IPM Strategies to Minimize Foliar Diseases in Vegetables

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IPM Strategies-outline

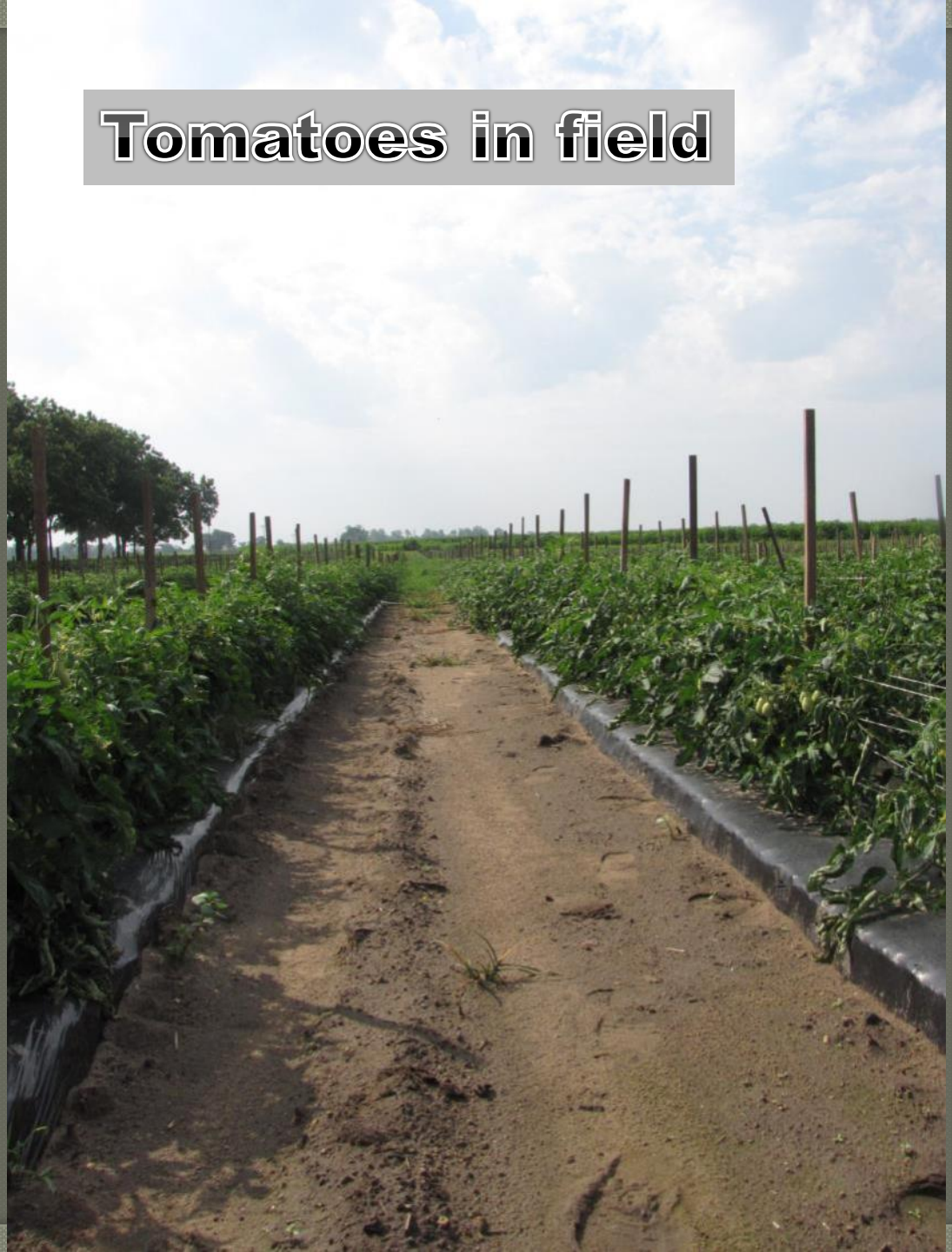
- Crop rotation
  - Featuring high tunnels
- Host resistance
  - Complete vs. incomplete resistance
- Fungicides
  - Fungicide selection
  - Fungicide timing
  - Fungicide resistance

Crop rotation

- Many disease causing microbes survive in crop residue.
- Anything that reduces crop residue, lessens chance of severe disease.
  - Crop rotation
  - Fall tillage

Plant pathogens may lurk in crop residue

Tomatoes in field



Tomato-year 2

Tomato-year 3

Tomato-year 1

Tomato-year 4

~~Crop rotation~~

Onions-year 2

Watermelon-year 3

Corn-year 4

Tomato-year 1

Crop rotation

Tomatoes in high tunnel

Tomato-year 2

Tomato-year 3

Tomato-year 1

Tomato-year 4

~~Cr[illegible]tion~~

Tomatoes in high tunnel

Minimizing diseases in HT

- Reduce crop residue
  - Crop rotation
  - Remove crop
  - Floor covering
- Increase aeration
  - Correct spacing
  - Prune lower branches
  - Ventilation

Host Resistance

- Complete resistance
- Incomplete resistance
  - Listed in seed catalogues
  - Not listed

Host resistance examples

- Tomato-VFN
- Pepper-bacterial spot-races
- Pumpkin-powdery mildew-partial
- Watermelon-pollenizers
  - Fusarium wilt-partial
  - Anthracnose-partial

Variety info in MW Veg Prod Guide.

Fruiting Vegetables — Pepper

Varieties	Season	Fruit Shape	Color[1]	DisTol/Res[2]	Comments
Alliance	mid-early	blocky, 3-4 lobes	G>R	BLS-1,2,3,4,5, CMV, PHY, PMV, PVY,	Large peppers
Archimedes	main	blocky, 3-4 lobes	G>R	BLS-1,2,3,7,8, PHY	
Aristotle X3R	main	blocky	G>R	BLS-1,2,3	Very consistent
Crusader	main	blocky	G>R	BLS-1,2,3, TMV, PVY, PMV, Stip	Dark green
Declaration	early-main	blocky 3-4 lobes	G>R	BLS-1,2,3,5, CMV,PHY	
Karisma	main	blocky 3-4 lobes	G>R	BLS-1,2,3, CMV,PMV,TMV,	
Lafayette	main	blocky	G>Y	BLS-1,2,3, PVY	Not for sandy soils
Paladin	early-main	long blocky	G>R	PHY	
PXX09941819	main	blocky, 3-4 lobes	G>R	BLB-1,2,3,4,5,	Large, blocky fruit
Revolution	main	blocky	G>R	BLS-1,2,3,5, CMV, PHY	Large peppers, not recommended for Iowa
Vanguard	main	blocky 4 lobe	G>R	CMV,PHY, BLS-1,2,3,4,5	

[1]Immature to ripe fruit color: G=green, R=red, Y=yellow
[2]Disease resistance or tolerance as reported by seed company. BLS-1,2,3=bacterial spot strains 1,2, and 3; CMV=cucumber mosaic virus; PHY=Phytophthora; PMV=pepper mottle virus; PVY=potato virus Y; TMV=tobacco mosaic virus.

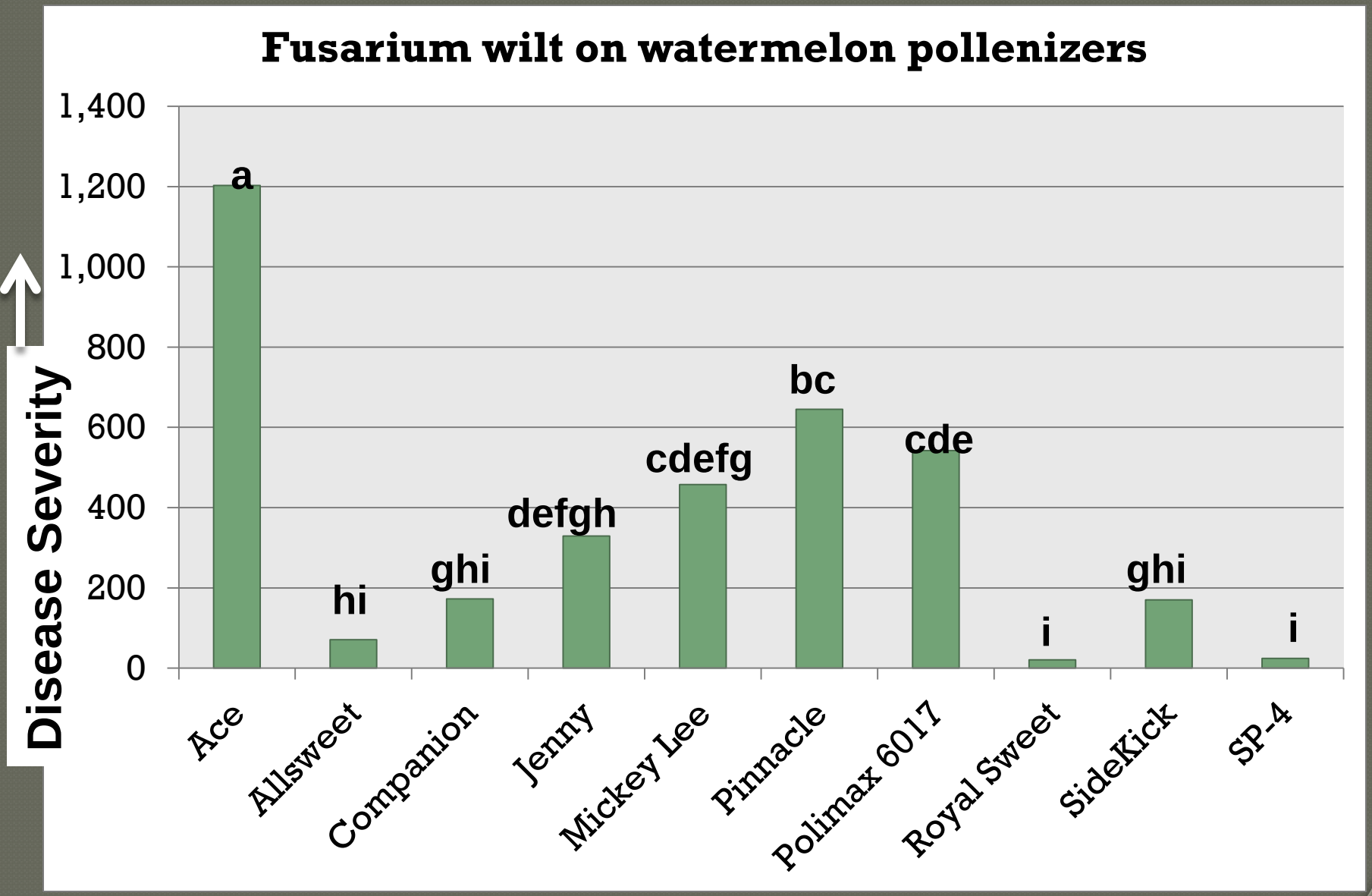
Fusarium wilt of watermelon

Fusarium wilt management

- Crop rotation >6 years
- Partial resistance
- Field/greenhouse sanitation
- No fungicides

Fusarium wilt of watermelon
Incomplete resistance-greenhouse trial

Fusarium wilt of watermelon
Incomplete resistance-field trial


Fusarium wilt on watermelon pollenizers
Disease Severity
1,400
1,200
1,000
800
600
400
200
0
a
hi
ghi
defgh
cdefg
bc
cde
i
ghi
i
Ace
Allsweet
Companion
Jenny
Mickey Lee
Pinnacle
Polimax 6017
Royal Sweet
SideKick
SP-4

Watermelon Variety Resistance to Fusarium Wilt[1]

Variety	Company	Type	Resistance[2]
Afternoon Delight	Dwayne Palmer	triploid	+1/2
Crunchy Red	Harris Moran	Triploid	++
Distinction	Syngenta seeds	Triploid	+
Fascination	Syngenta Seeds	triploid	++++
Fiesta	Syngenta Seeds	diploid	++1/2
Indiana	Seedway	triploid	++
Liberty		triploid	++
Palomar	Syngenta Seeds	triploid	+
Matrix		triploid	+++1/2
Melody		triploid	+++
Regency	Seminis	diploid	++++
Revolution		triploid	+
Royal Sweet	Seminis	diploid	++
Summer Sweet 5244	Abbott & Cobb	triploid	++
Summer Sweet 7167	Abbott & Cobb	triploid	+
SW 4502	Seedway	triploid	+1/2
Trillion	Abbott & Cobb	triploid	+1/2
Triple Threat		triploid	+++
Tri-X-313	Syngenta Seeds	triploid	+1/2
Troubadour	Harris Moran	Triploid	++
Vagabond		triploid	+++1/2

Pollenizer Watermelon Resistance to Fusarium Wilt

Variety	Type	Resistance[1]
Ace	pollenizer	+
Companion	pollenizer	+++1/2
Jenny	pollenizer/edible	++1/2
Mickey Lee	pollenizer/edible	++1/2
Pinnacle	pollenizer	+1/2
Polimax 6017	pollenizer	++
Sidekick	pollenizer	+++1/2
SP-5	pollenizer	++++
Regency	pollenizer/edible	++++

Table of Fusarium wilt resistance- Page 97 2014 MW Veg Prod Guide

+ is susceptible

++++ is resistant

I. Improperly diagnosis a plant problem

Anthracnose

Gummy stem blight

Which is anthracnose & which is gummy stem blight of watermelon?

Does it matter?

Products for anthracnose
Cabrio
chorothalonil
Inspire Super
Luna Experience
mancozeb
Pristine
Quadris
Tanos
Topsin M

Products for gummy stem blight
Cabrio*
chorothalonil
Inspire Super
Luna Experience
mancozeb
Monsoon, Toledo
Pristine*
Quadris*
Switch
**resistance possible*

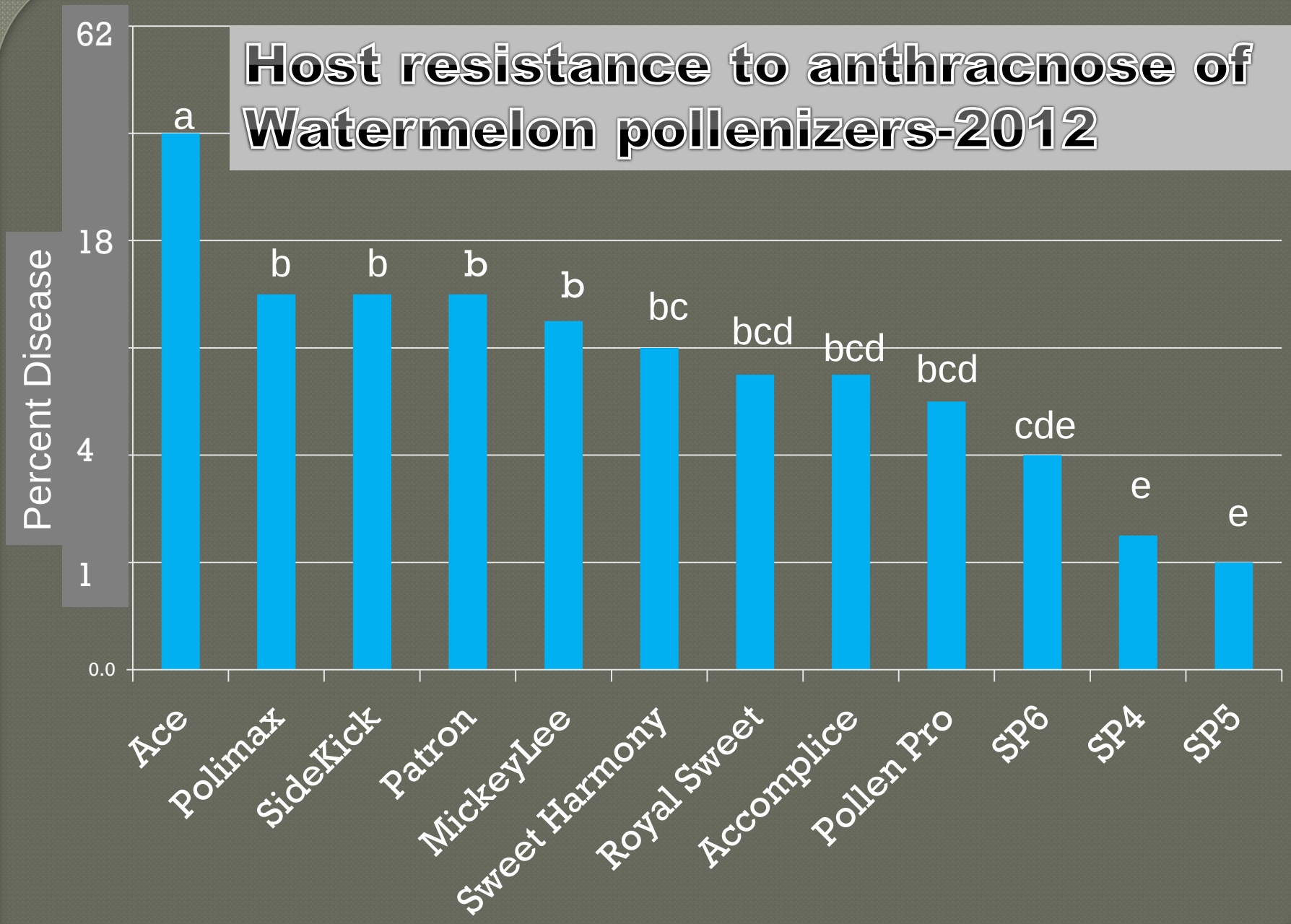
Does it matter?

Anthracnose management

- Crop rotation ~3 years
- Fall tillage
- Field/greenhouse sanitation
- Timely fungicide applications

Incomplete resistance
Example: anthracnose of watermelon

Host resistance to anthracnose of Watermelon pollenizers-2012



Host resistance of watermelon pollenizers-2013

Table of watermelon pollenizer anthracnose resistance-Page 98 2014 MW Veg Prod Guide

Variety	Type	Resistance[1]
Accomplice	pollenizer	++1/2
Ace	pollenizer	+
Mickey Lee	pollenizer/edible	++
Patron	pollenizer	++
Pollen pro	pollenizer	+++
Pollimax 6017	pollenizer	++
Royal Sweet	edible	++
Sweet Harmony	pollenizer	++1/2
SP-4	pollenizer	++++
SP-5	pollenizer	++++
SP-6	pollenizer	++++

+ is susceptible

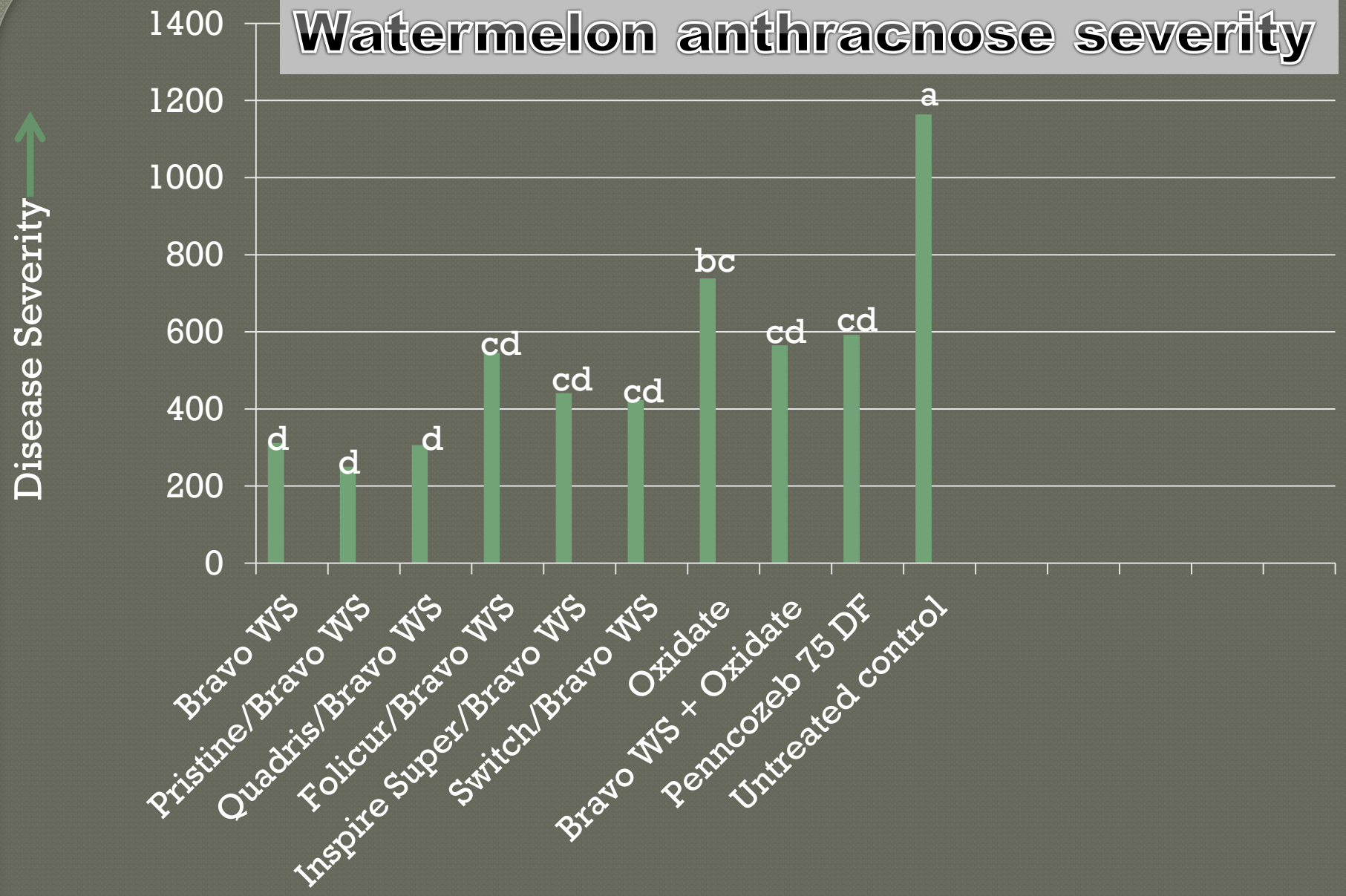
++++ is resistant

Anthracnose of watermelon

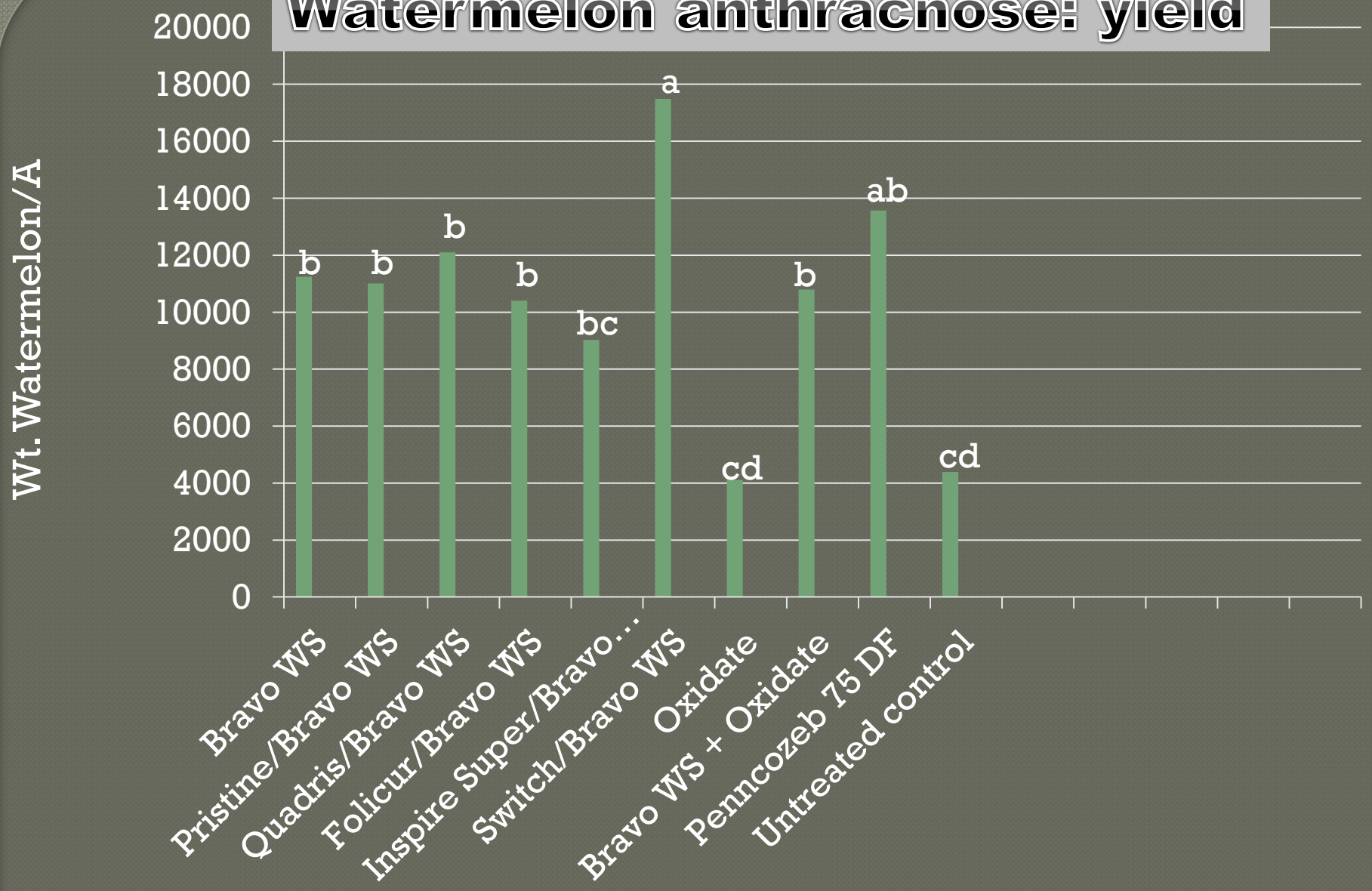
Fungicide selection

- Fungicide trials

Watermelon anthracnose severity



Watermelon anthracnose: yield



Bravo WS vs. Untreated Check

Quadris/Bravo WS vs. Oxidate

Fungicide recommendations in the MW Veg Prod Guide.

Product/Disease Ratings for All Cucurbits

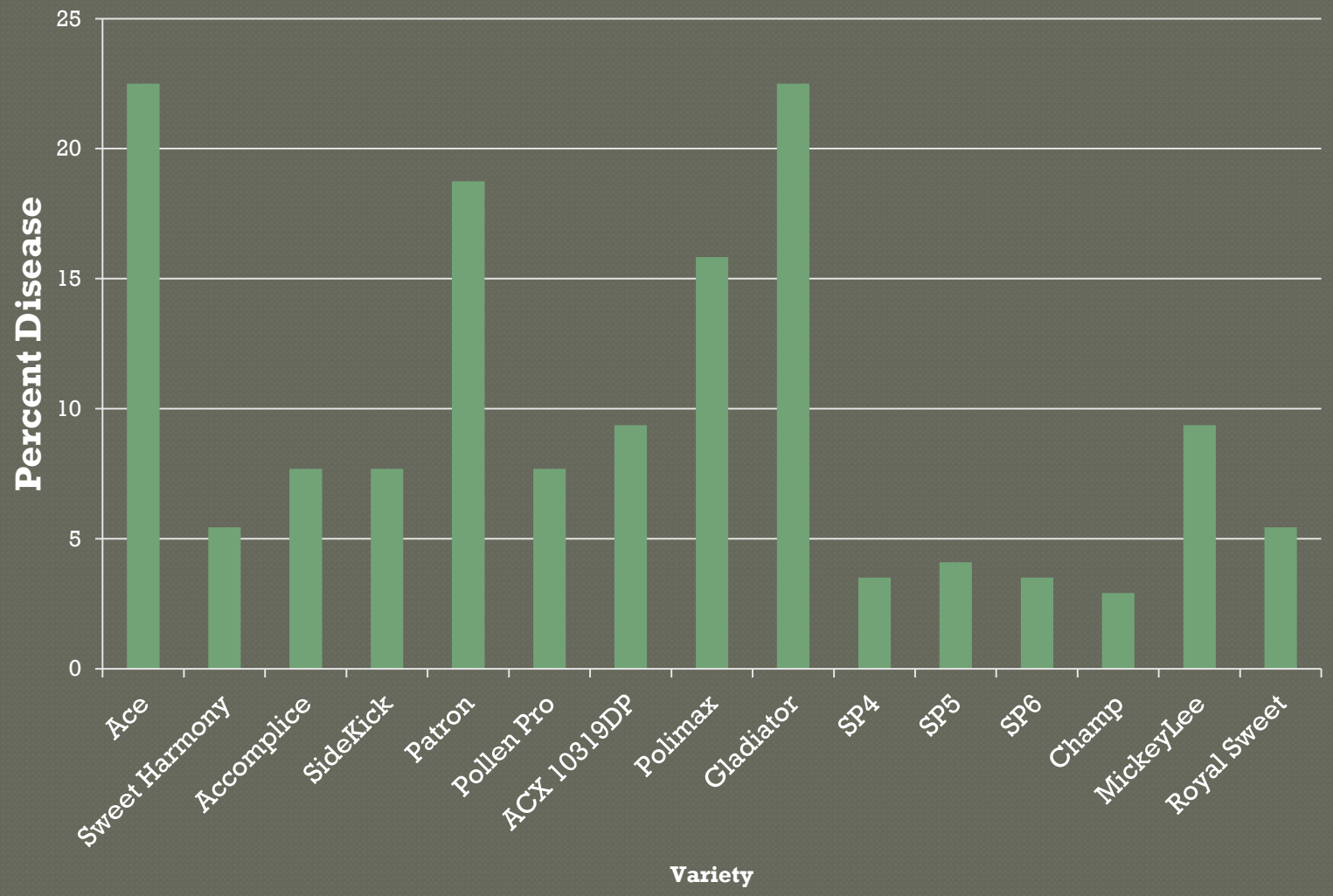
Product (REI/PHI)[1]	Common name MOA or FRAC code: fungicides with a number as the MOA code should be tank mixed or alternated with a different MOA code according to the label.	Alternaria leaf blight	Anthracnose	Bacterial fruit blotch	Bacterial fruit spot	Downy mildew	Gummy stem blight/black rot	Plectosporium blight	Phytophthora blight	Powdery mildew	Scab	Comments
Agri-Fos®, Phostrol®, Prophyt® (4/0)	phosphorus acid/phosphite (33)					G[2]	F		F			
Aliette® 12/1/2)	fosetyl-Al (33)					F			P			
Bravo®, Echo®, Equus® (12/0)	chlorothalonil (M)	G	G			F	G	G	P	F	G	
Cabrio® (12/0)	pyraclostrobin (11)	G	G			F	F	G		F		There may be resistance issues with downy mildew and gummy stem blight.
copper (active ingredient) (24/0)	copper (M)	P	P	G	F	P	P					
Curzate® (12/3)	cymoxanil (27)					G						
Dithane®, Manzate®, Penncozeb® (24/5)	mancozeb (M)	G	G			F	G	G			G	
Flint® (12/0)	trifloxystrobin (11)					F		F		F		
Fontelis® (12/1)	penthiopyrad (7)	G					G			G		There may be resistance issues with downy mildew and gummy stem blight.
Gavel® (48/5)	mancozeb (M), zoxamide (22)	G				G			G			
Inspire Super® (12/7)	difenoconazole (3), cyprodinil (9)	G	G				G	G		G		
Luna Experience® (12/7)	tebuconazole (3), fluopyram (7)	G	G				G			G		Watermelon only.
Luna Privilege® (12/3)	fluopyram (7)	G					G			G		Watermelon only.
Luna Sensation® (12/0)	trifloxystrobin (11), fluopyram (7)	G	G							G		Watermelon only.
Monsoon®, Onset®, Toledo® (12/7)	tebuconazole (3)						G			G		
Presidio 4SC® (12/2)	fluopicolide (43)					G			G			
Previcur Flex® (12/2)	propamocarb (28)					G						Has greenhouse label for damping-off
Pristine® (12/0)	boscalid (7), pyraclostrobin (11)	G	G			F	F			G		There may be resistance issues with downy mildew and gummy stem blight.
Procure® (12/0)	triflumizole (3)									G		
Quadris® (4/1)	azoxystrobin (11)	G	G			F	F	G		F		There may be resistance issues with downy mildew and gummy stem blight.
Quadris Opti® (12/1)	azoxystrobin (11), chlorothalonil (M)	G	G			F	F			F		
Quintec® (12/3)	quinoxyfen (13)									G		Contact fungicide with single mode of action
Rally® (24/0)	mycolobutanil (3)									G		
Ranman® (12/0)	cyazofamid (21)					G			G			
Revus® (4/0)	mandipropamid (40)					F			G			
Ridomil Gold Bravo® (48/0)	mefenoxam (4), chlorothalonil (M)		G			F	G					
Switch 62.5WB® (12/1)	cyprodinil (9), fludioxanil (12)	G					G			F		
Tanos® (12/3)	cymoxanil (27), famoxadone (11)	G	G	S		G			S			
Topsin M® (12/0)	thiophanate-methyl (1)		G				F			P		
Torino® (4/0)	cyflufenamid (U6)									G		
Zampro (12/0)	ametoctradin (45), dimethomorph (40)					G			G			See label for directions for at planting drench.

[1]REI (re-entry interval) in hours: do not enter or allow workers to enter areas treated during the REI period. PHI (pre-harvest interval) in days: the minimum time that must pass between the last pesticide application and crop harvest.
[2]Fungicide rating code: G=good. F=fair. P=poor. S=suppression only. Based on research and experience of the authors.

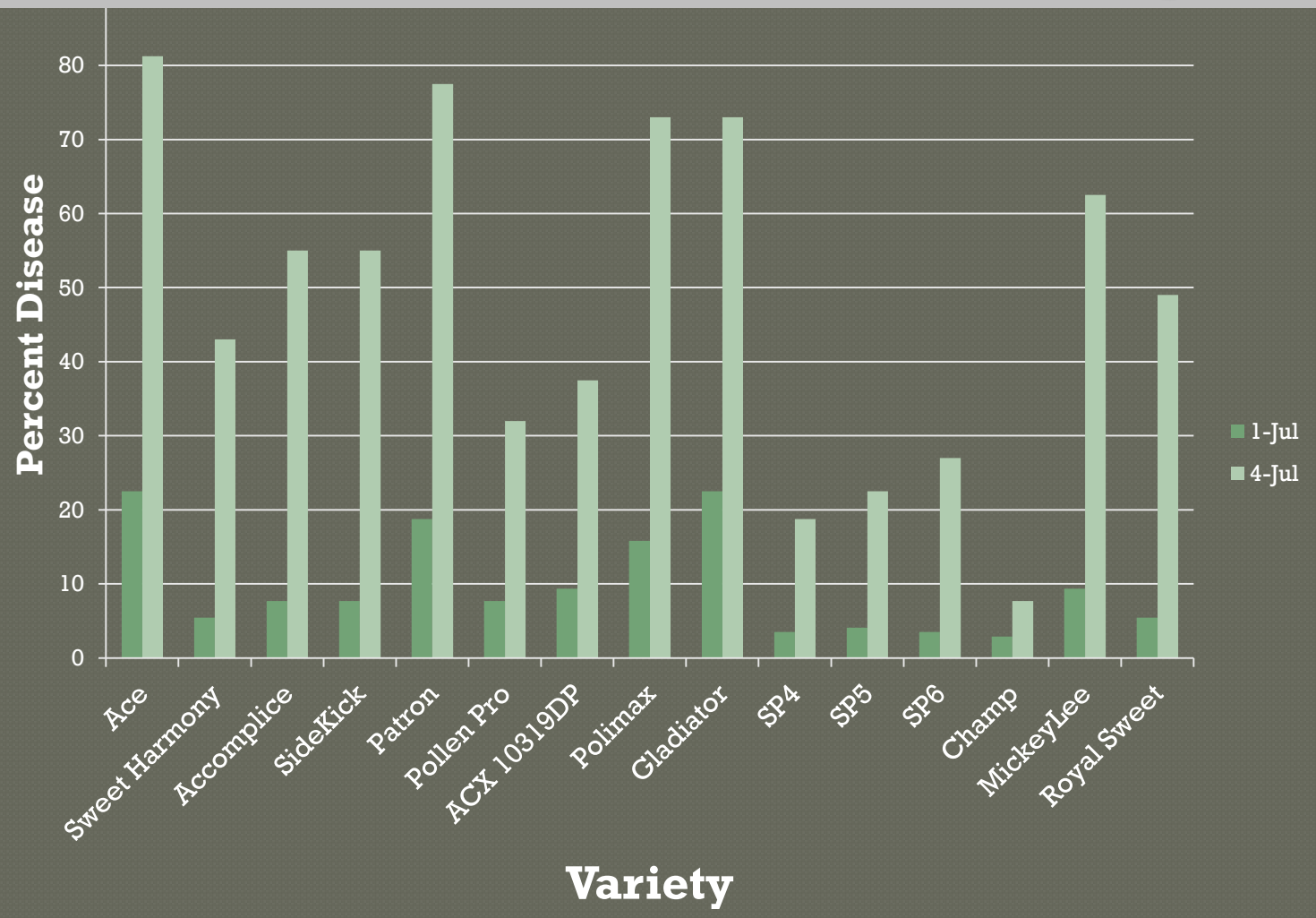
Fungicide timing

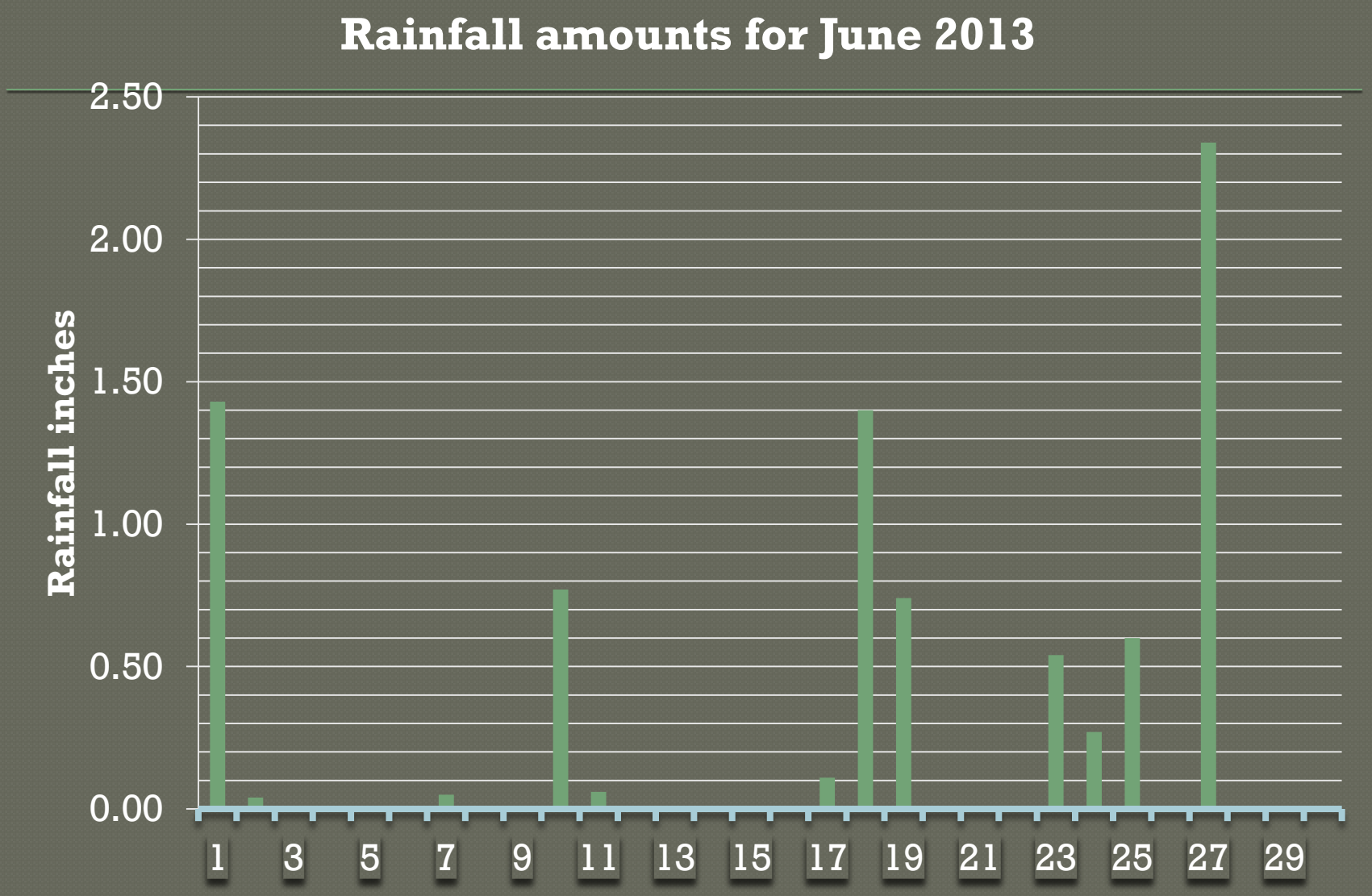
- Re-visit pollenizer trial

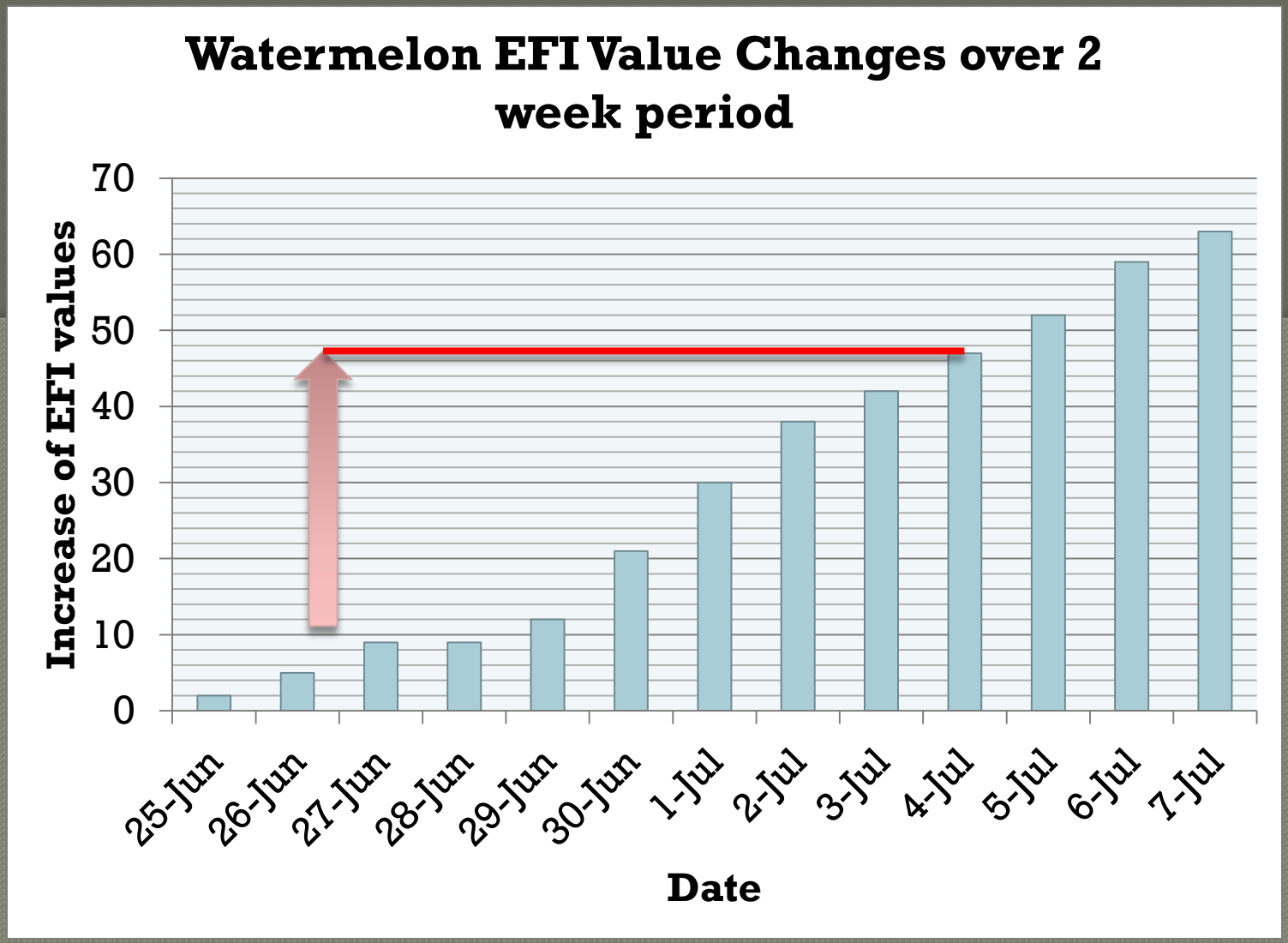
Anthracnose of watermelon-July 1 2013



Anthracnose of watermelon-July 4 2013




Rainfall amounts for June 2013
Rainfall inches
2.50
2.00
1.50
1.00
0.50
0.00
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29


Watermelon EFI Value Changes over 2 week period
Increase of EFI values
70
60
50
40
30
20
10
0
25-Jun
26-Jun
27-Jun
28-Jun
29-Jun
30-Jun
1-Jul
2-Jul
3-Jul
4-Jul
5-Jul
6-Jul
7-Jul
Date

How often should I spray?

- Most intervals should be 7-14 days.
- The frequency of rain is more important than the amount.
- A rain in the evening may be more impt than one at midday.
- It is best to spray before rain if possible.
- Poor crop rotation affects spray intervals.

Fungicide resistance

- Gummy stem blight
- Powdery mildew

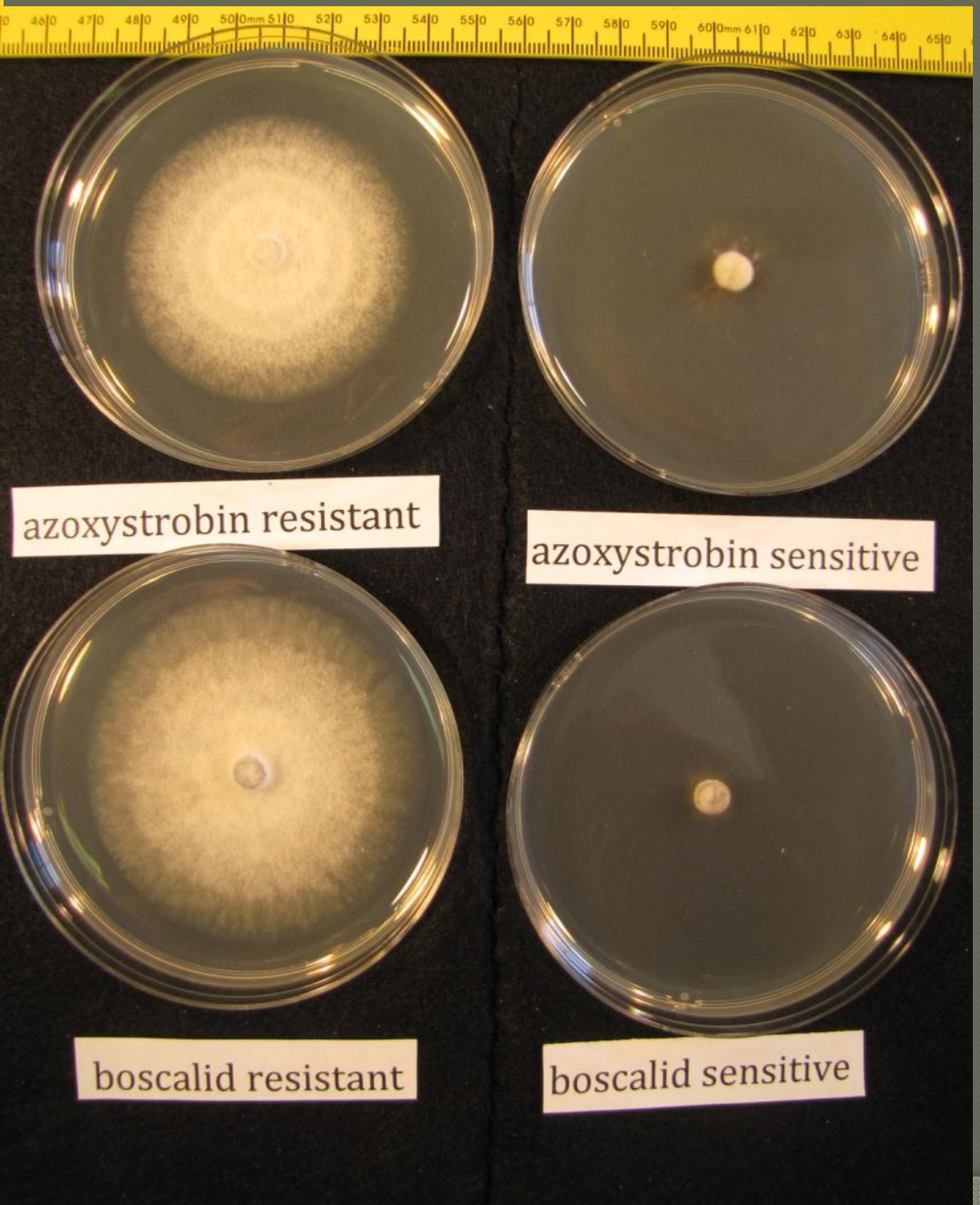
Gummy stem blight of watermelon (out-of-control)

Gummy stem blight of watermelon

My fungicide stopped working—Why?

- Severe disease pressure?
- Improper calibration?
- Improper rate?
- Is disease/crop on label?
- Fungicide resistance?

Gummy stem blight causal organism *Didymella bryoniae*



Nathan Kleczewski data

azoxystrobin=Quadris.
MOA group 11

boscalid=1/2 of Pristine*
Group 7

*the other i.a. in Pristine
is pyraclostrobin
MOA Group 11

Host: Cucurbits

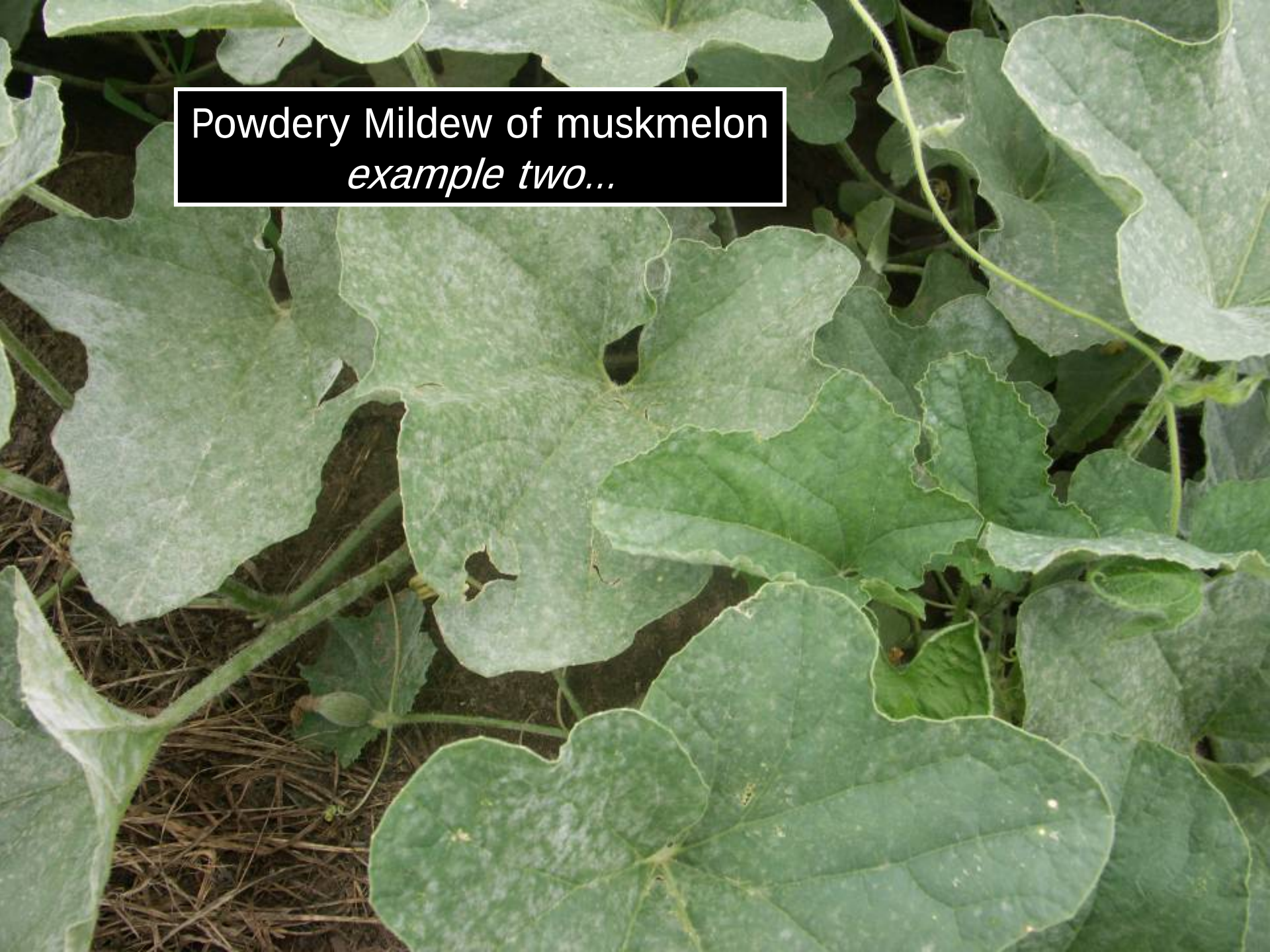
Disease: Gummy stem blight/black rot

Products with possible fungicide resistance:

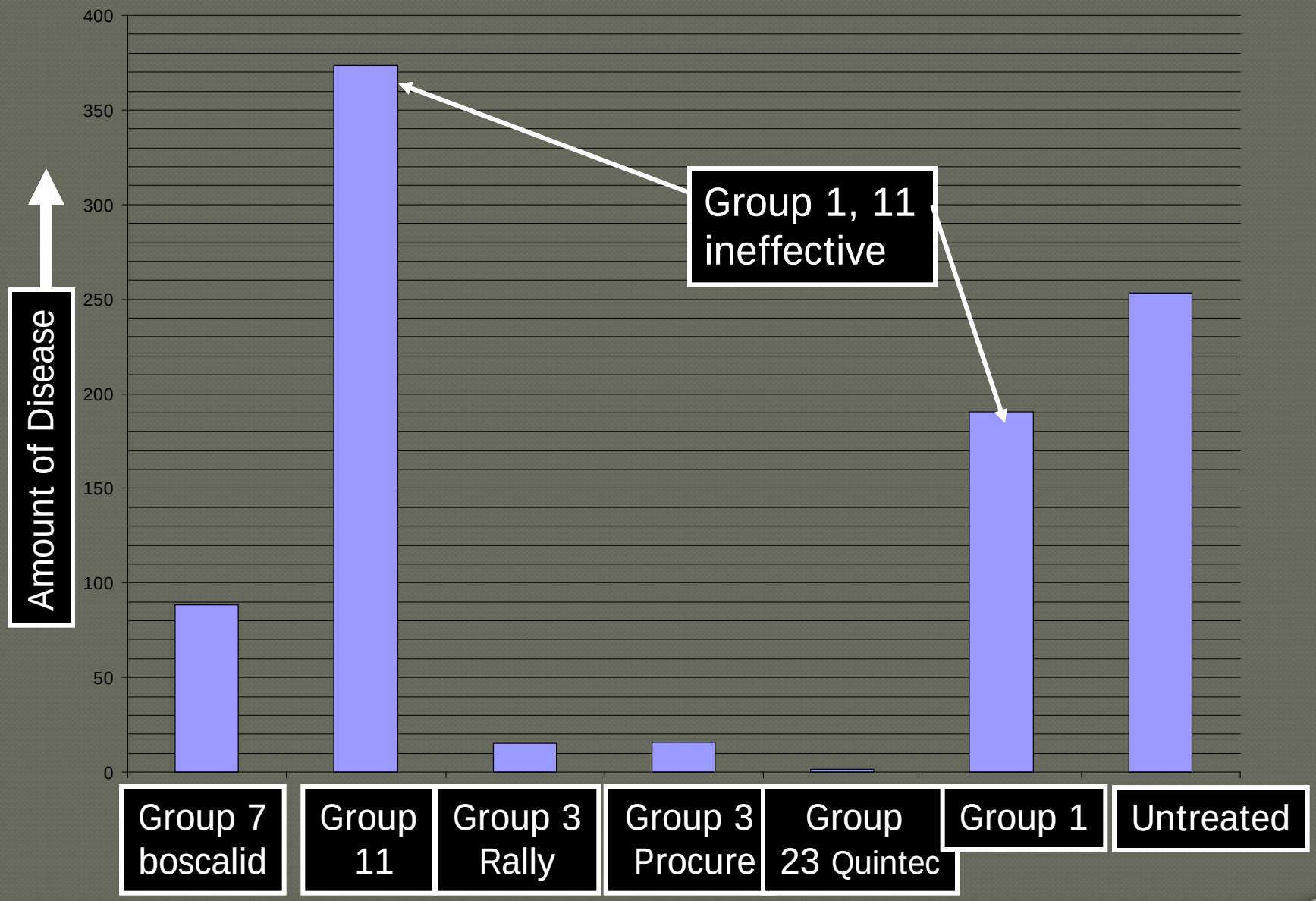
- Quadris (azoxystrobin (11));
- Cabrio (pyraclostrobin (11))
- Pristine (boscalid (7), pyraclostrobin (11))

Host: Cucurbits
Disease: Gummy stem blight/black rot
Alternative products:

- Bravo, Echo, Equus, Initiate (chlorothalonil)
- Dithane, Manzate, Penncozeb (mancozeb)
- Inspire Super (cyprodinil (9), difenoconazole (3))
- Luna Experience (fluopyram (7), tebuconazole (3))
- Luna Privilege (fluopyram (7))
- Monsoon, Toledo (tebuconazole (3))
- Switch (cyprodinil (9), fludioxonil (12)


Powdery Mildew of muskmelon
example two...

Powdery Mildew Assay



Host: Cucurbits

Disease: powdery mildew

Products with possible fungicide resistance:

- Quadris (azoxystrobin (11))
- Cabrio (pyraclostrobin (11))
- Topsin M 70WDG (thiophanate-methyl (1))

Host: Cucurbits
Disease: powdery mildew
Alternative products:

- Microthiol 80 DF (sulfur)
- Fontelis 1.67SC (Penthiopyrad (7))
- Inspire Super (cyprodinil (9), difenoconazole (3))
- Luna Experience (fluopyram (7), tebuconazole (3))
- Luna Privilege (fluopyram (7))
- Monsoon, Toledo (tebuconazole (3))

COROLLA
ننگرهار
ش ۱۳٤۱
NGR 1341 SH

Flint
Endura
NOVA 20
Topsin
Procure 80

What is fungicide resistance and why does it happen?

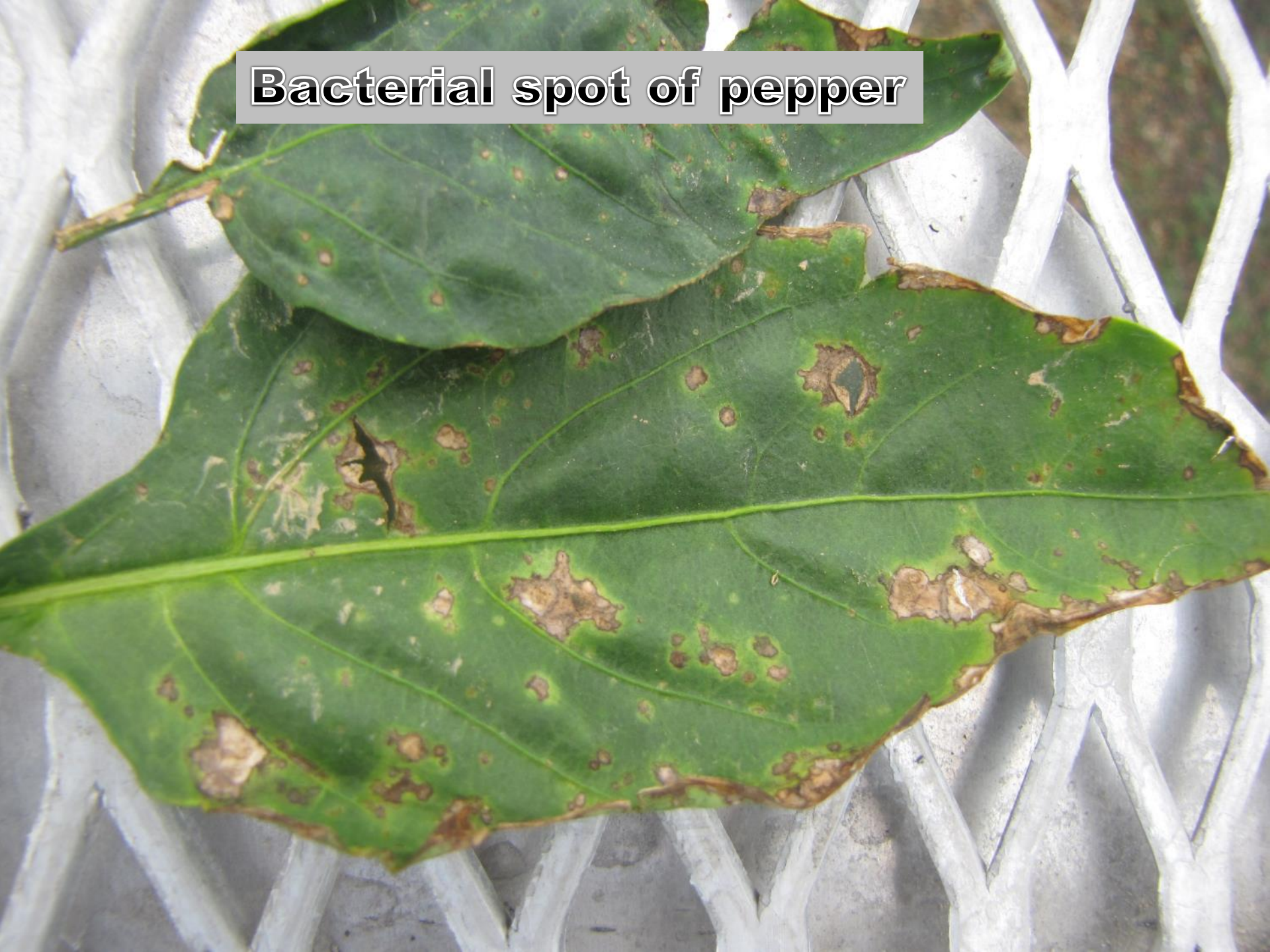
- Fungicides interrupt normal fungal systems
- Systems include cell wall development, energy production, protein synthesis etc.
- Fungicides may have single or multiple MOA.
- When just single MOA, one mutation may result in resistance.
- Population of resistant fungi may increase with repeated use of single MOA fungicide.
- Low rates of fungicide also encourage resistance.

Complete resistance

- Fusarium wilt of tomato

Complete resistance in tomato-VFN

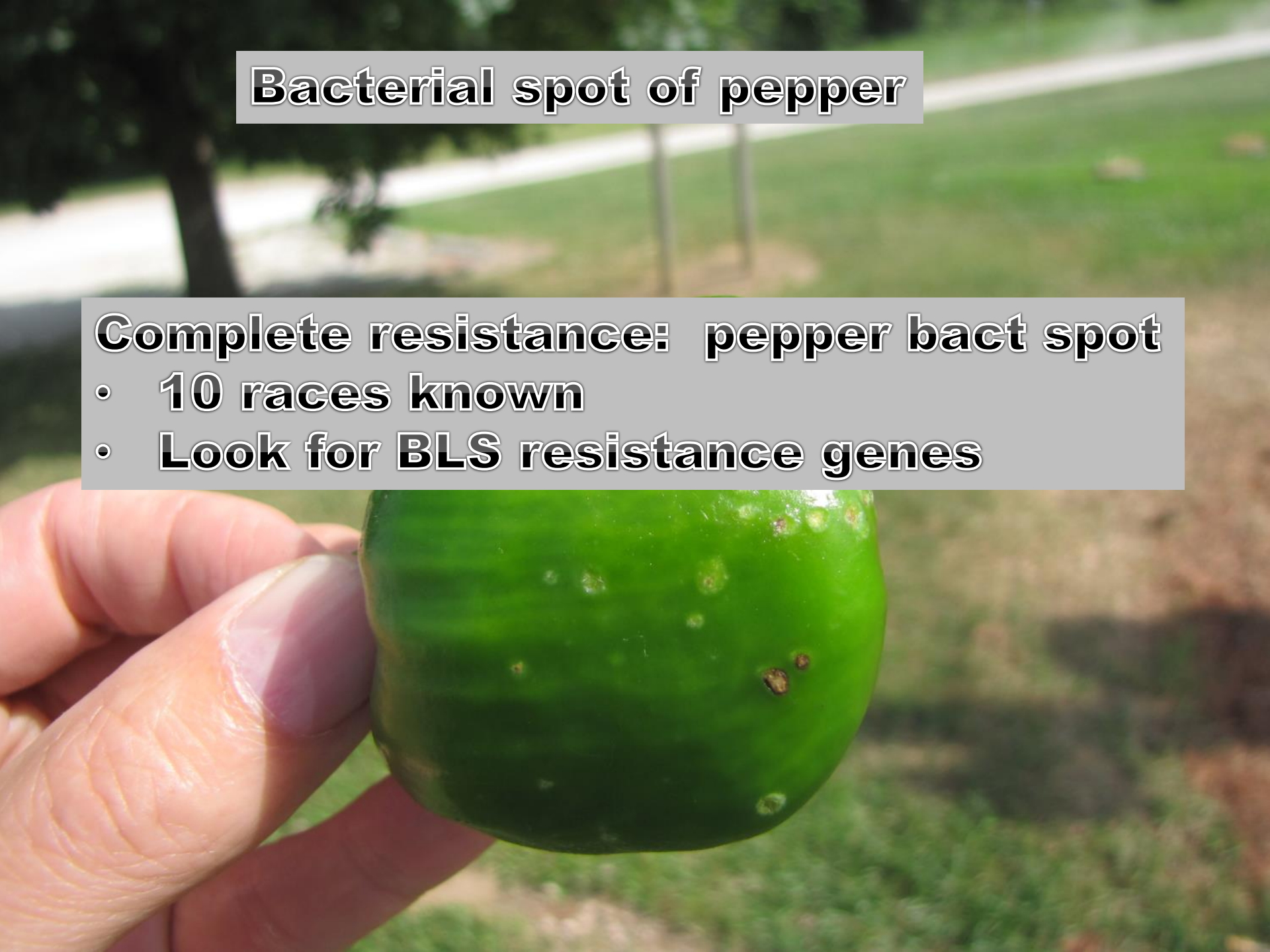
- Verticillium wilt
- Fusarium wilt
- root knot Nematode

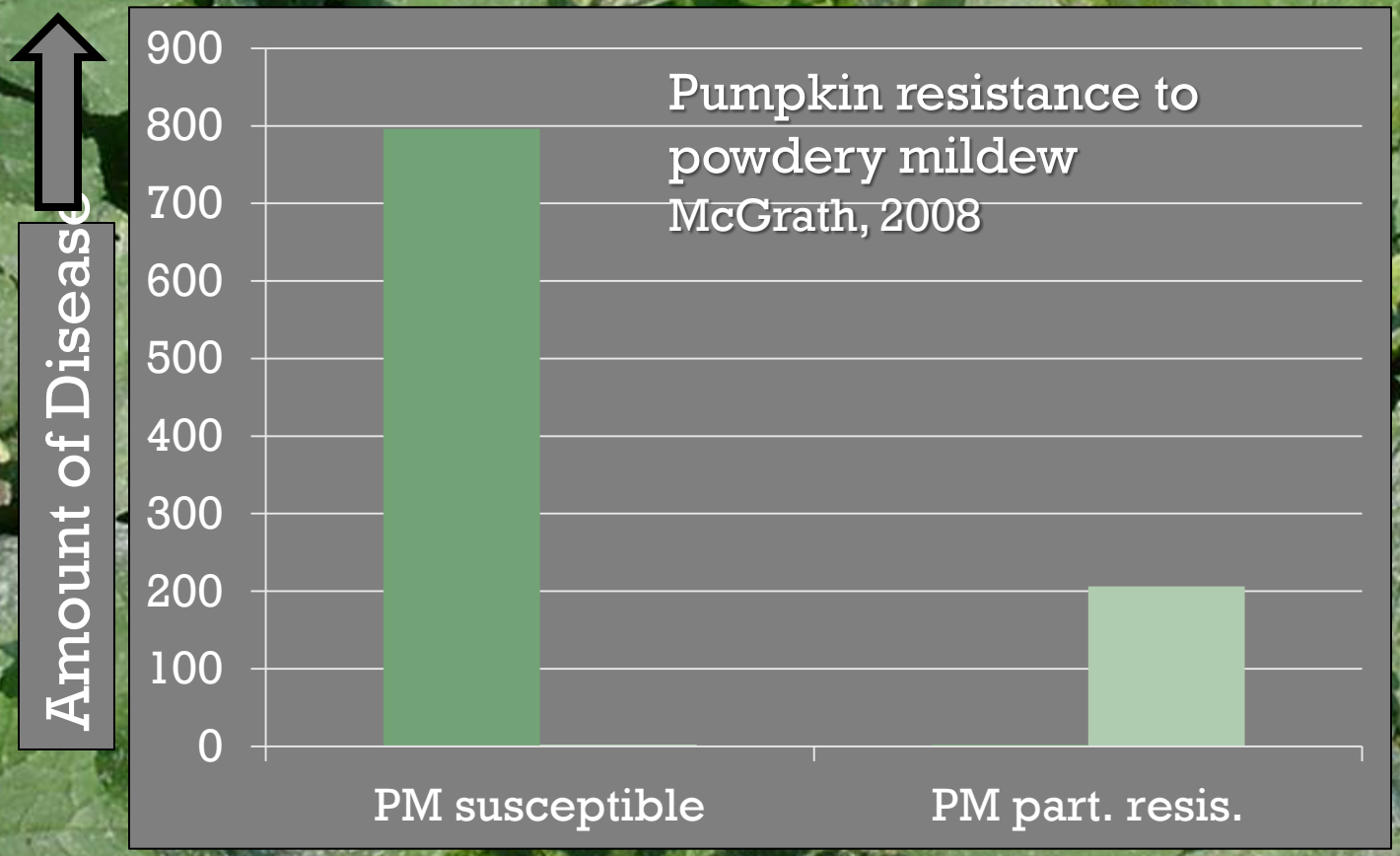

Bacterial spot of pepper

Bacterial spot of pepper

Complete resistance: pepper bact spot

- 10 races known
- Look for BLS resistance genes



Incomplete resistance

- Example: powdery mildew of pumpkin