

Effective Disease Management Strategies for Cucurbits & Tomatoes

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Important Cucurbit Diseases

- Abiotic diseases
 - ❖ Edema
- Biotic Diseases
 - ❖ Powdery mildew
 - ❖ Downy mildew
 - ❖ Phytophthora blight
 - ❖ Bacterial spot

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Edema (Oedema)



Management: Grow less sensitive cultivars

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Important Cucurbit Diseases

- Powdery mildew

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Powdery Mildew on Cucurbits

- Serious disease on:
 - ❖ Pumpkins (JOL & processing)
 - ❖ Squash (summer & winter)
 - ❖ Melons

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Powdery Mildew: Symptoms

- Symptoms & Signs
 - ❖ Powdery fungal growth (Mycelium and conidia)
- Infected tissues
 - ❖ Vines
 - ❖ Petioles
 - ❖ Upper and lower leaf surfaces
 - ❖ Fruit stems

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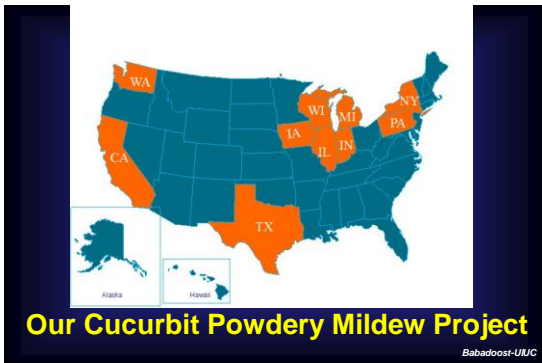
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Host species	Number of collected isolates from each location											Total isolate no.
	CA	IL	IN	MI	NY	PA	TX	WA	WI	Chile	Italy	
<i>Cucumis melo</i>		4									4	8
<i>Cucurbita maxima</i>	3	5	1	3								12
<i>Cucurbita moschata</i>		6		2								8
<i>Cucurbita pepo</i>	10	42	2	5	34	1	4	5	7	1	2	113
<i>Cucumis sativus</i>		7					4				3	14
<i>Lagenaria siceraria</i>								1				1
Unknown	4											4
Total	17	64	3	10	34	1	8	6	7	1	9	160

Hosts and collected locations of isolates of *P. xanthii*

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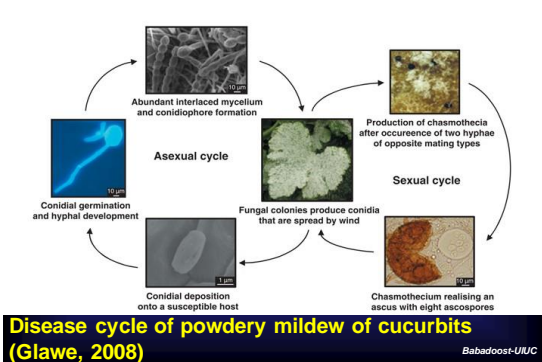
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Cucurbit Powdery Mildew Pathogen in the USA

- Fungus *Podosphaera xanthii*
- No sexual stage of the pathogen
- Considerable genetic variation among the isolates
- Significant fungicide efficacy

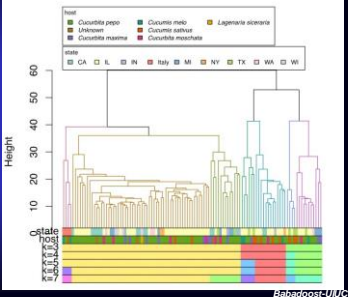
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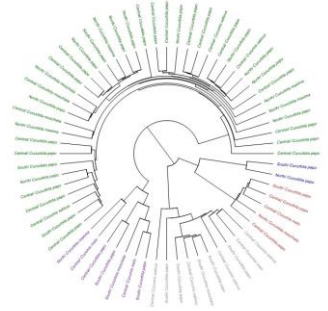
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7 distinct groups (from left to right: red, brown, light green, green, light blue, blue, pink) of 109 *Podosphaera xanthii* isolates (USA)



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Hierarchical clustering on the distance matrix of 64 isolates of *Podosphaera xanthii* from Illinois



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Fungicide Efficacy for Powdery Mildew

- In 2019: Procure, Prolovo, Quintec (IL)
 - More fungicides: The Veg. Prod. Guide
 - No strobilurin, or the highest rates
 - Fungicides needed for resistant cultivars
 - Fungicide application in IL: **After 15 July**
 - Check inside the canopy for PM
 - Efficacy testing: Needed every year
 - See Pumpkin Spray Suggestions
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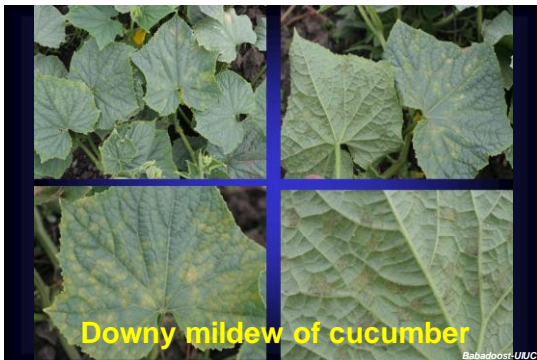
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Important Cucurbit Diseases

- ## ➤ Downy mildew

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Cucurbit downy mildew pathogen

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Cucurbit Downy Mildew

- Downy mildew: **a fungal disease**
- Pathogen: ***Pseudoperonospora cubensis***
- Occurrence: **may or may not occur in IL**
- Importance: **devastating disease**
- Management: **effective fungicides**

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Management of Downy Mildew

- Monitoring pathogen movement: **<http://cdm.ipmpipe.org/>**
- Field scouting is very important
- Accurate disease diagnosis is essential
- Fungicide applications is needed

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Fungicides for Downy Mildew

- Last field trial in Illinois: 2016
- Effective fungicides in Illinois: **Gavel, Omega, Orondis Opti, Orondis Ultra, Presidio, Ranman, Revus, Zampro**
- Suggested fungicides: **Revus, Ranman, or Presidio mixed with chlorothalonil (i.e., Bravo Weather Stik)**

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Important Cucurbit Diseases

- **Phytophthora blight**

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Phytophthora Blight of Vegetables (*Phytophthora capsici*)

Importance:

- *P. capsici* was identified by Leonian in 1922 in New Mexico, USA on pepper
- Now, worldwide occurrence
- Affects >50 species in 15 plant families
- Important in cucurbits and peppers
- Causes up to 100% crop losses

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Major Hosts of *Phytophthora capsici*

- Peppers (*Capsicum* spp.):
 - Causes root rot, fruit rot, defoliation, wilting & plant death
 - Resistant cultivars are available
- Cucurbits all species of Cucurbitaceae
 - Causes damping-off, vine infection, & fruit rot (No Root Rot)
 - NO Resistant Cultivars

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Phytophthora blight of bell pepper

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Phytophthora blight on chili pepper

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Phytophthora blight of pepper

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Phytophthora blight of pepper,
100% crop losses

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Phytophthora damping-off & vine infection

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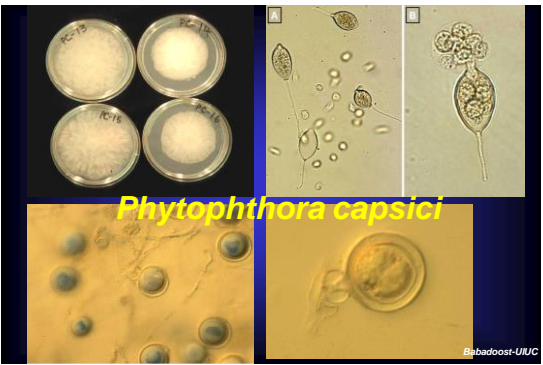
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Phytophthora Blight
(*Phytophthora capsici*)

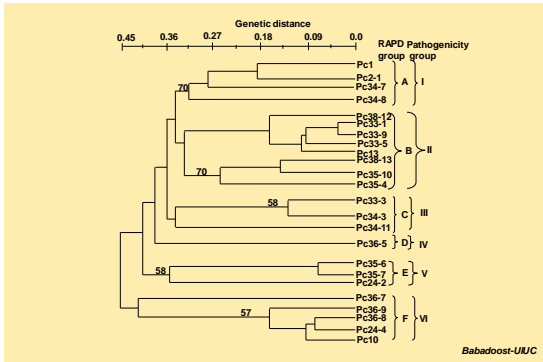
- An oomycete pathogen
- Genetic and pathogenic variations
- Multi-cycle pathogen
- Survival: oospores and mycelium
- Favorable conditions: moist & warm condi.

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Phytophthora Blight of Cucurbits
(Management)

- No resistant cultivar
- Integrated management approaches
 - ❖ Crop rotation
 - ❖ Seed treatment
 - ❖ Fungicide application
 - ❖ Sanitation

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Phytophthora Blight Management

(Host Range: 36 Crops and 9 Weed Species)

Host			Non-Host		
Cantaloupe	Cucumber	Gourd	Corn	Pigweed	Soybean
Eggplant	pepper	Beet	Broccoli	Kale	Cabbage
Pumpkin	Squash	Radish	Crabgrass	Basil	Chives
Zucchini	Watermelon	Turnip	Sandbur	Celery	Dill
Honeydew	Swiss-chard	Carrot	Wheat	Water hemp	Barley
Spinach	Nightshade	Onion	Cocklebur	Lamb's-quarters	
Green bean	Lima bean	Tomato	Mustard	Cauliflower	Kohlrabi
Velvet-leaf	Snow pea	Tobacco	Parsley	Puncture vine	

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Soil Survival of *P. capsici* in Field

- *P. capsici* survived in the field for 48 months.
- Spores were viable after 36 months, but not viable after 48 months; thus, 4 year of crop rotation is effective.

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Managing Seedling Death

- Seed treatment:
 - Mefenoxam (Apron XL LS)**
 - 0.64 fl oz/100 lb seed
 - (0.42 ml/kg seed)
- ❖ **Protection of plants for 5 Weeks**

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Managing Phytophthora on Vine & Fruit

- Since 1999 tested more than 40 potential fungicides and have effective fungicides
 - ❖ Orondis Ultra (FRACs: U15, 40)
 - ❖ Revus: (FRAC: 40)
 - ❖ Ranman (FRAC: 21) + Silwet L-77
 - ❖ Elumin (FRAC: 22)
 - ❖ Presidio (FRAC: 43)
- Spray at weekly schedule
- Follow label directions

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Sanitation



Pumpkin fruit rot in bins in storage, caused by *Phytophthora capsici*

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Pumpkin fruit rot in the field, caused by *Phytophthora capsici*

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Managing Cucurbit Phytophthora Blight

- Recommended practices in Illinois
 - ❖ ≥3 years of effective crop rotations
 - ❖ Seed treatment with mefenoxam
 - ❖ Grow on raised beds, if possible
 - ❖ Avoid using contaminated water
 - ❖ Remove or disk early infected plants
 - ❖ Fungicide applications at first sign of the disease (7-day, alternate)
 - ❖ Effective sanitation

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Important Cucurbit Diseases

- Bacterial spot of leaf and fruit

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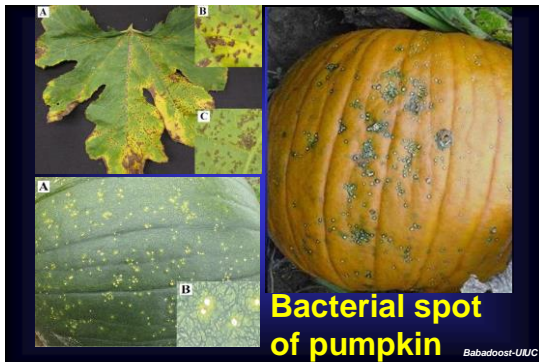
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Cucurbit Bacterial Spot

- Bacterial spot of leaf and fruit
 - ❖ Pathogen: *Xanthomonas cucurbitae*
 - ❖ Areas occurs: All over the world
 - ❖ Major hosts: pumpkin & winter squash
 - ❖ Favorable conditions: Wet & warm conditions

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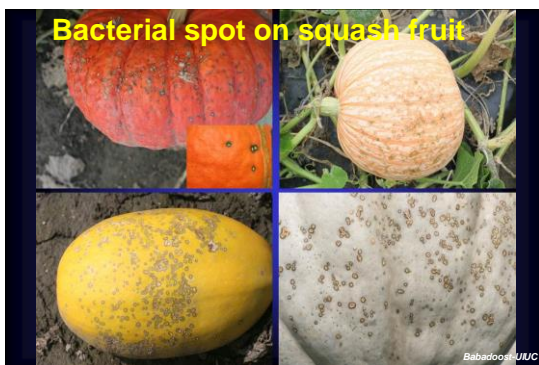
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Plant Infection by *X. cucurbitae*

- Leaf infection: Any time from 4-leaf growth stage - harvest
- Fruit infection: Any time from baseball size to harvest
- ❖ **Consideration:** Plants should be protected from 4-leaf stage until harvest

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Fruit Rot

- Does *X. cucurbitae* cause fruit rot?
 - ❖ **Answer:** NO, fruit rot is caused by other colonizing organisms (i.e., *Erwinia* and *Fusarium* species)
 - ❖ **Consideration:** If fruits with spots are harvested, keep them dry

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Host Range of *X. cucurbitae*

- In a greenhouse investigation, we found that *X. cucurbitae* is pathogenic only on plants of the Cucurbitaceae family
 - ❖ **Conclusion:** All non-cucurbit crops can be considered in crop rotation for managing *X. cucurbitae*

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Survival of *Xanthomonas cucurbitae* in the Field and in/on Seeds

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Field survival of *Xanthomonas cucurbitae*



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Xanthomonas cucurbitae: Survival

- Field survival: *X. cucurbitae* survived longer than 24 months with pumpkin leaves and fruit tissues and the bacterial were viable
- ❖ **Consideration:** 3-year crop rotation with non-cucurbits

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Xanthomonas cucurbitae: Seed Survival

- Seed: *X. cucurbitae* survived longer than 18 months in naturally-infected and artificially-inoculated seeds at 39°F and 72°F (4°C and 22°C)
- ❖ **Conclusion:** Infected/infested seeds will likely be free of *X. cucurbitae* in 3 years

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Seed Treatments

- Hot-water: 55°C for 15 min
- HCl: 0.5% for 40 min
- NaClO: was not effective
- ❖ **Conclusion:** Seed treatment with hot-water or HCl eradicate *X. cucurbitae* in/on seeds without significantly affecting seed germination and seedling vigor

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Plant Resistance

- We have screened more than 400 accessions/cultivars of pumpkins and squashes in the greenhouse and field for their resistance to *X. cucurbitae*
- ❖ **Conclusion:** No highly resistant accession/cultivar was found, but there were less susceptible ones

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Management of Bacterial Spot with Chemical Compounds and Biocontrol Agents: Lab and Field Studies

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List of compounds tested

Chemicals:

1. ActiGard 50 WG	14. SciEx83-3S
2. Agion E	15. SciEx83-4S
3. Agrimycin 17 WP	16. Tanos 50 DWG
4. Badge X2 DF	17. Quintec 2.08 SC
5. Cuprofix Ultra 40 DF	
6. Cueva FL	Biocontrol agents
7. Diathane 75 DF	18. Actinovate AG
8. Kasumin 2L	19. Cx-9030
9. Kocide 3000 46.1 DF	20. Regalia
10. Mil-Stop SP	21. Serenade ASO
11. Mycoshield 17 WP	22. Sonata ASO
12. Nordox 75 DF	23. Several new agents
13. Phyton-016B	

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Conclusions:

- Incidence and severity of bacterial spot on leaves and fruit were reduced by application of some chemicals and biocontrol agents, but not effectively controlled.
- Effective chemicals: **Kocide-3000 (M1), Manzate PRO Stick (M3), Regalia (P5), Quintec (13)**. Manzate, Quintec, or Regalia should be mixed with Kocide.

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Managing Bacterial spot

- Recommended practices
 - ❖ **Plant pathogen-free seed or disease-free seedlings**
 - ❖ **≥3 years crop rotation with non-cucurbits**
 - ❖ **Begin spray application at vine spread or earlier**

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Tomato Diseases

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Important Tomato Diseases, 2019

- Outdoor production
 - ❖ **Bacterial diseases**
 - ❖ **Fungal diseases**
- Indoor production
 - ❖ **Bacterial diseases** (bacterial canker)
 - ❖ **Fungal diseases** (white mold, leaf mold, Verticillium wilt)

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Tomato Diseases Updates

➤ Outdoor production - 2019

❖ Bacterial diseases

- ✓ Bacterial canker
- ✓ Bacterial speck
- ✓ Bacterial spot

❖ Fungal diseases

- ✓ Early blight
- ✓ Septoria leaf spot
- ✓ Anthracnose

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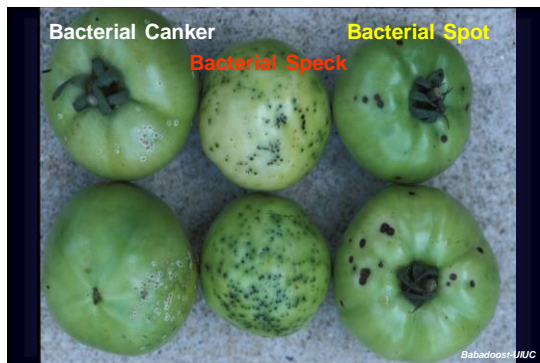
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Bacterial Diseases of Tomatoes

- Bacterial canker: *Clavibacter michiganense* pv. *michiganense*
- Bacterial speck: *Pseudomonas syringae* pv. *tomato*
- Bacterial spot*: *Xanthomonas* spp.

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Bacterial Spot of Tomato

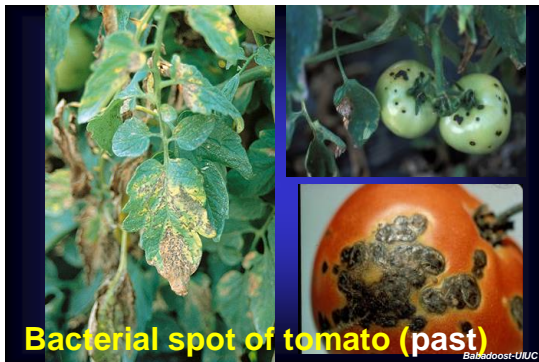
Pathogen: *Xanthomonas* spp.

New findings

- Occurrence: an annual disease
- Variety susceptibility: different
- Damage: mainly foliage necrosis, less incidence on fruits

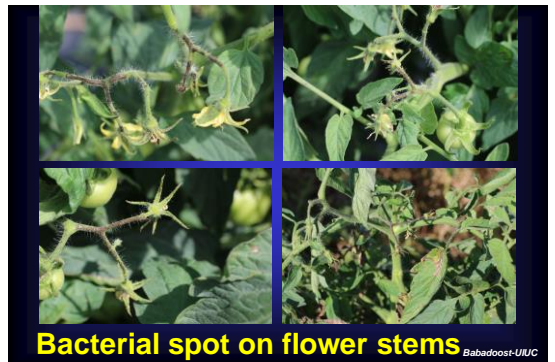
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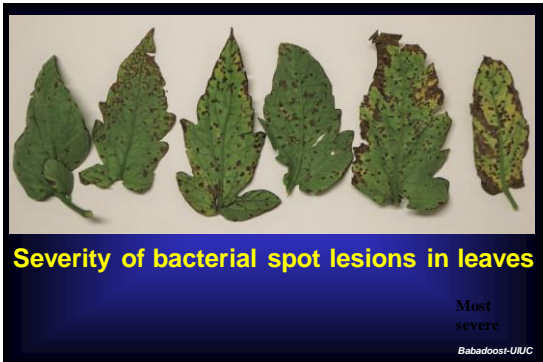


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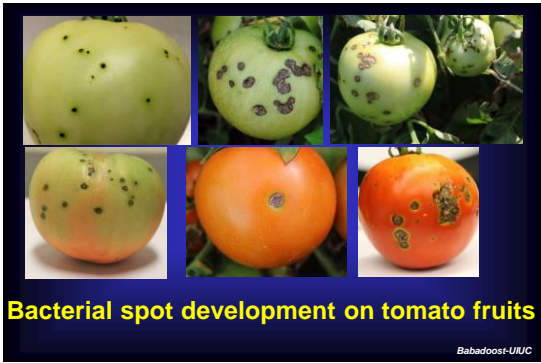
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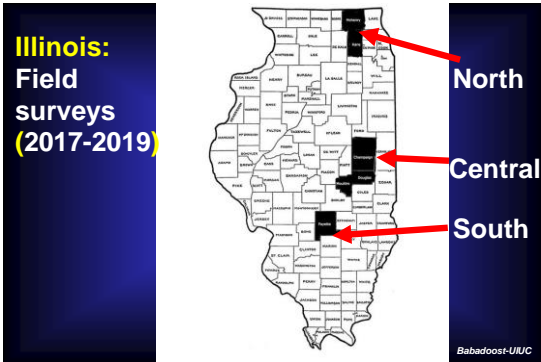
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Our Research on Bacterial Spot

- Research: 2017 - 2019
- Field survey: monitored development of bacterial spot in the south, central, & north
- Monitored tomato cultivars: Biltmore, Carolina Gold, Brandywine, Chefs Choice, Dixie Red, Heirloom, Phoenix, Primo Red, Pony Express, Red Duce, Red Morning, Rocky Top
- None resistant to bacterial spot
- Species identification: *X. vesicatoria* (past)
Now: *X. gardneri* and *X. perforans*

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Number of Samples Collected

Region	# Farm (# fields)	# Sample collected	
		Foliage	Fruit
Northern	3 (9)	59	18
Central	3 (6)	28	3
Southern	3 (12)	70	9
Total	9 (27)	157	30

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Severity of Bacterial Spot - Foliage (%)			
Region	2017	2018	2019
Northern	4-19 (12)	38-91 (64)	0-88 (46)
Central	3-5 (4)	9-19 (10)	5-75 (55)
Southern	9-38 (20)	9-81 (50)	45-92 (70)

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Incidence of Bacterial Spot - Fruits (%)			
Region	2017	2018	2019
Northern	<10	10-25	15-25
Central	0	0	20-30
Southern	<5	10-20	<5

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Xanthomonas Species Collected				
Region	Foliage		Fruit	
	<i>X. gardneri</i>	<i>X. perforans</i>	<i>X. gardneri</i>	<i>X. perforans</i>
Northern	54	9	24	4
Central	13	17	4	2
Southern	34	94	4	7
Total	101	120	32	13
Total: 266 isolates				

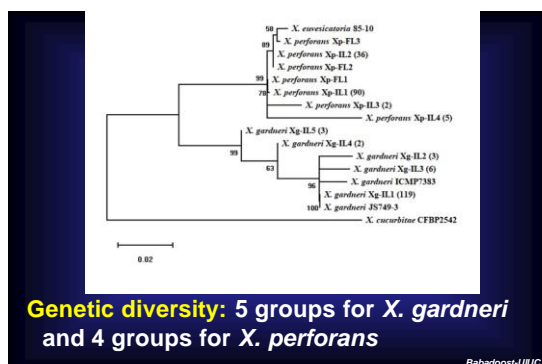
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Bacterial Spot of Tomato in Illinois	
➤ Dominant species in northern Illinois:	<i>X. gardneri</i>
➤ Dominant species in southern Illinois:	<i>X. perforans</i>
➤ Dominant species on fruits in Illinois:	<i>X. gardneri</i>

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Managing Tomato Bacterial Diseases	
➤ Plant less susceptible/tolerant cultivars	
➤ Plant pathogen-free seed and seedlings	
➤ A 3-year crop rotation	
➤ Field sanitation: remove old material	
➤ Plant varieties separately	
➤ Control volunteer plants and weeds	
➤ Use clean crates, boxes, and stakes	
➤ Do not enter the field if the foliage is wet	
➤ Disinfect pruning tools	

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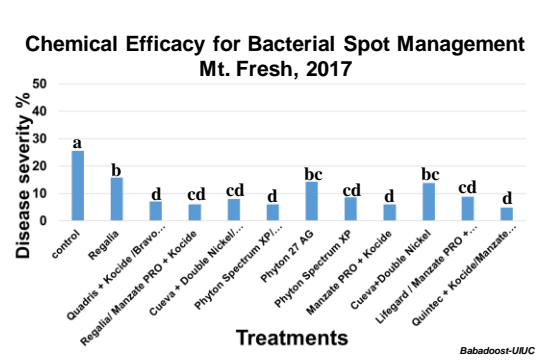
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Managing Tomato Bacterial Diseases

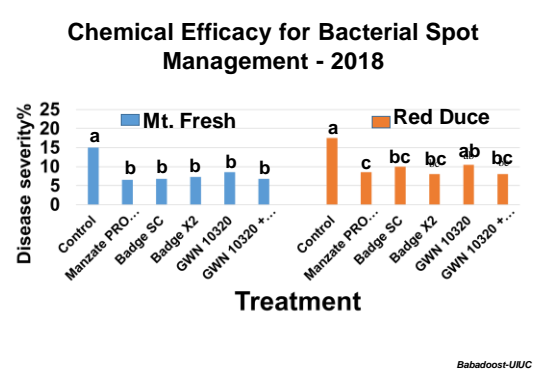
- Avoid cull pile in the field
- Scout your field weekly (**Not in Wet Con.**)
- Spray plants with effective bactericides; beginning at first sign of the disease

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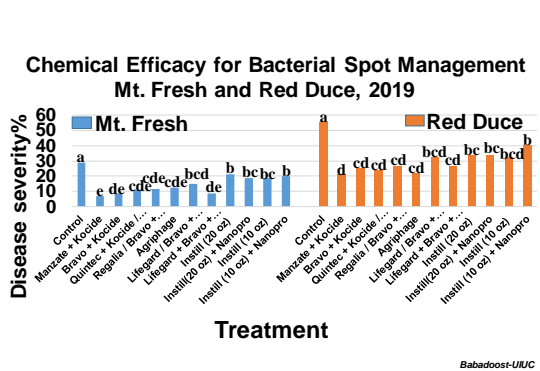
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Effective Chemicals for Managing Tomato Bacterial Spot

- Effective chemicals: Kocide-3000, Manzate PRO Stick, Agriphage, Regalia, Lifegard, Quintec
- Recommended sprays:
Manzate PRO Stick + Kocide-3000
alternated with
Regalia + Kocide-3000

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Common Fungal Diseases of Tomato

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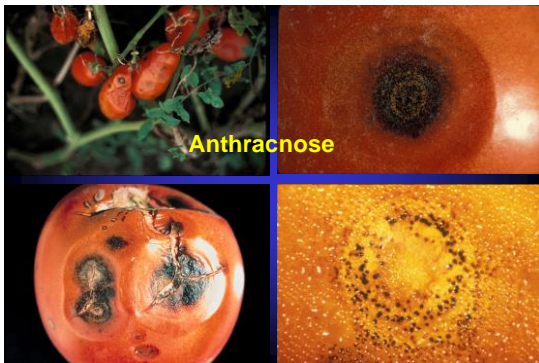
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Management of Tomato Early Blight, Septoria Leaf Spot, and Anthracnose

- Crop rotation: 3-4 years
- Fungicide use:
 - Quadris**
 - Alternated with*
 - Chlorothalonil (i.e., Bravo W. Stik)**

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