection of the fruit. Also, turn soil at least 6 inches deep when plowing.

Chemical Controls: Use of preplant soil fumigation will aid in the control of this disease.

Target Spot (*Corynespora cassiicola*)

Symptoms: Leaf spots start as small brown spots and as each increases in size, a sunken area, dull green in color, surrounds the spot. In older leaves the center of the spot is white.

Fruit rot is most often on the shoulder or sides and starts as small white, circular spots with a definite border. Later the spots enlarge or coalesce up to 1/2 inch, become noticeably sunken, and are brown to black.

Chemical Controls: See PPP-6.

Tobacco Etch Disease (*Tobacco etch virus*)

Symptoms: Effects of this virus on tomatoes is somewhat like those of *potato virus Y*, except plants are more stunted by *tobacco etch virus*. Leaves of the terminal shoots are cupped and petioles are bent downward. Fruits are not mottled or deformed. Spread of this virus is somewhat slower than *potato virus Y*. Laboratory assays are required to accurately diagnose this disease.

This virus is transmitted by aphids during feeding. A number of weed hosts (ground cherry, nightshade) serve to overseason the virus in Florida.

Cultural Controls: Eradicate wild host plants and volunteer tomatoes **before** the crop is planted. Avoid planting subsequent crops next to diseased early plantings until after the early plantings have been destroyed. Control aphids as needed. Applications of JMS Stylet Oil will reduce virus spread by aphids in the field.

Chemical Controls: See PPP-6.

Tomato Chlorosis Disease (Tomato Chlorosis Closterovirus)

Symptoms: This virus has been fairly restricted to the acreage of greenhouse tomato production. The virus is vectored by four whiteflies: the sweet potato, silverleaf, cotton and greenhouse species. Host range information is being researched along with important weed hosts in Florida. Onset of disease appears to occur during the short day-length period of late December-February. Lower leaves develop a progressive, interveinal chlorosis, often with necrotic flecking. Symptoms resemble these caused by magnesium deficiency in tomato but are less uniform within a leaflet or among leaflets on a leaf. No fruit abnormalities have been observed. Fruit size and number appear reduced by virus infection.

Cultural Controls: Raise clean transplants in a whitefly-free production site. Tighten greenhouse facilities to prevent ingress of whiteflies from the field. Use of insect screening can dramatically reduce virus incidence but will seriously limit cooling capabilities unless houses are structurally redesigned.

Chemical Controls: Judicious vector control with legally available insecticides will slow disease onset and reduce severity. See the latest recommendation in the Insect Management Guide.

Tomato Little Leaf Syndrome (physiological disorder)

Symptoms: Interveinal chlorosis in the young leaves could be the first sign of this disorder. Subsequent top growth could become severely distorted with leaflets along the midrib failing to expand properly, resulting in a “little-leaf” appearance. In addition, these symptoms may include cessation of terminal growth, leaflets with twisted and brittle midribs and axillary buds with distorted growth. Fruits that set in mildly affected plants are distorted with radial cracks extending from the calyx to the blossom scar. In more severely affected plants, blossoms are distorted and fail to set fruit. Affected plants can resume normal growth and set marketable fruit, if conditions no longer support the development of this syndrome.

Cultural Controls: Avoid waterlogged situations

Tomato Mottle (*Tomato mottle virus*)

Symptoms: *Tomato mottle virus* was the first begomovirus known to infect tomato in Florida. It was first found in 1989 and is widespread throughout the state. The virus is transmitted by the silverleaf whitefly, *Bemisia argentifolii*. Once the whitefly acquires the virus, it is retained for the remainder of its life. These viruses are not seedborne and are not mechanically transmitted in the field.

Virus symptoms on tomato have been variable but all varieties observed have been susceptible. One symptom type (least common) is a bright golden mosaic accompanied by leaf curling and plant stunting. The more widespread appearance is an interveinal chlorosis and mottle that is accompanied by a downward arching of leaves, leaflet curl, and plant stunting. Damage to yield appears to be a reduction in fruit numbers and size.

Cultural Controls: See *Tomato Yellow Leaf Curl Virus*.

Chemical Controls: See *Tomato Yellow Leaf Curl Virus*.

Tomato Mosaic (*Tomato mosaic virus*)

Symptoms: The ordinary green strains of *tomato mosaic virus* cause mottled areas of light and dark green on the leaves. The dark green areas are usually raised and crinkled.

Plants may be somewhat stunted and yields reduced if infected while small, but little harm is incurred if the plants are not infected until after one or two clusters of fruit have set.

There may be no fruit symptoms, or fruit may be deformed or marked with spots or streaks. Certain strains of *tomato mosaic virus* cause a yellow mottling of the leaves and occasionally a mottling of the stems and fruit.

The yellow mosaic is more severe than the green and may cause pronounced stunting of the plants and large yield reductions.

Cultural Controls: Before handling plants and during staking, pruning, or tying operations, wash hands thoroughly in soap and running water or in 70% alcohol. This will wash off or inactivate the virus. Do not use tobacco when working with tomato plants. If seedbeds are used, periodically remove diseased plants. Do not carry diseased plants to the field. Eliminate all volunteer tomato plants. Sterilize equipment before each growing season.

Tomato Spotted Wilt (*Tomato Spotted Wilt Virus*)

Symptoms: *Tomato spotted wilt virus* (TSWV) (genus Tospovirus), has a large host range and is vectored by thrips. The western flower thrips (*Frankliniella occidentalis*) is the main vector although the tobacco thrips (*F. fusca*), and other thrips can also vector this virus. The immature insect stages acquire the virus, the virus multiplies in its vector, and the insect remains infective throughout its life cycle. TSWV can infect some 35-plant families including the Solanaceae, Asteraceae, Leguminaceae, Brassicaceae, and Bromilidaceae. This virus is not easily mechanically transmitted in the field.

Symptoms on tomato include chlorotic and necrotic ringspots, leaf bronzing, stem necrosis, stunting, meristem necrosis, and fruit spotting. Distinctive circular patterns often appear on the fruit and leaves. These symptoms vary with the strain of virus involved, time of year, and whether other viruses exist in a plant.

Cultural Controls: Use virus-free transplants. Weed control in and around production field is encouraged. Use of UV-reflective plastic mulch (metalized mulch) will reduce TSW incidence. In north Florida, UV-reflective mulch could be used in spring and fall seasons, except early plantings in the spring. Cut infected plants as they appear in the

field before secondary spread. Avoid overlapping crop (peanut, pepper, tobacco) acreage nearby that can act as both a virus and vector reservoir. Monitor for thrips and manage populations with recommended insecticides. In north Florida, integration of metalized mulch with Actigard and insecticides reduced TSW incidence up to 75 % compared to black plastic mulch untreated plots.

Tomato Yellows (*Tomato yellows virus*)

Symptoms: Infected plants develop a stunted appearance with a general foliar chlorosis. There have been no typical viral symptoms of mosaic associated with this disease. Fruit do not express symptoms. It traditionally has been more of a problem in Southwest Florida.

The virus is transmitted by aphids to the tomato crop. Aphids pick up the virus from such wild hosts as nightshade, ground cherry, and *Datura* spp.

Cultural Controls: Maintain weed control as well as control of volunteer tomatoes prior to setting the next crop. Avoid planting subsequent crops next to diseased earlier plantings until these earlier plantings have been destroyed. Control aphids as needed.

Tomato Yellow Leaf Curl (*Tomato yellow leaf curl virus*)

Symptoms: *Tomato yellow leaf curl virus* (TYLCV-Is) is a whitefly-transmitted begomovirus virus that is native to the eastern Mediterranean. It was discovered in the eastern Caribbean in the early 1990's and was identified in Florida in July 1997. TYLCV-Is has been found throughout Florida. The disease is difficult to control, and management of whitefly populations at both the beginning and end of seasons is critical.

Two or three weeks after infection, mottling and distortion can be seen on the newest leaves. At this stage TYLCV symptoms are difficult to distinguish from TMoV. However, subsequently emerging leaves will be markedly reduced in size, upwardly cupped, mottled and have yellow margins. Infected plants are severely stunted. Flowers drop prematurely, leading to poor fruit set. Fruit production after infection may be reduced 90%.

Cultural Controls: Promptly remove sources of TYLCV and whiteflies. Don't locate new fields near infested crops. Promptly destroy fields. Keep fields clean of volunteers and resprouts during off-seasons. Create as long a crop-free period as economically practical. Use virus-free transplants. Reflective mulches will disorient whitefly adults, reducing numbers of infected plants. Rogue infected plants at first sign of disease. Scout fields for whiteflies and apply insecticides accordingly.

Chemical Controls: Chemical controls are centered on management of the whitefly vector. Use imidacloprid (Admire®) in the transplant water. Rates recommended are Admire®, 16 oz/A. See the insect control guide for suggestions for spray treatment of whiteflies if population becomes high later in the season. Do NOT use Pravado® If plants were treated with imidacloprid or similar insecticide at transplanting. Insect growth regulator insecticides can be applied when scouts find nymphal densities to exceed 5 per

10 leaflets by standard sampling procedures. Repellants (e.g. crop oil, UV-reflective mulch) can be used to interfere with secondary virus spread.

Verticillium Wilt (*Verticillium albo-atrum*)

Symptoms: The first symptoms generally do not occur until the beginning of fruit set, and consist of the diurnal wilting and recovery of the lower leaves. Initially, the leaves are green, but yellow areas develop along the margins or between veins of the leaflets. Fan-shaped necrotic lesions develop as the yellowing progresses, and the affected leaves gradually wither. The wilting and yellowing may involve only a few terminal leaflets, or it may occur on most of the bottom leaves, sometimes causing a 50% loss of foliage. Diseased plants, although not killed by the fungus, are stunted, do not respond to fertilizer, and produce only small fruit.

A lengthwise cut of an infected plant near the base reveals a light tan discoloration of the vascular tissue. The discoloration, in Florida, is typically lighter than that of Fusarium wilt and usually does not extend far up the stem before fruit are mature. There is no decay of the pith typical of bacterial wilt, nor dark-colored vascular bundles at the base of the petiole typical of Fusarium wilt.

Cultural Controls: Choose varieties with resistance or tolerance to this disease. Locate seedbeds on soil free of the Verticillium fungus. Practice sanitation and crop rotation.

Chemical Controls: Employ soil fumigants to assist in control of Verticillium wilt in the seedbed and in the field.

Watercress

Disease Management in Watercress (*Nasturim officinale*)

Pam Roberts

Cercospora Leaf Spot (*Cercospora nasturtii*)

Symptoms: Round to oval lesions develop on leaves. Leaf spots are light-colored and may coalesce to cover large areas of tissue. The pathogen produces abundant spores that are easily water-splashed or airborne.

Cultural Control: Insure that previous watercress debris is well decomposed before replanting of land. Eradicate volunteer plants and weed relatives in the Nasturtium genus to prevent carry over of this fungus from the field perimeter.

Chemical Control: See PPP-6

Damping-Off (*Rhizoctonia, Pythium, Fusarium, and Sclerotinia* spp.)

Symptoms: The distribution of seedlings that damp-off may be at random or in rapidly enlarging circular areas in the seedbeds. In the latter case, lesions may be observed well up on the petioles as well as the soil line. Entire plantings may be lost unless adequate control measures are practiced. Do not transplant disease plants.

Chemical Control: See PPP-6

Rhizoctonia Rot (*Rhizoctonia solani*)

Symptoms: *Rhizoctonia* is a soilborne fungus that can cause a damping-off of seedlings or seeds, as well as a mature plant decline from rot and stem decay. The fungus often invades at soil line producing a light-to-reddish-brown canker on the lower stem. Lower leaves exhibit yellowing, followed by necrosis and progressive plant wilt to death.

Cultural Control: Insure summer vegetation or previous crop debris is well decomposed prior to planting.

Chemical Control: See PPP-6

Viral Diseases (*Cucumber mosaic, Cabbage Leaf Curl*)

Symptoms: A single virus or multiple infection of several viruses can produce a variety of plant symptoms that include mosaic leaf distortion, ring spotting and stunting. *Cucumber mosaic virus* is vectored by aphids in a semi-persistent manner. *Cabbage leaf curl virus* is vectored by white flies.

Cultural Control: Clean field and field borders of volunteer crops and weeds to minimize reservoirs for both vector insects and viruses.

Watermelon

Disease Management in Watermelon (*Citrullis lanatus*)

Pam Roberts and Tom Kucharek

Alternaria Leaf Spot (*Alternaria cucumerina*)

Symptoms: The causal fungus infects the leaves only. Lesions are usually round to irregular, dark brown or black, and frequently occur with concentric rings. Lesions of *Alternaria* leaf spot can often be confused with young gummy stem blight leaf spots because of the zonate appearance. The pathogen over-seasons on old diseased plant debris. Spores are readily dispersed by wind and rain. Spores can be found in association with seed. See Plant Pathology Fact Sheet PP-32.

Chemical control. See PPP-6.

Anthracnose (*Colletotrichum orbiculare*)

Symptoms: This fungus infects leaves, stems, and fruits. It is seedborne and the disease may first appear as a brown spot on seedling cotyledons. Leaf lesions are angular or irregular, dark brown to black, and usually with a narrow yellow border. Many lesions characteristically develop on a single leaf thus originating the term “measles” for this disease.

Lesions on the stems are usually deep and elongate while those on the fruit are raised with sunken centers. The pathogen is spread from plant to plant in wind-driven rain and on animate and inanimate objects moving through the vines when they are wet.

Cultural Controls: Plant only anthracnose-resistant watermelon varieties. Deep plow plant residue and practice crop rotation.

Chemical Controls: See PPP-6.

Angular Leaf Spot (*Pseudomonas syringae* pv. *lachrymans*)

Symptoms: The bacterium affects both leaves and fruit. On the leaves, lesions begin as small water-soaked circular black spots surrounded by a yellow halo. The center of the spots may become white. As they enlarge, lesions become angular in shape and may involve an entire lobe of even larger portions of the leaf. This is a cool weather pathogen.

On fruits, lesions begin as small circular water-soaked areas a few millimeters in diameter and enlarge with age to cover larger portions of the melon surface. Lesions do not penetrate deeply into the fruit. On large lesions the cuticle ruptures and peels free from the melon surface. Bacterial ooze may be present.

Cultural Controls: Use disease-free seed.

Chemical Controls: See PPP-6

Bacterial Fruit Blotch (*Acidovorax avenae* subsp. *citrulli*)

Symptoms: Watermelon fruit develops a dark water-soaked lesion on the top or sides of watermelon fruit approximately 2 weeks before maturity or later. As these lesions expand, they crack and develop a brown, scaly appearance. Additional fruit breakdown occurs. The bacterium causes small, angular or linear necrotic lesions on true leaves. These lesions are small and similar to those caused by downy mildew or gummy stem blight. No significant leaf loss occurs. Lesions in seed leaves become necrotic, but they typically are water-soaked areas on the underneath side first. The pathogen is seedborne.

Spread within a field is by windsplashed rain, workers, or equipment. Wet conditions are favorable for disease development.

Cultural Controls: Use pathogen-free, indexed seed and healthy transplants.

Chemical Controls: See PPP-6.

Blossom-end Rot (Calcium Deficiency)

Symptoms: The blossom end of the fruit turns pale green to brown to black. These affected areas enlarge into sunken spots. The discolored fruit portion will shrivel into a dry rot unless the tissue is invaded by secondary organisms which often extend the area of rot throughout the fruit.

This condition can result from a number of situations that limit available calcium to the plant. Poorly limed soils may suffer from a deficiency of calcium in the soil. Calcareous soils seldom have this problem. Dry soil can limit calcium availability to roots regardless of the amount of calcium present in the soil. Fluctuations in between wet and dry soil conditions, even for short time periods, can result in deficiency symptoms.

Cultural Controls: Follow a program of soil testing and lime according to the soil test results. Supplement erratic rainfall with irrigation during fruit development to avoid blossom-end rot development. Foliar application of calcium may help existing blossom-end rot problems.

Cercospora Leaf Spot (*Cercospora citrullina*)

Symptoms: The fungus only causes symptoms on the leaves. Lesions are usually round, small, dark brown to black, with white centers, and encircled with a yellow halo that extends several millimeters wide. The pathogen over-seasons on old debris. Spores are readily wind-borne and rain splashed.

Chemical Controls: See PPP-6

Damping-Off (*Pythium* spp., *Fusarium* spp., *Rhizoctonia* spp.)

Symptoms: Several soil-inhabiting fungi that are almost universal in occurrence cause this disease affecting seedling watermelons. These fungi infect portions of the plant at or below the soil level, resulting in collapse and death of the seedling. Conditions unfavorable for rapid emergence of watermelons (cool, wet weather) are usually most favorable for this disease. See Plant Pathology Fact Sheet PP-1.

Chemical Controls: Plant only fungicide-treated seed (most seed purchased is pre-treated). See PPP-6.

Downy Mildew (*Pseudoperonospora cubensis*)

Symptoms: This fungus infects the leaves primarily. Lesions first appear on the crown leaves as yellow, mottled spots with indefinite borders. Older lesions are dark brown, contrasting sharply with the healthy tissue, and with only a small yellow border. As several lesions coalesce, the leaf curls inward toward the midrib and presents a “cupped hand” appearance. Under favorable conditions, downy mildew develops rapidly, resulting in a “burned-off” appearance over the entire field. The pathogen is spread rapidly by means of airborne and rain-splashed spores. The causal fungus overseasons in southern Florida and thus the fungus moves northward gradually by air currents as spring watermelon planting proceeds northward. See Plant Pathology Fact Sheet PP-2.

Chemical Controls: Fungicide applications will effectively control the fungus if infection is diagnosed at an early stage. See PPP-6

Fusarium Wilt (*Fusarium oxysporum* f. sp. *niveum*)

Symptoms: Infected plants develop a progressively severe wilt syndrome. Sectoring of wilt symptoms on one or more runners can occur. The vascular tissue in the crown develops a light brown to red discoloration. In severe cases, the entire root may become dark brown and a soft rot develops near the crown. The pathogen can be spread to new areas on seed on in soil transported by equipment, drainage water, and man. See Plant Pathology Circular 1025.

Cultural Controls: Plant watermelon varieties with resistance to this disease. However, even with resistant varieties, it is desirable to use new land or have a maximum number of years between crops on the same land. On land previously cropped in watermelon, some wilting of plants can occur even with resistant varieties and final thinning should be delayed as long as possible to eliminate the greatest number of wilt-susceptible plants before final stand is established. Contamination of new fields with soil from Fusarium-infested fields should be avoided.

Gummy Stem Blight (*Didymella bryoniae*)

Symptoms: This fungal pathogen can cause damping-off, crown rot, leaf spot, stem canker, and fruit rot of watermelon. Lesions in the cotyledons and leaves are round or irregular, brown and with faint concentric rings. Lesions on the crown and stem are brown and usually turn white with age. Lesions on fruit are brown, soft, nearly circular, and up to 4-6 inches in diameter. Lesions in stems and fruit may ooze or bleed an amber plant fluid: hence the name “gummy” stem blight. The pathogen is seedborne, spread by splashing rain from plant to plant, carried long distances on wind currents, and “over-winters” on old plant debris. See Plant Pathology Fact Sheet PP-27.

Cultural Controls: Use crop rotation. Turn vines when foliage is dry.

Chemical Controls: Plant only fungicide-treated seed. This disease requires fungicide applications to obtain adequate control. See PPP 6

Phytophthora Blight and Fruit Rot (*Phytophthora capsici*)

Symptoms: Any part of the plant can be infected by this fungus. However fruit symptoms are the most commonly observed. When the roots of stems are infected, wilting of the plant will occur. A whitish mold may appear on the outside of the stem. The fruit rot will appear as greasy blotches on the outer rind. A whitish, mold is likely to be present on the greasy tissue. This disease is most likely to occur during or after periods of excessive rains where water remained in the field.

Cultural Controls: Avoid fields known to have had this disease because the fungus can survive for many years in the soil. Provide for adequate drainage of water.

Chemical Controls: See PPP-6

Powdery Mildew (*Sphaerotheca* sp.)

Symptoms: Initially, older leaves have a reddish-brown bronzed appearance. The reader must realize that viral infections, chemical phytotoxicity and certain nutrient deficiencies can cause similar symptoms. At this point, microscopic examination is required to discern if characteristic spores of powdery mildew are present. At some point, obvious white, powdery fungal growth may occur. This has been an increasing problem for the past 5 years.

Cultural Control: None.

Chemical Controls: See PPP-6

Rind Necrosis (Several bacterial species)

Symptoms: Characteristic symptom of this disease is the development of light brown, dry corky spots in the rind which may enlarge and merge to form rather extensive necrotic areas that rarely extend into the flesh. There are no external symptoms of rind necrosis, but infected fruits appear to have exceptionally tough rinds in the affected areas. The means of dissemination of the pathogen is not known nor is the etiology of the disease well understood, but apparently infection is limited to the fruits.

Cultural Controls: Watermelon varieties differ in the relative incidence and severity of rind necrosis.

Speckle or Moonspots (unknown cause)

Symptoms: This name refers to the development of small white or yellow circular spots on the leaves and fruits. The cause or causes are unknown but this condition does not appear to be typical of an infectious disease. It is heritable. There is no control for this disease.

Tomato spotted wilt (Tomato spotted wilt virus)

This disease has occurred on a few occasions in watermelon in Florida, but an adequate range of symptoms cannot be described. No controls are available.

Mosaic (*Papaya ringspot virus type W*, *Watermelon mosaic virus 2*, *Zucchini yellow mosaic virus*)

Symptoms: The most common symptom is mottling of the leaf (alternate light and dark green areas). However, one or more of the following symptoms may also be associated with mosaic: stunted growth, abnormal leaf shapes, shortened internodes, “bushy” and erect growth habit of the runner tips, and mottled or bumpy appearance of the fruit.

This disease is usually spread by winged aphids during feeding. The aphids pick the virus up from weed hosts such as the creeping cucumber or melonette, *Melothria pendula* L., in south Florida or alyce clover (*Alysicarpus* sp.) farther north in the State. Virus transmission requires 9 seconds or less of aphid feeding on watermelon. See Plant Pathology Circular 1184.

Cultural Controls: No effective commercial control but isolation of cucurbit plantings by use of surrounding plantings of solanaceous crops (tomato, potato, eggplant, pepper) might be helpful in delaying initial infection. Elimination of wild hosts in the vicinity of commercial plantings of watermelons and other cucurbits is critical to the control of these viruses.