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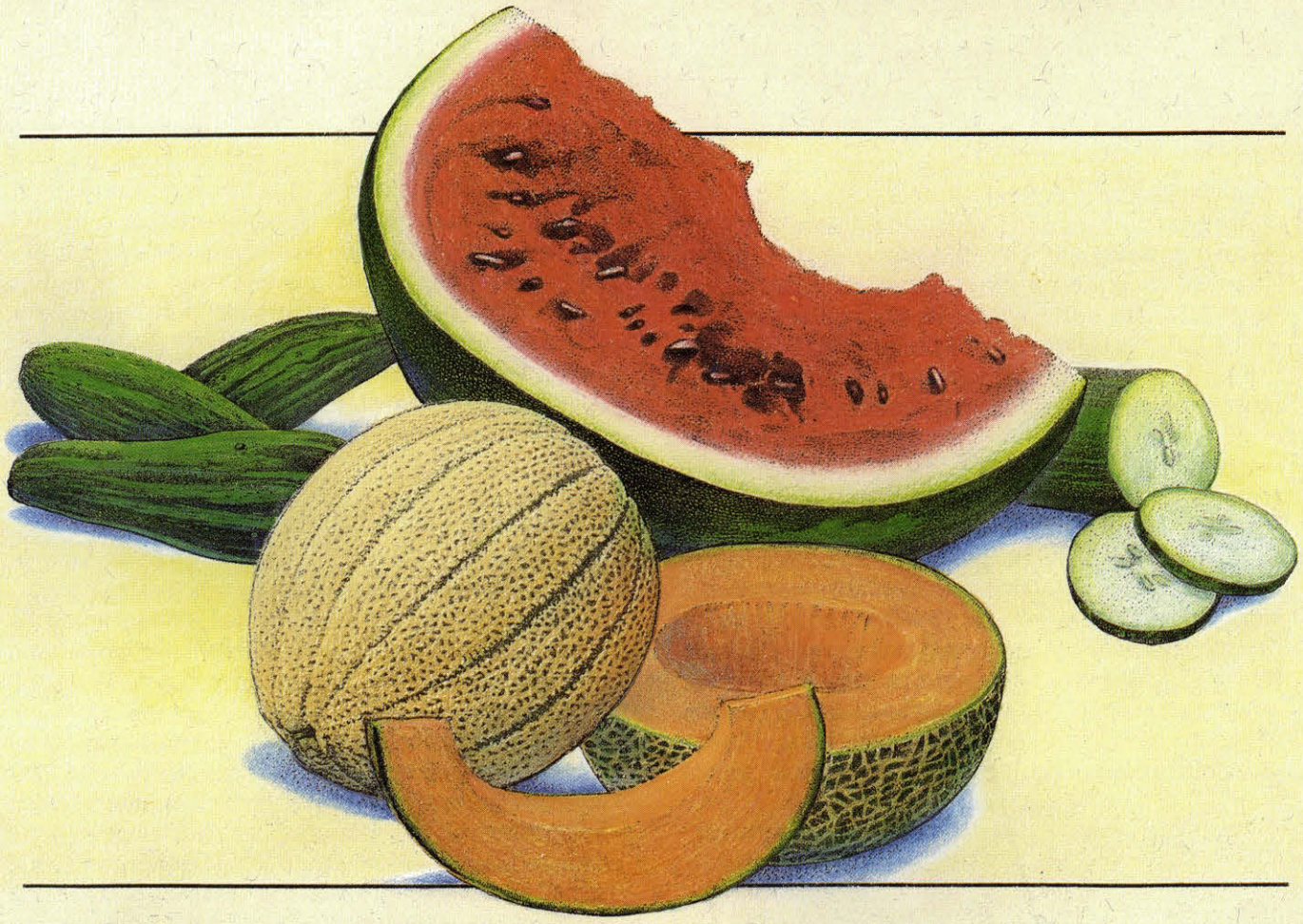
Guide for Identification and Management of Diseases of Cucurbit Vegetable Crops

(Cantaloupe, Cucumber, Pumpkin, Squash, Watermelon)



Oklahoma Cooperative Extension Service
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Oklahoma State University

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Guide for Identification and Management of Diseases of Cucurbit Vegetable Crops

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Cucurbits are generally well adapted for culture in Oklahoma and are grown both commercially and in home gardens throughout the state. However, diseases can limit the quality and number of cucurbits produced. Diseases can directly attack the fruit, rendering it unmarketable. Diseases also indirectly reduce yields by killing plants prior to harvest, cause defoliation which reduces fruit size and quality, and expose fruit to sun scald. Cucurbit crops are subject to biotic diseases caused by pathogens that include fungi, bacteria, viruses, and nematodes. Abiotic diseases are caused by environmental conditions, such as soil imbalances (nutrients or pH), moisture imbalances, and chemical injuries (herbicides and toxic chemicals).

The purpose of this publication is to aid in the identification of important diseases of cucurbits in Oklahoma and to provide general guidelines for their management. Correct disease identification is the first step in effective management. Incorrect identification can lead to the implementation of an ineffective management practice and crop failure. For example, diseases caused by bacteria or viruses are not controlled with most fungicides. Furthermore, some fungicides will control one fungal disease, but not another. Cucurbit growers should learn to recognize the more common diseases by their symptoms and have sufficient knowledge of disease development to select appropriate management practices. Some diseases are easy to identify in the field, while others are more difficult. The OSU Plant Disease Diagnostic Laboratory offers disease diagnosis as a service to commercial growers and homeowners. Samples can be submitted to the laboratory through your county Extension office (see OSU Extension Facts F-7612).

Management of Cucurbit Diseases

Integrated pest management (IPM) involves the use of several different strategies and the judicious use of pesticides for management of diseases and other cucurbit pests. Better and more economical control is usually achieved when IPM is practiced, compared to reliance on a single management practice such as pesticide application. In addition, infection and spread of some pathogens is associated with the presence of certain weeds (alternate hosts) and insects (vectors). Therefore, weed and insect management are important components of disease control in an IPM system for cucurbits. Management strategies that are effective components of an IPM system are listed below.

Crop Rotation

Fungi, bacteria, and nematodes which cause soilborne and some foliar diseases survive in the soil between cucurbit crops and build up to damaging levels with repeated cucurbit cropping. A four-year rotation with non-cucurbit crops, where possible, is recommended.

Site Selection

Most cucurbits are best grown on sandy loam, sand, or silt loam soils with a pH of 6 to 7. Growth on acid and/or poorly drained soils often results in increased incidence of Fusarium wilt and fruit rots. Maintaining records of the disease history of fields is beneficial for avoiding disease problems or implementing preventive measures. Late plantings should not be situated near early plantings where a disease already exists.

Sanitation

Several destructive diseases of cucurbits can be spread from infested fields to clean fields in soil and crop debris carried on equipment and workers. Equipment and boots should be washed to remove all clinging soil and debris when leaving infested fields to avoid contamination of clean fields. Clean fields can also be worked before entering infested fields.

Variety Selection

Disease resistant varieties of cantaloupe, watermelon, and cucumber are available and should be planted where possible. Resistance is the most effective and economical means of disease control. For some diseases, resistance is the only effective control.

Soil Fumigation

Fumigation increases yields, earliness, and controls soilborne diseases. However, fumigation is expensive and potentially dangerous for inexperienced applicators. For

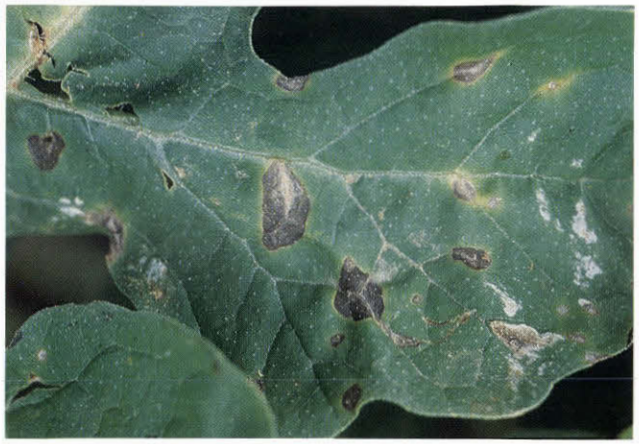

Figure 1. Anthracnose leaf spots on watermelon leaf.

Figure 2. Anthracnose lesions on watermelon stem.

production of high-value cucurbits, such as early cantaloupes, row fumigation may be economically feasible.

Disease-free Seed and Transplants

Some diseases may be seedborne or introduced into fields on infected transplants. Efforts should be taken to obtain seed and transplants from reputable sources. Fungicides are effective in minimizing the potential for seedborne diseases caused by fungi and in helping to ensure establishment of an adequate stand. Only healthy transplants should be used to initiate plantings.

Weed Control

Some weeds serve as alternate hosts or sources of infection for viral diseases. Utilize effective weed control practices in and around cucurbit plantings.

Insect Control

Some insects transmit viral and bacterial diseases. Insects should be controlled when warranted in and around cucurbit plantings.

Irrigation

Excessive irrigation or frequent irrigations with small amounts of water favors the spread and development of many diseases. Drip irrigation helps reduce foliage diseases, because drip systems do not wet foliage and increase the duration of leaf wetness—a condition which favors infection. Drip irrigation also reduces the spread of diseases moved by splashing water or runoff.

Chemical Control

Fungicide sprays may be needed for effective management of some foliar diseases caused by fungi. Consult the latest edition of the *OSU Extension Agents' Handbook of Insect, Plant Disease, and Weed Control* for a list of suggested chemical treatments for the specific disease. Generally, fungicides are most effective when applied on an approved schedule, using an adequate spray volume to achieve thorough vine coverage. Most soilborne diseases cannot be controlled by foliar fungicide application.

Scouting

Plantings should be scouted regularly (at least once per week) for all pests and diseases. Scouting allows for early detection of diseases so that timely management practices can be implemented. Regular crop inspections also allow for assessment of the effectiveness of management programs already implemented.

Residue Management

Vine debris should be incorporated into the soil by plowing or disking after harvest to hasten decomposition, since many of the pathogens survive in and on the debris.

Foliar Diseases

Anthracnose (caused by the fungus *Colletotrichum obiculare*)

Anthracnose is a common and destructive disease of watermelon, cantaloupe, and cucumber in Oklahoma. Pumpkin and squash are rarely affected. The disease is favored by extended periods of warm and rainy weather. All parts of the foliage, stems, and fruit can become infected. Foliage spots first appear as small yellowish areas that enlarge rapidly. On cantaloupe and cucumber, spots turn tan and are often surrounded by a yellow border or "halo." Spots on watermelon are dark brown to black *(Figure 1)*. Spots eventually dry and crack, and leaves shatter or die completely. Elongated lesions also appear on stems and petioles *(Figure 2)*. Entire vines may be killed by combined leaf and stem infections. Circular and sunken spots, which range in size from 1/4 to 2 inches in diameter, develop on infected fruit *(Figure 3)*.

The anthracnose fungus overwinters on infected de-

Figure 3. Anthracnose on watermelon fruit.

Figure 4. Angular leaf spot on pumpkin leaf.

bris from previous cucurbit crops. The first infections on the new crop are caused by spores produced on this debris. These spores are carried to plants by splashing rain or running water. Thereafter, disease increase is a result of infection by spores produced on new lesions which are spread in the same manner. The fungus may also be seedborne and introduced into clean fields on contaminated seed. Anthracnose is managed by crop rotation, resistant varieties, and fungicide sprays. Anthracnose may develop in resistant varieties because races (strains) of the fungus develop which are capable of infecting previously resistant varieties.

Angular Leaf Spot (caused by the bacterium *Pseudomonas syringae* pv. *lachrymans*)

Angular leaf spot is a bacterial disease that may also affect stems and fruit when severe. While all cucurbit crops are susceptible, the disease has been more common in Oklahoma on cucumber, squash, and pumpkin. The bacterium survives in infected seed, cucurbit debris, or soil for up to two years. The disease is spread by splashing rain and water runoff. Consequently, infection and disease development are favored by long periods of leaf wetness, warm temperatures, and excessive nitrogen fertility. The appearance of leaf spots varies for the different cucurbit crops. On cucumber, leaf spots first appear as small, water-soaked areas which enlarge, become irregular in shape, and tend to be angular as their boundary is confined by leaf veins. As spots age, they turn grey, dry, and fall out, leaving irregular holes in leaves. On squash and pumpkin, spots are brown, surrounded by a yellow halo, and appear water-soaked on the lower leaf surface following periods of leaf wetness *(Figure 4)*.

Angular leaf spot is managed primarily by crop rotation and planting clean seed. Varieties resistant to angular leaf spot are available only in cucumber. Copper sprays are also useful in reducing angular leafspot, but they can cause leaf burn under some conditions.

Alternaria Leaf Spot (caused by the fungus *Alternaria cucumerina*)

This leaf spot disease has been of minor importance in Oklahoma, but it does occur on cantaloupe and watermelon. Fruit are rarely infected, but defoliation, which results from leaf infections, reduces fruit size and quality. The fungus survives in contaminated debris from old cucurbit crops for up to two years. Initial infection is from airborne spores. Thereafter, spores produced on leaf spots serve to increase disease levels when long periods of leaf wetness occur.

Symptoms appear first on older leaves near the crown of the plant. At first, leaf spots are very small, but they enlarge to 1/4 inch in diameter on watermelon and 3/4 inch in diameter on cantaloupe. Spots become numerous and turn dark brown to black on watermelon, but are light brown on cantaloupe *(Figure 5)*. Key features of Alternaria leaf spots are their distinct margin and the zonate rings within the lesion that impart a target-like appearance. Severely infected cantaloupe leaves shrivel and die, after curling upwards at the margins. Infections then spread to the outer leaves. Control is achieved through the use of crop rota-

Figure 5. Alternaria leaf spot on cantaloupe leaf.

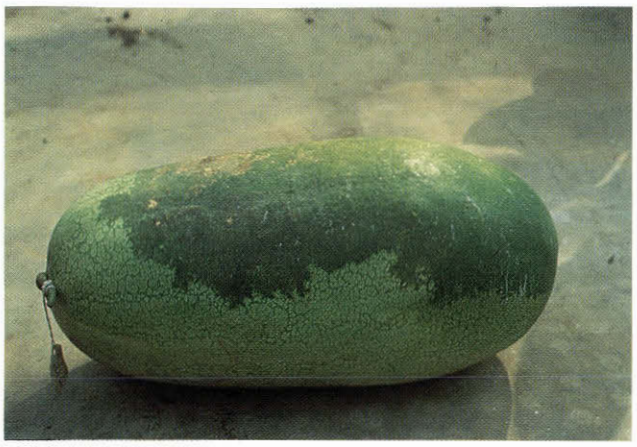

Figure 6. Bacterial fruit blotch of watermelon. ***(Photo courtesy of K. Rane, Purdue Univ.)***

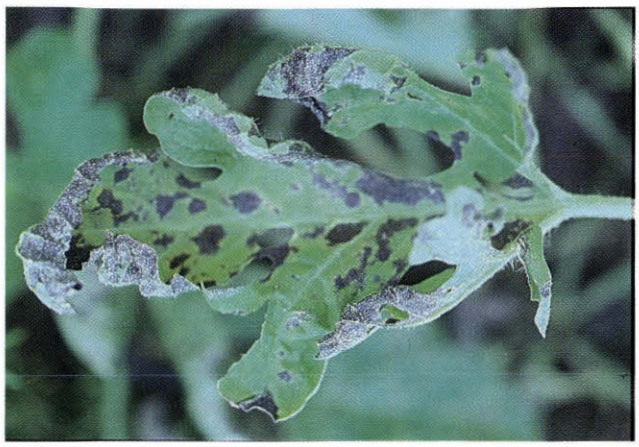

Figure 8. Downy mildew on watermelon leaf.

tion, residue management, and fungicide sprays. No cucurbit varieties are available with resistance to this disease.

Bacterial Fruit Blotch (caused by the bacterium *Pseudomonas* spp.)

Bacterial fruit blotch is a new disease of watermelon first found in Oklahoma in 1991. The disease has not become widespread, but it has the potential to reduce yield of marketable melons by up to 50 percent based on experiences in other states where watermelons are grown. The bacterium survives in seed and in infested residue in the soil for some time. Seed contamination is thought to be the source of most fruit blotch epidemics to date.

Symptoms of fruit blotch can be found as early as plant emergence, but the important phase of the disease is the blemishing of mature fruit. Small water-soaked areas (a few millimeters in diameter) on cotyledons or leaves may develop, but they are easily overlooked. These later turn brown, but they remain small and cause little, if any, damage to leaves. Fruit infections first appear as small water-soaked areas on the upper surface of melons. The water-soaking expands to cover a large portion of the fruit surface, but it does not extend into the melon flesh (*Figure 6*). Areas within older lesions may turn brown and crack. A white bacterial ooze may also exude from cracked areas and the rind may then decay. Control of bacterial fruit blotch centers on planting seed or transplants that are free of the bacterium and on crop rotation. Preliminary research indicates that losses may be minimized by spraying copper fungicides in fields where the presence of the bacterium has been confirmed.

Figure 7. Downy mildew on cantaloupe leaves.

Downy Mildew (caused by the fungus *Pseudoperonospora cubensis*)

Downy mildew infects all members of the cucurbit family. In some areas, certain crops are affected more than others. In Oklahoma, cantaloupes and watermelons have been very prone to downy mildew attack. The disease causes rapid vine defoliation and, while it does not directly attack fruit, fruit from infected vines may be small and poor in quality. The fungus probably does not overwinter in Oklahoma; rather, it spreads as airborne spores northward from southern areas as the season progresses. The disease is favored by periods of high humidity and leaf wetness. Unlike downy mildew fungi that affect other crops, infection can occur when temperatures are warm (up to 80°F). Downy mildew spores can also tolerate several hot days and remain infective.

Symptoms of downy mildew are variable, depending on both weather conditions and the host crop, but are almost always confined to the leaves. The oldest leaves are usually attacked first. On cucurbits other than watermelon, symptoms first appear as pale green areas on otherwise healthy leaves which turn to yellow angular spots confined by leaf veins (*Figure 7*). Under moist conditions, a downy layer of fungal growth may be seen on the underside of spots. Leaf spots on watermelon are typically irregular in shape and dark brown to black in color (*Figure 8*). Infected leaves quickly die, curl inward, and remain attached to upright petioles. Severely infected

Figure 9. Gummy stem blight lesion on cantaloupe stem.

Figure 10. Black rot of pumpkin.

fields appear as if they had been frosted. Petioles and stems remain intact for some time following defoliation. This is in contrast to anthracnose which affects and kills stems and petioles as well as leaves. Control of downy mildew is achieved through the use of resistant varieties (cantaloupe and cucumber only) and fungicide sprays.

Gummy Stem Blight and Black Rot (caused by the fungus *Didymella bryoniae*)

Gummy stem blight refers to the stem phase and black rot to the leaf and fruit phases of this disease. All cucurbits are susceptible; however, symptoms of the disease vary widely, depending upon the host plant. On watermelon, the disease is mainly confined to the foliage, although seedling blight and fruit rot do occur. Leaf spots are circular to irregular in shape and dark brown to black in color. Tiny dark specks (fruiting bodies) may be seen imbedded within the spots when viewed through a hand lens. Heavily spotted leaves are killed.

The fungus causes a gummy stem blight of cantaloupe. Symptoms first appear on the stem nodes of plants nearing harvest. Affected nodes appear water-soaked and may exude sap which dries to form amber-colored gum deposits (*Figure 9*). Fruiting bodies of the fungus may also form on infected nodes and appear as tiny brown specks. As infections progress, vines beyond the infected nodes yellow, wilt, and die.

The fungus causes fruit rots of cucumber, squash, and pumpkin most often in storage. A black blossom end rot occurs on immature cucumber fruit in the field. More commonly, water-soaked spots appear anywhere on fruit after harvest. Gummy exudates may develop within these spots. Infected fruit later develop black discoloration. On pumpkin and winter squash, black rot symptoms appear as water-soaked areas which later become sunken and black in color (*Figure 10*). Tiny dark fruiting bodies develop within blackened areas. On butternut squash, the fungus causes a large area of superficial bronzing with distinct concentric rings.

The disease is favored by cool to warm rainy weather, high humidity, and wet soils. Control of gummy stem blight is achieved primarily with fungicides and crop rotation. Black rot is controlled by proper handling, curing, and storage of fruit after harvest.

Powdery Mildew (caused by the fungi *Erysiphe cichoracearum* and *Sphaerotheca fuliginae*)

Powdery mildew affects cantaloupe, cucumber, squash, pumpkin, but rarely watermelon. Mildew symptoms first appear on oldest leaves as small areas of whitish, powdery growth. The powdery growth may occur on either or both sides of a leaf. Areas of powdery growth eventually expand and cover most of the leaf surface (*Figure 11*). Affected leaves eventually wither and die. Extensive defoliation leads to increased sunburning, premature ripening, and poor quality fruit. The disease is favored by warm to hot temperatures and high humidity, although the fungi can infect leaves at relative humidities as low as 46 percent. Rainy weather is not necessary for powdery mildew development. Control of powdery mildew is best achieved with resistant varieties. Chemical control

Figure 11. Powdery mildew on cantaloupe leaves.

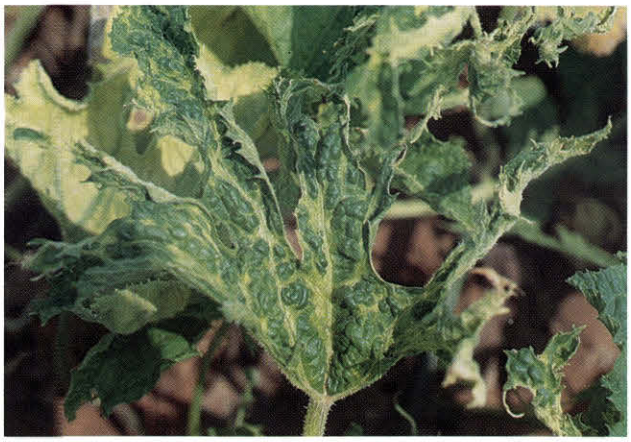

Figure 12. Mosaic virus symptoms on pumpkin leaf.

Figure 14. Wilt symptom on cantaloupe vine.

of *Sphaerotheca* has proven to be more difficult than for *Erysiphe*. Unfortunately, *Sphaerotheca* has become a common cause of cucurbit powdery mildew.

Cercospora Leaf Spot (caused by the fungus *Cercospora citrullina*)

Cercospora leaf spot is most common on watermelon, cantaloupe, and cucumber and is mainly confined to leaves. Spots appear first on older leaves and may become numerous. Spots are circular to irregularly circular with white to tan centers and dark margins. While the disease may cause defoliation and reduced fruit quality, significant damage from this disease in Oklahoma has been infrequent.

Mosaic Viruses (CMV, WMV-1, WMV-2, ZYMV)

Several types of mosaic viruses infect cucurbits in Oklahoma. Symptoms caused by the different mosaic viruses are usually similar. More than one virus may be present in plants exhibiting symptoms. The most susceptible crops in Oklahoma are pumpkin and squash, but mosaic symptoms are common in other cucurbits. Losses from mosaic viruses can be extensive if a large proportion of plants are infected early in the season. Losses result from stunted plant growth, reduced fruit set, and abnormal fruit development.

Figure 13. Mosaic virus symptoms on squash fruit.

Plants can be infected at any stage of growth. Symptoms are most striking on new growth of young, rapidly growing plants. Leaves are dwarfed, misshapen, puckered, pale green in color, and/or mottled with areas of light and dark green color (*Figure 12*). In crops such as squash and pumpkin, infected plants remain stunted throughout the season and may fail to set fruit. Stunting is usually less severe in watermelon, but vine growth may be abnormal and upright. Fruit from virus-infected plants may be small in size, deformed and knobby, and may develop unusual color patterns, such as the conspicuous green areas that form on yellow summer squash (*Figure 13*). Virus infection of older plants usually results in less dramatic symptom development and damage.

Mosaic viruses that commonly infect cucurbits are usually spread by aphids, but they also may be spread mechanically or by cucumber beetles. Aphids acquire the virus by feeding on virus-infected crops or on weeds that harbor viruses and act as virus reservoirs. Aphids then migrate to cucurbit crops and rapidly infect plants during their probing and feeding activities. Aphids other than the melon aphid, a significant cucurbit pest itself, are usually responsible for initial infection in fields. Generally, only a few plants are initially infected from aphids moving from field to field. Melon aphid activity within fields then accounts for secondary spread which can be extensive. Aphid numbers in an area increase as the growing season progresses, making late cucurbit plantings particularly vulnerable.

Control of mosaic viral diseases is difficult and is best achieved with resistant varieties. However, virus resistance is lacking in most cucurbit crops except cucumber. Aphid control with insecticides is not effective because insecticides do not kill aphids before they infect plants.

Figure 15. Stem discoloration caused by Fusarium wilt.

Figure 16. Diagnosis of bacterial wilt of cantaloupe.

Reflective mulches which repel aphids are partially effective. Weed management should be practiced in and around cucurbit fields. Cucurbit plantings, particularly those planted late in the season, should not be situated near or downwind of other fields or areas known to be infected with a virus.

Soilborne Diseases

Fusarium Wilt (caused by the fungus *Fusarium oxysporum*)

Separate strains of *F. oxysporum* attack either cantaloupe or watermelon. Within each strain, races occur which attack different varieties. However, symptoms are similar on both crops. Seedling infection causes damping-off and seedling blight. Infection of older plants results in wilting of one or more vines (*Figure 14*). Elongated brown lesions (dead areas) may develop along stems near the crown. Spore masses which appear as pink mold may also appear on these lesions in wet weather. Affected vines and entire plants eventually wilt and die. Reddish-brown discoloration of vascular tissue is apparent when wilted stems are cut near the crown (*Figure 15*). Roots of severely affected plants are often decayed and appear shredded.

Fusarium spp. are persistent soilborne fungi that increase in soils repeatedly cropped to cucurbits. Introduction of wilt fungi into clean fields in infested soil clinging to equipment or on contaminated seed should be avoided. Control is achieved through the use of resistant varieties, soil fumigation, or both. Fields with a known history of wilt problems should be avoided. Only long crop rotations (six-year minimum) will rid a field of the wilt fungi, but shorter rotations will help limit increase of the fungus and development of races capable of attacking resistant varieties.

Bacterial Wilt (caused by the bacterium *Erwinia tracheiphila*)

Bacterial wilt is severe on cantaloupe and cucumber, less damaging on squash and pumpkin, and rarely affects watermelon. The bacterium is spread by cucumber beetles (striped and spotted) and occurrence of the disease is always associated with beetle feeding. Symptoms first appear as dull green, wilted areas on leaves. Later, individual runners and then entire plants wilt and die. A field diagnosis can be made by pressing the cut surfaces of a wilted stem together and observing the sticky threads that form when the stems are slowly pulled apart *(Figure 16)*. The wilt bacteria overwinter in cucumber beetles. Prompt control of cucumber beetles is the only effective management strategy for this disease.

Root-knot (caused by the nematode *Meloidogyne* spp.)

All cucurbits are susceptible to damage from root-knot nematodes in soils where high populations occur. Sandy soils are the most prone to nematode problems. Symptoms are pale green to yellow foliage, uneven growth along rows, plant stunting, and wilting during hot days. Uprooting affected plants reveals the presence of a knobby and poorly developed root system *(Figure 17)*. The degree of symptom development varies greatly, depending upon soil type, weather, and the level of nematode infestation.

Control is best achieved with crop rotation with non-host crops (grasses). Laboratory analysis of soil samples

Figure 17. Symptoms of root-knot nematode on cantaloupe.

Relative effectiveness of management practices for different cucurbit diseases (H=high, M=moderate, L=low).

Practice	Disease*												
	ANTH	ANG LS	ALT LS	BFB	DM	PM	GSB	CLS	MV	FW	RKN	AY	BW
Crop rotation	H	H	M	H	L	L	H	M	L	M	H	L	L
Site selection	M	L	L	L	M	L	M	L	H	H	H	H	L
Variety selection	H	H	L	L	H	H	L	L	H	H	L	L	L
Sanitation	H	H	M	H	L	L	H	L	L	H	H	L	L
Soil fumigation	L	L	L	L	L	L	L	L	L	H	H	L	L
Seed and transplant health	H	H	H	H	L	L	H	L	L	H	L	L	L
Weed control	L	L	L	L	L	L	L	L	M	L	L	L	L
Insect control	L	L	L	L	L	L	L	L	L	L	L	L	H
Irrigation	M	M	M	M	M	L	M	M	L	L	L	L	L
Chemical control	H	M	H	M	H	H	H	H	L	L	L	L	H
Residue management	M	M	M	M	L	L	M	M	L	L	L	L	L

***ANTH**=Anthracnose, **ANG LS**=Angular Leaf Spot, **ALT LS**=Alternaria Leaf Spot, **BFB**=Bacterial Fruit Blotch, **DM**=Downy Mildew, **PM**=Powdery Mildew, **GSB**=Gummy Stem Blight, **CLS**=Cercospora Leaf Spot, **MV**=Mosaic Viruses, **FW**=Fusarium Wilt, **RKN**=Root-knot Nematode, **AY**=Acid Yellows, **BW**=Bacterial Wilt.

Relative importance of cucurbit diseases on specific cucurbit crops (H=high, M=moderate, L=low, — does not occur).

Disease	Crop				
	Cantaloupe	Cucumber	Pumpkin	Squash	Watermelon
Acid yellows	M	—	—	—	—
Anthracnose	H	H	L	L	H
Angular leaf spot	M	M*	H	H	M
Alternaria leaf spot	H	—	—	L	L
Bacterial fruit blotch	—	—	—	—	H
Bacterial wilt	H	H	L	L	—
Cercospora leaf spot	M	—	—	—	M
Downy mildew	H	M	M	M	H
Fusarium wilt	H	—	—	—	H
Gummy stem blight	H	M	M	M	H
Mosaic viruses	M	M	H	H	M
Powdery mildew	M*	M	H	H	L
Root-knot nematode	M	M	M	M	M

*Resistant varieties have reduced the importance of this disease on the specified cucurbit crop.

is encouraged for soils in which nematodes have been a problem. Nematode damage may also increase levels of Fusarium wilt and various root rots.

Acid Yellowing of Cantaloupes (caused by low soil pH)

Cantaloupes do not grow vigorously in a strongly acid soil. Plants grown in soils below pH 6.0 grow poorly and develop a yellow-green color known as acid yellowing—an abiotic disease. Crop production is delayed and yield can be greatly reduced. Acid soils should be avoided or corrected with lime before planting cucurbits.

Vine Decline (caused by the fungus *Macrophomina phaseolina* and other factors)

Vine decline is a general term used to describe a gradual deterioration in vine health. Cantaloupe and other cucurbits are affected by various vine declines which become apparent as the fruit approach maturity. Leaves near the plant crown turn yellow and die. Yellowing and leaf death then progresses outward from the crown. Some of the vine declines are apparently complex in nature and their cause is not fully understood. Cantaloupe is susceptible to a vine decline which occurs in Oklahoma and is caused by the charcoal rot fungus *Macrophomina*. Typically, a water-soaked canker develops on the main stem at the soil line. Amber-colored droplets form in the canker which later dries and turns tan in color. The affected area may extend several inches above the soil line. Tiny black specks (sclerotia) later form within the canker. The disease is favored by hot weather and can easily be confused with gummy stem blight. No effective controls have been documented, although fumigation of sandy soils is probably effective. Some cantaloupe varieties are partially resistant to this vine decline.

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