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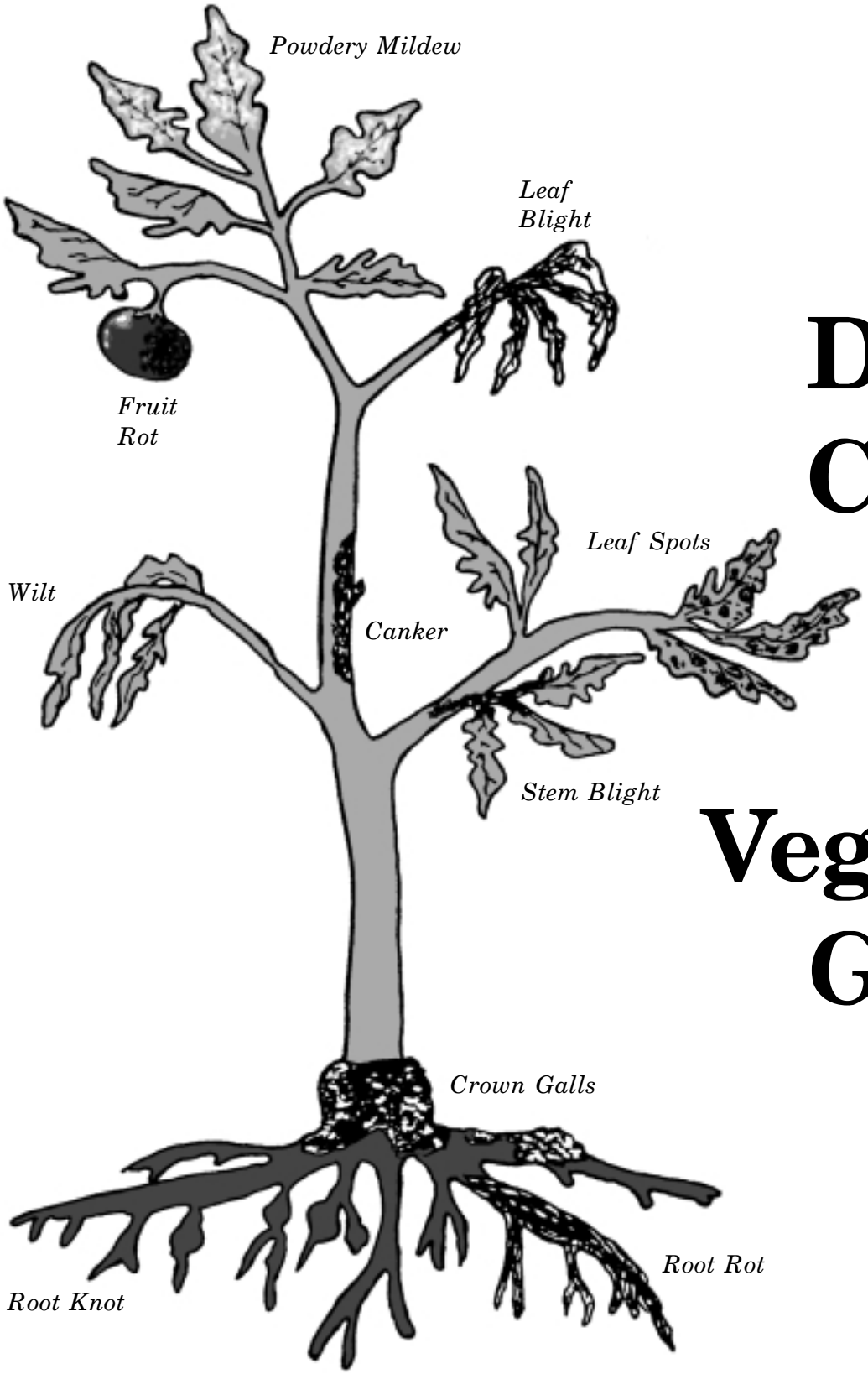
Agricultural Extension Service
The University of Tennessee

PB1215



Disease Control in the Home Vegetable Garden

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Foreword

Control of vegetable pests (diseases, insects, weeds) involves a total production program that includes both chemical and non-chemical means of pest control. The establishment of a healthy, vigorous crop is central to a successful pest control program. Production practices such as maintaining proper soil pH and fertility are helpful in reducing potential losses from all types of pests.

This publication deals mainly with chemical and biological pest control, because these recommendations change more often than do cultural practices. Cultural practices of pest control are extremely important and are addressed throughout the publication.

Disease Control in the Home Vegetable Garden

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Entomology and Plant Pathology

Cultural Methods of Vegetable Disease Control

Most vegetables are susceptible to one or more diseases. You can, therefore, anticipate disease problems sooner or later in your vegetable garden. By following good cultural practices and taking preventive measures, your chances of garden failure due to disease problems can be reduced.

Garden site selection is important to produce high yields of healthy vegetables. Trying to grow vegetables on a poor site is one of the main causes of garden failure. Although few people will have ideal garden sites, they should select the best site available.

Garden sites should not be within the dripline of large trees. Avoid planting near black walnut trees, since they produce a root substance that is toxic to certain vegetables, especially tomatoes. The garden site should be slightly sloped to provide good water and air drainage through the soil.

Excess soil moisture can damage vegetable roots, as well as promote root diseases caused by certain fungi. Air movement through the garden is also important to help dry the foliage, thus reducing the chances of fungal and bacterial infections. Garden sites with good air drainage are less likely to be damaged by late frosts. Most garden vegetables require full sunlight for maximum production. Sunlight also hastens drying of foliage.

Soil tillage should be done early enough, prior to planting, to allow decomposition of raw organic matter such as manure or green plant material. This usually requires about six weeks under warm temperatures and longer at low temperatures. Organic material that has not decomposed can be a source of disease organisms and can also promote development of certain diseases such as root and stem rots. Applying nitrogen fertilizer before plowing or tilling green plant material into the soil will hasten its decomposition.

Crop rotation will help prevent the build up of disease-causing organisms in the soil. Some disease-causing organisms affect one vegetable or group of vegetables, but may not affect another. Several vegetables of the same family, such as squash, cucumbers and cantaloupes, may be affected by the same disease. Therefore, it is not a good practice to grow plants of the same family in rotation. Table 1 gives crop groupings for rotation to control soil-borne diseases. At least a three-year rotation is suggested for vegetable crops.

Sanitation is very important in controlling vegetable diseases. Many disease-causing organisms survive the winter in plant debris, cull fruit or plant stubble left in the garden. Any practice that will eliminate these overwintering sites for fungi, bacteria, viruses and nematodes will reduce the occurrence of disease problems the following year.

Removal or plowing-under of crop stubble and trash helps destroy overwintering populations of disease organisms. Some disease-causing organisms are able to survive the off season on contaminated equipment or containers. Equipment that has been used in disease-infested

Table I. Crop Grouping for Rotation to Control Soil-borne Diseases

Group A	Group B	Group C	Group D	Group E	Group F
Cantaloupe Cucumbers Honeydew melon Pumpkin Squash Watermelon	Brussels sprouts Cabbage Cauliflower Collard Lettuce Mustard Radish Rutabaga Spinach Swiss chard Turnip	Eggplant Irish potato Okra Pepper Tomato	Beet Carrot Garlic Onion Shallot Sweet potato	Sweet corn	All beans Cowpeas Peas

vegetable gardens or containers used in handling diseased vegetables should be disinfested before being used again.

Disease-free seed and transplants are a must in vegetable production. Seed should not be saved from diseased plants. Always buy seed from a reputable dealer, since you normally cannot tell from their external appearance if seed are contaminated with disease-causing organisms.

Certain geographical areas, such as the arid western states, can produce disease-free seed because of climatic conditions. Seed from these areas should be stipulated in your seed orders. Gardeners starting their crop from transplants should, likewise, insist on disease-free plants.

Seed treatments vary, depending on the crop as well as the disease to be controlled. Some disease-causing organisms are carried on the surface of seed and can be controlled by a simple fungicide treatment. Fungicides are not effective against those organisms carried beneath the seed coat.

Fungicides applied to seed also give young seedlings some protection from soil-borne disease organisms as they germinate and emerge. Such treatments, however, do not control organisms that attack the plant after the seedling stage.

A seed treatment is usually applied by the company from which the seed is purchased. Home-grown seed can be treated at home with relative ease. Thiram or Captan fungicides can be used as seed treatments on most vegetable crops. Use these protectant fungicides according to instructions on the label. For small quantities of seed, such as packets, apply sufficient fungicide to coat the seed surface. Simply place a small quantity (comparable to the size of a match head) in the packet, reclose and shake to coat the seed with the fungicide.

Planting dates can be an effective tool in reducing diseases of vegetables. Okra, for instance, requires warm soil for good germination and growth. If planted when the soil is still cold, the seeds will rot, or if they do germinate, they will probably develop damping-off or stem rot. Some crops, such as corn and beans, should be planted as early as the weather permits to escape severe virus infections. Aphids that transmit viruses are usually at lower population levels early in the season.

Mulches can be used to conserve moisture, keep fruit clean and prevent diseases. Mulches reduce fruit rot on crops, such as strawberries, tomatoes, squash, cucumbers and melons by preventing direct contact with the soil. Mulching will reduce splashing of soil onto lower fruit and foliage by rain.

Staking or trellising tomatoes, pole or half runner beans and cucumbers will prevent soil contact with the foliage and fruit. Air circulation will be better if these plants are trellised, thus promoting better drying of foliage and reducing diseases. Pesticides can be more effectively applied to trellised plants.

Watering can influence the development and severity of many foliage diseases. Wet foliage is favorable for the development of most diseases. To reduce infections, apply irrigation water to the soil rather than the foliage. If water must be applied to the foliage, then it should be done in late morning or mid-afternoon to allow the foliage to dry before evening.

Maintaining uniform soil moisture can reduce problems such as blossom end rot of peppers and tomatoes. Excessive soil moisture can result in increased root and stem rot diseases. It is best to work in the garden when the foliage is dry to reduce disease spread. Bacterial diseases of tomatoes, beans and other crops are readily spread on hands and clothing of workers when the foliage is wet.

Use of resistant varieties is one of the most economical ways of controlling vegetable diseases. Resistant varieties should be used in areas where diseases are present or where the soil is known to be infested with disease-causing organisms. Resistant varieties should be used even when rotation is practiced.

Extension publication SP 277-K, "*Disease Resistance in Recommended Vegetable Varieties for Home Gardens*," gives additional information on recommended vegetable varieties and their resistance to various diseases. Home gardeners should consult their seed catalogs for information on varieties of vegetables with disease resistance.

Proper plant spacing is very important in vegetable crops. Humid or wet conditions occur if plants are crowded and unable to dry quickly. Many disease organisms require moisture to infect plants. Blossom blight of okra and squash and fruit rot of strawberries are encouraged by dense foliage. Also, pesticides will not penetrate through this canopy of foliage.

Avoid using tobacco while working in tobacco mosaic susceptible crops, such as tomato and pepper. Tobacco mosaic virus is carried in tobacco products and is easily transmitted to susceptible vegetables on workers' hands. Workers should wash their hands thoroughly in soap and water after handling tobacco and before they work with tobacco mosaic susceptible plants.

Proper fertilization helps prevent vegetable diseases. Have your soil tested and apply fertilizer accordingly. Some soils will need applications of minor elements to produce certain vegetable crops. The soil pH should be adjusted to suit the particular vegetables you plan to grow.

Insects as Related to Vegetable Disease Control

Insect control can reduce the spread of diseases in the garden. Cucumber beetles can transmit bacterial wilt, flea beetles are a source of Stewart's wilt of corn and aphids transmit numerous virus diseases. Insects also cause injuries that serve as entry sites for disease organisms. Vegetables should be checked regularly for insects, with insecticides applied as needed. In some situations, beneficial insects will control insect pests. Gardeners should be able to distinguish insect pests from beneficial insects.

Nematode Control

Nematode control is important in growing garden vegetables. Nematodes are microscopic, soil-inhabiting, round worms that can become a serious problem in vegetable production. They injure vegetables by feeding on their root system, causing decay or galling. The most common nematode that attacks garden vegetables is the root knot nematode, so-called because of the knots it causes on roots of certain vegetable crops. Cultural practices that aid in disease control will also help prevent or control nematode damage to vegetable crops. See Extension Publication SP 341-L, "*Nematode Control in the Home Garden*," for more information on nematodes and their control.

Rotations that include non-susceptible crops, such as grass, will help reduce nematode populations. Resistant varieties are available in some vegetables. Fallow cultivation and destruction of plant stubble after harvest will also help control nematodes. These cultural practices are not always feasible due to limited land available for a garden. In such situations it may be necessary to fumigate the garden soil to kill the nematodes. Unfortunately, there are presently no

available chemicals (nematicides) for use in the home garden.

A nematode testing service is available through The University of Tennessee Agricultural Extension Service. The fee is $5 per sample. The test requires a pint of moist soil from the suspect area. Mail samples in plastic bags to: Plant and Pest Diagnostic Center, 5201 Marchant Dr., Nashville, TN 37211-5112 (UPS or Fedex use 37220 Zip Code). County Extension personnel can assist you with collecting appropriate samples and in interpreting test results.

Pesticides and Vegetable Disease Control

Fungicides can be a great help in preventing diseases when properly applied to the plant foliage. Since fungicides are preventive, they should be applied before the disease occurs, or as soon as the first symptoms of disease appear. Some vegetable diseases require specific fungicides for their control. An outline of diseases of specific vegetables, disease description, suggested cultural and chemical control and comments follows this section.

Fungicides are available primarily as wettable powders, dry flowables and dusts, but a few are sold as emulsifiable concentrates, flowables and liquids. Wettable powders (WP) and dry flowable (DF) are formulated in such a manner as to be readily suspendable in water. Dusts (D) should not be mixed in water, but applied directly to the plant. Emulsifiable concentrate (EC) fungicides contain an emulsifying agent that makes them readily suspendable in water. Flowable (F) fungicides are finely ground wettable powders that are suspended in a liquid.

Some soil fungicides are available as granules and are applied in the furrow at planting. Dust and spray fungicides may also be used as in-furrow treatments for seedling disease control.

Table II gives trade names and rates of broad spectrum fungicides for controlling foliar diseases of vegetables. Applying foliar fungicides to vegetables is best done by spraying, because it provides coverage of all plant surfaces. Foliar fungicides are available in dust formulations, but dusts are usually not as effective as sprays. Never attempt to use dust formulations of fungicides in spray solutions. Dusts will not suspend in the spray solution. Wettable powder formulations may appear similar to dusts, but they are formulated to be suspended in spray solutions.

Foliar sprays will aid in controlling leaf spots, rusts, mildews, anthracnose and fruit rots. Foliar sprays are not effective against vascular wilts or root rots. Foliar sprays are protectants, because they form a protective layer of fungicide over the surface of the fruit and foliage. Disease agents (bacteria and fungi) that land on these fungicide-coated surfaces are killed or prevented from infecting the plant.

Most fungicides are not effective in inhibiting disease organisms once they have infected a plant. It is imperative that foliar fungicides be applied prior to infection of the plant. A spray schedule should be followed that maintains a protective fungicide layer on the foliage and fruit during favorable infection periods. By carefully monitoring their vegetables, some gardeners can usually delay the first fungicide application until the first sign of disease. Then a 7-14 day spray schedule should be followed. During rainy or humid weather, spray application intervals should be shortened.

Proper pesticide mixing and spraying plays a very important part in achieving disease control. Most home gardeners will find a 1-2 gallon compressed-air sprayer adequate for applying foliar sprays. A nozzle with a cone pattern will provide the most effective coverage of plant foliage. Keep the pressure up to insure small spray particle size and good coverage.

Sprayers should be cleaned and rinsed after each use. Hose-end sprayers are not very effective in applying fungicides to vegetables. Never use the same sprayer for fungicides and insecticides that has been used for herbicides. Residues of certain types of herbicides are very difficult to remove from sprayers. These residues may cause crop injury if a herbicide-contaminated sprayer is used in applying fungicides or insecticides.

Homeowners should protect themselves when mixing or applying pesticides.

Always read the label for use directions and precaution statements.

As of spring 1992, the Environmental Protection Agency is requiring that all mancozeb, maneb and metiram product registrations and

Outline for Control of Vegetable Diseases

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
ASPARAGUS					
Root Rot (Fusarium)	Deterioration of root system and poor growth of plants.	Mancozeb 75 DF	1 TBSP		Pre-plant root dip.
Rust	Numerous small, reddish-yellow spots on spears and ferns.	Mancozeb 75 DF	2 TBSP	180	Apply to ferns after harvest of spears. Make applications at 7-10 day intervals, beginning at first appearance of disease.
BEAN (SNAP)					
Anthracnose	Brown spots on leaves, sunken with pinkish ooze.	Basic copper sulfate 53WP Chlorothalonil 54 F	mfg directions 3 tsp	0 7	Use western-grown seed. If plants become infected, do not work while plants are wet. Spray at weekly intervals. Do not plant beans in field for at least two years following occurrence of disease. Plow infested bean trash deeply into soil. Do not graze treated areas or feed treated plants to livestock.
Bacterial Blights	Water-soaked spots on leaves and pods. Red margin and sometimes a yellow halo around spot.	Fixed Copper	mfg directions	0	Same applies as for anthracnose.
Gray Mold (Botrytis)	Gray moldy growth on pods and stems.	Chlorothalonil 54 F	3 tsp	7	Begin at 25 to 50% bloom. Repeat at peak bloom. Do not graze treated areas or feed treated plants to livestock.
Mosaic Virus (bean yellow mosaic, bean common mosaic, and peanut stunt viruses)	Yellowed leaves, with or without crinkling or speckling. Leaves cupped, runners killed.				Use resistant varieties. Half runners are most susceptible, particularly "Pink.' Make successive plantings, as mosaic is more severe at certain times of the year.
Powdery Mildew	White, powdery mold on surface of leaves.	Sulfur Dust Wettable Sulfur	mfg directions mfg directions	0 0	Use resistant varieties. Spray or dust with sulfur when disease first appears and repeat treatment 10 days later.
Root Rot & Seedling Disease (Rhizoctonia)	Rots of seeds death of seedlings (damping off), and root rots.	Terraclor 75 WP	mfg directions		Apply Terraclor in-furrow at planting. Rotate crops, avoid double cropping beans and turn under plant debris well in advance of planting. (See Extension factsheet SP277-O)
Rust	Reddish brown pustules develop on leaves.	Chlorothalonil 54 F	3 tsp	7	Spray plants when rust appears and repeat at 7-10 day intervals. Do not graze treated areas or feed treated plant parts to livestock.
White Mold (Sclerotinia)	White moldy growth on pods and stems.	Terraclor 75 WP	mfg directions		Spray at first appearance of disease.

Outline for Control of Vegetable Diseases (con't)

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
BEAN (lima) AND BUTTER PEA					
Stem Anthracnose	Reddish brown spots on leaves and pods. Small black specks sometimes can be seen.	Basic copper sulfate 53 W	mfg directions	0	Plant disease-free seed and rotate lima beans with other crops. Start applications of fungicide at first bloom and continue at 7-day intervals.
Root-knot	Swollen, galled root system.				See section above on nematode control.
Root Rot					See Bean, Snap.
BEET					
Downy Mildew Leaf Spots	Various leaf spots.	Fixed Copper	mfg directions	0	Spray at first appearance and repeat at 7-10 day intervals.
Rust	Orange to rust colored spots that will rub off on hands.	Sulfur	mfg directions	0	
BROCCOLI (SEE CABBAGE)					
BRUSSELS SPROUTS (SEE CABBAGE)					
CABBAGE					
Alternaria Leaf Spot	Target spots on older leaves. Small, black spots may also occur.	Chlorothalonil 54 F Maneb 80 WP	1.5 tsp 3-4 tsp	0 7	Start spraying when this disease first appears. Continue spray at 7-10 day intervals until disease is under control. Remove excess residues by washing.
Downy Mildew	Yellow areas on upper side of leaves; downy growth on lower surface.				
Bacterial Soft Rot	Soft, watery rot occurs, favored by hot, wet conditions. Begin in center of broccoli head.				Control of black rot will also help control bacterial soft rot. Avoid damage to the crop which will provide infection sites for soft rot bacteria.
Black Leg	Lower stem turns brown and rots causing a canker.				Use certified disease-free seeds or transplants.
Black Rot	Yellow V-shaped spots on edge of leaves. Veins near spots turn black.				Use certified disease-free seeds or transplants. Follow good sanitation practices. Don't grow cabbage in locations where black rot occurred the previous year. See Extension factsheet SP277-P.
Club Root	Galls or clubs on roots. Plants have light green color and are stunted.	Hydrated lime Terraclor 75 WP (transplant solution)	mfg directions 6 TBSP/gal. water		Broadcast and work lime into soil by tilling within 3 days before planting. Apply 3/4 pint of Terraclor solution per plant as a transplant solution.

Outline for Control of Vegetable Diseases (con't)

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
CABBAGE CONT'D					
Damping-Off	Young plants are rotted off at soil line.	Terraclor 75 WP (seedbed drench)	1 TBSP/gal. water/50 sq. ft. seedbed		Sterilize seedbed soil. Apply Terraclor drench after seeding.
Wire Stem	Brown discoloration of stem. Entire stem becomes hard and constricted.	Terraclor 75 WP	10-15 lbs./10,900 ft. of row		Sprayed as 8-inch band centered on row.
Yellows (Fusarium)	Leaves turn yellow. Cross section of stem shows brown discoloration in veins.				Grow resistant varieties in areas where soil is infested. Secure disease-free transplants.
CANTALOUPE					
Alternaria Leaf Spot	Tan target spots on leaves, followed by blighting.	Chlorothalonil 54 F	1.5-3 tsp	0	Use disease-free seed. Fungicide applications can be delayed until first sign of disease if adequate survey of garden is maintained.
Anthracnose	Sunken spots on fruit and tan leaf spots.	Mancozeb 75 DF	2-3 TBSP	5	
Downy Mildew	Yellow, irregular spots on leaves.	Maneb 80 WP	4-6 tsp	5	
Gummy Stem Blight	Brown, round leaf spots. Cracks on stems with gummy ooze.				
Bacterial Wilt	Individual runners suddenly wilt and die.				Apply insecticide to control cucumber beetles, which spread the bacterium. See Extension factsheet SP277-C.
Powdery Mildew	White, powdery mold on surface of leaves.	Sulfur	mfg directions	0	Apply at first sign of disease and repeat at 7-14 day intervals. Do not apply sulfur if temperatures exceed 90 degrees F.
CAULIFLOWER (SEE CABBAGE)					
CARROT					
Alternaria Blight	Numerous dark brown spots which may coalesce.	Chlorothalonil 54 F	1.5-2 tsp	0	Spray at first appearance and repeat at 7-10 day intervals. Alternaria blight can spread rapidly.
Cercospora Leaf Spot	Small, dark brown to black spots on leaves.				
Southern Blight	White mycelial growth on lower stem; death of plant.				Use crop rotation.

Outline for Control of Vegetable Diseases (con't)

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
COLLARD, KALE, MUSTARD & TURNIPS					
Alternaria Leaf Spot	Brown target spots on leaves.	Fixed Copper Maneb 80 WP	mfg directions 3-4 tsp	0 10	Maintain thin plant stand. Avoid low-lying or poorly-drained soils. Avoid hot part of growing season. Maneb for kale only. Begin sprays when disease is first noticed and repeat at 7-10 day intervals. Use a spreader-sticker for better fungicide coverage.
Anthracnose	Small, tan spots with dark brown margins on leaves.				
Cercospora Leaf Spot	Tan leafspots with yellow haloes.				
Downy Mildew	Yellow spots on upper surface of leaf with white, downy growth on underside.				
CORN (SWEET)					
Blights (Helmintho-sporium)	Spots on leaves and drying or blighting of leaves.	Chlorothalonil 54 F Mancozeb 75 DF Maneb 80 WP	0.75-2 tsp 1.5 TBSP 3 tsp	14 7 7	Begin applications when conditions favor disease development and repeat at 4-7 day intervals. Do not apply chlorothalonil to sweet corn to be processed. Do not graze treated areas or feed treated plants to livestock. Use Maneb on crop for seed production only.
Maize Dwarf Mosaic	Alternating light and dark green streaks in leaves. Plants are stunted.				Plant early and preferably in fields not heavily infested with Johnsongrass. Silver Queen, a white variety, has fair tolerance to this disease.
Rust	Bronze, elongate spots.	Chlorothalonil 54 F Mancozeb 75 DF Maneb 80 WP	0.75-2 tsp 1.5 TBSP 3 tsp	14 7 7	See "Blights."
Stewart's Wilt	Brown streaks in leaves parallel to veins.				Control corn flea beetle. See insect section of this publication. Also called bacterial blight.
CUCUMBER					
Alternaria Leaf Spot	Brown, target spots on leaves.	Chlorothalonil 54 F Mancozeb 75 DF Maneb 80 WP	1.5-3 tsp 2-3 TBSP 2-4 tsp	0 5 5	Use disease-free seed. Fungicide applications can be delayed until first sign of disease if an adequate survey of garden is maintained.
Anthracnose	Brown, irregular spots on leaves, sunken spots on fruit.				
Angular Leaf Spot	Brown, angular spots on leaves.	Fixed Copper	mfg directions	0	Spray at first appearance and repeat at 7-14 day intervals. Use disease-free seed. (Copper can injure young plants).

Outline for Control of Vegetable Diseases (con't)

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
CUCUMBER CONT'D					
Downy Mildew	Yellow, irregular spots on leaves.	Chlorothalonil 54 F Mancozeb 75 DF	1.5-3 tsp 2-3 TBSP	0 5	Use disease-free seed. Fungicide applications can be delayed until first sign of disease if an adequate survey of garden is maintained.
Gummy Stem Blight	Brown, circular leaf spots. Cracks on stems with gummy ooze.	Maneb 80 WP	2-4 tsp	5	
Bacterial Wilt	Starts on individual runners and eventually the entire plant wilts and dies.				Apply insecticide to control cucumber beetles, which spread the disease. See Extension factsheet SP277-C and the insect control section of this publication.
Powdery Mildew	White, powdery mold on surface of leaves.	Sulfur	mfg directions	0	Apply at first sign of disease and repeat at 7-14 day intervals. Do not apply sulfur if temperatures exceed 90 F.
Scab	Sunken spots on fruit.	Chlorothalonil 54 F	2-3 tsp	0	Resistant varieties widely available. Apply at first sign of disease and repeat at 7-10 day intervals.
EGGPLANT					
Leaf Blights, Fruit Rots	Spots develop on leaves and fruits.	Fixed copper Maneb 80 WP	mfg directions 3-4 tsp	0 0	Begin spraying before disease appears.
KALE (SEE COLLARD)					
MUSTARD (SEE COLLARD)					
OKRA					
Pod Blight	Young pods fail to develop and deteriorate.				Many times this blight is associated with poor pollination. The fungus Choanephora attacks the flowers and young pods. Providing good air drainage will help prevent infection by Choanephora.
Root-knot Nematode	Swollen, galled root system.				See section above on nematode control.
Verticillium Wilt	Yellowing of leaves. Inside of stem will have brown discoloration.				Rotate okra with crops which are not susceptible to Verticillium wilt.

Outline for Control of Vegetable Diseases (con't)

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
ONION					
Downy Mildew	Pale green, oval, sunken spots on leaves. Purplish mold may be in spots.	Chlorothalonil 54 F Mancozeb 75 DF Maneb 80 WP	1.5-3 tsp 3 TBSP 2-6 tsp	14 7 7	Apply when disease first appears and repeat at 7-10 day intervals. Do not apply Mancozeb or Maneb on exposed bulbs. Do not apply Chlorothalonil within seven days of harvest on dry-bulb onions or within 14 days on green onions, leeks or shallots. Do not apply Chlorothalonil to sweet Spanish onions.
Leaf Blast (Botrytis)	White to tan streaks on leaves. Leaves eventually die.				
Purple Blotch (Alternaria)	Purple target spots on leaves.				
PEA (SOUTHERN)					
Cercospora Leaf Spot	Light to dark brown spots on leaves.	Chlorothalonil 54 F	1.5-2 tsp	42	Spray at early bloom and repeat at 7-10 day intervals. For use on beans harvested dry with pods removed (blackeye pea only). Only Bravo 720 or Bravo DG is labeled. Do not graze treated areas or feed treated plants to livestock.
Rust	Bronze to rust-colored spots that will rub off on hand.				
Mosaic Virus	Mosaic of leaves (alternate light and dark green areas). Distortion of leaves and pods.				Use virus-free seed. Plant resistant varieties.
Powdery Mildew	Dull white, felt-like growth on leaves.	Sulfur	mfg directions	0	Spray at first appearance at 7-10 day intervals.
Root Rot	Brick-red lesions on lower stem and roots. Roots later die.				See Bean, Snap.
PEPPER					
Bacterial Spot	Black, angular spots appear on leaves. Dark raised spots also occur on fruits. Plants shed infected leaves.	Fixed Copper Plus Maneb 80 WP	mfg directions mfg directions	0	Use disease-free seed or buy disease-free transplants. Spraying with fixed copper will help prevent spread.
Blossom-end Rot	Tan sunken areas on blossom end and side of fruit.				Lime soil to provide adequate calcium. Avoid planting on droughty soils. Do not use excessive nitrate fertilizer. Irrigate and follow culture practices that tend to provide the most uniform soil moisture.
Cercospora Leaf Spot	Circular spots with gray centers develop on leaves.	Fixed copper Maneb 80 WP	mfg directions 3-6 tsp	0 7	Apply fungicide when disease appears and continue as needed on a 7-10 day schedule.
Anthracnose	Sunken spots on ripening fruit.				

Outline for Control of Vegetable Diseases (con't)

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
PEPPER CONT'D					
Phytophthora Blight	Rapid wilt and death of plants in wet areas of field.				Plant on raised bed.
Root-knot	Swollen, galled root system.				See previous section on nematode control.
Southern Blight	Plants wilt and die. White mold can often be seen on base of stem.	Terraclor 75 WP (soil treatment)	mfg directions		Turn soil deep to bury plant debris that might harbor disease organism. Use Terraclor in setting water at planting. Rotate with sod crops.
Sun Scald	Dry, white bleached spot on side of pod exposed to sun.				Fruits on plants kept in a healthy, vigorous condition are not likely to be injured by sun scald. Control of bacterial spot will prevent loss of leaves and keep the fruit protected from the sun.
POTATO, IRISH					
Early Blight	Small brown, target spots appear on leaves in hot, wet weather.	Chlorothalonil 54 F Mancozeb 75 DF Maneb 80 WP	1-1.5 tsp 1-2 TBSP 3-4 tsp	0 14 14	Start applications when plants are 4-6 inches high and continue at 7-10 day intervals.
Late Blight	Water-soaked irregular spots on leaves in cool, wet weather. Plants appear scalded.				
Black Leg	Stem turns black. Plant wilts and dies.				Plant certified seed.
Rhizoctonia Canker (Black Scurf)	Black cankers girdle stem, causing poor growth.	Terraclor 75 WP	mfg directions		
Scab	Rough, scabby spots on tubers.				Use disease-free seed. Where soil is infested with scab organism, use resistant varieties and rotate crops. See SP277-G.
Seed Piece Decay	Rotting of seed piece.	Mancozeb Maneb	Use dust formulations according to mfg directions		Treat seed pieces with fungicide dust before planting. Plant seed pieces immediately after treating. Do not use treated seed pieces for food, feed or oil purposes.
Ring Rot	Brown discoloration of vascular tissue in tuber.				Plant certified disease-free seed and practice crop rotation.
Virus Diseases	Curling, streaking, or mosaic in leaves. Plants may be stunted.				Plant certified disease-free seed and practice crop rotation.

Outline for Control of Vegetable Diseases (con't)

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
PUMPKIN					
Downy Mildew	Yellow, irregular spots on leaves.	Chlorothalonil 54 F Maneb 80 WP	1.5-3 tsp 3-4 tsp	0 5	Begin spraying at first sign of disease. See label for spray intervals. Use higher rates for scab control.
Gummy Stem Blight	Black, circular spots on fruit.				
Microdochium Blight	White dashes on stem surface.				
Scab	Sunken or raised spots on fruit.				
Mosaic Virus	Green patterns on fruit.				Reflective mulches, aphid control, and weed control may be helpful. Control is difficult.
Powdery Mildew	White, powdery mold on leaf surface.	Sulfur	mfg directions	0	Begin spraying at first sign of disease.
SPINACH					
Downy Mildew (Blue Mold)	Yellow spots on upper leaf surface. Gray downy fungus on underside of leaf.	Basic copper sulfate 53 WP	mfg directions	0	Start fungicide applications at first sign of disease and continue at 7-10 day intervals as necessary. Where white rust has been a problem in the past, spraying should start when the first true leaves develop. "Fall Green," a fall variety, is moderately resistant to white rust and several races of blue mold.
White Rust	Yellow spots on upper leaf surface. White powdery mass on underside of leaf.				
SQUASH					
Downy Mildew	Yellow, irregular spots on leaves.	Chlorothalonil 54 F Mancozeb 75 DF Maneb 80 WP	1.5-3 tsp 2-3 TBSP 3-4 tsp	0 5 5	Begin spraying at first sign of disease. See label for spray intervals.
Powdery Mildew	White, powdery mold on leaf surfaces.	sulfur	mfg directions	0	Apply at first sign of disease and repeat at 7-14 day intervals. Do not apply sulfur if temperatures exceed 90 F.
Scab	Sunken or raised spots on fruit.	Chlorothalonil 54 F	2-3 tsp	0	Begin spraying at first sign of disease. See label for spray intervals.
Blossom Blight	Blossoms rot and stick to young fruit. The end of the fruit turns black.				Provide good air circulation for rapid drying.
Mosaic Virus	Greening of fruit. Leaves mottled, veins stunted.				Reflective mulches may be of some value. The yellow-stemmed varieties Multipik, Superpik and Supersett are tolerant of watermelon mosaic virus.

Outline for Control of Vegetable Diseases (con't)

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
SWEET POTATO					
Black Rot	Black spot on roots. Dry, black decay extends in flesh of root.				Use certified seed. Do not replant for 3 years in locations where this disease has been present.
Scurf	Brownish black discoloration on surface of potato.				
Cork	Small, black, corky spots in potatoes. Spots do not extend to surface.				Use certified, disease-free seed.
Root-knot Nematodes	Longitudinal cracking of potato.				See previous section on nematode control.
Soil Rot (Pox)	Circular sunken areas on fleshy roots. Feeder roots are blackened.				Rotate sweet potatoes with other crops. Maintain pH below 5.2 in infested fields. Grow a resistant variety.
Stem Rot (Fusarium Wilt)	Plants are yellow and stunted. The interior of the vine shows a brown discoloration.				Select disease-free seed stock by examining vines of each hill. If cross section of vine shows a brown discoloration, do not use roots for seed stock.
Southern Blight (Plant Bed)	Plants die in spots in bed. White growth on lower stem.				Use new soil in beds each year.
TOMATO					
Bacterial Spot	Small, raised spots on fruits. Water-soaked spots on foliage.	Fixed Copper plus Mancozeb 75 DF OR plus Maneb 80 WP	mfg directions 1.5-2 TBSP 3-4 tsp	0 5 5	Use hot water seed treatment or use disease-free seed.
Blossom-End Rot	Black spot on blossom end of small green fruit.				Maintain adequate calcium level in soil and uniform soil moisture. Plant least susceptible varieties. Avoid droughty soils.
Early Blight	Brown target spots followed by blighting of foliage.	Chlorothalonil 54 F Mancozeb 75 DF Maneb 80 WP	1.5-2 tsp 1.5-3 TBSP 3-6 tsp	0 5 5	Start preventative spraying as soon as plants are established in the garden. Spray at 7-10 day intervals. During periods favorable for disease development, shorten the spray interval. Maneb 80 WP can be used in the greenhouse and in the garden.
Anthracnose	Circular, sunken spots on ripe fruit.				
Septoria Leaf Spot	Small, gay circular leaf spots with dark borders.				
Buckeye Fruit Rot	Circular, zonate bands within large spot on fruit, worse on lower clusters.				Mulch and stake plants to keep soil off fruit clusters.

Outline for Control of Vegetable Diseases (con't)

Disease	Symptoms	Chemical & Formulation[1]	Approximate Rate/Gallon[2]	PHI[3]	Limitations
TOMATO CONT'D					
Fusarium Wilt	Yellowing and wilting of foliage. Inside of stem has brown discoloration.				Use a resistant variety and rotate tomato fields. Obtain disease-free plants and plant on disease-free soil.
Gray Mold (Botrytis)	Leaves turn brown from tip back; gray mold can be seen on foliage during humid weather.	Chlorothalonil 54 F	3 tsp	0	Begin fungicide spray applications at first sign of disease.
Late Blight	Irregular, watersoaked spots on leaves. Occurs in mold, wet weather.	Chlorothalonil 54 F Mancozeb 75 DF Maneb 80 WP	1.5-3 tsp 1.5-3 TBSP 2-6 tsp	0 5 5	Follow spray schedule for early blight. If weather conditions are favorable for late blight, shorten spray interval. Obtain disease-free plants and plant in non-infested soil.
Leaf Mold	Yellow spots on upper surface of leaves. Olive to gray mold on underside of leaves. Primarily in greenhouses.	Chlorothalonil 54 F	1.5-2 tsp	0	Fungicides will control leaf mold in the garden, but are not adequate in greenhouse production. The best control in greenhouse tomatoes is the use of resistant varieties and regulation of humidity.
Pythium Stem Rot	Dark, water rot of lower stem of young plants.				
Southern Blight	Plants wilt and die. White mold can often be seen on base of stem.	Terraclor 75 WP (soil treatment)	mfg directions		Turn soil deep to bury plant debris which might harbor disease organisms. Use Terraclor in setting water. Rotate with turf.
Verticillium Wilt	Yellowing of leaves; inside of stems will have brown discoloration.				Use resistant varieties. Practice long rotations of tomatoes with other crops.
TURNIP (SEE COLLARDS)					
WATERMELON					
Alternaria Leaf Spot	Brown, target spots on leaves.	Chlorothalonil 54 F Mancozeb 75 DF Maneb 80 WP	1.5-3 tsp 2-3 TBSP 2-4 tsp	0 5 5	Begin at first sign of disease. See label for spray intervals. Plant anthracnose-resistant varieties. Mancozeb and Maneb are not labeled for scab control.
Anthracnose	Brown irregular spots on leaves and sunken spots on fruit.				
Cercospora Leaf Spot	Tiny, dark brown spots.				
Downy Mildew	Yellow, irregular spots on leaves.				
Gummy Stem Blight	Irregularly circular leaf spots. Cracks on stems with gummy ooze.				
Scab	Small, raised warts on fruit.				
Fusarium Wilt	Yellow and wilting of leaves. Brown discoloration in interior of vine.				Grow resistant varieties. Long rotations should be practiced even where resistant varieties are used.

[1] Common names are used for chemical recommendations. Trade names are listed in Table II.
[2] Consult label for precise rate of application. The rates given in teaspoon or tablespoon per gallon in the publication are only approximate and the label of the specific product to be used should be consulted before mixing and applying any fungicide.
[3] PHI (pre-harvest interval) is the minimum number of days between last application and harvest.

Table II. Common Names and Trade Names of Chemicals for Controlling Diseases of Vegetables

Common Names	Trade Names[1]
benomyl	Note: Home garden benomyl products are no longer available.
chlorothalonil	Bravo 720 (54%) Bravo 75 WP Bravo 90 WDG Bravo Flowable Fungicide Broad Spectrum Liquid Fungicide Fungi-Gard Lawn, Ornamental and Vegetable Fungicide Vegetable Disease Control
fixed coppers	Basicop Blue Shield Kocide Tri-Basic Copper Sulfate
mancozeb[2]	Dithane DF Manzate 200 DF Penncozeb
maneb[2]	Maneb 80 WP Maneb Spray Maneb Liquid Fungicide
PCNB	Terraclor 10 G Terraclor 75 WP

[1] Follow label instructions when mixing and applying fungicides. One gallon of fungicide spray will usually cover 400-450 square feet of garden area (130-150 linear feet in three foot wide rows). The application rate varies with plant size. Some product labels stipulate higher quantities of weaker sprays than other similar products. Always follow the label. Labels may limit the number of applications or the total allowable amount of fungicide/unit area.

[2] The Environmental Protection Agency is requiring that all mancozeb, maneb and metiram product registrations and labels bearing homeowner uses be amended to bear the following protective clothing and hygiene language: "Home gardeners applying this product must wear long-sleeved shirt, long pants and chemical-resistant gloves. The gloves must be washed thoroughly with soap and water before removing. Clothes must be changed immediately after using these EBDC products and must be laundered separately from other laundry items before reuse."

This listing does not imply any preference or discrimination to other products of similar suitable composition, but is provided solely as a reference. All formulations of a particular fungicide may not be labeled for all crops; check label before purchasing or using any fungicide.

labels bearing homeowner uses be amended to bear the following protective clothing and hygiene language:

"Home gardeners applying this product must wear long-sleeved shirt, long pants and chemical-resistant gloves. The gloves must be washed thoroughly with soap and water before removing. Clothes must be changed immediately after using these EBDC products and must be laundered separately from other laundry items before reuse."

Pesticide Safety

Pesticides used improperly can be injurious to humans, animals and plants. Follow the directions, and heed all precautions on the labels. Store pesticides in original containers under lock and key – out of the reach of children and animals – and away from food and feed.

Apply pesticides so they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on the skin or clothing, remove the clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment with insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly and according to the law.

Recommendations given in this publication do not apply to vegetables grown in greenhouses, unless otherwise noted.

Use Pesticides Safely
Follow Label Directions

U.S. Department of Agriculture

PRECAUTIONARY STATEMENT

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

DISCLAIMER STATEMENT

Pesticides recommended in this publication were registered for the prescribed uses when printed. Pesticide registrations are continuously being reviewed. Should registration of a recommended pesticide be cancelled, it would no longer be recommended by The University of Tennessee.

Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product.

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