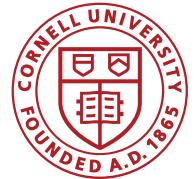


Cornell Cooperative Extension
Cornell Vegetable Program



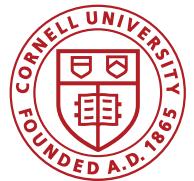
Control of Alternaria head rot in broccoli featuring exciting results from 2018 on-farm fungicide trial

Christy Hoepting, CCE Cornell Vegetable Program

Empire Producers Expo – Cole Crop Heat Stress Session
Syracuse, NY: January 15, 2019

Alternaria leaf spot vs. Downy mildew

Head symptoms – broccoli & cauliflower



Hoepting

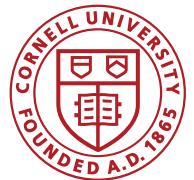


Hoepting



UMass



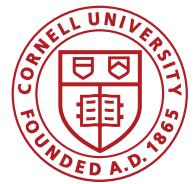
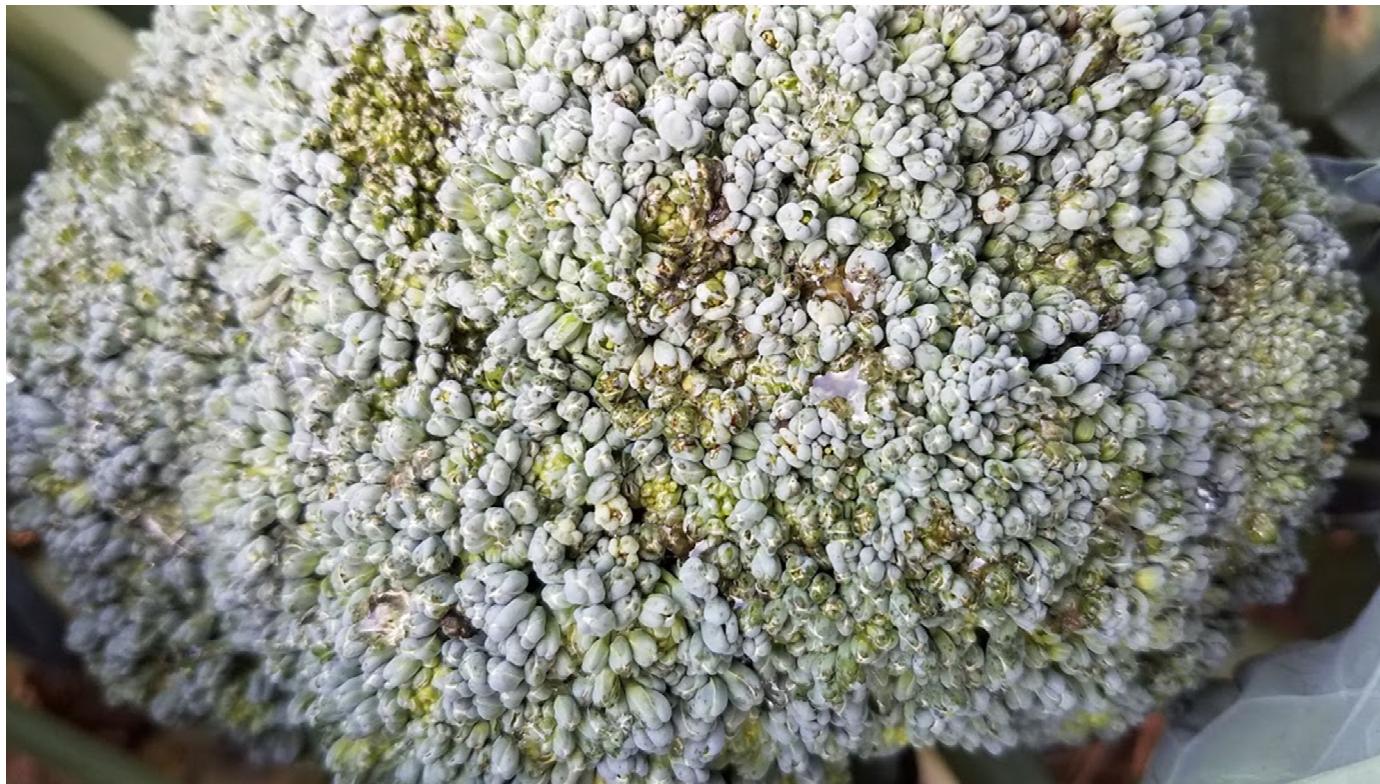


Alternaria leaf spot vs. Downy mildew Head symptoms – broccoli & cauliflower

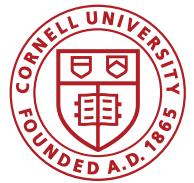
Confusing!



Water-soaked spots are bacterial
(rest is chasing)

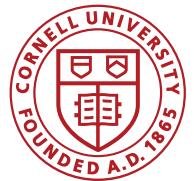


Water-soaked spots are bacterial
(rest is chasing)



Alternaria leaf spot vs. Downy mildew

Look at leaf symptoms



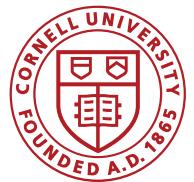
Lower frame leaves turn yellow



Alternaria leaf spot



Downy mildew



Alternaria leaf spot: Diagnostic leaf symptoms

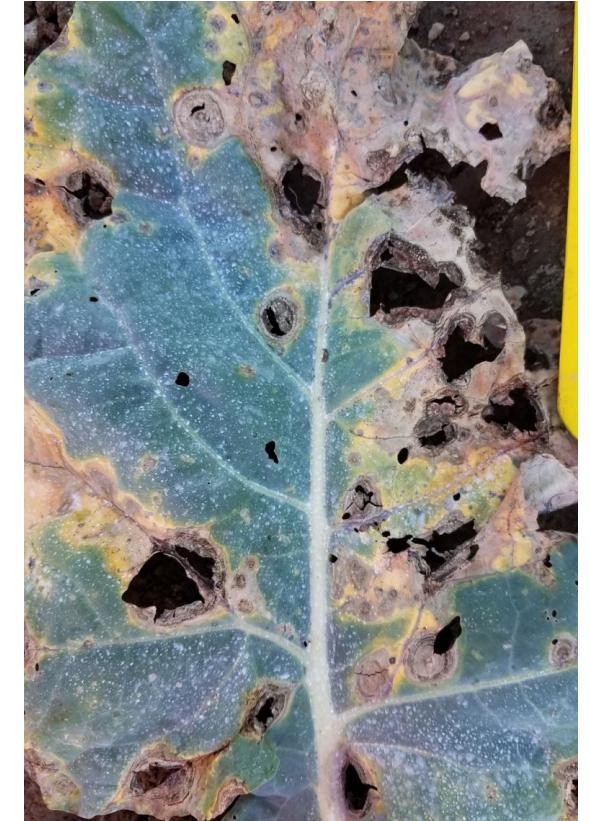
Photos: C. Hoepting



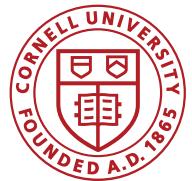
Round, papery target-spot lesions



Black sooty spores
(during moist conditions)



Old lesions fall out
= shot hole



Downy mildew: Diagnostic leaf symptoms

Photos: C. Hoepting



Upper leaf

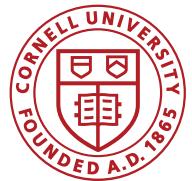


Lower leaf



Lower leaf – close up
(white fuzzy sporulation
under moist conditions)

Alternaria leaf spot vs. Downy mildew: Leaf symptoms



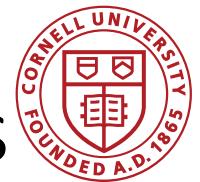
Photos: C. Hoepting



Old/dry downy mildew



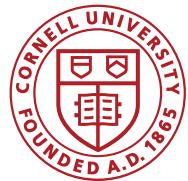
Old/dry ALS



Alternaria leaf spot: “young” leaf symptoms

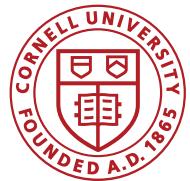


Note: ALS (and bacterial rot) may also chase heat stress symptoms



Alternaria leaf spot vs. Downy mildew vs. Other: When in doubt...

- Have problem diagnosed accurately
 - Cornell Cooperative Extension Vegetable Specialist
 - NYSAES – Plant Pathology, Chris Smart Lab
- Causal agent:
 - Alternaria leaf spot – *Alternaria brassicicola* (fungus)
 - Downy mildew - *Hyaloperonospora parasitica* (fungus – different family)
 - Black rot – *Xanthomonas campestris* pv. *campestris* (bacteria)
 - Other head rotting bacteria - ?? (bacteria)
- Different diseases may require different management practices



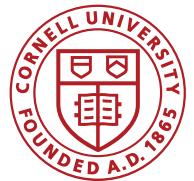
Devastating outbreaks of ALS in 2018

Photos: Jud Reid



Alternaria leaf spot: optimum 75° to 82°F, 9 hours of leaf wetness

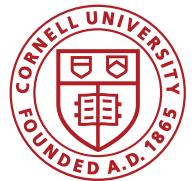
- When leaf wetness is prolonged for 20 hours or more, ALS can produce many spores outside of the optimum range of temperatures



Ad-hoc on-farm fungicide trial for ALS in broccoli, 2018



Is it possible to effectively control ALS with fungicides in broccoli when disease pressure is high?



Stemphylium leaf blight of onion: Same family as ALS in broccoli



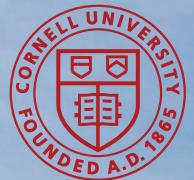
Target spot lesions



Excessive leaf dieback



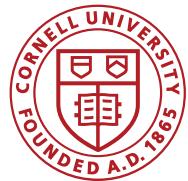
Premature mortality “dying standing up”



Stemphylium leaf blight of onion: On-farm fungicide trial, 2017

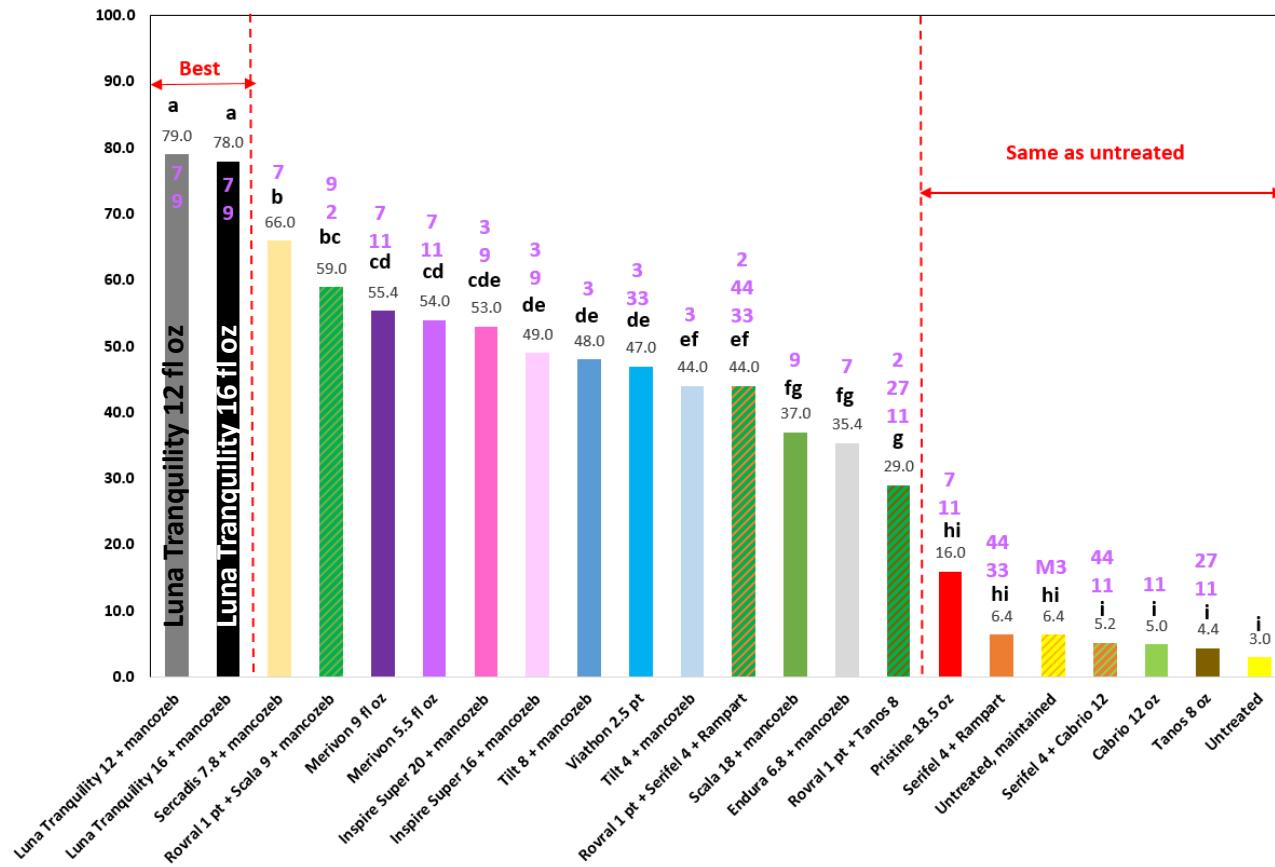
- Strong treatment effect



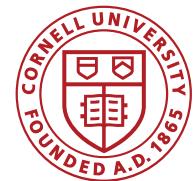


Stemphylium leaf blight of onion: On-farm fungicide trial, 2017 - Results

% Green Foliage (per plot) 6-Sep



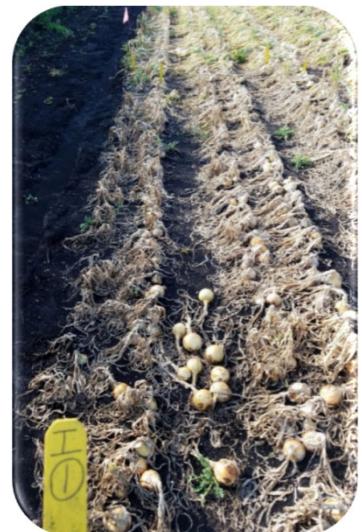
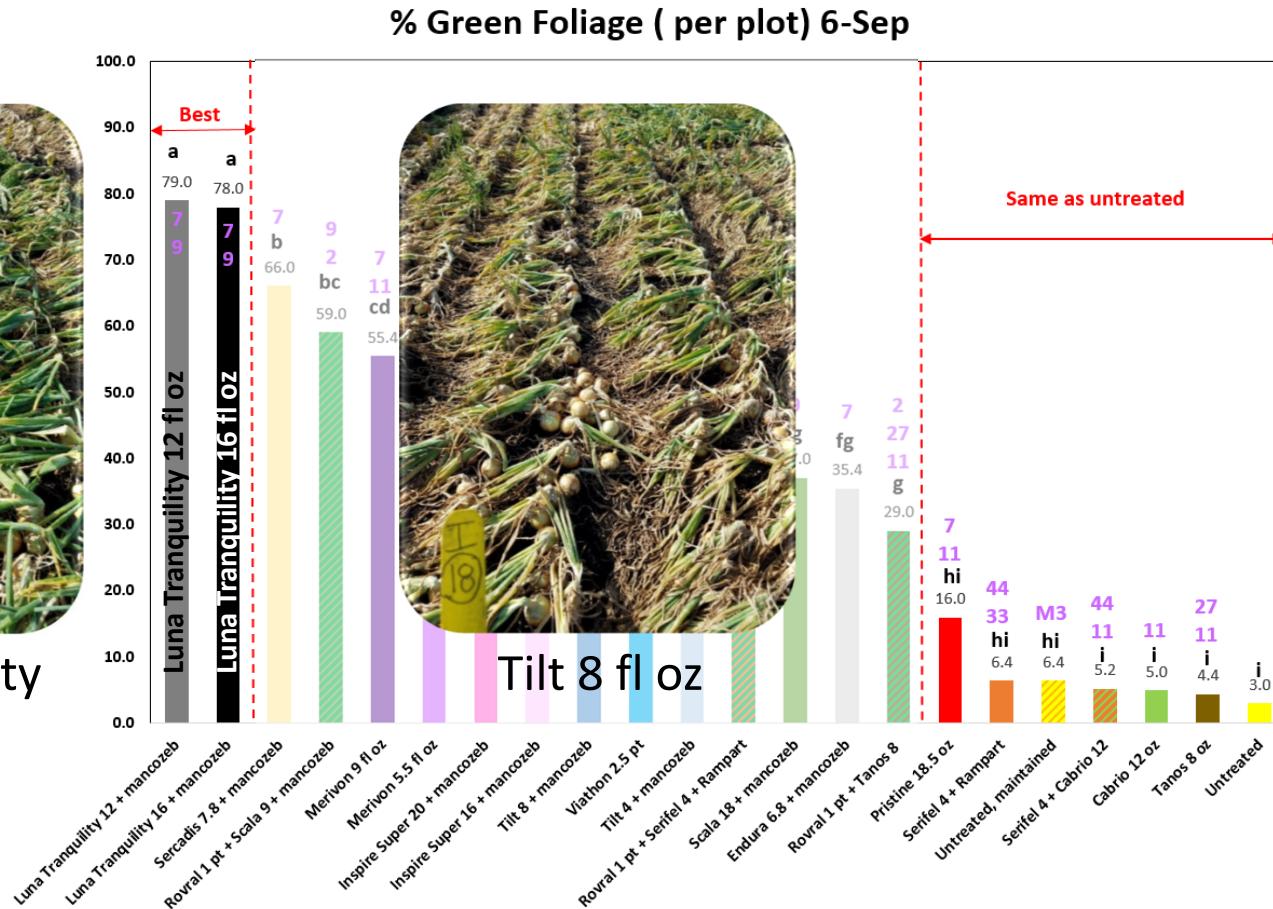
Stemphylium leaf blight of onion: On-farm fungicide trial, 2017 - Results



Luna Tranquility

12 fl oz

79%



Untreated

3%

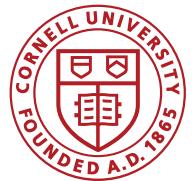
Fungicide ALS broccoli trial, 2018: Treatments



NIS: non-ionic surfactant (Dyne-Amic 0.25% v/v)

Product & Rate/acre	Rate Comments	FRAC Group	PHI (days)	Labeled on Broccoli
Bravo Weather Stik 1.5 pt	Highest label rate	M5	7	Yes
Quadris 11.2 fl oz + NIS	Medium label rate = Quadris in Quadris Top 14 fl oz	11	0	Yes
Quadris Top 14 fl oz + NIS	Highest label rate	3, 11	1	Yes
Endura 9 oz + NIS	Highest label rate	7	0	Yes
Switch 14 oz + NIS	Highest label rate	9, 12	7	Yes
Inspire Super 20 fl oz + NIS	Highest label rate	3, 9	7	Yes
Viathon 2 pt + NIS	Only label rate (use 2.5 pt in onion)	3, 33	7	Yes
Luna Experience 8.6 fl oz + NIS	Highest label rate (= Luna Tranquility 13.5 fl oz)	3, 7	7	Yes
Merivon 9 fl oz + NIS	Medium rate (5.5.-11 fl oz)	7, 11	3	No, but Priaxor is
Tanos 8 oz + NIS	High rate	11, 27	na	No
Previcur Flex 1.2 pt + NIS	Highest rate (not expected to have activity on ALS)	28	na	No (requested by grower)

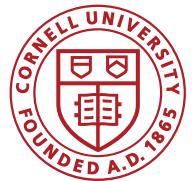
Fungicide ALS broccoli trial, 2018: Methods



- Located in field where last planting of broccoli suffered 85% crop loss due to ALS
- Started in broccoli planting (Emerald Crown):
 - 3 weeks post-transplanting
 - 1 week after Bravo WS 1.5 pt
 - ~2-5 ALS lesions per leaf on lower frame leaves



Fungicide ALS broccoli trial, 2018: Methods

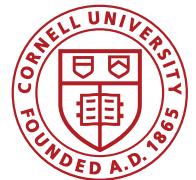


- Plot size: 1 x 15-ft row, untreated rows on each side, 4 reps
- 4 weekly fungicide applications
 - Week 1: Sep 9 (pre-heading)
 - Week 2: Sep 17 (pre-heading, canopy closed in)
 - Week 3: Sep 24 (pre-heading to 2" head)
 - Week 4: Sep 30 (heads 1-5", after 1st harvest)
- CO₂ backpack sprayer
- 40 gpa
- Single Teejet 8004 VS flat fan nozzle
- 25-30 psi
- Heads harvested on Sep 30, Oct 4, 8 and 10* “sniff” test to identify very minor severity



*Note: Oct 10 harvest was 10 days since last fungicide spray.

Fungicide ALS broccoli trial, 2018: Results



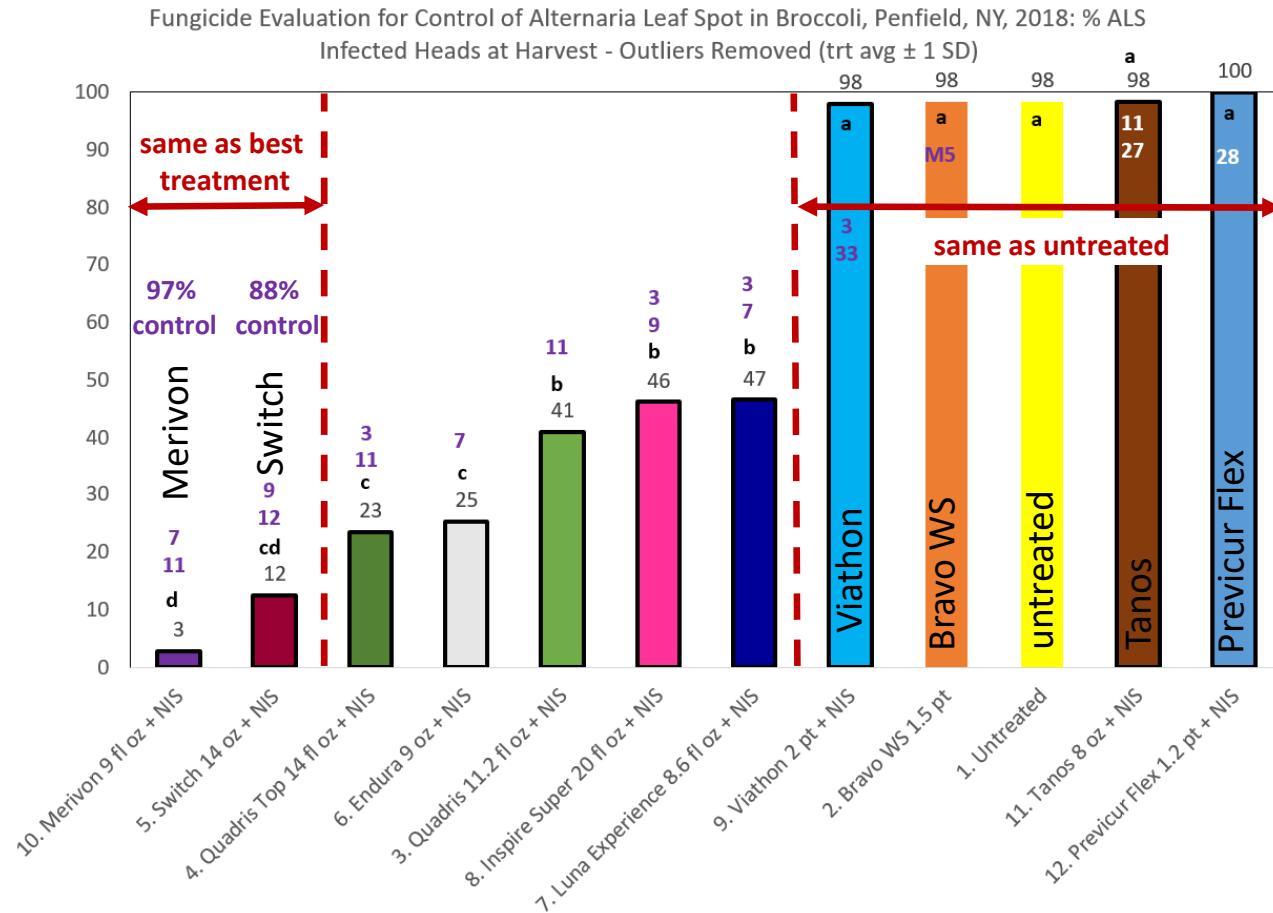
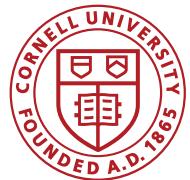
Results were striking!

- Untreated had **98% Unmarketable heads**
(disease pressure was high)
- Best treatment had
97% Marketable heads



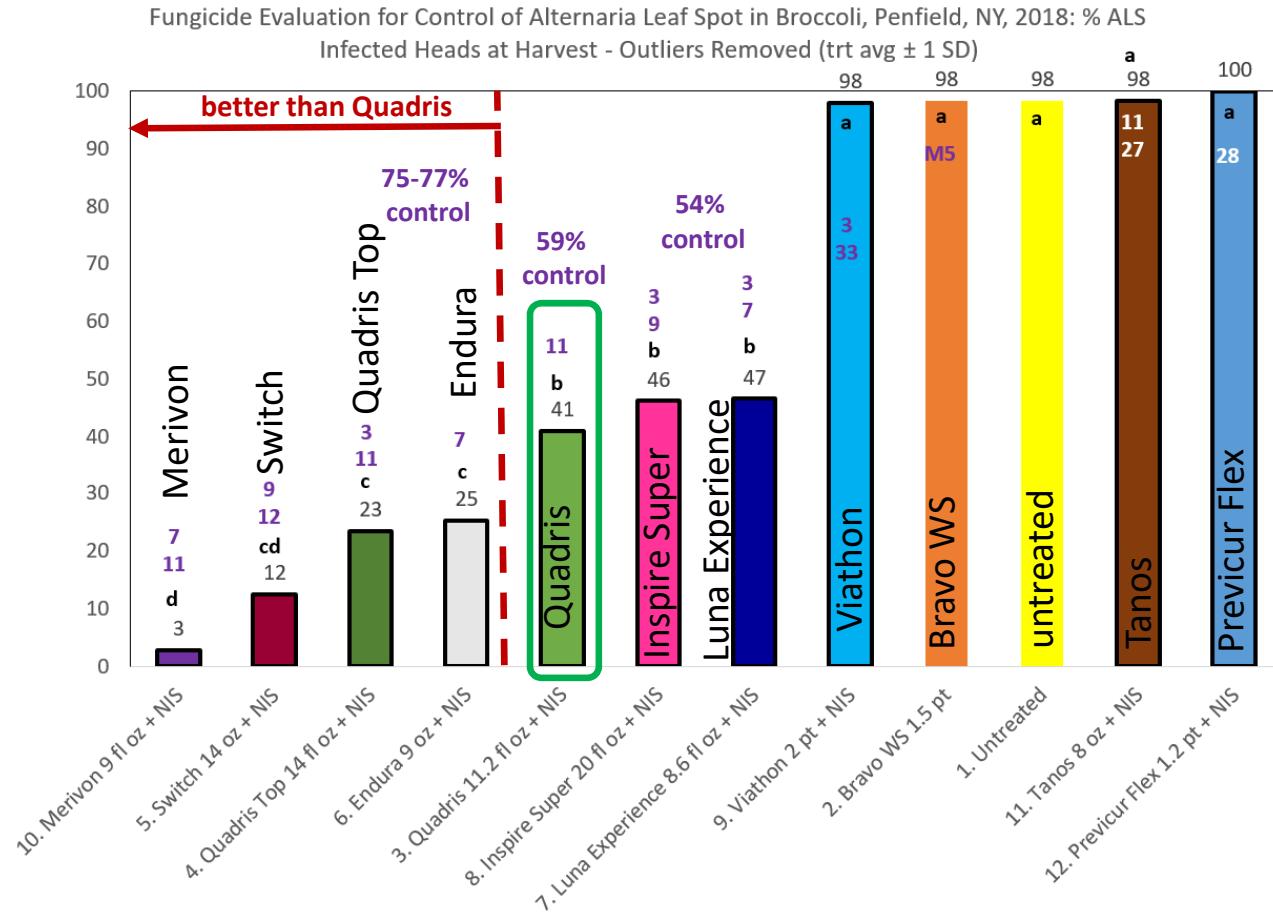
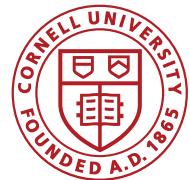
Fungicide ALS broccoli trial, 2018: Results

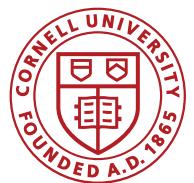
% Unmarketable heads (due to ALS at harvest)



Fungicide ALS broccoli trial, 2018: Results

% Unmarketable due to ALS at harvest





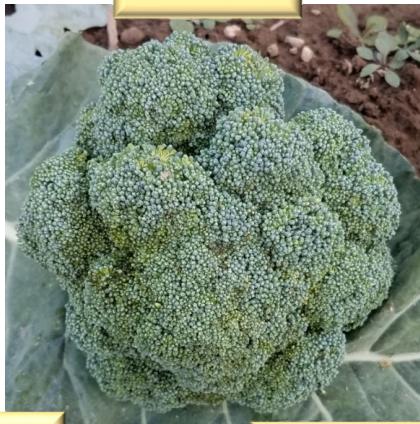
Fungicide ALS broccoli trial, 2018: Results

Severity of ALS in harvested heads

1 = very minor



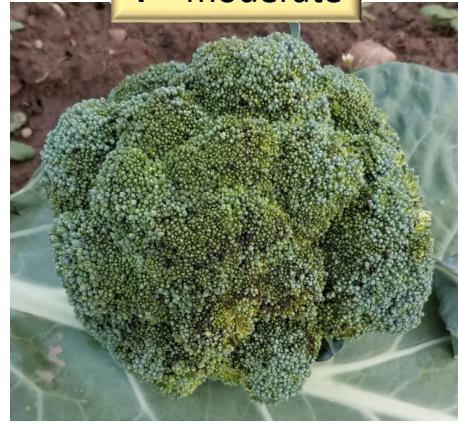
2 = minor



3 = minor-moderate



4 = moderate



5 = moderate-severe

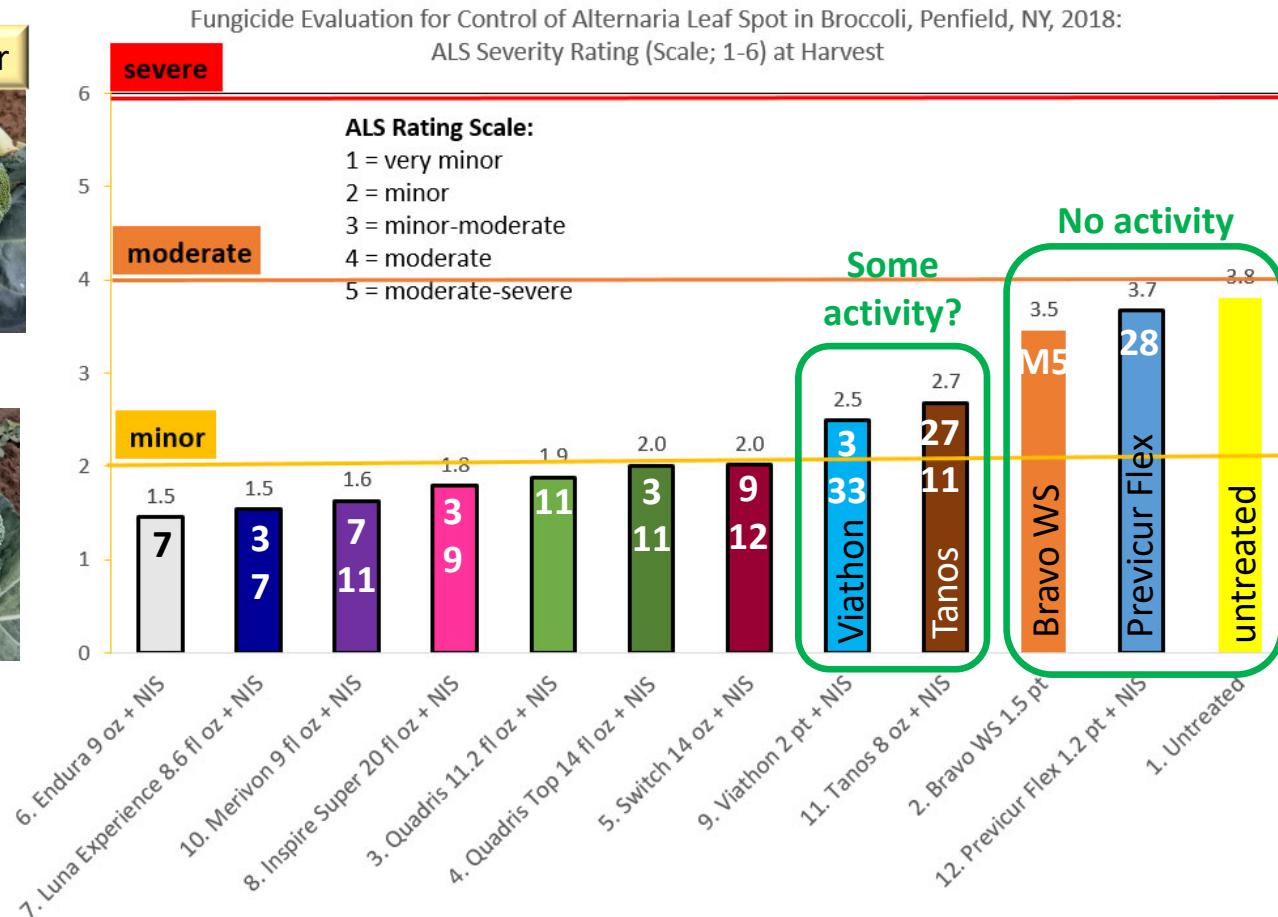
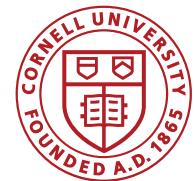


6 = severe



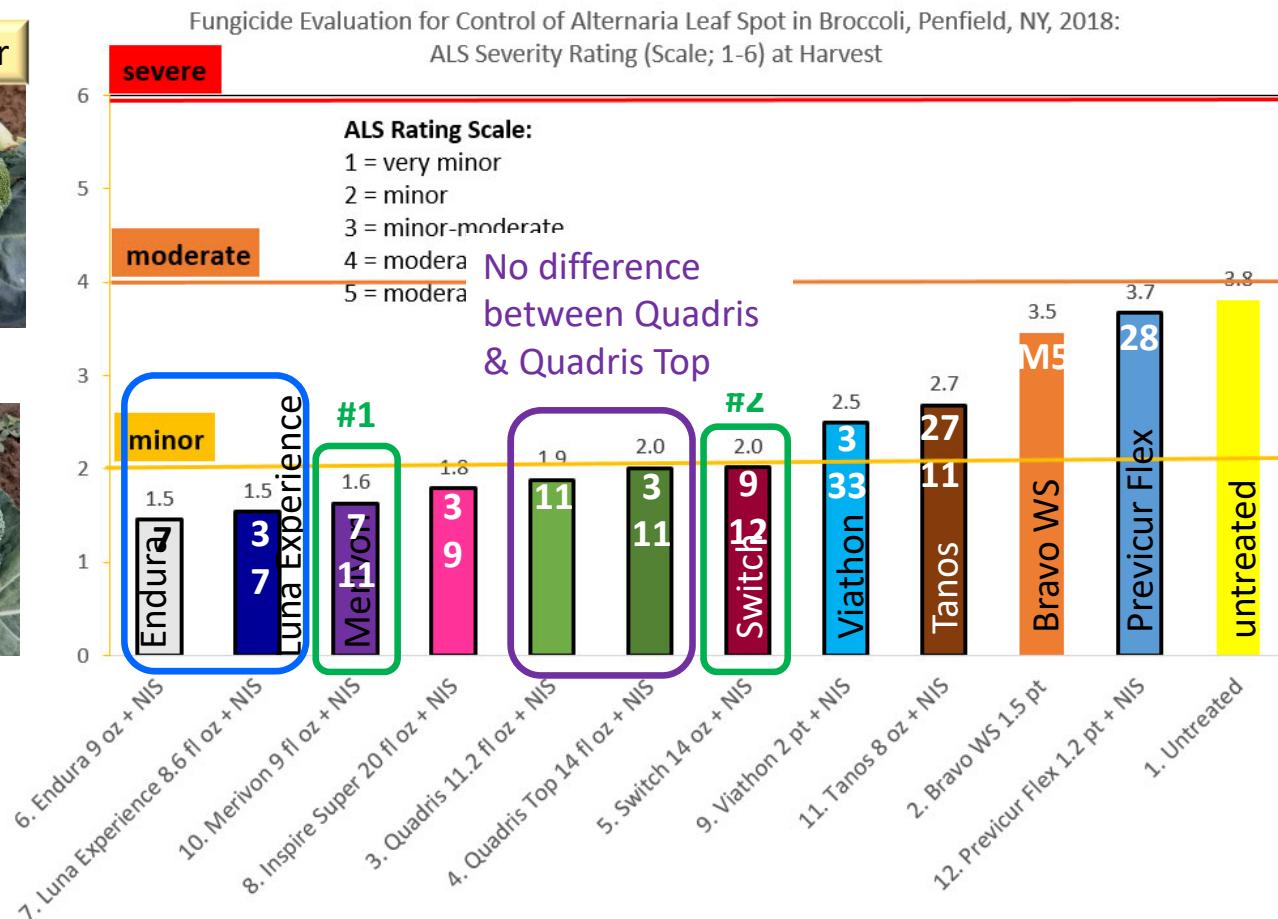
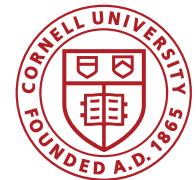
Fungicide ALS broccoli trial, 2018: Results

Severity of ALS in harvested heads

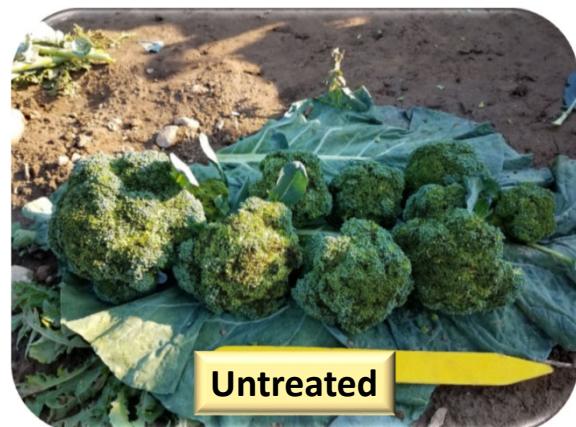
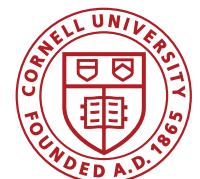


Fungicide ALS broccoli trial, 2018: Results

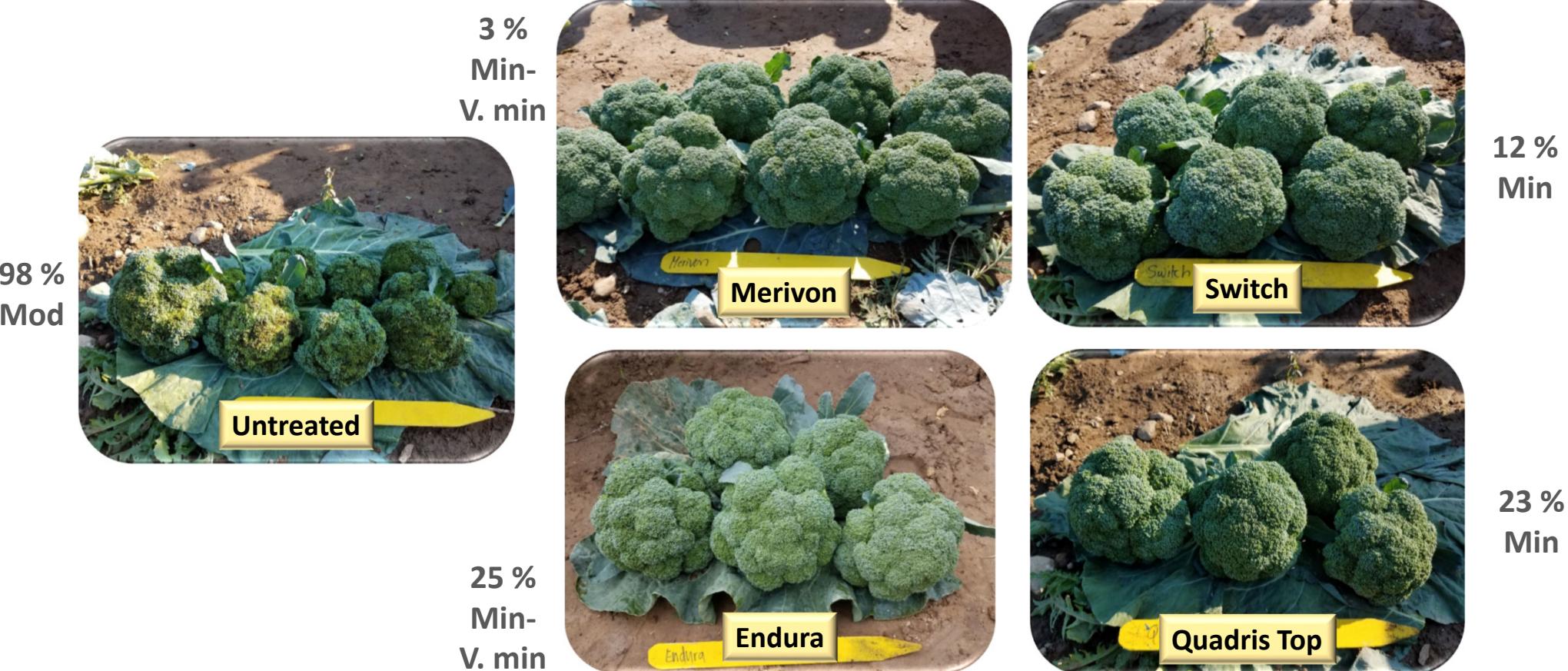
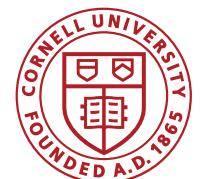
Severity of ALS in harvested heads



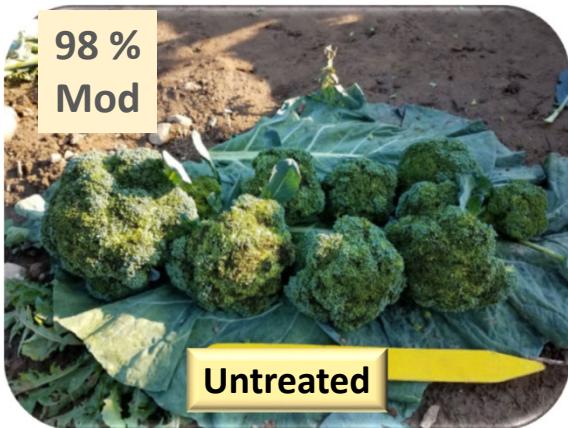
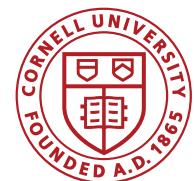
Fungicide ALS broccoli trial, 2018: Results Head Quality at harvest



Fungicide ALS broccoli trial, 2018: Results Head Quality at harvest



Fungicide ALS broccoli trial, 2018: Results Head Quality at harvest

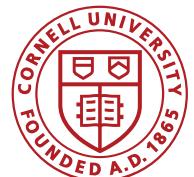


46 %
Min

100 %
v. min-
min

47%
v. min-
min

Fungicide ALS broccoli trial, 2018: Results ALS leaf lesion counts at harvest

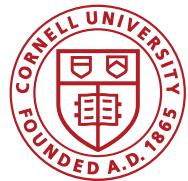


Counted number ALS lesions > 3 mm



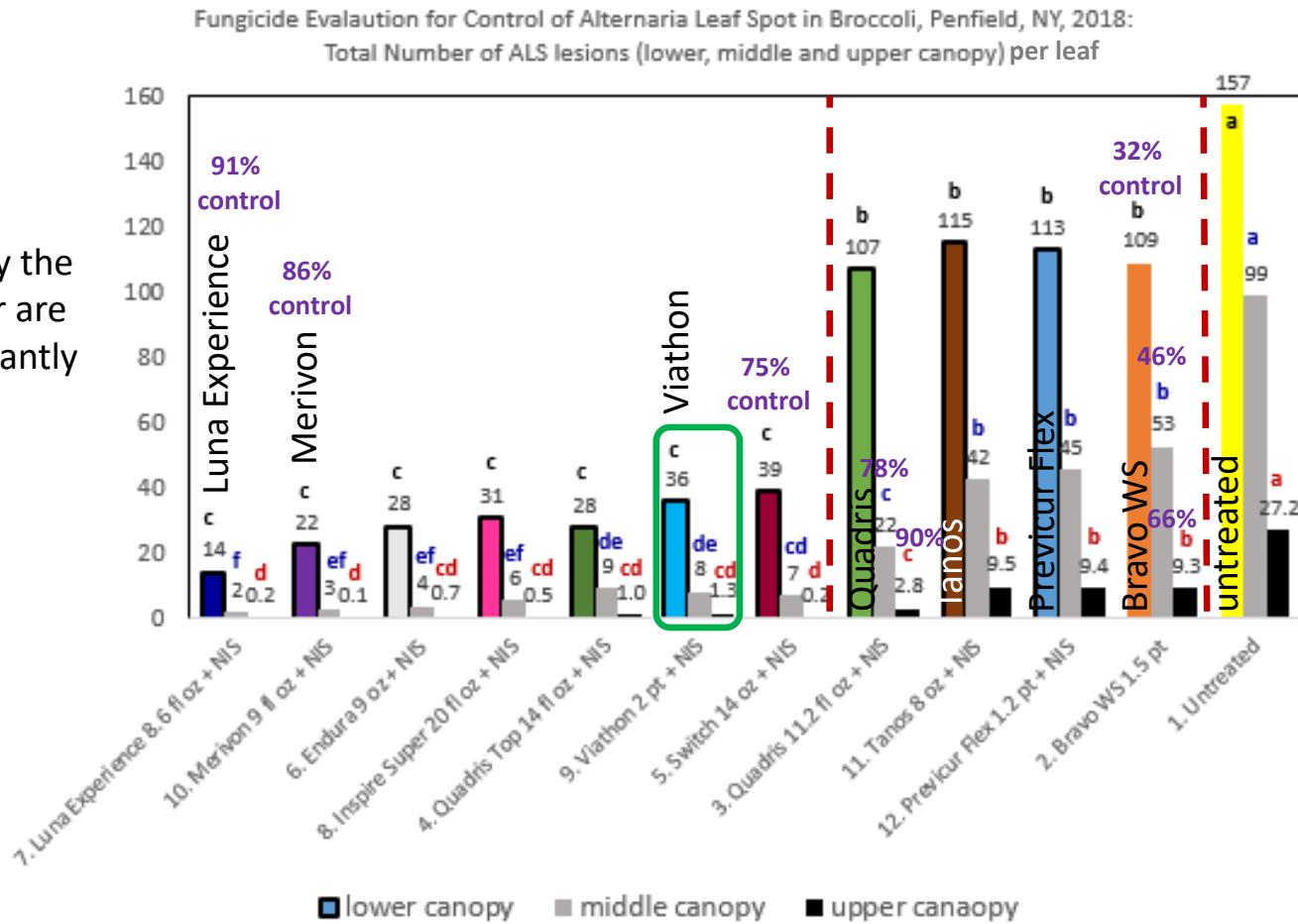
1 leaf per lower, middle & upper canopy, 6 plants per plot





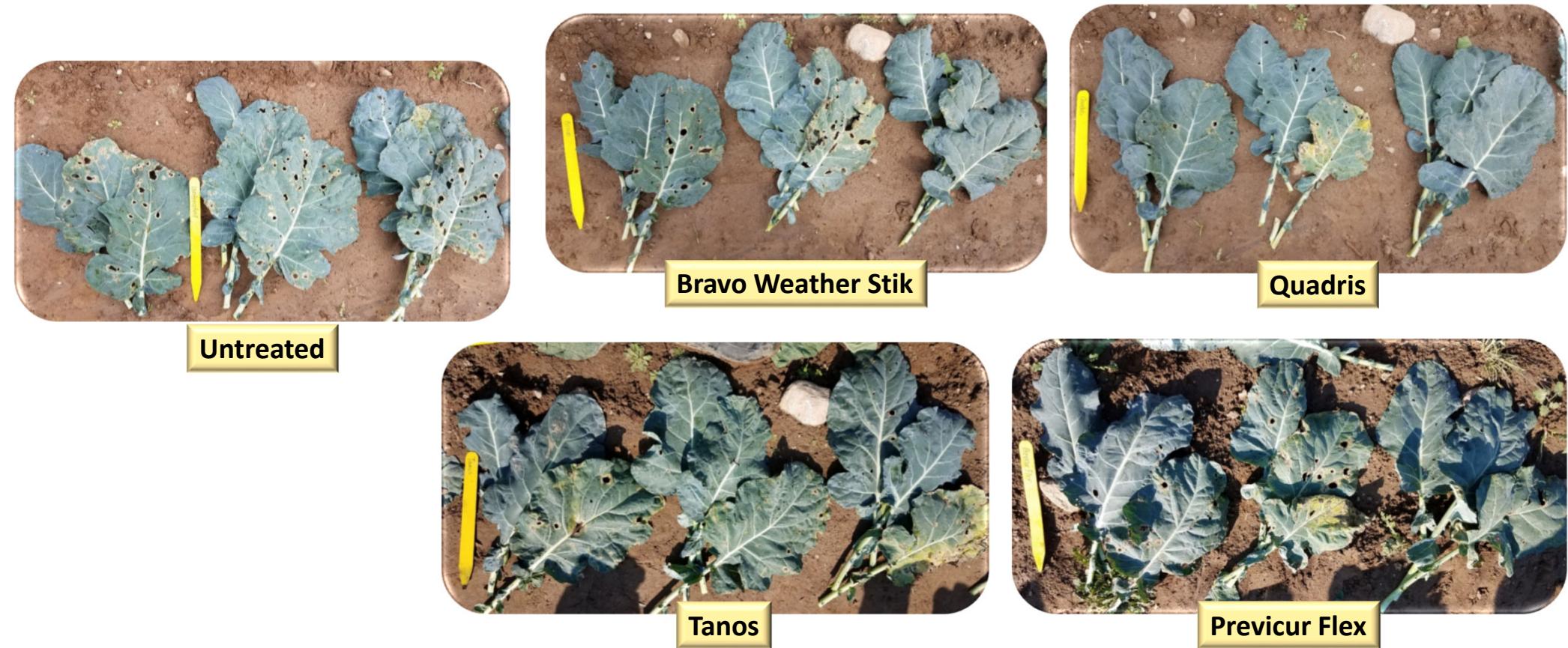
Fungicide ALS broccoli trial, 2018: Results ALS leaf lesion counts at harvest

Columns followed by the same letter are not significantly different



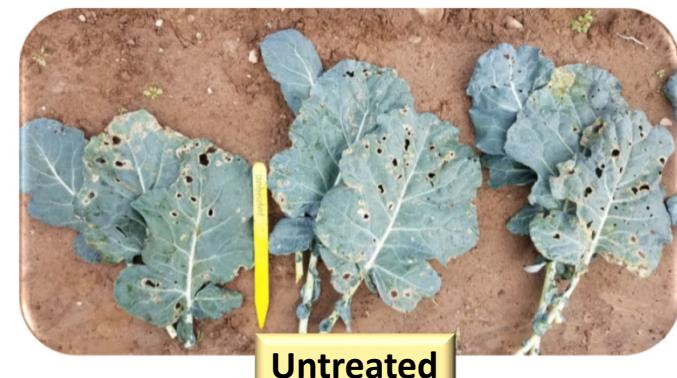


Fungicide ALS broccoli trial, 2018: Results ALS leaf lesion counts at harvest





Fungicide ALS broccoli trial, 2018: Results ALS leaf lesion counts



Untreated



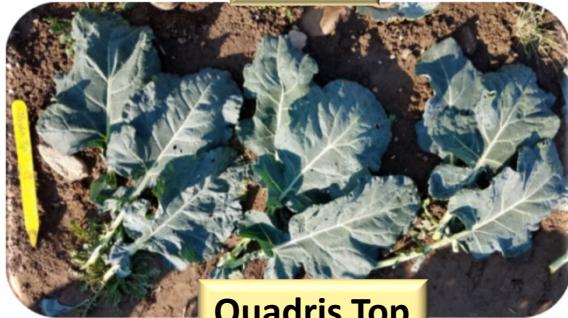
Luna Experience



Merivon



Endura



Quadris Top



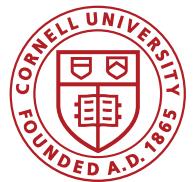
Inspire Super



Viathon



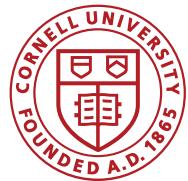
Switch



Fungicide ALS broccoli trial, 2018: Results

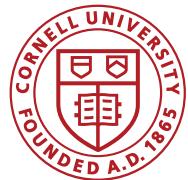
Fungicide coverage was good





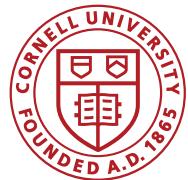
Fungicide ALS broccoli trial, 2018: Summary

- **Merivon** provided best control of ALS head rot (97% control) and ALS lesions on foliage (86% control)
- **Endura** (75%), **Switch** (88%), **Quadris Top** (77%) and **Luna Experience** (53%) provided very good control of ALS head rot and ALS lesions on foliage
- **Bravo Weather Stik**, **Previcur Flex** and **Tanos** failed to control ALS head rot, and only reduced ALS lesions on foliage by 32%
 - Bravo: overwhelmed by high pressure, contact fungicide (FRAC M5)
 - Previcur Flex: FRAC 28 more of a downy mildew fungicide – NOT labeled
 - Tanos: FRAC 27 expected to be weak on ALS, FRAC 11 did not work – NOT labelled



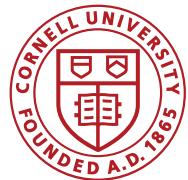
Fungicide ALS broccoli trial, 2018: Summary

- **Viathon** failed to control ALS head rot, but significantly reduced ALS lesions on foliage (77% control)
 - FRAC 3 has activity, perhaps not “systemic enough” or “ran out of gas” to protect heads?
- **Quadris Top** significantly better than **Quadris**, especially for reducing ALS lesions on foliage (82% v.s. 32%)
 - FRAC 3 is doing most of the work
 - Is ALS developing resistance to FRAC 11/Quadris?
 - Reported in Georgia and Virginia
 - Under investigation in New York – stay tuned!



Fungicide recommendations for ALS in broccoli

- Spray fungicides preventatively (before disease establishes itself)
 - Infected lower frame leaves serve as inoculum to infect heads
- All fungicides evaluated in this trial EXCEPT Bravo, are at risk of ALS developing resistance
- Follow label directions diligently
 - No more than 1-2 apps in a row before rotating to a different FRAC group
 - Maximum use rates per season (for product, active ingredient & FRAC group)
 - Be mindful of pre-mixes (more than one FRAC group per fungicide)
- Note: Merivon is NOT labeled in brassicas – but **Priaxor** is!
 - High rate of Priaxor 8.2 fl oz
 - = Merivon 5.5 fl oz for FRAC 7 (39% less)
 - = Merivon 11 fl oz for FRAC 11 (18% higher)



FRAC Groups on front page of label

Priaxor®

Xemium® Brand Fungicide

Group 7 11 Fungicide

Classified for
"RESTRICTED USE"
in New York State
under 6NYCRR Part 326

ACCEPTED
FOR REGISTRATION
AUG 25 2017

New York State Department
of Environmental Conservation
Division of Materials Management
Pesticide Product Registration

For disease control and plant health in the following crops: alfalfa, barley, Brassica leafy vegetables, citrus fruit, corn (all types), cotton, dried shelled peas and beans, edible-podded legume vegetables, fruiting vegetables (including tomato), grass grown for seed, oats, oilseed crops (flax seed, rapeseed, safflower, and sunflower), peanut, rye, sorghum and millet, soybean, succulent shelled peas and beans, sugar beet, sugarcane, tuberous and corm vegetables (potato), wheat and triticale

Powered by Xemium® and F500® fungicides

Active Ingredients:

fluxapyroxad*: 1*H*-Pyrazole-4-carboxamide, 3-(difluoromethyl)-1-methyl-N-(3',4',5'-trifluoro[1,1'-biphenyl]-2-yl)-..... 14.33%
pyraclostrobin**: (carbamic acid, [2-[[1-(4-chlorophenyl)-1*H*-pyrazol-3-yl]oxy]methyl]phenyl)methoxy-, methyl ester)..... 28.58%

Other Ingredients:

Total:

* Equivalent to 1.39 pounds of fluxapyroxad per gallon

** Equivalent to 2.78 pounds of pyraclostrobin per gallon

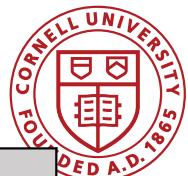
EPA Reg. No. 7969-311

EPA Est. No. 51036-GA-001

**KEEP OUT OF REACH OF CHILDREN
CAUTION/PRECAUCION**

Doc ID: 553056

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)



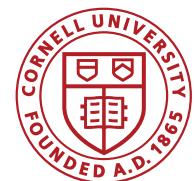
Fungicide recommendations for ALS in broccoli

Week	Crop Stage	Fungicide	FRAC Group	PHI (days)	Activity on DM
1 & 2	1-2 weeks after transplanting, prior to ALS infection	Bravo WS 1.5 pt	M5	7	Good
3	Pre-heading, large canopy	Switch 14 oz	9, 12	7	None
4	Heading begins	Switch 14 oz	9, 12	7	None
5	Harvest begins	Priaxor 8.2 fl oz	7, 11	3	Good
6	During harvest	Endura 9 oz	7	0	None



Cadillac Program
~\$260/A

- Preventative fungicide program – keep canopy free of disease
- Use best performing fungicides
- For resistance management, no more than 2 apps per FRAC.
- For resistance management, no more than 2 sequential apps per FRAC.
- For resistance management, avoid FRAC 11.
- Save products with PHI of 0-3 days to use during harvest.



Fungicide recommendations for ALS in broccoli

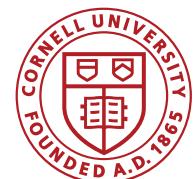
Week	Crop Stage	Fungicide	FRAC Group	PHI (days)	Activity on DM
1 & 2	1-2 weeks after transplanting, prior to ALS infection	Bravo WS 1.5 pt	M5	7	Good
3	Pre-heading, large canopy	Switch 14 oz	9, 12	7	None
4	Heading begins	Switch 14 oz	9, 12	7	None
5	Harvest begins	Priaxor 8.2 fl oz	7, 11	3	Good
6	During harvest	Endura 9 oz	7	0	None

Fungicides for Downy mildew control:

Best control: Presidio (no control of ALS) in Chris Smart trials

Good control: FRAC 11 fungicides (e.g. Quadris, Quadris Top, Cabrio)

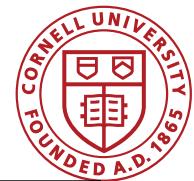
Good control: Bravo (some control of ALS)



Fungicide recommendations for ALS in broccoli

Week	Crop Stage	Fungicide	FRAC Group	PHI (days)	Activity on DM
1 & 2	1-2 weeks after transplanting, prior to ALS infection	Bravo WS 1.5 pt	M5	7	Good
3	Pre-heading, large canopy	Switch 14 oz	9, 12	7	None
4	Heading begins	Switch 14 oz	9, 12	7	None
5	Harvest begins	Priaxor 8.2 fl oz	7, 11	3	Good
6	During harvest	Endura 9 oz	7	0	None

ALS Fungicide	FRAC Group	PHI (days)	Activity on DM
Quadris Top	3, 11	1	Good
Luna Experience	3, 7	7	None
Inspire Super	3, 9	7	None
Quadris	11	0	Good

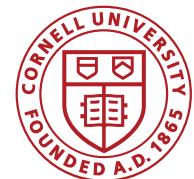


Fungicide recommendations for ALS in broccoli

Week	Crop Stage	Fungicide	FRAC Group	PHI (days)	Activity on DM
1 & 2	1-2 weeks after transplanting, prior to ALS infection	Bravo WS 1.5 pt	M5	7	Good
3	Pre-heading, large canopy	Luna Exp. 8.6 fl oz	3, 7	7	None
4	Heading begins	Luna Exp. 8.6 fl oz	3, 7	7	None
5	Harvest begins	Quadrис	11	0	Good
6	During harvest	Quadrис	11	0	

ALS Fungicide	FRAC Group	PHI (days)	Activity on DM
Quadrис Top	3, 11	1	Good
Luna Experience	3, 7	7	None
Inspire Super	3, 9	7	None
Quadrис	11	0	Good

~\$125/A

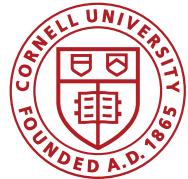


Fungicide recommendations for ALS in broccoli

Week	Crop Stage	Fungicide	FRAC Group	PHI (days)	Activity on DM
1 & 2	1-2 weeks after transplanting, prior to ALS infection	Bravo WS 1.5 pt	M5	7	Good
3	Pre-heading, large canopy	Luna Exp. 8.6 fl oz	3, 7	7	None
4	Heading begins	Priaxor 8.2 fl oz	7, 11	3	Good
5	Harvest begins	Quadris Top 14 fl oz	3, 11	1	Good
6	During harvest	3, 7, & 11 used up			

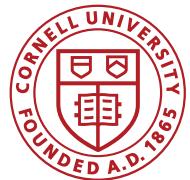
ALS Fungicide	FRAC Group	PHI (days)	Activity on DM
Quadris Top	3, 11	1	Good
Luna Experience	3, 7	7	None
Inspire Super	3, 9	7	None
Quadris	11	0	Good

~\$135/A



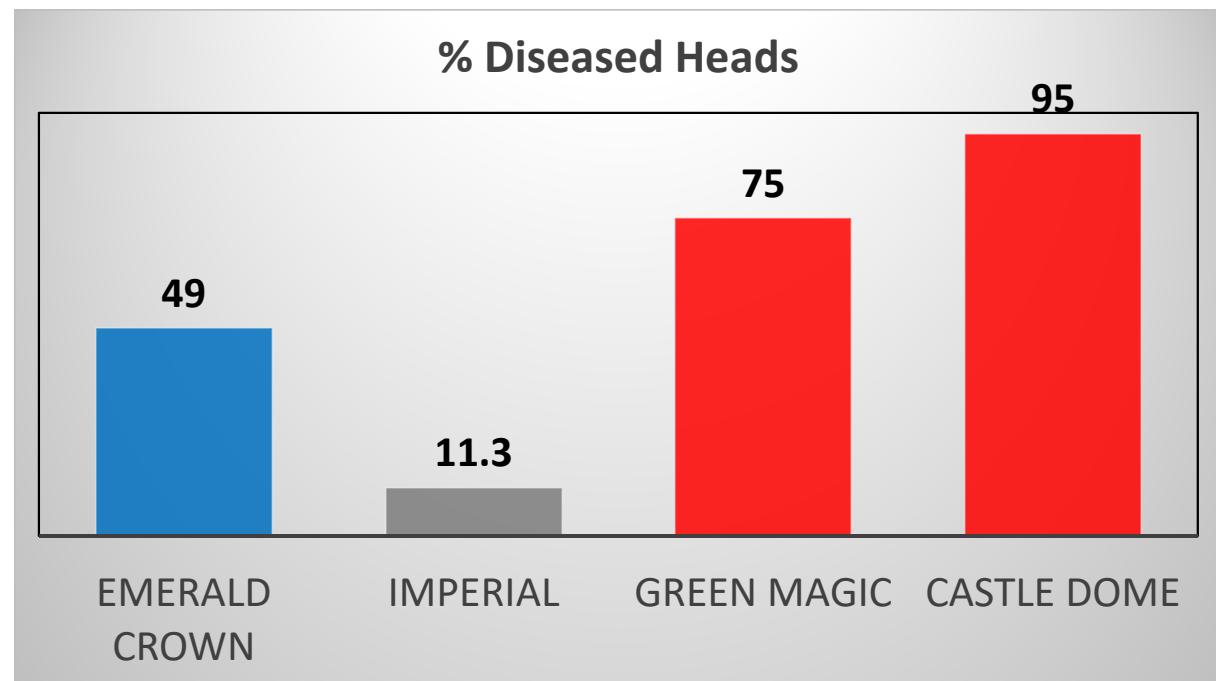
Can you afford not to?

- In Penfield, grower spray program (3x Bravo, 1 Quadris) = \$44/acre
 - At \$18 per box (20 lb), fungicide program costs 2.4 boxes
 - Average yield = 8000 lb/A (= 400 box/A & \$7,200/A)
 - **85% crop loss** (50 box/A) results in \$1,080/A; **\$1,036/A after fungicide cost**
- New fungicide program:
 - **Bravo 2x, Switch 2x, Priaxor, Endura** = **\$260/acre (= 14 boxes of broccoli)**
 - Assume **85% marketable heads** = 6800 lb/A
 - = 340 box/A @ **\$18/box** = \$6,129/A; **\$5,869 after fungicide cost**
 - Or, **@ \$10/box**; \$3,400; **\$3,140 after fungicide costs (= 26 boxes of broccoli)**
- **Increase cost of fungicide program by 6x**
- **Increase net profit by 6x (+\$4,833)**

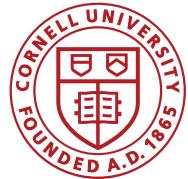


Alternaria leaf spot: Cultural management practices

- Avoid using varieties that have shown chronic problems to ALS.
- Manage susceptible varieties more aggressively

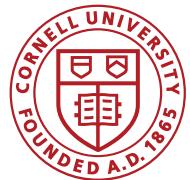


Steve Ridout, Virginia Tech, 2018



Alternaria leaf spot: Cultural management practices

- Incorporate crop residue immediately after harvest to remove this as a source of disease for other plantings and to hasten decomposition of the infested material.
- Rotate away from cruciferous crops for a minimum of two years.
- Mulch (straw, plastic, etc.) can reduce disease incidence by providing a protective barrier against soil-borne inoculum.



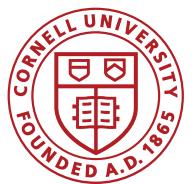
Alternaria leaf spot: Cultural management practices

- Maintain good weed control, especially of brassica-type weeds.
- Be aware that brassica cover crops (e.g. tillage radish) may harbor diseases.



Julie Kikkert

Alternaria leaf spot on Shepherd's purse and cabbage



Questions?

