Disease Control for Squash in Florida[1]

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Summer and winter squash are grown commercially throughout the state of Florida. In the middle of the winter, southern Florida is the primary supplier of fresh squash for the produce departments of supermarkets all over the nation. In 2012, squash was harvested from 10,000 acres in the state with a total value of $66 million (USDA 2013).

Several diseases must be controlled successfully if squash is to be grown commercially in our subtropical environment. Even though many growers have been combating these diseases for many years, substantial losses sometimes still occur. A sequential disease control program is presented in this pointer as a guide for commercial growers. If followed, disease losses should be minimized for the majority of plantings.

Characteristics of Pathogens that Cause Disease of Squash

The great majority of plant health problems called diseases are caused by micoorganisms. These extremely tiny disease agents cause losses in squash in two basic ways. Fruit may be attacked directly, rendering them unfit for consumption or reducing their cosmetic appeal. The pathogens may attack plant parts other than the fruit. In these cases, plant vigor and carbohydrate production may be reduced, with subsequent losses in yield.

The pathogenic microorganisms attacking squash may be classified into three major groups: fungi and oomycetes (here after referred to as fungal-like), bacteria, and viruses.

Fungi are microscopic organisms that we often call molds in everyday language. In the past, they were commonly classified as plants. However, they are sufficiently different from plants that most experts now classify fungi in a unique kingdom by themselves. They have no true roots, stem, or leaves. Instead, they grow as hyphae (microscopic threads of living matter) that absorb food and water directly into their cells. Although fungi have cell walls, the chemical composition of the wall material is often drastically different chemically from the cellulose wall material found in higher plants. Fungi also do not have chlorophyll; therefore, they must depend on outside sources of food, including living plants. Two common pathogens, *Pythium* and *Phytophthora,* used to be considered fungi but are substantially different from fungi taxonomically that they were reclassified and are no longer considered fungi. Some now commonly call them "fungal-like organisms" or "oomycetes", referring to the special taxonomic group these organisms belong to.

Many of the fungi which attack squash reproduce by developing and releasing large numbers of spores. Some spores (e.g., those of the powdery mildew fungus) are readily spread by wind. Others require splashing rain or irrigation for dispersal. Some fungi, particularly those that cause root and stem diseases, have specialized spores that can survive

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many years in the soil in the absence of squash. Fungi may enter plants through wounds or natural openings (e.g., stomates). Certain fungi are capable of penetrating directly into host cells by pushing through and/or dissolving the cuticle and cell walls.

Bacteria are smaller than fungi and are not at all plant-like. All bacteria are single-celled microorganisms. The ones that cause plant disease do not form spores and lack chlorophyll. The major type of reproduction for plant pathogenic bacteria is by simple cell division. Bacteria never enter plants directly. They must have a wound or a natural opening to get inside a potential host plant.

Viruses probably shouldn't be considered "organisms." They are nothing more than very large molecules of nucleic acid (RNA or DNA) with a wrapping or "coat" of protein. There are no cellular structures. New virus particles can only be reproduced inside of living cells. They are much smaller than bacteria, and normally require sophisticated techniques such as electron microscopes and polymerase chain reaction to be studied. Viruses probably spread from infected weed hosts to squash. Aphids are usually responsible for spreading virus particles on their feeding probe (stylet). Healthy plants then may become infected on subsequent feedings.

It must be remembered that the development of disease is dependent on the proper combination of factors in the so-called disease triangle: a susceptible host, the pathogen, and weather conditions favorable for a given disease. If any of these conditions is absent, plants will not become diseased.

Effective control of diseases of squash is based on a sound understanding of the biology of both the host and the pathogen. It is essential that the disease is correctly diagnosed. Selecting cultivars with minimal susceptibility to key diseases can reduce dependence on other types of control. Knowing the weather conditions that enhance development of certain diseases can lead to more informed control strategies. A brief outline of the characteristics of the major diseases of squash in Florida is given in Table 1.

With this important background information, we can proceed to a reasonable sequential disease control program for squash grown commercially in Florida.

I. Seed Treatment

Squash is generally susceptible to a soil borne disease called damping-off. Damping-off is a term to describe the death of seedlings before or soon after emergence from the ground. Fungi and fungal-like organisms in the soil, particularly *Pythium* and *Rhizoctonia,* are responsible for damping-off. In order to minimize damping-off damage, most commercial seed is treated with a fungicide prior to purchase. If the seed is not treated, a general-purpose seed treatment is recommended.

II. Preplant Treatments

A. Mefenoxam

The fungicide mefenoxam can be applied as a preplant treatment for the control of *Pythium,* a soilborne disease. This may be helpful in fields that have a history of *Pythium* or *Phytophthora* damage. Historically, *Pythium* has been most damaging during warm, rainy weather.

- Products containing the active ingredient mefenoxam can be applied at the rate of 1–2 pints per treated acre as a preplant incorporated application, as a soil surface spray in a 7-inch band after planting, or as an injection in the irrigation water (for properly equipped drip-irrigation systems). See the label and the Cucurbit Production chapter in the Florida Vegetable Production Handbook for details.

B. Fumigants

In some parts of the state, squash is grown on raised, plastic-mulched beds that have been fumigated prior to planting. Fumigants include either 1,3-D dichloropropene (Telone®), dimethyl disulfide (Paladin®), chloropicrin, metam potassium, or metam sodium, dimethyl. These fumigants have a wide range of activity against many soilborne pests including soil insects, nematodes, and weed seed. These fumigants can be applied individually or as a system of two to three fumigants applied or injected directly to the soil during field preparations. The use of fumigants typically requires the use of a plastic-mulch, which helps retain the fumigant to maximize efficacy, retains soil moisture during crop production, inhibits many weeds, and also helps reduce wet rot damage of fruit by serving as a barrier between fruit and the soil. When using fumigants for the initial crop it is important that crop or weed residues be worked thoroughly into the soil and allowed to decompose 4 to 6 weeks before application. Fumigants can also be used to "clean up" beds after an initial crop prior to planting a second crop in the same beds, referred to as "double cropping," in this scenario the fumigant is typically applied to the beds through the drip irrigation system.

III. Application of Foliar Fungicides

Periodic application of foliar fungicides is important in an overall program to control a number of foliar diseases in Florida. Failure to do so limits the production of squash on a commercial scale. Aircraft or ground application is used, but the latter is preferred because of superior coverage, especially of the lower surfaces of leaves.

The method of application is as important as the choice of material if adequate control is to be achieved. A typical planting of squash would be sprayed with a tractor-mounted boom sprayer at 200–250 psi and 100 gal finished spray volume per acre. Equipment should be properly calibrated to a tractor speed of 3 miles/hr. At this speed an observer should be able to walk behind the tractor at a comfortable pace. When these calibration guidelines are followed, most disease problems should be adequately controlled on a 5–7 day spray schedule.

Thorough coverage is absolutely essential. The addition of drop nozzles will enhance coverage of larger plants, especially the lower surfaces of leaves. The air inside the squash canopy must be completely displaced by a fine mist of fungicidal spray in order to prevent hard-to-detect disease outbreaks.

Fungicides are primarily preventative; that is, they must be applied before pathogens penetrate plant surfaces in order to be effective. Timing of applications is very important. If fungicides are applied after a disease is first found in a field, it may be impossible to prevent serious losses from occurring.

Two common fungicides, chlorothalonil and mancozeb, are available in many formulations from various companies and will control a number of foliar diseases of squash. Downy mildew is a serious disease on cucurbits in general, including squash, and there currently are many labeled products that have high efficacy in control of this disease. Some fungicides for downy mildew may also provide control of powdery mildew but additional fungicide applications aimed specifically at powdery mildew may be required. A number of fungicides (i.e. Flint, Quadris, and Topsin) are labeled for *Golovinomyces* (formerly *Erysiphe*) but not all are for use against *Podosphaera* (formerly *Sphaerotheca).* Laboratory examination to detect signs of the pathogen causing the powdery mildew fungus is necessary to confirm which of the two powdery mildew fungi exists in a field, although recent information indicates that *Podosphaera* is most commonly found in Florida.

Phytophthora blight can be a limiting disease in squash production in southern Florida. The disease causes substantial losses regardless of control methods if environmental conditions are conducive to disease development. Fungicides are labeled for the control of this disease. Water management and avoidance of previously infected fields may help to manage this disease.

Copper compounds may be needed if angular leaf spot occurs; however, some cucurbits are sensitive to copper. Fungicides are also needed when gummy stem blight threatens (primarily a problem on winter squash).

Sprays of stylet oil have been shown to be helpful in the management of aphid-vectored viruses in squash if applied early enough. Widespread and destructive outbreaks of Papaya ringspot and other viruses have occurred on squash in previous years. Applications of oil may reduce outbreaks; however, very specific use directions must be followed for best results. The oil must be applied with a ground rig at a pressure of 400 pounds per square inch. TX5 SS nozzles must be used. These special requirements often dictate that a rig or rigs be dedicated to oil applications.

Readers are urged to consult the Cucurbit Production chapter in the Florida *Vegetable Production Handbook* or their local UF/IFAS Extension agent for current, specific fungicide recommendations.

References

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Table 1. Characteristics of major squash diseases in Florida[1]

Disease	Pathogen(s)	Type of Organism	Seed Transmission	Soil Survival	Insect Transmission	Favorable[2] Conditions	Areas Most Likely to Occur
Angular leaf spot	*Pseudomonas syringae* pv. *lachrymans*	bacteria	+	+	-	C, wet	NF, CF
Cucurbit leaf crumple virus	CuLCrV	virus	-	-	+	-	All
Downy mildew	*Psuedoperonospora cubensis*	fungal-like	-	-	-	W, wet	All
Powdery mildew	*Podoshaera xanthii (form. Spaerotheca fuliginea)*	fungus	-	-	-	C	All
Powdery mildew	*Golovinomyces cichoracearum (Erysiphe cichoracearum)*	fungus	-	-	-	C	All
Wet rot	*Choanephora cucurbitarum*	fungus	-	++	+	W, wet	All
Gummy stem blight	*Didymella bryoniae*	fungus	+	++	-	W, wet	All (winter squash, primarily)
Pythium crown rot	*Pythium* spp.	fungal-like	-	++	-	wet	All
Phytophthora blight	*Phytophthora capsici*	fungal-like	-	++	-	C, W, wet	SF, All
Alternaria leaf spot	*Alternaria cucumerina*	fungus	-	+	-	W, wet	All
Papaya ringspot virus (Watermelon mosaic virus race 1)	PRSV (WMV-1)	virus	-	-	++	C	CF, SF
Watermelon mosaic virus	ZYMV	virus	-	-	++	C	CF, NF
Squash vein yellow virus	SqVyV	virus	-	-	++	-	SF
Target spot	*Corynespora cassicola*	fungus	-	-	-	C, heavy dews	All (primarily on cucumber)

[1] = may occur occasionally, may be of some importance.
++ = occurs often, important to know for proper disease control.
--= not known to occur or relatively unimportant.
[2] W = Warm weather
C = Cool weather
[3] NF = North Florida
CF = Central Florida
SF = South Florida