Disease Control for Florida Tomatoes[1]

Shouan Zhang, Mathews Paret, Ken Pernezny, and Pamela Roberts[2]

Introduction

Fresh-market tomato is ranked as the second most valuable vegetable crop in Florida. In 2022, 22,000 acres of tomatoes were commercially harvested in the state with a production value of nearly $323 million (USDA 2023 VegetablesMelonsAndBerries.pdf (usda.gov)).

Tomatoes are grown throughout the state, with commercial production centered in five locations: Miami-Dade County (Homestead), Palm Beach/St. Lucie Counties, southwest Florida (Immokalee/Naples), Manatee/Hillsborough Counties (Ruskin), and northwest Florida (Quincy). Most of these are fresh-market tomatoes produced from September to June.

Successful disease management has always been vital in Florida tomato production, given the generally ideal environmental conditions for most plant diseases. An integrated disease management program is a successful approach.

Tomato Pathogens

The majority of plant problems that we call diseases are caused by pathogenic microorganisms. These extremely tiny disease agents cause losses by attacking the tomato fruit directly, rendering them unfit for consumption, or sufficiently detracting from their appearance to reduce consumer preference. They also affect other plant parts, reducing plant vigor and carbohydrate production and incurring subsequent yield and monetary losses.

The pathogens attacking tomato can be classified into three major groups: fungi and oomycetes (hereafter referred to as fungal-like), bacteria, and viruses.

Fungi

Fungi are microscopic organisms composed of hyphae (microscopic threads) that absorb food and water into their cells. Although fungi have cell walls like plants, their cell walls are composed of chitin or polysaccharides or both and not cellulose as in higher plants. Because fungi have no chlorophyll, they must depend on outside sources of food, including living plants.

Many of the fungi that infect tomato reproduce by creating large numbers of spores. Some spores are borne by wind or rain splashing and spread readily within and between fields. Some fungi, especially those causing wilt and root diseases, can survive one or more years between susceptible crops with the aid of thick-walled spores or sclerotia (aggregates of hyphae).

1. This document is PPP35, one of a series of the Plant Pathology Department, UF/IFAS Extension. Original publication date July 2003. Revised March 2008, August 2008, June 2013, and March 2024. Visit the EDIS website at https://edis.ifas.ufl.edu for the currently supported version of this publication.

2. Shouan Zhang, professor, vegetable plant pathology, Plant Pathology Department, UF/IFAS Tropical Research and Education Center, Homestead, FL; Mathews Paret, professor and department chair, UF/IFAS Plant Pathology Department, Gainesville, FL; Ken Pernezny, professor emeritus, Plant Pathology Department, UF/IFAS Everglades Research and Education Center, Belle Glade, FL; and Pamela Roberts, professor, Department of Plant Pathology, UF/IFAS Southwest Florida Research and Education Center, Immokalee, FL

The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this publication do not signify our approval to the exclusion of other products of suitable composition.

All chemicals should be used in accordance with directions on the manufacturer's label.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office. U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Andra Johnson, dean for UF/IFAS Extension.

Fungi may enter plants through wounds or natural openings (e.g., the stomata that allow normal exchange of oxygen and carbon dioxide between the plant cells and the atmosphere). Some can also penetrate directly through the cuticle and cell walls.

Oomycetes (Fungal-Like Organisms)

Oomycetes are commonly referred to as "water molds" or "fungal-like" organisms. Although formerly classified as fungi, members of this class were taxonomically reclassified when they were shown to be distinct from fungi through comparative genomics (Fry and Grünwald 2010). Oomycetes are different from fungi in some key characteristics. For example, their cell walls are made of cellulose, whereas the cell walls of true fungi are composed of chitin. As the name "water molds" implies, many in this group favor wet conditions, and the spores that they produce, called zoospores, are capable of swimming and use plant-produced chemical cues to reach and infect their host. Because of these fundamental biological and physiological differences, management of oomycete diseases like those caused by *Phytophthora* and *Pythium* spp. requires its own set of control measures.

Bacteria

Bacteria are smaller microorganisms than fungi. They are single-celled, and the ones that cause plant disease do not form spores. Simple cell division is the main known type of reproduction for plant pathogenic bacteria. They are not known to penetrate the plant directly but must have a wound or natural opening to get inside a potential host plant. Bacteria cause some of the most serious diseases in tomatoes in Florida.

Viruses

Viruses should not be considered organisms. They are simply molecules made of nucleic acid (DNA or RNA) with a "wrapping" of protein and have no cellular structures. New virus particles can only be synthesized within living plant cells. They are much smaller than bacteria and normally require the high magnification of an electron microscope to be seen.

Most of the important tomato viruses are transmitted from tomato and wild hosts (such as black nightshade) to tomato by aphids, whiteflies, and thrips. A few viruses are spread mechanically.

Basic Characteristics of Tomato Diseases

For a disease to occur in tomato plants, all three components of the "disease triangle" are required: a virulent pathogen, a susceptible variety, and weather conditions favorable for the disease. If any one of these components is missing, plants will not become diseased.

Effective tomato disease control is based on understanding the biology of the causal organism, the response of the host to this pathogen, and the interplay of outside physical forces, such as temperature and soil type on the living systems involved. Characteristics of the major Florida tomato diseases are listed in Table 1.

Suggested Sequential Program for Disease Control

Soil Fumigation

Most Florida tomatoes are now produced using the full-bed fumigation, plastic-mulch system. Fumigants are volatile biocides that can be applied to the soil. During a period of exposure, they can effectively control many potentially harmful disease agents, especially fungi. Most of the organisms that survive well in the soil (**Table 1**) can be managed if fumigants are properly applied prior to planting. In addition, combinations of fumigants and materials used in conjunction can destroy other pests, including nematodes, soil insects, and weed seeds.

The fumigants must thoroughly penetrate the spaces between soil particles. Since crop residues can interfere with fumigant penetration, they must be worked into the soil and allowed to decompose before fumigation.

Host Resistance

Choose varieties with disease resistance. Using disease-resistant plants can reduce the amount of pesticides required to produce quality fruit and ensure economic returns. Knowing which diseases are present in production areas or knowing the disease history within a particular field can help determine the resistance needed. This method makes it possible to attain practical control of many diseases. Disease resistance must be considered as important a factor in variety selection as fruit quality, yield, and other horticultural traits if a farmer is to be successful in growing tomatoes in Florida.

Specific Cultural Control Measures

The use of **plastic mulch** is a very important cultural control for fruit rots in the field. Root rot (*Rhizoctonia solani*) and buckeye rot (*Phytophthora spp.*) are two soilborne pathogens that caused great losses before plastic mulch was used to prevent contact between fruit and the soil. Staking plants has also reduced losses from fruit rots.

Production of disease-free transplants is a very important measure for control of many serious problems, especially early blight, late blight, bacterial spot, and several viruses. Use of certified "pathogen-free" seed is also important for some diseases, such as tomato mosaic and bacterial spot.

Destruction of volunteer plants is an important practice in the control of several diseases because it prevents large populations of pathogens from surviving from one crop to another. Crop rotation also works to prevent crop-to-crop survival of specific tomato pathogens.

Upward adjustment of soil pH by liming is an effective management strategy for Botrytis gray mold on sandy soils. A pH of 6.5–7.0 is recommended for Fusarium wilt suppression.

Choice of planting date continues to be a largely economic decision based on anticipated market windows for a given production region. However, controlling a disease by planting date may be considered if a particular problem does not lend itself well to other control measures. Late blight, Sclerotinia stem rot, and leaf mold are cool-weather diseases; while others, such as bacterial spot, southern blight, and bacterial wilt, occur primarily in warm weather. If the actual planting dates can't be used as a primary control strategy, the grower should be aware of the relationship between environmental conditions and certain diseases and apply measures in accordance with the prevailing conditions.

Excessive handling of plants, such as thinning, pruning, and tying, may help spread some diseases, including bacterial spot, tomato mosaic, and bacterial speck. Whenever possible, plants should be handled and harvested when they are driest. If used, stakes should be decontaminated. Farm equipment should also be periodically decontaminated to reduce between-field pathogen spread.

Several experiments have also shown that **overhead irrigation aggravates disease problems**, especially those caused by bacteria. Well water is preferred for spraying because surface water may be contaminated with pathogens.

Rapid crop destruction at the end of the season is crucial for managing tomato yellow leaf curl virus (TYLCV) and tomato chlorotic spot virus (TCSV). It is extremely important that crops be destroyed immediately after harvest because this reduces areas where whiteflies and thrips can build up and move to new crops. Rapid crop destruction, especially for those crops infected with diseases, can prevent spread of many pathogens.

Manage and remove weeds that can serve as sources of inoculum for viruses and other pathogens during production and the off-season.

Foliar Fungicide and Stylet Oil Application

Periodic fungicide application is an important component of current tomato disease control programs. Ground applications are typically used for good canopy penetration and coverage of leaf undersurfaces. Attention to the application technique is as important as choice of material for achieving adequate disease control. Proper application calibration should result in tractor speed of about 3 miles/hour. At this speed, an observer should be able to walk behind the tractor at a comfortable pace. If the tractor speed is properly adjusted, most diseases can be adequately controlled with one application of fungicide per week. Faster tractor speeds can lead to poor control and may make more frequent applications necessary. Care must be taken to ensure that nozzles work properly, strainers are clear, and nozzle arrangement allows for adequate coverage. Tomato growers should start adding drop nozzles early (certainly by first bloom). The air in the tomato canopy must be completely displaced by a fine mist of fungicide to prevent disease outbreaks that can begin from deep inside.

Fungicides are primarily preventative: they must be applied before the pathogen arrives on the foliage to have effective disease control. Timing of the sprays is very important. If fungicide sprays are started after the disease is discovered, it may be impossible to curb an epidemic. This is particularly true for late blight. Experiments have shown that even when fields are scouted closely on a regular basis, spray programs initiated after the first detection of late blight may not prevent severe economic loss.

Growers should consult the University of Florida *Vegetable Production Handbook* for current, specific fungicide recommendations found in the chapter *Tomato Production in Florida* (https://edis.ifas.ufl.edu/cv137) (Olson et al. 2012).

Management of aphid-transmitted viral diseases (including potato virus Y, tobacco etch virus, and tomato yellow virus) by insecticide alone is generally poor. All these viruses are carried on the stylet (feeding probe) of the aphid and are transmitted to the tomato plants at the same time that a lethal dose of insecticide is being ingested by the aphid.

JMS stylet oil, a high-grade petroleum oil, has shown promise in protecting several vegetables, including tomato, from aphid-transmitted virus diseases. A thin layer of this oil on the plant surface apparently serves to inactivate the virus as the aphid probes through the cuticle.

Whitefly-Transmitted Viruses

In recent years, devastating outbreaks of a group of viruses—the "gemini" viruses and begomoviruses—have occurred in most Florida tomato-growing areas. The major virus problems in this group have been identified as tomato yellow leaf curl virus and tomato mottle virus. These viruses are transmitted to healthy plants by the silverleaf whitefly. Great progress has been made in the control of these diseases through a sound integrated management program and using resistant varieties. It is extremely important that crops be destroyed immediately after harvest, as this reduces areas where whiteflies can build up and move to new crops. Weeds and volunteer tomato plants that can serve as hosts for whiteflies should be eliminated. Symptomatic plants within a field should be rogued immediately. A systemic insecticide, imidacloprid, can be applied prior to planting and provides good early season control of silverleaf whitefly. Metalized mulch that reflects UV light is effective in disorienting whiteflies and protecting young plants.

Thrips-Transmitted Viruses

Thrips transmits tomato spotted wilt virus (TSWV) (Funderburk et al. 2011) and the closely related groundnut ringspot virus (GRSV) and tomato chlorotic spot virus (TCSV). TSWV can be a damaging disease, and GRSV has been found with increasing incidence since 2009 (Webster et al. 2010). TCSV was first reported in tomatoes in south Florida in 2012 (Londoño et al. 2012). Only after a couple of years, outbreaks of tomato chlorotic spot disease caused by TCSV occurred in the 2014-2015 season in Miami-Dade County, Florida (Poudel et al. 2019). Approximately 30-40% of tomato plants in many commercial fields were infected with TCSV in Homestead and the infected plants had to be rogued attempting to reduce the spread of the disease. Since then, TCSV has caused significant losses to tomato growers in South Florida. Field surveys in Miami-Dade County indicated that TCSV is the predominant virus among TSWV, GRSV, and TCSV in South Florida with TCSV being detected in 43.8% of symptomatic tomato samples collected in the 2016–2017 season. Mixed infection with any two tospoviruses ranged from 2.8 to 6.3%, and 2.0% of the symptomatic samples were infected with all three viruses. The distribution pattern of TCSV-infected plants in a commercial tomato field in Homestead, FL suggested that the initial source of TCSV could be ornamental crops in adjacent nurseries. Up to 56.0% of the tomato plants with symptoms were observed in this field adjacent to ornamental nurseries, whereas the incidence gradually decreased to zero on the other side of the same field. Management of these viruses is difficult, but TSWV-resistant varieties and metalized mulch have been effective for tomato spotted wilt and tomato chlorotic spot management. Planting tomatoes far from nurseries and other landscapes is a strategy to avoid infection by these viruses. Rogueing infected plants within a field should be considered immediately. Removing weeds such as purslane and jimsonweed is important for managing these viruses.

References

Fry, W. E., and N. J. Grünwald. 2010. "Introduction to Oomycetes." *The Plant Health Instructor.* doi:10.1094/PHI-I-2010-1207-01.

Funderburk J., S. Reitz, S. M. Olson, P. Stansly, H. Smith, G. McAvoy, O. Demirozer, C. Snodgrass, M. L. Paret, and N. Leppla. 2011. *Managing Thrips and Tospoviruses in Tomato.* ENY859. Gainesville: University of Florida Institute of Food and Agricultural Sciences. https://edis.ifas.ufl.edu/in895

Londono, A., H. Capobianco, S. Zhang, and J. E. Polston. 2012. First record of tomato chlorotic spot virus in the U.S. Tropical Plant Pathology 37: 333-338.
Marco, G. M., and R. E. Stall. 1983. "Control of Bacterial Spot of Pepper Initiated by Strains of *Xanthomonas campestris* pv. *vesicatoria* That Differ in Sensitivity to Copper." *Plant Dis.* 67: 779–781.

Olson S. M ., P. J. Dittmar, G. E. Vallad, S. E. Webb, S. A. Smith, E. J. McAvoy, B. M. Santos, and M. Ozores-Hampton. 2012. *Tomato Production in Florida.* HS739. Gainesville: University of Florida Institute of Food and Agricultural Sciences. https://edis.ifas.ufl.edu/cv137

Poudel, B., O. Abdalla, Q. Liu, Q. Wang, E. McAvoy, D. Seal, K.-S. Ling, M. McGrath, and S. Zhang. 2019. Field distribution and disease incidence of tomato chlorotic spot virus, an emerging virus threatening tomato production in south Florida. Tropical Plant Pathology 44(5): 430-437.

United States Department of Agriculture (USDA). 2013. "Vegetables: 2012 Summary." https://downloads.usda.library.cornell.edu/usda-esmis/files/02870v86p/9z9032488/fn107149q/VegeSumm-01-29-2013.pdf

Webster, C. G., K. L. Perry, X. Lu, L. Horsman, G. Frantz, C. Mellinger, and S. Adkins. 2010. "First Report of Groundnut Ringspot Virus Infecting Tomato in South Florida." *Plant Health Progress* doi:10.1094/PHP-2010-0707-010BR.

Table 1. Some characteristics of principal tomato diseases in Florida.[1]

Diseases	Pathogen	Organism	Seed transmission	Soil survival	Insect transmission	Available resistance	Favorable conditions[2]	Areas most likely to occur
Bacterial speck	*Pseudomonas syringae* pv. *tomato*	Bacterium	++	+	-	-	C, R	ALL
Bacterial spot	*Xanthomonas perforans*	Bacterium	+	+	-	-	H, R	ALL
Botrytis gray mold	*Botrytis cinerea*	Fungus	-	+	+	-	C, R	Sandlands
Buckeye rot	*Phytophthora* species	Fungal-like	-	++	-	-	H, R	ALL
Damping-off	*Pythium* spp., *Rhizoctonia* spp., *Phytophthora* spp.	Fungal-like and fungus	-	++	-	-	H, R	ALL
Double virus streak	Potato virus X plus tobacco mosaic virus	Viruses	+	+	-	+	C	ALL
Early blight	*Alternaria solani*	Fungus	-	-	-	+	H, R	ALL
Fusarium wilt	*Fusarium oxysporum* f. sp. *lycopersici*	Fungus	-	++	-	++	H	Sandlands
Fusarium crown rot	*Fusarium oxysporum* f. sp. *radicis-lycopersici*	Fungus	-	+	-	++	C	Sandlands
Gray leaf spot	*Stemphyllium solani*	Fungus	-	+	-	++	R	ALL
Groundnut ringspot	Groundnut ringspot virus	Virus	-	-	+	-	H	Central and South Florida
Late blight	*Phytophthora infestans*	Fungal-like	-	-	++	-	C, R	ALL
Pseudocurly top	Pseudocurly top virus	Virus	-	-	++	-	H	ALL
Potato virus Y (vein-banding virus)	Potato virus Y	Virus	-	-	++	-	C	East coast
Sclerotinia stem rot (white mold)	*Sclerotinia sclerotiorum*	Fungus	-	++	-	-	C, R	Miami-Dade
Soil rot	*Rhizoctonia solani*	Fungus	-	++	-	-	H, R	ALL
Southern bacterial wilt	*Ralstonia solanacearum*	Bacterium	-	++	-	-	H	Sandlands
Southern blight	*Sclerotium rolfsii*	Fungus	-	++	-	-	H	Sandlands
Target spot	*Corynespora cassiicola*	Fungus	-	-	-	-	R	Sandlands
Tobacco etch	Tobacco etch virus	Virus	-	-	++	-	C	East coast
Tomato pith necrosis	*Pseudomonas corrugata*	Bacterium	-	+	-	-	C	ALL - Heavy nitrogen rates contribute to disease
Tomato mosaic	Tobacco mosaic virus	Virus	+	+	+*	+	-	ALL
Tomato spotted wilt	Tomato spotted wilt virus	Virus	-	-	++	+	H	North Florida
Tomato chlorotic spot	Tomato spotted wilt virus	Virus	-	-	++	+	H	South Florida

Diseases	Pathogen	Organism	Seed transmission	Soil survival	Insect transmission	Available resistance	Favorable conditions[2]	Areas most likely to occur
Tomato yellow leaf curl	Tomato yellow leaf curl virus	Virus	-	-	++	+	C, H	ALL
Verticillium wilt	*Verticillium albo-atrum* and *V. dahliae*	Fungus	-	++	-	++	C	Miami-Dade

[1] + = may occur occasionally, of some importance.
++= occurs often, important to know for proper control.
- = not known to occur or relatively unimportant.
[2] H = warm weather; C = cool weather; R = favored by extended rainfall.
*Possibly transmitted by insects with *chewing* mouthparts.
Note: A picture database of tomato diseases can be found in the U-scout of the University of Florida: https://plantpath.ifas.ufl.edu/u-scout/tomato/index.html.