Cucumbers, Melons, Squash

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Most cucurbits are perishable and are consumed shortly after harvest—cucumber (*Cucumis sativus*), muskmelons (*C. melo*), summer squash (*Cucurbita pepo*), and watermelon (*Citrullus vulgaris*) are some of them.

A few, such as winter squash (*Cucurbita maxima* and *C. moschata*) and pumpkin (*C. pepo*, *C. moschata*, and *C. mixta*) can be stored for later use.

Others are processed, such as some varieties of cucumber and gherkin (*Cucumis anguria*). Some are used as ornamental gourds (mostly *Cucurbita pepo* and *Lagenaria siceraria*) and for commercial fibers, such as the luffas (*Luffa aegyptiaca*).

A variety of diseases affect the fruits and other parts of the plant, rotting the produce or affecting the plant in such a way that the yield is reduced.

Seed decay and seedling blight are diseases that reduce plant stands. Good stands of cucumber, muskmelon, squash, and watermelon are usually had by seeding in moist, warm soils in warm weather. Poor stands usually result when seeds are sown in cool, wet soils in cool weather. Poor stands are due to decay of the seed or to the death of seedlings, caused by action of such soil-inhabiting fungi as *Pythium irregulare*, *P. ultimum*, and *Rhizoctonia solani*.

The severity of seed decay and seedling blight is related to the relative growth rates of the attacking fungi and the cucurbit plant.

Cucurbit seeds germinate best and seedlings grow most rapidly when the soil temperatures are between 85° and 95° F. and soil moisture is moderate and not excessive. Seeds planted in cold, overly wet soils, or planted too deep, germinate and emerge slowly; they may decay before they break through the seed coat. After they break through, the slow-growing, tender seedlings are susceptible to attack by *Pythium* and *Rhizoctonia* for several days.

If the soil temperature and moisture are right, the cucurbit grows fast, the period of exposure to the causal fungi is shortened, and the more robust seedling escapes infection or is able to overcome the effects of attack.

Seed decay may be controlled by dusting the seed with a protectant fungicide such as chloranil (Spergon) at the rate of 6 ounces to 100 pounds of seed, or thiram (Arasan) at the rate of 4 ounces to 100 pounds. Seed protectants do not control blight of seedlings after they break through the seed coat.

The best stands and minimum losses from seedling blight will be assured by coating the seeds with a protectant fungicide, sowing the seeds as shallow as possible consistent with adequate soil moisture supply, and planting during the warm season when soil temperatures are above 80° F.

Root rot occurs on cucurbits at all stages of growth. The first symptoms are usually stunting, production of small and somewhat yellowish leaves, wilting, failure of fruit to set and mature, and sometimes collapse and death of the plants.

The roots of affected plants may appear water-soaked and flaccid, with some sunken, darkened lesions on the larger, fleshy roots. Occasionally the crown of the plant may become girdled and the top break off.

The two most common root rots are incited by fungi. One, pythium root rot, is caused by the soil inhabitors *Pythium aphanidermatum*, *P. irregulare*, and *P. ultimum*. The other, fusarium root rot, is caused by *Fusarium (Hypomyces) solani* f. *cucurbitae*.

Pythium root rot may affect all cultivated cucurbits, but the disease becomes important only in certain seasons on particular crops.

Cucumber, squash, and watermelon are affected by root rot incited by *P. irregulare* and *P. ultimum* only in the spring and fall when the soil temperatures are comparatively low and hence favorable for the growth of the fungi and unfavorable for the growth of the plants. Pythium root rot is most damaging in soils that are poorly drained and have been cropped to cucurbits or other plants, such as peas and spinach, which provide an increase in abundance of *Pythium* in the soil. Land previously cropped to alfalfa, carrots, cereals, crucifers, lettuce, and some other plants that do not support a large population of these species of *Pythium* in the soil will usually yield satisfactory harvests of cucumber, squash, and watermelon.

Root rot of muskmelon, incited by *Pythium aphanidermatum*, occurs during the warm season and not when the soil temperatures are low, for the causal fungus grows best at high temperatures and sufficiently better than the muskmelon so that root decay results. Root rot of muskmelon is usually most severe in land previously cropped to alfalfa and sugar beets, for the fungus is able to increase in numbers on those crops, providing a large fungus population for infection of the muskmelon crop. Damage from pythium root rot may be minimized by planting on land which was not sown to muskmelon at least the preceding year and which is adequately drained and by planning an appropriate rotation system that avoids alfalfa and sugar beets the preceding year.

Fusarium root rot primarily affects pumpkin and squash. It occasionally occurs on muskmelon, watermelon, and cucumber. The fungus may affect the fibrous and fleshy roots, but it is most commonly found on the main root and crown of the plant, usually girdling it at the ground level and causing the collapse of the plant. The fungus can persist in the soil for years, but is able to attack only cucurbits. Fruits on the ground are frequently rotted by the fungus. Seeds harvested from such infected fruits carry the fungus on their surface, providing a ready means for introducing it into clean, uninfested soils. Seed may be disinfested by soaking it for 5 minutes in 1–1,000 mercuric chloride and rinsing well in water. Land known to be contaminated by the fungus should not be planted to susceptible cucurbits.

FUSARIUM WILT in muskmelon and watermelon is caused by fungi that enter the root system from the soil and grow in the water-conducting vessels of the plants.

If very young plants are attacked the seedlings may rot before or after emergence or the plants may become stunted. When mature plants are attacked, the tips of the runners wilt, and gradually the entire plant wilts and dies. The woody part of the stem is discolored brown. The roots may exhibit cankers.

The disease is most severe when soil temperatures are comparatively high, about 80° F., favoring growth of the causal fungi, and sufficiently below the optimum for plant growth, about 90° F., to retard plant growth enough to render them more susceptible to damage.

The fusarium wilts of muskmelon and watermelon are caused by two different biological races of the causal fungus. The race that causes watermelon wilt is *Fusarium oxysporum* f. *niveum*, which is able to infect watermelon and citron but not muskmelon. The race that causes muskmelon wilt is *F. oxysporum* f. *melonis;* it can infect only muskmelon. Both fungi can survive in soils for many years. Their populations are increased when the respective hosts are grown.

Crop rotation omitting muskmelon

and watermelon will reduce the populations of the causal fungi, but the diseases are best controlled by growing muskmelons and watermelons in soils that are free from these parasites or by planting wilt-resistant varieties.

Verticillium wilt resembles fusarium wilt in many respects, but differs in that it is caused by the fungus *Verticillium albo-atrum* and affects not only muskmelon, citron, and watermelon, but also cucumber, pumpkin, and squash.

Verticillium wilt is most commonly observed in California, but it may occur in many Eastern and Southwestern States. It usually becomes severe when the plants are fairly large and the fruits are ripening and when the soil temperatures are about 70° to 75° F. Like *Fusarium*, the fungus is able to persist indefinitely in soils. Unlike *Fusarium*, the fungus attacks a wide variety of plants such as tree crops, small fruits, ornamentals, and many vegetables, making it difficult to find uninfested land suitable for cropping to cucurbits. Muskmelon, pumpkin, and squash are most susceptible to attack. Cucumber and watermelon are fairly resistant. Verticillium wilt may be definitely distinguished from fusarium wilt only by isolation and identification of the fungus from the infected plant tissue.

Verticillium wilt in cucurbits can best be controlled by growing the crops in soils free from the fungus. In districts where verticillium wilt occurs, losses can be minimized by growing cucurbits so that they mature their crop during hot weather when temperatures of the soil are high. No verticillium wilt resistant varieties of cucurbits are available. Fusarium wilt resistant varieties are susceptible to verticillium wilt.

Bacterial wilt is a serious disease of cucumber and muskmelon, principally in the Middle West, North Central, and Northeast. It is rare in the Southern or Western States. Pumpkin and squash are susceptible to infection but are rarely severely damaged. Plants infected with the causal organism, *Erwinia tracheiphila*, show first a wilting of a single leaf which remains green. Eventually all the leaves wilt and the plant dies. Freshly cut wilted vines display a viscid white ooze of the bacteria, which is stringy and may be pulled out into strands of an inch or more.

Plants become infected after bacteria-infested spotted and striped cucumber beetles feed on them. The bacteria overwinter in the body of the insect. As the adult beetle feeds on the cucurbit plant it introduces the bacteria, which soon multiply and become distributed throughout the vascular system.

Since the only way in which plants may become infected is through the feeding of the cucumber beetles, it is advisable to use insecticides to destroy the insects.

Although cucumber varieties differ in their susceptibility to bacterial wilt, there are as yet no highly resistant varieties available for commercial use. No resistant muskmelons or other cucurbits have yet been developed.

Anthracnose seriously affects muskmelon and watermelon and to a lesser extent cucumber and gourd, but not pumpkin or squash. The disease occurs principally in the Middle West, Northeast, and Southeast in areas of summer rains and rarely if at all in the Southwestern and Western States.

The causal organism is a fungus, *Colletotrichum lagenarium*, which overwinters on diseased vines and may also be carried on seeds taken from infected fruits. The organism is disseminated by means of rain and surface water and may infect not only leaves and stems but also fruits.

Spots formed on leaves of cucumber and muskmelon are at first light brown and more or less circular. Later the lesions turn dark brown to red. They may coalesce, consuming the entire leaf and giving it a scorched appearance. Similar leaf spotting occurs on watermelon, the spots becoming dark brown or black. Elongated, narrow, slightly sunken, water-soaked lesions often appear on the stems and petioles. These later may turn yellow or brown. Infected fruits bear circular to oval sunken lesions, in which the pink fruiting spore masses of the fungus may be seen.

In districts where the disease is troublesome, western-produced, disease-free seed should be used. If such are unavailable, the seed should be soaked for 5 minutes in 1–1,000 mercuric chloride, rinsed in water, and planted in land that has not been recently planted with cucurbits. Clean cultivation and crop rotation should be practiced to prevent the building up of large populations of the parasite in the soil.

Losses from anthracnose can be reduced by spraying or dusting with copper fungicides, ziram, or zineb, or spraying with nabam used with zinc sulfate.

ANGULAR LEAF SPOT is serious only on cucumber. It causes water-soaked spots on leaves and fruits. The spots on the leaves become angular (because their margins are confined by veins), turn gray to tan in color, and form an exudate on the lower surface of the leaf. Finally a good many of the infected spots loosen and fall out. Infected fruits show a brown, firm rot extending into the flesh.

The inciting organism is a bacterium, *Pseudomonas lachrymans*, which like the causal agent of anthracnose, overwinters on infected vine refuse, is seed-borne, and is spread by rain and surface water. Although the chances of seedling infection may be greatly reduced by soaking the seed for 5 minutes in 1–1,000 mercuric chloride, rinsing in water, and quickly drying or planting, the treatment may not prevent an occurrence of the disease if conditions favor its development.

SCAB is primarily a disease of cucumber. It may cause some damage to muskmelon. The small, circular, water-soaked lesions that occur on leaves of cucumber and muskmelon are usually first bound by a faint yellow halo. The halo later disappears, and the infected tissue turns brown and becomes necrotic.

Sometimes the causal fungus, *Cladosporium cucumerinum*, infects the petioles and stems, producing spots similar to those on the leaves, but smaller. The fungus can also cause sunken, dark-brown spots on cucumber and muskmelon fruits. Usually young muskmelon fruits do not develop conspicuous fruit-spotting symptoms, the infection remaining minute and of no consequence until the fruit ripens. When the fruit is shipped to market, the fungus becomes active and causes a serious blemish and decay on the fruit.

The disease is most severe during cool, moist weather. Losses can be held to a minimum by growing cucumbers and muskmelons at locations and during seasons in which high temperatures and low humidities prevail and rains seldom occur. Where scab occurs, the resistant varieties of cucumber, Maine No. 2, SR 6, or Highmoor, can be used. Resistant varieties of muskmelons are not available.

DOWNY MILDEW is a destructive disease of cucumber, muskmelon, and watermelon. Occasionally it causes damage to gourd, pumpkin, and squash. It is favored by warm, moist weather. It is most prevalent in regions where rain falls during the growing season. Downy mildew is particularly destructive in the Eastern and Southern States, is usually less damaging in the North Central States, and rarely occurs in the Southwest.

The disease is incited by the fungus *Pseudoperonospora cubensis*. The causal organism is able to infect leaves only. It first appears as a gray-tinged spore mass on older leaves. It causes small, angular, yellowish spots, which later increase in number and size. Severely infected leaves become chlorotic, turn brown, and shrivel. The disease begins to appear on the young foliage as the older leaves die. The loss of foliage precludes normal flower set and fruit development. Maturing fruits fail to color properly, are tasteless, and usually are sunburned.

The fungus attacks several species in related genera of wild cucurbits. Its spores can be carried from naturally infected native cucurbits to cultivated ones by wind, splashing rain, and such insects as cucumber beetles.

The observations of several investigators in eastern and southern agricultural research centers suggest that the fungus does not overwinter in northern areas but that it grows on cucurbits at all times of the year in frost-free areas in the South and migrates northward each season to the Atlantic seaboard. The time of appearance and the severity of the disease depend on the severity of the disease in localities further south and on local weather conditions.

Losses from downy mildew may be reduced in areas adjacent to native sources of the causal fungus by eradicating the wild cucurbits. Where that is not practicable, susceptible cultivated cucurbits should be planted some distance away. Production fields should be isolated from one another and especially from small home-garden plantings, where plant disease control measures are not practiced. Sanitation practices will also help reduce losses from downy mildew. Harvested and abandoned fields should be disked promptly. Late plantings should be isolated from earlier ones. Insect pests should be controlled. Men and equipment should stay out of fields when the plants are wet from dew or rain.

The disease may be controlled by the application of fungicidal dusts and sprays. Among the most promising materials are nabam, 2 quarts to 100 gallons of water plus 1.5 pounds of lime or zinc sulfate; zineb, 1.5 pounds to 100 gallons of water; tribasic copper sulfate, 3 pounds to 100 gallons. A variety of other copper-containing compounds may also be used successfully. A wetting and sticking agent should be added to all the sprays.

Dusts may be used with some satisfaction when the disease is not severe or following a spray program that has reduced the incidence of the disease. Dusts are usually applied at the rate of 40 to 50 pounds per acre and sprays at the rate of 200 to 400 gallons per acre. Fungicides should be applied before the disease appears and continued through the season in districts where downy mildew is known to be troublesome.

Satisfactory control can only be had by applying enough material to cover the upper and lower surfaces of the leaves and applying often enough to cover new foliage and replace old residues that have been removed by rain. Such a schedule usually requires treating plantations once a week during rain-free periods and perhaps twice a week during rainy periods.

Resistance to downy mildew has been found in cucumber and muskmelon from Cuba, China, and India by a number of investigators at several research stations. The resistant importations are poor in quality and are not suitable for commercial culture.

Hybridization with American varieties and several years of breeding and selection in Texas yielded a resistant cantaloup that is also resistant to aphids. It is Texas Resistant Number 1. Resistance to downy mildew has been combined with resistance to powdery mildew and aphids in a cantaloup variety released by the Georgia Agricultural Experiment Station as Georgia 47.

Several years of hybridization and selection in South Carolina resulted in the development of the downy mildew resistant varieties, Palmetto and Santee. They are somewhat susceptible to a race of the fungus that appeared after their development, but it has been reported that the disease may be more readily controlled with fungicides on these varieties than on more susceptible varieties.

The progress made in the combined efforts of investigators at several State and Federal experiment stations indicates that downy mildew may be controlled by an integrated program that embraces sanitation practices, the use of resistant varieties, and the application of fungicides coordinated with the forecasts of the Plant Disease Warning Service.

POWDERY MILDEW affects the leaves and stems of cucumber, muskmelon, squash, and occasionally gourd, pumpkin, and watermelon. The disease causes the greatest damage in the warm, dry, rain-free growing season of the Southwest.

Powdery mildew first appears as round, white spots on the under side of the older leaves. The spots enlarge, increase in number, coalesce, appear on the upper surface of the leaf, and eventually cover both surfaces with a white, powdery growth. Severely affected leaves lose their normal dark-green color and become pale yellow green, then brown and shriveled. When the fungus attacks the stems and young leaves of plants, they become chlorotic, grow poorly, and may be killed. Fruits on infected vines ripen prematurely and lack the desired texture, flavor, and sugar content. Late-set fruits are often small, irregular, and sunburned.

The causal fungus of powdery mildew is *Erysiphe cichoracearum*. It is obliged to grow on living plant tissue and is not confined to cultivated or native cucurbit species. It is found on many kinds of plants, such as aster, lettuce, and sunflower. Although the fungi that occur on these several hosts look alike, and are included in the single morphologic species, *E. cichoracearum*, they are not identical biologically and are differentiated into numerous biological forms that differ from one another in their ability to attack particular kinds of plants.

T. W. Whitaker and his associates have demonstrated the occurrence of two distinct races of the fungus on muskmelon and have shown that one of the races successfully infected 18 species in 9 genera but failed to infect 3 species in 2 genera of the Cucurbitaceae.

The powdery white growth on the leaves and stems of susceptible cucurbits is made up of a tangled web of fungus threads. Some of the threads remain upright and form chains of countless oval or barrel-shaped spores. The masses of spores give the spot its powdery appearance and the disease its name. The chains of spores break up; the individual units are carried by the wind to other leaves and other plants and are capable of producing new infections. The spores may germinate in the absence of water and in relative humidities of 20 percent or less. In that regard they differ markedly from the spores of *Pseudoperonospora cubensis*, which germinate best in water and only rarely when the relative humidity is 80 percent or lower. The spores of powdery mildew are viable for only a few hours when air temperatures are 80° F. or above. They last much longer with air temperatures below 40° but are killed by temperatures below 30°.

Erysiphe cichoracearum produces on some plants perithecia and ascospores, which permit the fungus to overwinter in cold climates, but those fruiting structures are rarely produced on cucurbits and have never been observed on cucurbits in the Southwest. The fungus overwinters in the warm climate of the Southwest in the mycelial and conidial stage in sheltered locations on a variety of volunteer and cultivated cucurbits as well as on a number of susceptible evergreen herbaceous perennials.

Powdery mildew can be controlled by dusting with sulfur on sulfur-resistant cucurbits such as the gourd, pumpkin, squash, and watermelon. Sulfur is the most effective fungicide currently available for the control of powdery mildew on cucurbits and may effectively control the disease with as little as 10 pounds of material an acre. Sulfur can be safely used on some varieties of muskmelon and cucumber and not on others, for different species and varieties of cucurbits vary in their sensitivity to sulfur.

Resistance to sulfur injury in muskmelon was discovered by J. B. S. Norton in commercial fields in California many years ago. This type of resistance has been introduced into desirable commercial strains of cantaloup and made available as sulfur-resistant cantaloup varieties V–1 and S. R. 91. Those varieties are susceptible to attack by powdery mildew and must be dusted with sulfur or some other fungicide in order to yield satisfactory crops.

Powdery mildew on susceptible sulfur-sensitive varieties of cantaloup may be controlled by spraying them with liquid lime-sulfur, 38 ounces per 100 gallons of water, plus a suitable wetting agent, and applied at the rate of 200 to 400 gallons per acre when air temperatures will not go above 95° F. for at least 3 days following application. This should be followed about 2 weeks later with a spray application of cuprous oxide, 1.5 pounds per 100 gallons, plus wetting agent, at the same dosage.

Other copper-containing fungicides tested to date are less effective for the control of the disease. None of the copper fungicides is especially effective when applied as a dust. Iscothan, Ovotran, and possibly some other miticide dusts may be safely and effectively used against powdery mildew.

Powdery mildew of cucumber can be controlled by 15 percent sulfur dust applied at the rate of 40 to 50 pounds per acre when air temperatures do not exceed 90° F. This dust is comparatively ineffective when air temperatures are below 70° F. A dust mixture containing 15 percent sulfur and 7 percent copper (expressed as metallic) such as basic copper sulfate or cuprous oxide satisfactorily controls the disease when temperatures are above or below 70° F. Iscothan and Ovotran are also highly effective for the control of the disease on cucumber, but zineb gives only fair control.

Resistant varieties of sulfur-sensitive muskmelon offer the best bet for commercial production of melons when powdery mildew is present. I. C. Jagger and his associates at La Jolla, Calif., utilized resistance found in wild muskmelon from India to develop the varieties Powdery Mildew Resistant Cantaloup No. 45 and No. 50. Those varieties were found susceptible to a new race of the powdery mildew fungus.

Additional breeding work was undertaken by T. W. Whitaker and his associates at the same research station. It yielded Powdery Mildew Resistant Cantaloup No. 5, No. 6, and No. 7. They are not immune to races 1 and 2 of the fungus prevalent in the Southwest, but are resistant and productive. Other muskmelon material with still greater resistance is used in breeding work for new and improved lines and as a bulwark against the eventuality that additional races of the powdery mildew fungus may appear. Georgia 47 has resistance not only to powdery mildew but to downy mildew as well and moderate resistance to aphids.

Virus diseases are numerous and widespread throughout the United States. They are responsible for substantial crop losses, especially in cucumber and muskmelon and occasionally in squash and watermelon.

Cucumber plants infected with mosaic display a mottled leaf pattern of yellow and green areas, which are most conspicuous in the young terminal leaves of the vine. The mosaic usually becomes less marked as the plants grow older and become dwarfed. Fruits on the infected vines are mottled in a green and yellow pattern and become distorted and malformed. Cucumber mosaic is sometimes referred to as white pickle disease because fruits on severely infected vines lose practically all their normal green color and turn almost completely white, with wartlike malformations.

Cucumber mosaic is caused by a group of strains of a virus that can infect not only a number of cucurbits but also a wide variety of agricultural and ornamental plants and a large number of annual and perennial weeds. The cucumber mosaic virus is also the causal agent of a mosaic of bean, pea, spinach, and sugar beet, southern celery mosaic, and "shoestring" of tomato, to name only a few.

The cucumber mosaic virus is rarely seed-transmitted in cucumber, but some strains are carried by muskmelon seed. The virus is known to overwinter in a number of perennial hosts in fields and gardens. It is readily transmitted from its plant source to cucumber by means of aphids, primarily the melon and green peach aphids.

Control of the disease through eradication of weed host plants is impracticable because of the large variety of plants that harbor the virus. Control of the insect vectors by currently available insecticides fails to control the disease because, even though the insect population is reduced to a level wherein the insect is no longer considered a pest, enough carriers remain to permit spread of the virus. The time required for the kill of a vector is usually long enough to permit the insect to feed, introduce the virus, and infect the plant before it is killed.

Development of resistant cucumbers offers the best means of control. The Ohio Agricultural Experiment Station has developed a pickling variety, MR 17, and the New York (Cornell) Agricultural Experiment Station has introduced York state Pickling and Niagara. Early Surecrop Hybrid and Burpee Hybrid have been developed by commercial seed companies.

Squash is sometimes affected with mosaic, which causes a yellow-green mottle, crumpling, and considerable leaf distortion. The leaves of severely infected plants often are reduced to no more than the veins and narrow strips of attendant leaf tissue. Infected fruits are irregular in shape and distorted by numerous raised, circular areas, which color prematurely. Seed taken from infected fruits is usually light, poorly filled, and deformed in comparison with seed from healthy fruits.

The squash mosaic virus produces typical disease symptoms in gourd, muskmelon, and pumpkin, but infects very few other plants except a few perennial cucurbitaceous weeds such as *Cucurbita foetidissima* and *C. palmata*. The virus can infect cucumber but rarely produces any marked pattern other than a faint yellowing about the veins of the leaves. The virus is seed-transmitted in gourd, muskmelon, pumpkin, squash, and in the two *Cucurbita* species mentioned before, but not in cucumber. The transmission in muskmelon and squash ranges from none to 3.4, and is usually 0.24 percent. The poorly filled, deformed seed carry a notably higher percentage of the virus than normal seed. Although originally the virus was believed to be transmitted by both aphids and cucumber beetles, it is now thought to be transmitted only by beetles.

Some relief from squash mosaic may be obtained by planting virus-free seed. Although that does not assure freedom from the disease, mosaic does not usually become serious enough to reduce yields until late in the growing season after the bulk of the crop is harvested and when the virus is introduced from other sources by migrating cucumber beetles.

Seedsmen can remove a fairly large proportion of virus-infected seed by not harvesting infected fruits and by careful cleaning to remove light, deformed seeds, which are known to be the principal seed source.

Eradication of the few weeds known to overwinter the virus will effectively reduce outside sources of squash mosaic. New plantings of squash should not be sown adjacent to old plantings, which may be reservoirs of the virus.

Muskmelon mosaic is another disease caused by a virus. Leaves of infected plants show a conspicuous dark-green banding about the larger veins. Later leaves usually do not show vein banding but display a severe to mild yellow and green mottle. The margins of many leaves are serrated. Some leaves may become distorted and curled. Flowers on infected plants are often deformed and generally fail to set. The pollen grains are irregular in shape and fail to germinate normally. Only rarely are there mild mosaic patterns on immature fruits. The symptom normally disappears with the development of the normal fruit net, but sometimes the virus appears to inhibit normal netting. The total soluble solids of infected fruits are lower than normal.

The muskmelon mosaic virus infects only cucurbits. It causes typical mosaic symptoms on gherkin, pumpkin, and squash and only a faint mottle on cucumber. The virus is commonly seed-transmitted, ranging from more than 95 percent in fresh seed to less than 5 percent in seed 3 years old. It has been recovered from seed stored 5 years. It is readily transmitted by aphids.

Although the planting of virus-free muskmelon seed will assure freedom from the disease in young plantings, it fails to assure continued freedom from infection as the plants mature when grown in the vicinity of other sources of the virus.

Muskmelons grown in the Southwest frequently are affected by mosaic caused by all three of the viruses we described and by a complexity of strains. Usually one virus is predominant over the others. Symptoms may vary somewhat from year to year depending on the particular virus, but the similarity of the symptoms produced by the several viruses is such that they cannot be readily distinguished in muskmelon. Crop losses due to the reduction of foliage and exposure of fruits (so that many are sunburned) usually are great. A fairly large number of the fruits fail to develop a satisfactory net and are discarded; others appear normal but are of inferior quality.

Mosaic in muskmelon has been observed in the Imperial Valley of California for many years, but not until 1946 did the disease appear in epiphytotic form. Since then it has been of considerable economic importance.

Attempts to control mosaic of muskmelon through control of insect vectors by airplane application of DDT, parathion, benzene hexachloride, and nicotine were unsuccessful.

R. C. Dickson and his associates determined that the causal viruses were spread principally by transient populations of aphids, chiefly the green peach aphid, which did not originate from melons but came mostly from sugar beets and weeds and moved across the melon fields in great swarms. The aphids usually fed for less than a minute on the melon plant and moved on in short flights to feed on a large number of plants. Such a feeding pattern is efficient in distributing the viruses and allows a large increase in the low initial incidence of the disease on weeds, escaped and cultivated melons, and squash.

In the absence of methods for reducing aphid populations at their source, intensive efforts are being made to develop muskmelons resistant to the several causal viruses.

FRUIT ROTS of cucurbits occur in the field, in transit, in storage, and in market. Many of the decays observed on harvested produce originate from infections initiated while the fruits were maturing upon the plant. For a discussion of some of these disorders, the reader is referred to our earlier discussion of angular leaf spot (also known as bacterial spot of cucumber); anthracnose, the most serious fruit decay of muskmelon, squash, and watermelon; fusarium root rot, also a rot of gourd, pumpkin, and squash fruit; and scab (sometimes referred to as cladosporium rot), a fruit rot of cucumber and muskmelon.

Fusarium rot of muskmelon and pumpkin is an important market disease. Many small, scattered lesions are found on the surface of infected fruits which are tan to light brown and often difficult to separate from healthy tissue. Later the spots become sunken, more extensive, and covered by a white or pink growth of the fungus. Infections are usually confined to the rind but may sometimes extend into the flesh and seed cavity. The seeds then appear clumped and embedded in the fungus mycelial mat. The disease is caused by *Fusarium moniliforme*, *F. roseum*, and *F. solani*. Those fungi can enter the fruit only through ruptures in the skin. The common occurrence of the rot on ripe muskmelons is associated with appearance of minute rifts and abrasions on the surface, many of which result from handling practices.

Fusarium rot can be fairly well controlled by reducing the frequency of handling muskmelons, shipping under refrigeration at about 45° F., and marketing promptly.

Rhizopus soft rot may affect all cucurbits but is of most importance on muskmelon, pumpkin, and squash. The disease appears first as soft, water-soaked spots on the rind. As the affected area increases in size, it becomes soft, sunken, and easily broken. The fungus *Rhizopus* appears after the skin has been broken and develops a profuse mold growth when the temperature ranges from 80° to 90°. Decay may be controlled by avoiding skin ruptures, shipping under refrigeration at 40° to 45°, and by prompt disposal of ripe fruit.

Soft rot may also be caused by bacteria, such as *Erwinia aroideae* and *E. carotovora*, which usually gain entrance through breaks in the skin of fruits and cause a putrid collapse of tissue. Bacterial soft rots are not common and are usually unimportant. Soft rot due to fungus infections are more common and of economic importance. Perhaps the most important of the fungal decays are those caused by *Phytophthora* and *Pythium*.

Phytophthora rot occurs naturally on muskmelon and watermelon. It affects cucumber and squash by artificial inoculation. The diseased tissue is first water-soaked, then turns brown, and becomes soft; the result is a sunken and wrinkled lesion. Infections generally occur in the field and are caused by *Phytophthora capsici*, *P. drechsleri*, and *P. parasitica*. Decay of fruit can be arrested by shipping under refrigeration at 45°.

Pythium rot is similar to phytophthora rot. It naturally affects muskmelon, watermelon, cucumber, pumpkin, and squash. Diseased cucumber and squash fruits are conspicuously water-soaked; the tissue is soft and flaccid and ruptures readily under pressure. In cucumber and squash the disease is sometimes referred to as leak. It is incited by *Pythium aphanidermatum* during hot weather and by *P. irregulare* and *P. ultimum* in cooler weather. The fungi infect fruits in the field and serve as a source of further infections during transit and storage. Quite often a luxuriant white fungus growth covers the affected tissue. Losses may be reduced by careful sorting of field-picked fruit, shipping under refrigeration at 45° to 50°, and rapid distribution to retail market.

Muskmelon, pumpkin, and watermelon fruits affected by pythium rot are water-soaked and soft, but are also discolored a light tan to brown. As the infections increase, the lesions become sunken and wrinkled, breaking open easily and discharging quantities of watery fluid. Primary infections are initiated in the field, but secondary infections result from contact of healthy fruits with diseased ones. The rot in muskmelon is usually incited by *Pythium aphanidermatum* and *P. ultimum*; in pumpkin by *P. ultimum*; and in watermelon by *P. acanthicum*, *P. myriotylum*, and *P. periplocum*. Careful sorting of fruit to exclude infected merchandise in the packed container and shipping under refrigeration at 45° to 50° will reduce transit losses.

Stem-end rot of watermelon, induced by the fungus *Diplodia natalensis*, is an important disease and is responsible for a high percentage of the watermelons lost in transit. The fungus infects the stem end of the fruit following its cutting from the vine. The fungus does not infect fruits other than through cuts or other wounds. Infected tissues turn brown and shrivel, and the fungus may produce pycnidia and a grayish-white mycelium on the fruit surface. The disease develops most rapidly between 85° and 90°. Prompt coating of the freshly made stem cut with bordeaux paste containing no less than 6 percent copper sulfate prevents its development. Field cutters should be careful to avoid contaminating the cutting knife by faulty harvest of an infected fruit. All harvesting and packing equipment should be washed down thoroughly each day and disinfected with phenol or formaldehyde. Shipment of watermelon at 50° will deter development of the disease in transit and assure satisfactory arrival condition. The disease sometimes affects muskmelon; it is not restricted to stem end but occurs over the entire fruit surface, making surface sterilization impracticable. Temperature control and careful field selection offer some relief from losses.

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Developing Healthier Vegetables

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Work progresses steadily toward the important goal of breeding vegetables that can withstand the ravages of disease. How close are we to it?

The latest edition of the vegetable seed catalog of one company lists more than one-half of the varieties of pea, approximately one-third of the varieties of watermelon, and one-fourth of the varieties of tomato and cabbage as resistant to one or more diseases. The proportion would be higher if all of the new varieties released within the past few years were included. That is an excellent record for an endeavor that had barely started in this country before 1900.

What are some of the problems facing us today and how are we prepared to meet them? Emphasis currently is directed toward incorporating higher degrees of resistance into a wider range of varieties and resistance to several diseases—multiple resistance—within one variety. Superior quality, resistance to insects, wide adaptation, high nutritive value, and good qualities of processing, shipping, and storage also are essential.

The need for multiple resistance is becoming more and more important. It is no longer enough to have varieties resistant to only the diseases present in the areas where the crop is grown for market or processing. They must also be resistant to the diseases in the seed-producing areas. For example, most of the seed of snap beans