INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

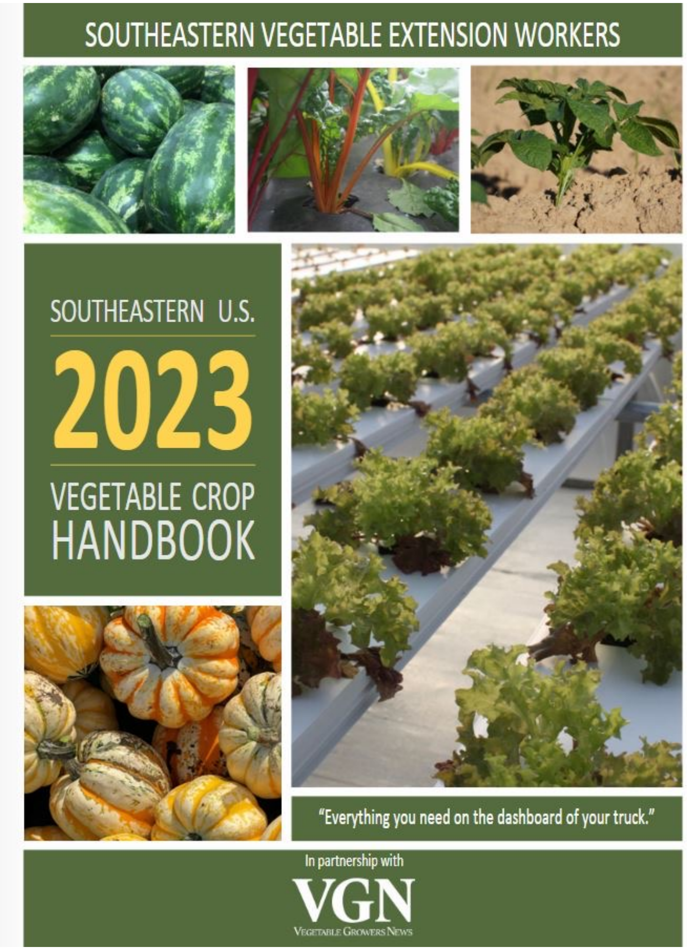
UT EXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Vegetable Disease Update
Pick TN Conference

Zach Hansen
Assistant Professor / Extension Specialty Crops Pathologist
Department of Entomology and Plant Pathology
University of Tennessee Institute of Agriculture
February 16, 2023
zhansen1@utk.edu / office: 865-974-7784

Since 1963, the IR-4 Project (IR-4) has been the primary entity in the United States to **facilitate registrations of conventional pesticides and biopesticides on Specialty Food crops (fruits, vegetables, nuts, herbs, spices) and non-food Environmental Horticulture crops**.

Chemical control and variety selections
2022 Southeastern U.S. Vegetable Crop Handbook



Available for free download:

https://vegetablegrowersnews.com/2023-southeast-vegetable-crop-handbook/

Phytophthora blight

Oomycete (water mold) - *Phytophthora capsici*

– Effects several important crops
  - Cucurbitaceae (pumpkins, summer/winter squash)
  - Solanaceae (peppers, tomatoes, eggplant)
  - Fabaceae (beans)

Phytophthora blight vine crop symptoms

- Crown and root rot
  - Sudden permanent wilting
  - Plants may die within days
  - Brown, water-soaked roots and stem

- Fruit rot
  - Water-soaked spot
  - Originating where fruit touches ground, or stem
  - Soft lesions
  - White sporulation

Phytophthora blight on summer squash

Phytophthora blight on peppers

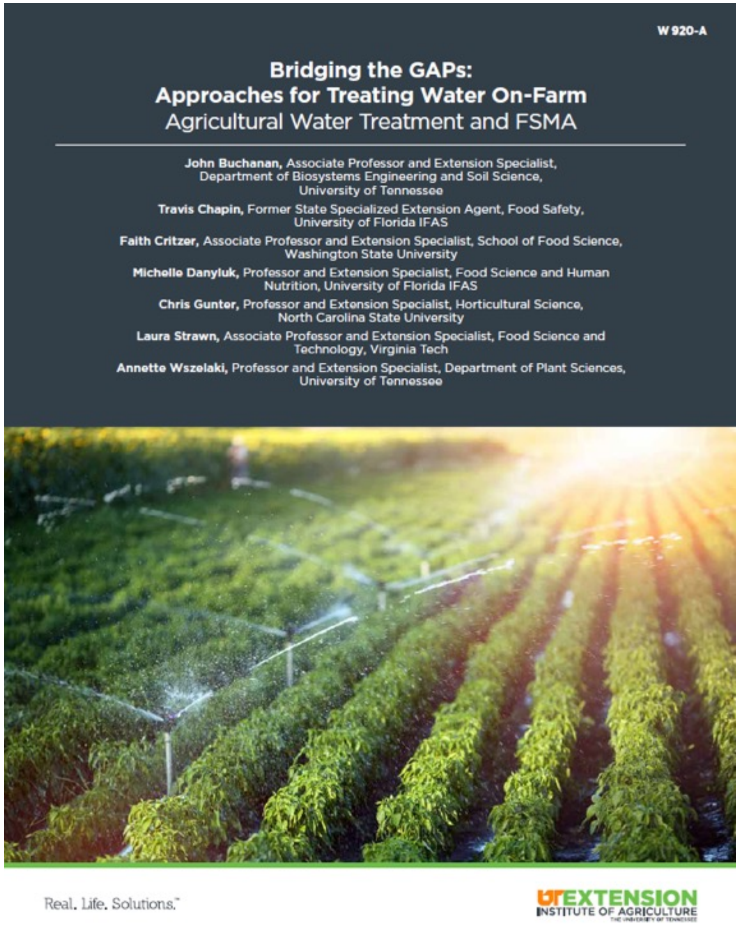
Phytophthora blight management

- Difficult to manage
- Management program should include
  - Avoidance (wash shared equipment)
  - Cultural practices
    - Crop rotation
    - Raised beds
    - Well drained soil
    - Plastic mulch, drip irrigation
    - Dispose of culls off site
    - Avoid untreated surface irrigation water
  - Host resistance
    - Some resistance in peppers
    - Most cucurbits susceptible
  - Chemical control
    - Always read the label
    - Rotation is important

Real. Life. Solutions.™

UTEXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE

Treating irrigation water



4-part publication series

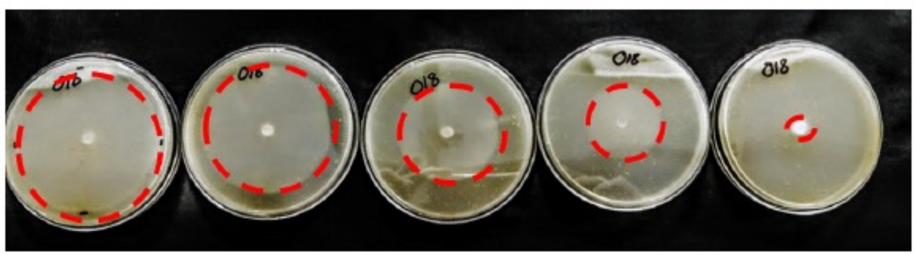
- Agricultural water treatment and FSMA (W920-A)
- Agricultural water treatment tools (W920-B)
- Developing on-farm agricultural water treatment programs (W920-C)
- Implementing agricultural water treatments on the farm (W920-D)

All available for free download at

extension.tennessee.edu/publications/Pages/default.aspx

Fungicide sensitivity testing in TN

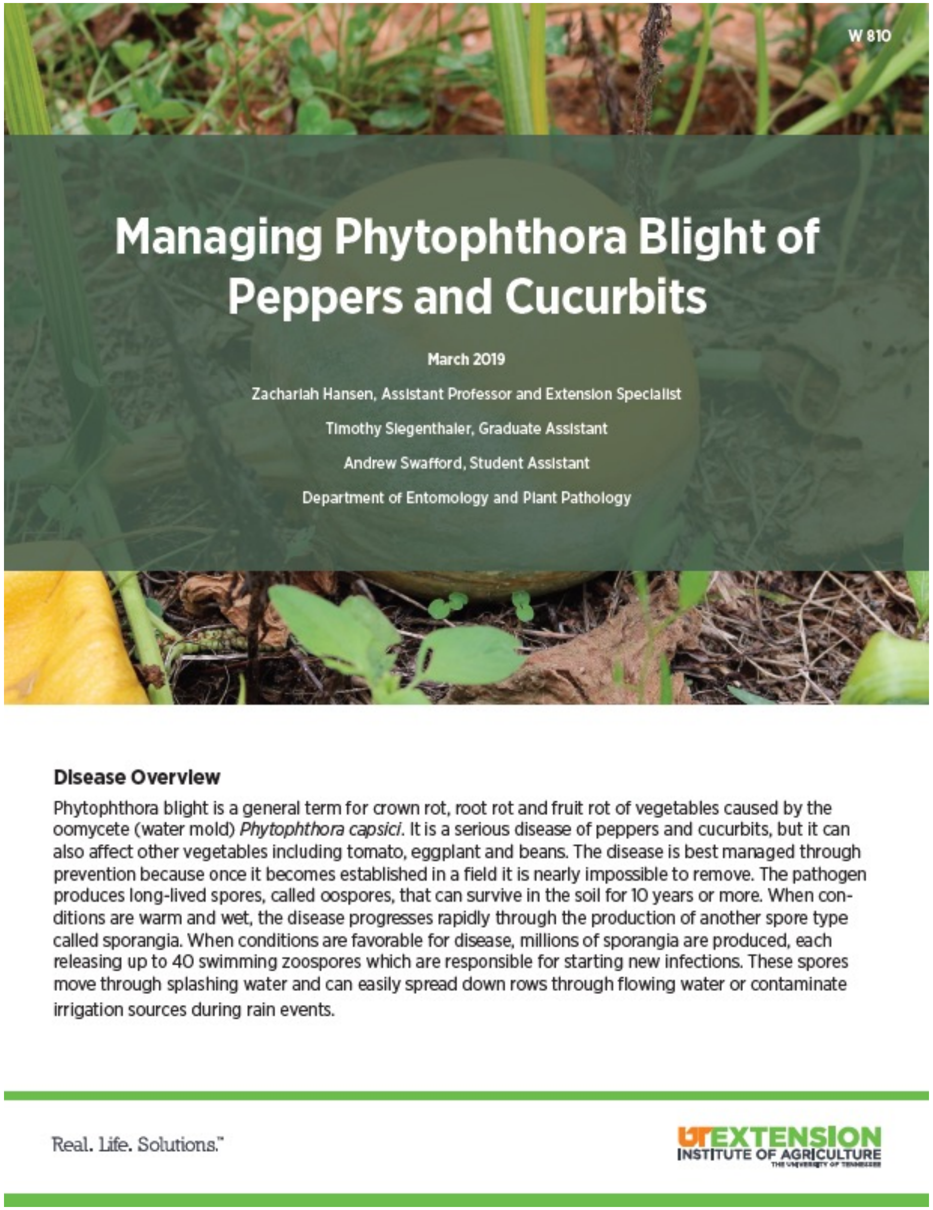
Product*	Active ingredient(s)
Orondis Gold 200	oxathiapiprolin
Forum 4.17SC	dimethomorph
Revus	mandipropamid
Presidio	fluopicolide
Ridomil Gold SL, Ultra Flourish	mefenoxam
Ranman	cyazofamid



Conclusions

- Best against Phytophthora blight
  - Orondis (Gold 200, Ultra)
- Fair against Phytophthora blight
  - Ridomil (high resistance risk)
  - Zampro
  - Forum
  - Revus
  - Elumin
  - Ranman (high resistance risk)
  - Presidio (high resistance risk)

These products also manage downy mildew


W 810

Managing Phytophthora Blight of Peppers and Cucurbits

March 2019

Zachariah Hansen, Assistant Professor and Extension Specialist

Timothy Siegenthaler, Graduate Assistant

Andrew Swafford, Student Assistant

Department of Entomology and Plant Pathology

Disease Overview

Phytophthora blight is a general term for crown rot, root rot and fruit rot of vegetables caused by the oomycete (water mold) *Phytophthora capsici*. It is a serious disease of peppers and cucurbits, but it can also affect other vegetables including tomato, eggplant and beans. The disease is best managed through prevention because once it becomes established in a field it is nearly impossible to remove. The pathogen produces long-lived spores, called oospores, that can survive in the soil for 10 years or more. When conditions are warm and wet, the disease progresses rapidly through the production of another spore type called sporangia. When conditions are favorable for disease, millions of sporangia are produced, each releasing up to 40 swimming zoospores which are responsible for starting new infections. These spores move through splashing water and can easily spread down rows through flowing water or contaminate irrigation sources during rain events.

Real. Life. Solutions.™

UT EXTENSION INSTITUTE OF AGRICULTURE THE UNIVERSITY OF TENNESSEE

UT Extension Publication W 810

- utextension.tennessee.edu/

Or

- www.utspecialtycrop.com

W 1003

Fungicide Recommendations for Phytophthora Blight Management in Tennessee in Light of Newly Discovered Fungicide Resistance

Tim Siegenthaler, Research Specialist
Zachariah Hansen, Assistant Professor and Extension Specialist
Department of Entomology and Plant Pathology

Introduction

Phytophthora blight, caused by a fungus-like organism named *Phytophthora capsici*, is a common vegetable disease throughout Tennessee. Primarily, this disease affects cucurbits, such as squash, cucumber, pumpkin and melons, and peppers but can infect a wide range of other hosts as well. Signs and symptoms of *Phytophthora* blight are root rot, crown rot, fruit rot, rapid wilting and circular necrotic lesions, which often have white spores present on the surface of the plant. See UT Extension publication "Managing Phytophthora Blight of Peppers and Cucurbits W 810" for more information on *Phytophthora* blight symptoms and diagnostics. *Phytophthora* blight is soilborne and thrives in wet and temperate soils. Disease spread occurs through the movement of spores found in infested soil, plant material, surface water (such as irrigation ponds and streams) and farm equipment. Once *Phytophthora* blight infests a field it can be difficult to manage. The disease can spread rapidly within a field and can persist in the soil for many years.

Several methods are recommended to manage the disease, including avoidance, cultural controls and chemical controls (W810).

Fungicides are an important tool for *Phytophthora* blight management, and several fungicide products are available. However, fungicide resistance has been observed in *P. capsici*, which limits the potential effectiveness of these chemical controls. Fungicide resistance in *P. capsici* varies among regions so it is very important to test local populations in order to track the development of resistance. For this reason, we screened samples of *P. capsici* from Tennessee farms to document fungicide resistance.

Information on the products tested in this study can be found in Table 1. A complete list of fungicides labeled for *Phytophthora* blight management can be found in the Southeastern U.S. Vegetable Crop Handbook. An analysis of costs associated with a *Phytophthora* blight fungicide program in commercial peppers is available in the UT Extension publication "Sample Budgets for Large-scale Bell Pepper Operations and the Impact of Phytophthora Blight on Farm Revenue and Costs, 2019 W 831."

Summary of experiments

In 2018 and 2019, we collected samples of cucurbit and pepper plants infected with *Phytophthora* blight from Rhea, Bledsoe, Putnam and Lincoln Counties. A total of 184 pathogen samples were screened for fungicide resistance. The fungicides included in the experiments were Ridomil (mefenoxam), Ranman (cyazofamid), Forum (dimethomorph), Presidio (fluopicolide), Revus (mandipropamid), and Orondis (oxathiapiprolin) (Table 1), which were six of the most effective fungicides available at the time of testing. Samples were tested in the lab with a series of fungicide concentrations from high to low concentrations. *Phytophthora* growth was

Real. Life. Solutions.™

UT EXTENSION INSTITUTE OF AGRICULTURE THE UNIVERSITY OF TENNESSEE

UT Extension Publication W 1003

- utextension.tennessee.edu/

Or

- www.utspecialtycrop.com

Pumpkin Growers Survey

Please complete this survey (QR code or a paper copy), so that we can better understand your production challenges.

Thank you!

Start the survey here.

Additional updated Extension resources

- Commercial pepper budget (large scale)
- Commercial tomato budget (small scale)

W 831

Sample Budget for Large-Scale Bell Pepper Operations and the Impact of Phytophthora Blight on Farm Revenue and Costs - 2022

Margarita Velandia, Department of Agricultural and Resource Economics
Zachariah Hansen, Department of Entomology and Plant Pathology
Annette Wszelaki, Department of Plant Sciences
Ty Wolaver, Department of Agricultural and Resource Economics

Preface

This sample budget aims to guide bell pepper producers and those interested in producing bell peppers on the factors to consider when estimating their potential net revenue from growing and marketing bell peppers. Additionally, we used this sample budget to help producers evaluate the economic impact of Phytophthora blight at the farm level by comparing a baseline budget with an alternative budget that includes managing costs and potential yield losses associated with this disease. This document will also help producers navigate the Excel version of this sample budget created by the University of Tennessee (UT), available on the Department of Agricultural & Resource Economics website at https://arec.tennessee.edu/extension/budgets/.

At the end of this document, we provide some instructions on how to use the Excel version of this sample budget.

The budget presented here is an example; therefore, users should modify numbers to estimate their net farm revenue. Every farm is unique; hence, estimated costs and revenue will vary depending on soil conditions, pepper varieties, production practices used, pest and disease pressure and other factors.

One of the most common diseases for bell peppers in Tennessee is Phytophthora blight, a soil-borne disease caused by the oomycete (water mold) *Phytophthora capsici*. Phytophthora blight reduces yield by killing plants outright as well as causing pre- and post-harvest fruit rot. Disease severity is influenced by environmental conditions, including temperature and rainfall, and cultural factors such as soil drainage and irrigation source and method, making it challenging to estimate expected losses to disease. Once the disease becomes established in the soil, it is nearly impossible to eradicate and must be managed each season through cultural practices and fungicides (Hansen, Siegenthaler and Swafford, 2019). However, in fields where the disease has not been introduced, there is no need to use Phytophthora blight-specific fungicides, thereby significantly decreasing disease management costs. For information about managing Phytophthora blight, go to tiny.utk.edu/W810, and for up-to-date fungicide recommendations, see the latest version of the Southeast U.S. Vegetable Crop Handbook.

Bell Pepper Production in Tennessee

According to the U.S. Department of Agriculture (USDA) 2017 Census of Agriculture, there were 434 farms growing bell peppers in Tennessee on 235 acres (USDA NASS, 2017). The number of operations growing bell peppers and the number of acres of bell pepper production in Tennessee increased by 280 percent and 8 percent, respectively, between 2012 and 2017. Although many alternative production methods exist, this publication focuses on conventional plasticulture, which is the most common method of pepper production in Tennessee.

Data

Sources of information used to create this sample budget include: 1) custom vegetable price reports from the U.S. Department of Agriculture, Agricultural Marketing Services (USDA AMS); 2) a 2017 bell pepper variety trial conducted in Dayton, TN (University of Tennessee Extension); 3) input suppliers; 4) the 2022 Southeast U.S. Vegetable Crop Handbook; 5) labor data collected from a pepper farm in East Tennessee; 6) labor data collected from a 2019

Real. Life. Solutions.™

UTEXTENSION INSTITUTE OF AGRICULTURE THE UNIVERSITY OF TENNESSEE

UT Extension Publication W 831

- utextension.tennessee.edu/

Or

- www.utspecialtycrop.com

Example season-long pepper fungicide programs

Table 1. Example of Fungicide Program When Phytophthora Blight Does Not Need to Be Managed

Week (post-transplanting spray #)	Product (active ingredient)	Target disease	Rate per acre
Pre-plant	Fumigants1 (1,3-dichloropropene + chloropicrin)	Nematodes, soil-borne pathogens, weeds	Various[1]
Pre-plant	Agri-Mycin 17, Firewall	Bacterial spot *(Xanthomonas euvesicatoria)*	1 lb/100 gallon
0 (at planting)	Blocker (PCNB)	Southern blight *(Sclerotium rolfsii)*	4.5-7.5 pt/100 gal; use 0.5 pt solution per plant
1	fixed copper (various)	Bacterial spot *(Xanthomonas euvesicatoria)*	Kocide as an example (1.5 lbs per acre)
2	fixed copper (various)	Bacterial spot *(Xanthomonas euvesicatoria)*	Kocide as an example (1.5 lbs per acre)

Table 2. Example of Fungicide Program When Phytophthora Blight Needs to Be Managed

Week (post-transplanting spray #)	Product (active ingredient)	Target disease	Rate per acre
Pre-plant	Fumigants1 (1,3-dichloropropene + chloropicrin)	Nematodes, soil-borne pathogens, weeds	Various[1]
Pre-plant	Agri-Mycin 17, Firewall	Bacterial spot *(Xanthomonas euvesicatoria)*	1 lb/100 gallon
0 (at planting)	Blocker (PCNB)	Southern blight *(Sclerotium rolfsii)*	4.5-7.5 pt/100 gal; use 0.5 pt solution per plant
	Orondis Gold 200 (oxathiapiprolin)	Phytophthora blight *(Phytophthora capsici)*	9.6 fl oz per acre
1	fixed copper (various)	Bacterial spot *(Xanthomonas euvesicatoria)*	Kocide as an example (1.5 lbs per acre)
	Ridomil Gold SL (mefenoxam)	Phytophthora blight *(Phytophthora capsici)*	1 pt per acre
2	fixed copper (various)	Bacterial spot *(Xanthomonas euvesicatoria)*	Kocide as an example (1.5 lbs per acre)
	Ranman (cyazofamid)	Phytophthora blight *(Phytophthora capsici)*	2.75 fl oz per acre

UT Extension Publication W 831

- utextension.tennessee.edu/

Or

- www.utspecialtycrop.com

W 1125

Sample Budget for Small-Scale Commercial Tomato Operations

Margarita Velandia, Department of Agricultural and Resource Economics
Zachariah Hansen, Department of Entomology and Plant Pathology
Annette Wszelaki, Department of Plant Sciences
Ty Wolaver, Department of Agricultural and Resource Economics

Table 1. An Example of Estimated Cost and Returns for a Small-Scale Tomato Operation

GROSS RETURNS	UNIT	QUANTITY	$/UNIT	TOTAL
Tomatoes	lb	450.00	$2.00	$900.00
VARIABLE COST				
Tomato plants-hybrid[1]	plant	50	$0.26	$13.10
Fertilizer[2]				
Plant Starter (20-20-20)	lb	5.5	$1.50	$8.59
Calcium nitrate	lb	3.9	$0.50	$1.95
Potassium nitrate	lb	8.1	$0.70	$5.67
Soil Test[3]	test	1	$15.00	$15.00
Fungicides[4]				
Chlorothalonil 6SC	ml	22.8	$0.01	$0.30
Inspire Super	ml	24.42	$0.08	$1.89
Fontelis	ml	24.42	$0.07	$1.69
Mancozeb	lb	0.06	$18.51	$1.11
Copper	lb	0.1	$2.85	$0.28
Herbicide[5]				
Metribuzin	oz	0.11	$0.92	$0.10
Poast	pt	0.03	$14.60	$0.44
Insecticide[5]				
Dipel DF	oz	0.42	$1.10	$0.46
Radiant SC	ml	3.24	$0.29	$0.94
Admire Pro	ml	3.54	$0.07	$0.25

Cucurbit downy mildew

Oomycete (water mold) – *Pseudoperonospora cubensis*

- Host specific
- All cucurbits are susceptible
- Spores are dispersed long distances
  - overwinter in warm climates or greenhouses
- Disease favored by high humidity and wet conditions
- Symptoms
  - Angular, yellow lesions bound by leaf veins
  - Lesions may appear water soaked or brown in certain varieties
  - Brown, dark “powdery” sporulation on lower leaf surface

Cucurbit downy mildew

- Management
  - Chemical control – avoid resistance – rotate fungicides!
    - GOOD
      - Oxathiapiprolin (**Orondis**)
      - Ethaboxam (**Elumin**)
      - Cyazofamid (**Ranman**)
    - FAIR
      - Ametoctradin + dimethomorph (**Zampro**)
      - Famoxadone + cymoxanil (**Tanos**)
      - Fluazinam (**Omega**)
      - Propamocarb (**Previcur Flex**)

Photo: Gerald Holmes
Bugwood.org

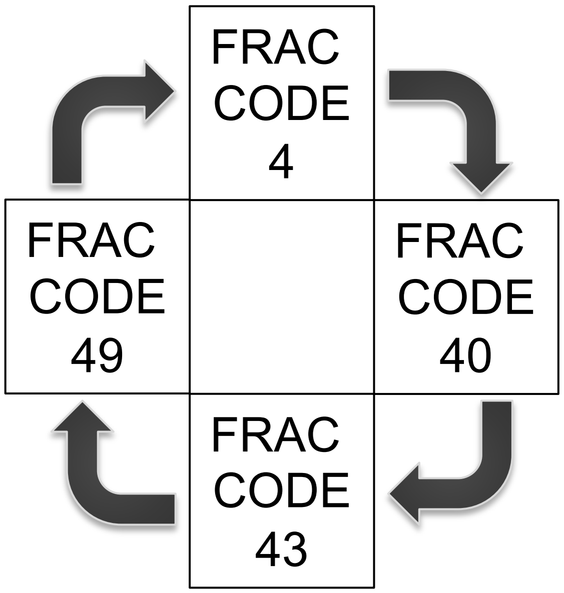
  - Cultural practices
    - Avoid excess leaf wetness
      - Drip irrigation
      - Increased row and plant spacing

Rotate fungicides for cucurbit downy mildew management

- Resistance to 13 fungicides indicated in SE Veg Crop Handbook

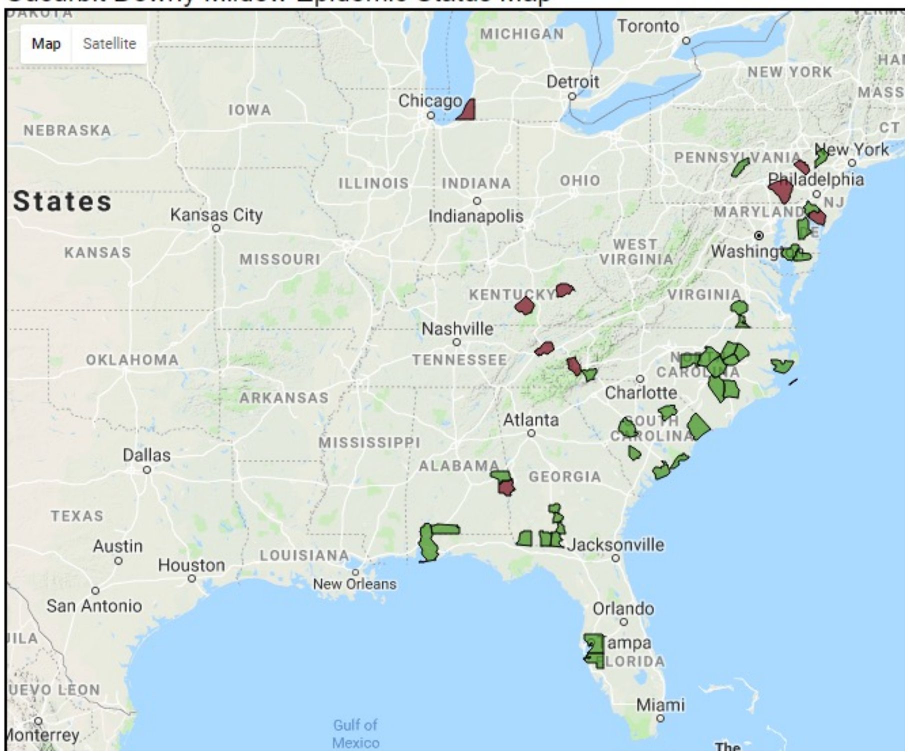
- Choose fungicides from different FRAC groups in consecutive sprays

Rotate fungicides

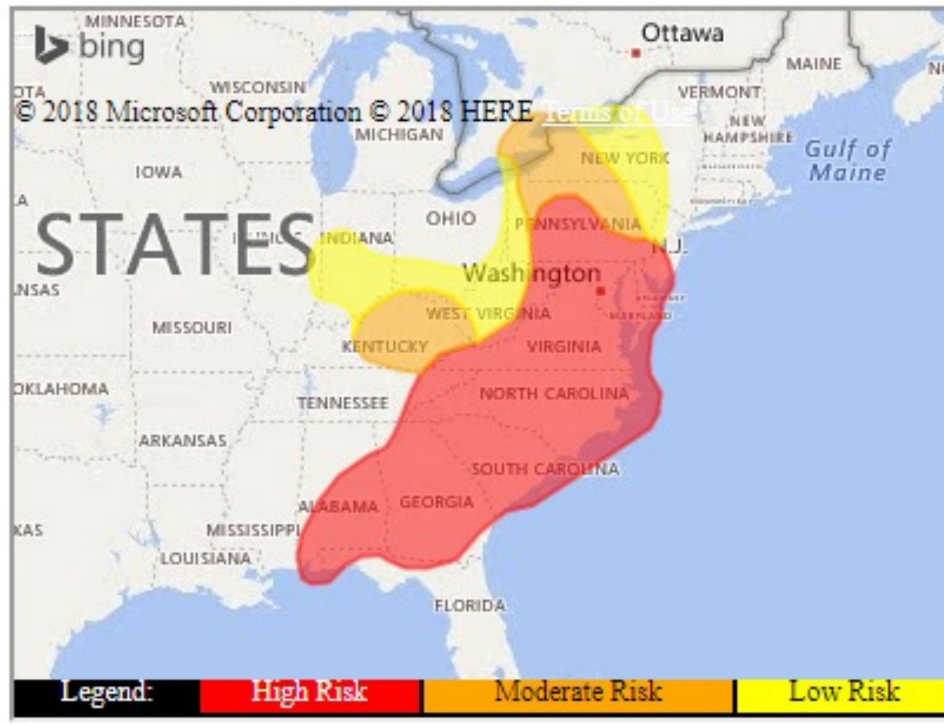


cdm.ipmpipe.org

Cucurbit Downy Mildew Epidemic Status Map



Risk prediction map for Day 2: Monday, July 30



Cucurbit downy mildew

Oomycete (water mold) – *Pseudoperonospora cubensis*

- Sentinel plot first reports (Knoxville)
  - 2018: July 30
  - 2019: July 31
  - 2020: Aug 9
  - 2021: July 20
  - 2022: July 29
  - 2023: ???

Cucurbit downy mildew clades

- Clade 1
  - Watermelon
  - Pumpkin
  - Squash

Photos: Bugwood.org

- Clade 2
  - Cucumber
  - Cantaloupe

Photos: Bugwood.org

Choose disease-resistant varieties

- Excellent strategy for powdery and downy mildew management

- See "Specific Commodity Recommendations" in 2023 SE Veg Handbook for details (contents page xi)

- Remain mindful of other diseases at your location

Choose disease resistant varieties

- Cucumber – all varieties in the handbook have DM or PM resistance now (Page 58)
  - Many have both
- Cantaloupe – only 'Ambrosia' has DM resistance, most have some PM resistance
- Pumpkin – Most susceptible to DM
  - 'Blue Bayou' and 'Blue Doll' have DM resistance (large 12-20 lbs)
  - Many varieties have PM resistance
- Summer squash – lots of PM resistance, no DM resistance




Fungicides may still be necessary for PM and DM management

- Many options to choose from
- Fungicide resistance reported for many

2022 greenhouse powdery mildew trial

Several products tested for PM management on acorn squash ‘Table Queen’ in the Greenhouse

Provided good control

- Serenade (97% control)
- Zonix (91% control)
- Regalia (88% control)

Provided moderate control

- Nordox (52% control)

2023 cucurbit downy and powdery mildew field trials

2023 cucurbit <u>powdery</u> mildew field trial plans

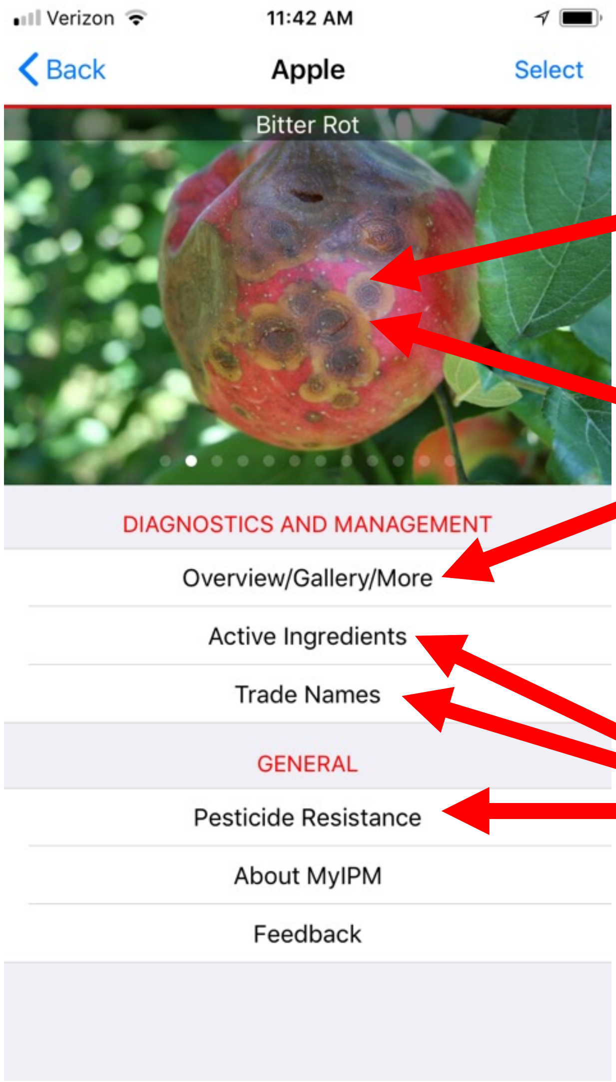
Fungicide	Active Ingredient	Conventional or Organic?	PHI (days)	Resistance reported
Bravo Weatherstik	chlorothalonil	Conventional	2	No
Quintec	quinoxyfen	Conventional	3	Yes
Torino	cyflufenamid	Conventional	0	Yes
Gatten	flutianil	Conventional	0	No
Vivando	metrafenone	Conventional	0	No
Nordox 75 WG	Cuprous oxide	Organic	0	No
Oxidate	hydrogen peroxide/peracetic acid	Organic	0	No
Regalia	Reynoutria sachalinensis	Organic	0	No
Serenade	Bacillus subtilis strain QST 713	Organic	0	No
Zonix	rhamnolipid biosurfactant	Organic	0	No

2023 cucurbit downy mildew field trial plans

Fungicide	Active Ingredient	Conventional or Organic?	PHI (days)	Resistance reported
Orondis Opti	oxathiapiprolin/chlorathalonil	Conventional	2	No
Orondis Ultra	oxathiapiprolin/mandipropamid	Conventional	3	No
Ranman	Cyazofamid	Conventional	0	No
Bravo Weatherstik	chlorothalonil	Conventional	0	No
Revus	Mandipropamid	Conventional	0	No
Nordox 75 WG	Cuprous oxide	Organic	0	No
Oxidate	hydrogen peroxide/peracetic acid	Organic	0	No
Regalia	Reynoutria sachalinensis	Organic	0	No
Serenade	Bacillus subtilis strain QST 713	Organic	0	No
Zonix	rhamnolipid biosurfactant	Organic	0	No

"MyIPM" – free mobile app for fruit growers

In development for vegetables in 2023



- Swipe photos left/right to see different diseases or pests
- Click on picture or Overview/Gallery/More for photos and management info
- Active Ingredients, Trade Names, & Pesticide Resistance geared towards commercial growers

New (ish) EPA regulations

- EPA has always been required to comply with Endangered Species Act (ESA)
  - Historically has only met requirement for <5% of registered products
- EPA facing numerous lawsuits over this
  - Currently >50 a.i.s and >1,000 pesticides under litigation
- Moving forward, EPA will review ALL products for ESA compliance
- **“Every product label likely to see major changes from this”** – Ag chem company reps
- Process slow, new registrations slower than ever

Contact Information

Zach Hansen
zhansen1@utk.edu
G059 McCord Hall
865-974-7784
www.utspecialtycrop.com

@UTSpecialtyCrop

Start the survey here.

Pumpkin Growers Survey

Please complete this survey (QR code or a paper copy), so that we can better understand your production challenges.

Thank you!

Conclusions

Resistance	Product	Active ingredient(s)	For pepper, cucurbit, or both	Efficacy	Application method	Max. consecutive applications	Max. applications per season
Rare	Orondis Gold 200	oxathiapiprolin	both	good	in furrow, transplant water, drip	2	4
Rare	Orondis Opti A	oxathiapiprolin	both	good	foliar	2	6
Rare	Orondis Ultra*	oxathiapiprolin + mandipropamid	both	good	foliar	2	4
None	Revus*	mandipropamid	both	good/fair	foliar	2	4
None/unknown	Zampro	ametoctradin + dimethomorph	both	good/fair	drench, drip, foliar	2	3
Common	Presidio*	fluopicolide	both	good/fair	drip, foliar	1	2
Rare	Ridomil Gold + copper	mefenoxam + copper	pepper	good/fair	varies by crop	4	4
Rare	Ridomil Gold SL, Ultra Flourish	mefenoxam	both	fair	preplant incorporated, soil spray, drip	1	2
Common	Ranman	cyazofamid	both	fair	transplant water, foliar	3	6
Unknown	Reason	fenamidone	pepper	fair	foliar	1	3

Table taken from UT Extension publication W810 “Managing Phytophthora Blight of Peppers and Cucurbits”

Real. Life. Solutions.™

UT EXTENSION
INSTITUTE OF AGRICULTURE
THE UNIVERSITY OF TENNESSEE