

Cornell Cooperative Extension
Cornell Vegetable Program

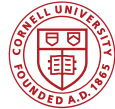


The Ever-Changing Field Performance of Fungicides for Control of Stemphylium Leaf Blight in Onion

Christy Hoepting, CCE Cornell Vegetable Program

Onion SLB Fungicide Resistance Workshop: Part I, 2020 Empire Producers Expo
Syracuse, NY: January 15, 2020

Acknowledgements



Funding:

- Bayer Crop Science
- BASF
- Certis
- Syngenta
- Onion Research and Development Program (ORDP) - Early BLB/SLB fungicide trial
- Other – Frank Hay projects

Grower Cooperators:

- Max Torrey, Big O, Elba
- Triple G, Elba
- CY Farms, Elba
- Abe Datthyn & Sons, Sodus



CVP Technicians:

Emma van der Heide & Sarah Vande Brake

Stemphylium Leaf Blight (SLB)

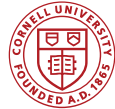


- Tan, black and purplish-red target spot lesions on necrotic tissue.



Photos: C. Hoepting

Stemphylium Leaf Blight (SLB)



- Less descript spots of tan/black splotching and sporulation (black)



Photos: C. Hoepting

Stemphylium Leaf Blight (SLB)



- Causes excessive leaf die back; onions “dying standing up”



normal

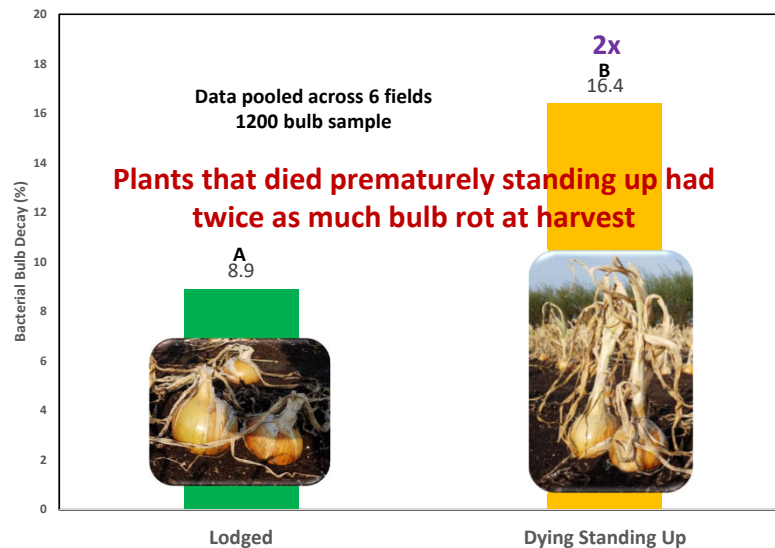
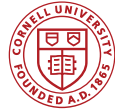


excessive



Photos: C. Hoepting

Effect of “dying standing up” on bacterial bulb rot



Hoepting 2015

Downy Mildew-SLB Complex - Can Be Devastating

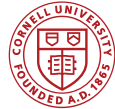


August 13, 2014



August 27, 2014

Spray by Number for Fungicide Resistance Number = FRAC Code



FRAC:
Fungicide Resistance
Action Committee

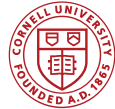
Fungicide Active Ingredients



★ NOT labeled on onion in New York

Trade Name	Active Ingredient	FRAC Code	Trade Name	Active Ingredient	FRAC Code
Bravo	chlorothalonil	M5	Luna Tranquility	Fluopyram pyrimethanil	7(1) 9
Manzate Max, Roper, etc.	mancozeb	M3	Luna Experience	Fluopyram tebuconazole	7(1) 3
Rovral	iprodione	2	Endura	boscolid	7(3)
Scala	pyrimethanil	9	Fontelis ★	penthiopyrad	7(2)
Tilt	propiconazole	3	Pristine	boscolid pyraclostrobin	7(3) 11
Quadris Top	difenaconazole azoxystrobin	3 11	Cabrio	pyraclostrobin	11
Inspire Super	difenaconazole cyprodinil	3 9	Merivon	fluxapyroxad pyraclostrobin	7(2) 11
Viathon	Phosphorous acid tebuconazole	33 3	Sercadis ★	fluxapyroxad	7(2)

Fungicide Active Ingredients



	Trade Name	Active Ingredient	FRAC Code
	Switch	cyprodinil fludioxanil	9 12
★	Miravis Prime	pydiflumetofen fludioxonil	7(4) 12
★	Miravis	pydiflumetofen	7(4)
★	Cannonball	fludioxinil	12
★	BASF 750 07 SC	mefentrifluconazole	3
	Double Nickel LC	<i>Bacillus amylefaciens</i> strain D747	44
	Oso 5% SC	Polyoxin D zinc salt	19
	Lifegard	<i>Bacillus mycoides</i> isolate J	P06

★ NOT labeled on
onion in New York

★ Labeled as a soil
drench only

SLB Onion Fungicides FRAC Groups



FRAC 7

C. respiration	C2 complex II: succinate-dehydro- genase	SDHI (Succinate- dehydrogenase inhibitors)	phenyl-benzamides	benodanil flutolanil mefpronil	7		
			phenyl-oxo-ethyl thiophene amide	isofetamid			
			pyridinyl-ethyl- benzamides	Luna Tranquility = sub-class 1			
			furan- carboxamides	fenfuram		Resistance known for several fungal species in field populations and lab mutants. <i>Target site mutations in sdh.</i>	
			oxathin- carboxamides	carboxin oxy-carboxin			
			thiazole- carboxamides	thifluzamide			
			pyrazole-4- carboxamides	Aprovia Top = sub-class 2			
				Merivon = sub-class 2 int			
				Fontelis = sub-class 2 k			
				pentulen penthiopyrad sedaxane		See FRAC SDHI Guidelines for resistance management.	
			N-cyclopropyl-N- benzyl-pyrazole- carboxamides	isoflucypram		Miravis = sub-class 4	
			N-methoxy-(phenyl- ethyl)-pyrazole- carboxamides				
			pyridine- carboxamides				
			pyrazine- carboxamides	pyraziflumid			
						Endura = sub-class 3	

FRAC 3

MOA	TARGET SITE AND CODE	GROUP NAME	CHEMICAL OR BIOLOGICAL GROUP	COMMON NAME	COMMENTS	FRAC CODE		
sterol biosynthesis in membranes	G1 C14: demethylase in sterol biosynthesis (erg11/cyp51)	DMI-fungicides (DeMethylation Inhibitors) (SBI: Class I)	piperazines	triforine	There are big differences in the activity spectra of DMI fungicides.	3		
			pyridines	pyrifenox pyrisoxazole				
			pyrimidines	fenarimol nuaimol				
			imidazoles	imazali oxpoconazole pelarazolate prochloraz triflumizole				
			triazoles	azoxaconazole bifentriol bromuconazole	(erg 11) Y137F, cyp51		Resistance is known in various fungal species. Several resistance mechanisms are known incl. target site mutations in	
				Inspire Super/Quadris Top				
				epoxiconazole etaconazole fenbuconazole flusulfonazole flutriazole hexaconazole imibenconazole	promotor; ABC transporters and others.			
				BASF 750 07				
				myclobutanil	DMI fungicides are Sterol synthesis Inhibitors (SBIs). It show no cross resistance to other SBI classes.			
				Tilt				
				Viathon				
				Luna Experience				
			triazolothiones	triadimethyl trifludiozinol trifluconazole prothioconazole	Medium risk.			
				Guidelines management.				

Methods – Fungicide Field Trials



- Four small-plot on-farm field trials for fungicide evaluation in 2019
 - 91 treatments in total
 - 364 individual plots (4 reps)
 - 2,912 individual plants
 - 8,736 ratings/counts
- CO2 back pack sprayer
 - Flat fan nozzles
 - 40 gpa
 - 25-35 psi
 - 2.6 mph

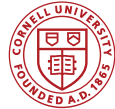


Methods – Fungicide Field Trials



Location	Grower Cooperator	Variety	Date & Crop Stage		No. Weekly Sprays
			Start	End	
Elba	Triple G	Red Wing	Jun 12 3-leaf	Aug 28 6-8 leaf 1.5-2+” bulb 20-75% lodging	11
Elba	Torrey	Pocono	Jul 14 6-7 leaf prebulb	Aug 30 8 leaf 1.5-2+” bulb 65-95% bulbing	7
Elba	CY Farms	Gunnisen	Jul 19 8 leaf 1” bulb	Aug 5 7-8 leaf 1.5-2” bulb ~ 75% lodging	4
Wayne (Sodus)	Abe Datthyn	Red Wing	Jul 19 8-10 leaf 0.5-1” bulb	Aug 15 8 leaf 2” bub 40-70% lodging	5

Methods – Fungicide Field Trials



Fungicide Evaluations:

- 8 plants per plot:
 - % leaf dieback/plant
 - % SLB colonization/plant
 - Total No. target spot lesions/plant
- Per plot:
 - % green foliage
 - Yield



Methods – Fungicide Field Trials



2018 SLB Fungicide Trial, Oswego: SLB Severity

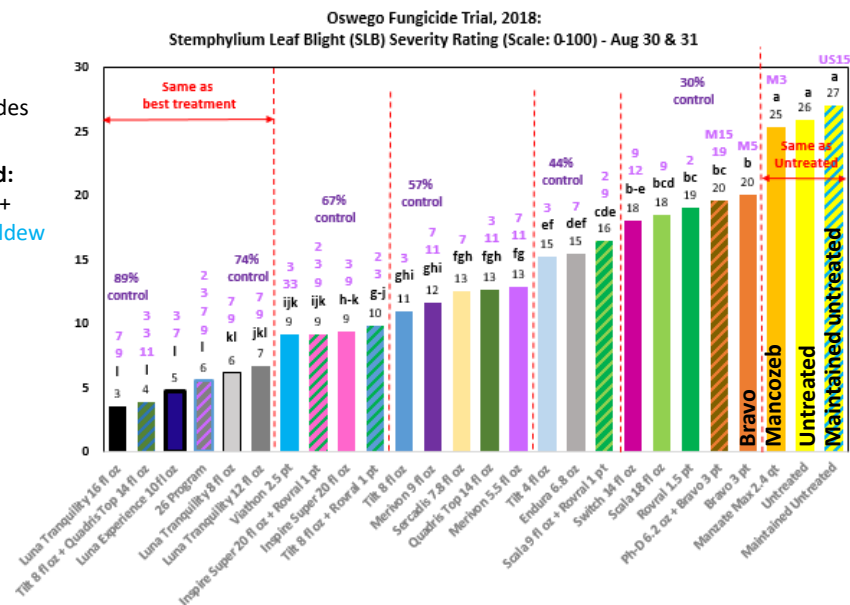


Untreated: No pesticides

Maintained Untreated:
Insecticides for thrips +
Orondis for Downy mildew

Mancozeb (M3): FAIL

Bravo (M5): Poor



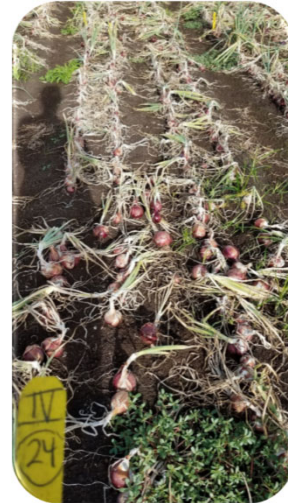
2018 SLB Fungicide Trial – Oswego (Sep 6)



Untreated

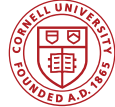


Manzate Max 2.4 qt



Bravo 3 pt

2015 On-Farm SLB Fungicide Trial, Elba: Green Foliage



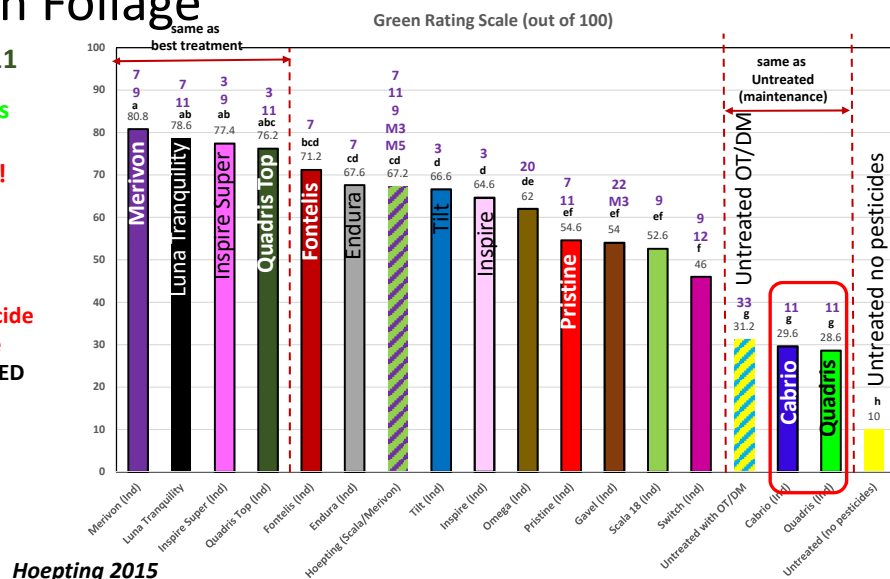
FRAC 11

Quadris

Cabrio

FAILED!

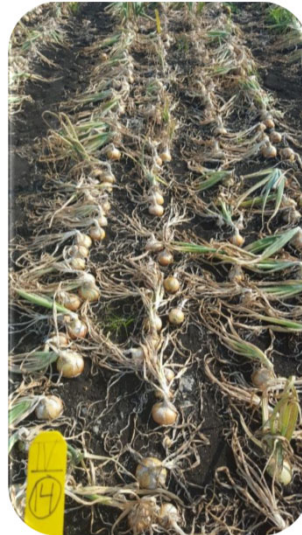
SLB fungicide
resistance
CONFIRMED



2015 On-Farm SLB Fungicide Trial – Elba (Aug 30)



Untreated



Quadris



Cabrio

2017 SLB Fungicide Trial, Elba: Green Foliage



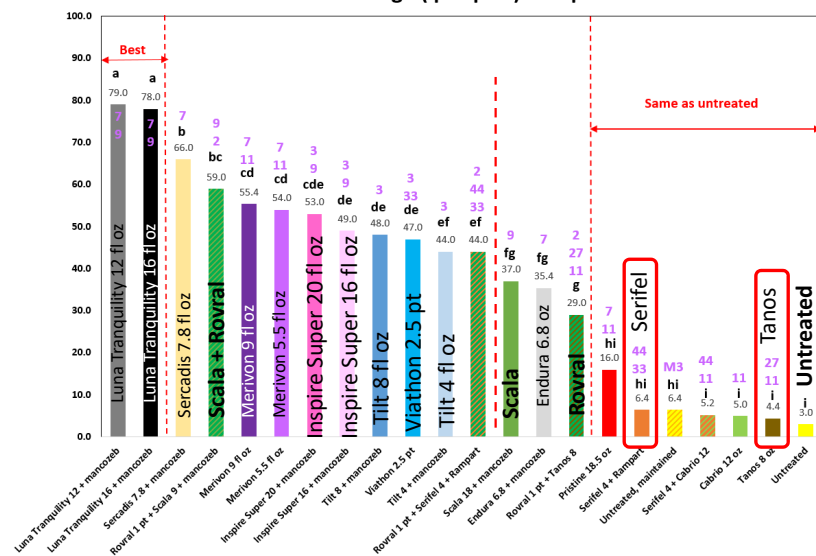
% Green Foliage (per plot) 6-Sep

FRAC 11 + 27

Tanos FAILED

FRAC 44 (biological)

Serifel FAILED



2017 SLB Fungicide Trial, Elba: Green Foliage



FRAC 7(3)

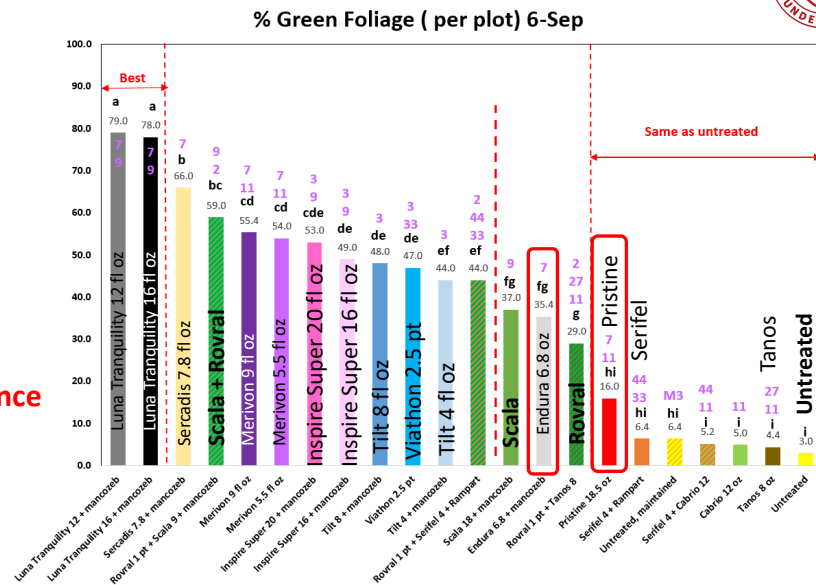
Endura **POOR**

Pristine

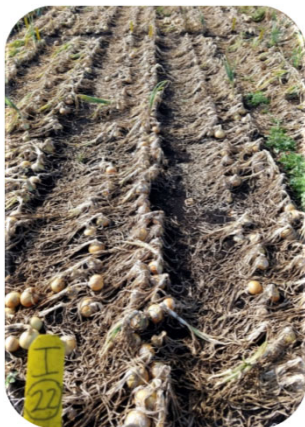
(= Endura + Cabrio)

FAILED

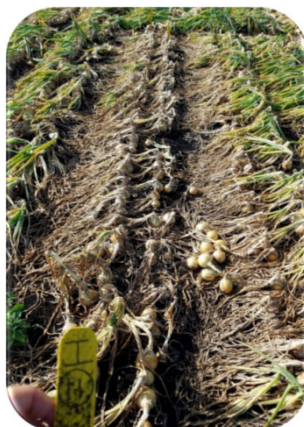
**SLB Fungicide resistance
CONFIRMED**



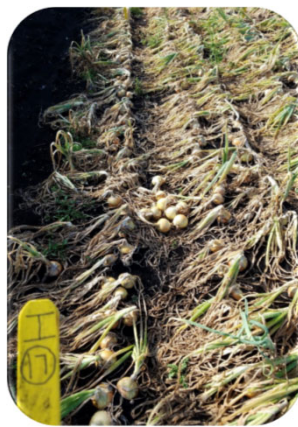
2015 On-Farm SLB Fungicide Trial – Elba (Aug 30)



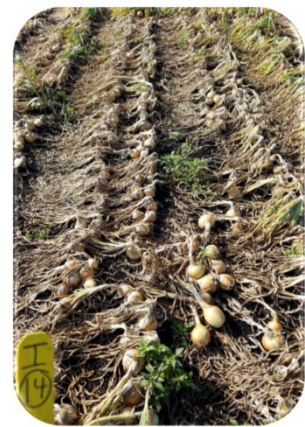
Tanos 8 oz



Serifel 4 oz



Endura 6.8 oz



Pristine 18.5 oz

2018 SLB Fungicide Trial, Oswego: SLB Severity



FRAC 7(1)

Luna Tranquility

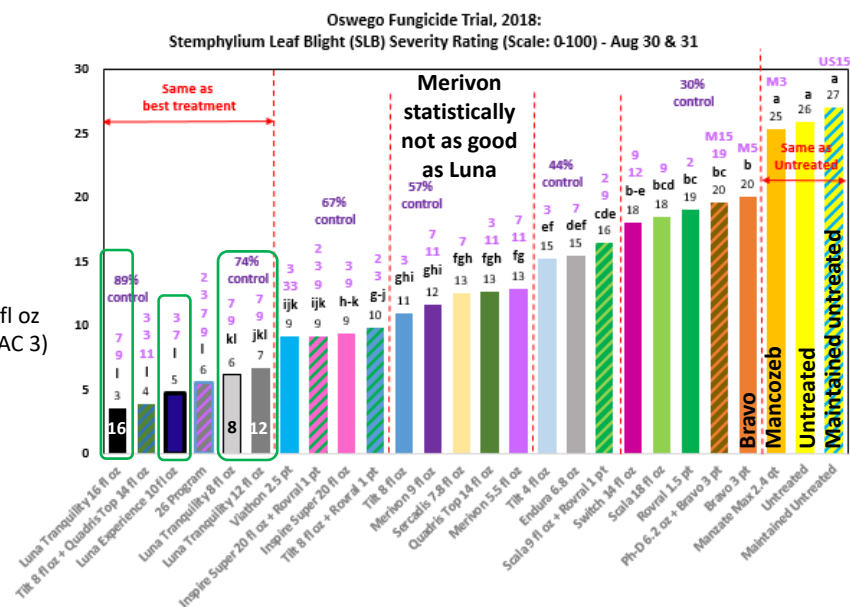
16 fl oz

12 fl oz

8 fl oz

Luna Experience 10 fl oz
(= Luna 16 fl oz + FRAC 3)

No difference
between 16, 12 and
8 fl oz rates



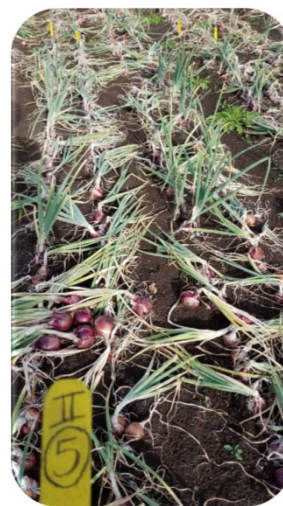
2018 SLB Fungicide Trial – Oswego (Sep 6)



Luna Tranquility 16 fl oz



Luna Tranquility 12 fl oz



Luna Tranquility 8 fl oz

2017 SLB Fungicide Trial – Elba (Sep 6)



Luna Tranquility 16 fl oz



Luna Tranquility 12 fl oz

2019 SLB Fungicide Trial, Elba: SLB Score



FRAC 7(1)
Luna Tranquility

16 fl oz

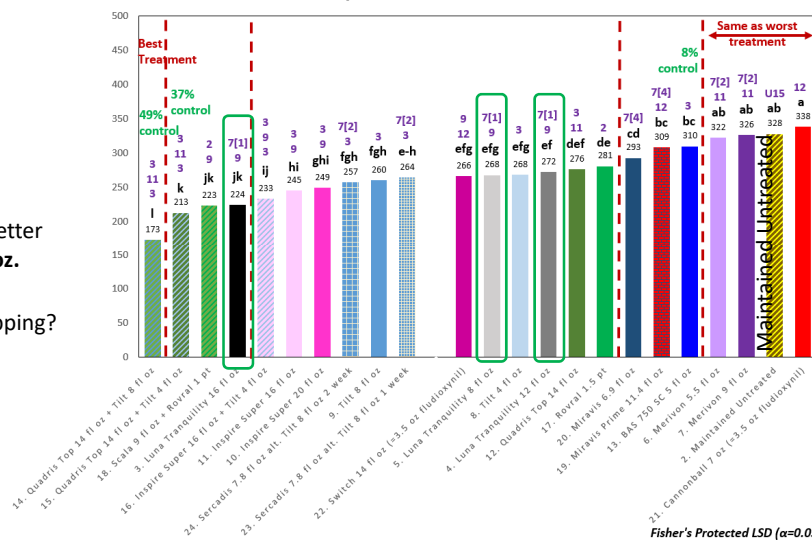
12 fl oz

8 fl oz

16 fl oz significantly better
than 12 fl oz and 8 fl oz.

Is Luna Tranquility slipping?

Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
5 point SLB Score



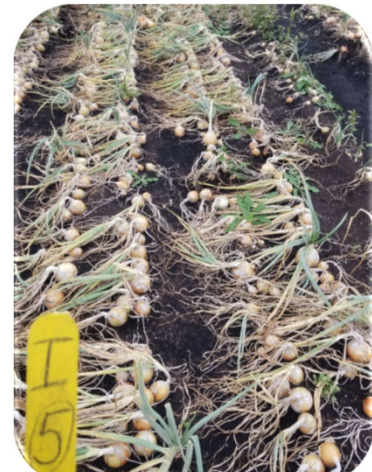
2019 SLB Fungicide Trial – Elba, Sep 15



Luna Tranquility
16 fl oz



Luna Tranquility
12 fl oz



Luna Tranquility
8 fl oz

2019 SLB Fungicide Trial, Elba-CY: SLB Score



Fungicide Evaluation, Elba (CY Sheelar), 2019: 4 Sprays

SLB Score (3 Data Points)

Outliers Removed (AVG $\pm$ 2SD)

FRAC 7(1)

Luna Tranquility

16 fl oz

Luna Experience (16 fl oz)

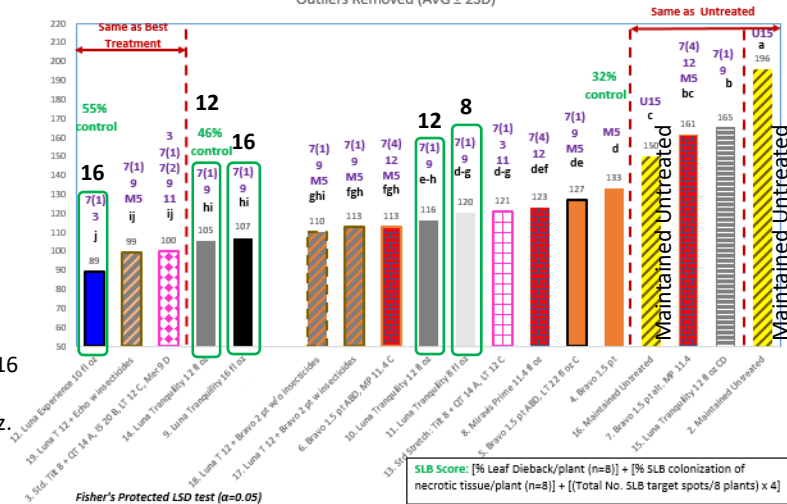
12 fl oz

8 fl oz

Luna Experience (+ FRAC 3)
significantly better than Luna
Tranquility (+ FRAC 9)

No significant difference between 16
and 12 fl oz of Luna Tranquility.
8 fl oz significantly less than 16 fl oz.

Is Luna Tranquility slipping?



2019 SLB Fungicide Trial, Sodus: SLB Index



FRAC 7(1)

Luna Tranquility

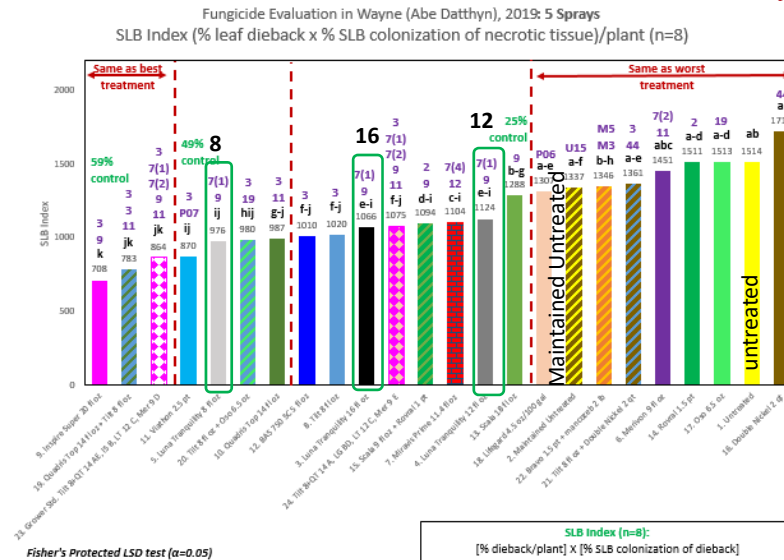
16 fl oz

12 fl oz

8 fl oz

All rates "middle-of-the-pack".
No significant differences
among them.

Is Luna Tranquility slipping?



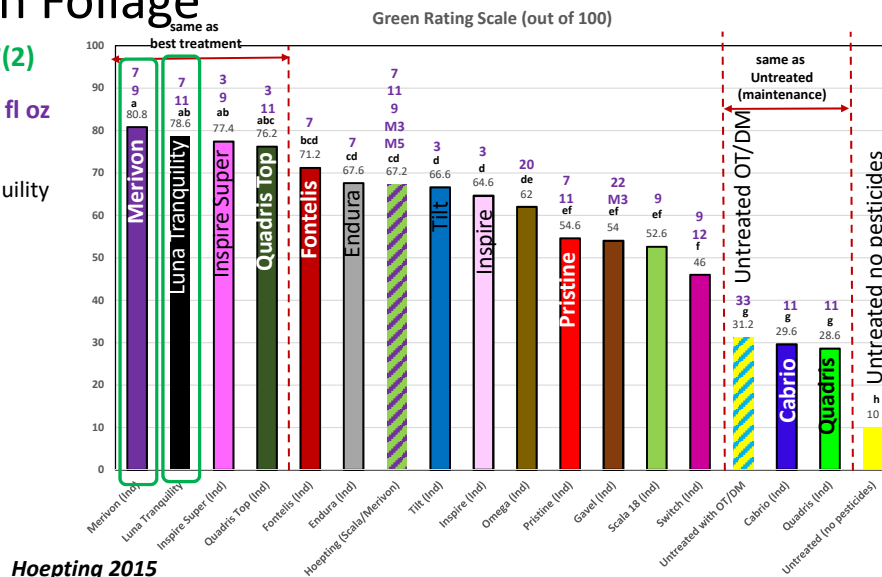
2015 On-Farm SLB Fungicide Trial, Elba: Green Foliage



FRAC 7(2)

Merivon 9 fl oz

As good as
Luna Tranquility



2018 SLB Fungicide Trial, Oswego – SLB Severity



Oswego Fungicide Trial, 2018:
Stemphylium Leaf Blight (SLB) Severity Rating (Scale: 0-100) - Aug 30 & 31

FRAC 7(2)

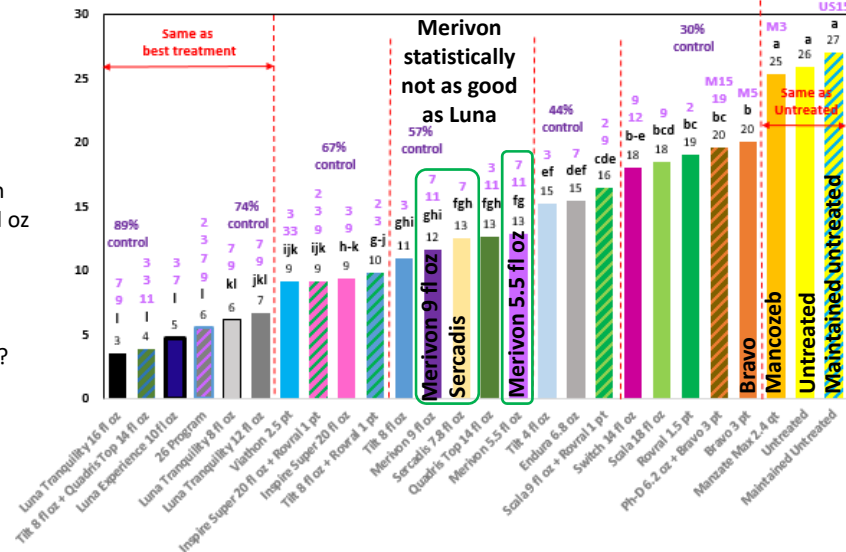
Merivon

9 fl oz

5.5 fl oz

No difference between
Merivon 5.5 fl oz & 9 fl oz
rates

Is Merivon FRAC 7(2)
developing resistance?



2018 SLB Fungicide Trial, Elba Torrey: % Die Up



SLB Program Trial (6 sprays), Elba, 2018:
% Dying Standing Up 4x Plot (Aug 27)

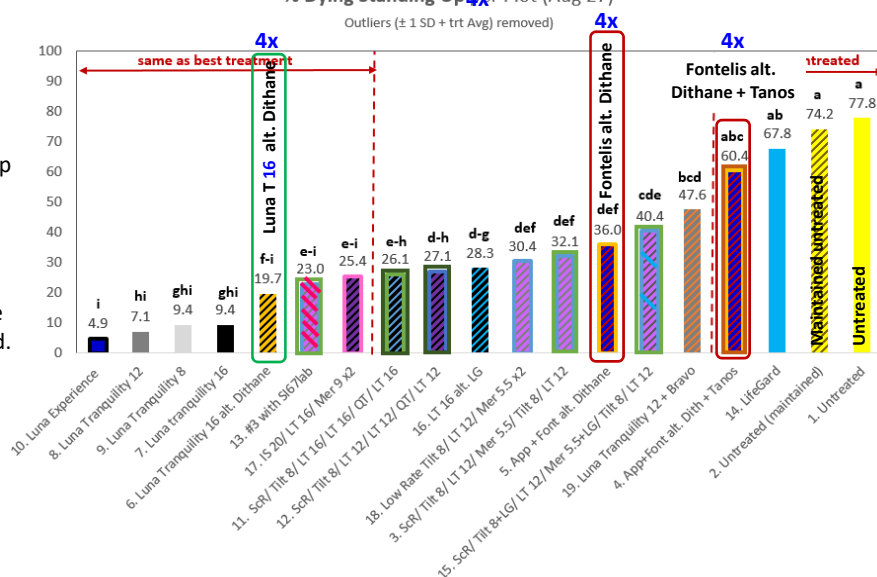
FRAC 7(2)

Fontelis 4x:

- alt. **Dithane** (FRAC M3)
statistically 2x more dying up
than Luna T 4x, statistically
not as good as best
treatment.
- alt. **Dithane + Tanos** (FRAC
27, 11) significantly 3x more
dying up, same as untreated.

Fontelis is in same FRAC 7 sub-
class as **Merivon**

- Is this sub-class slipping?



2019 SLB Fungicide Trial, Elba: SLB Score



Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
5 point SLB Score

FRAC 7(2)

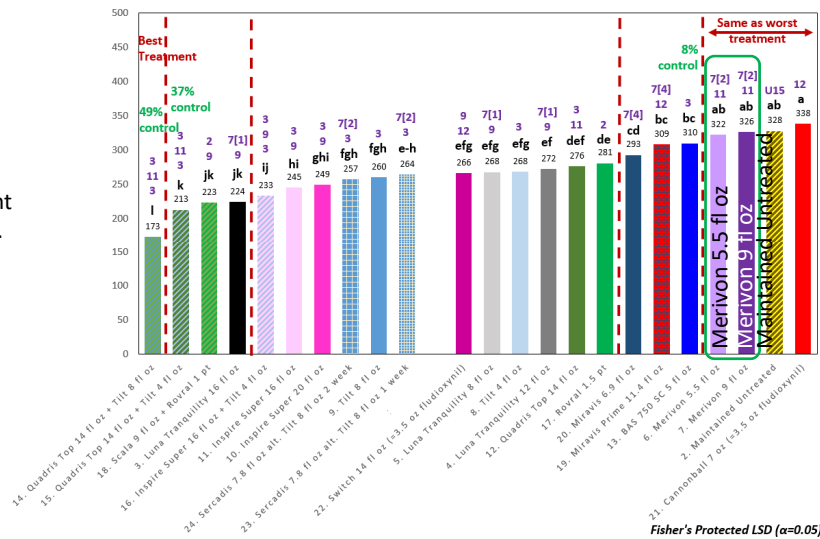
Merivon

9 fl oz

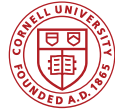
5.5 fl oz

Merivon is no different than untreated check.

Looks like Fungicide resistance!



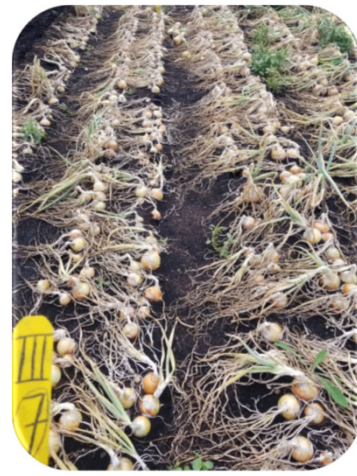
2019 SLB Fungicide Trial – Elba, Sep 15



Maintained Untreated



Merivon 5.5 fl oz



Merivon 9 fl oz

2019 SLB Fungicide Trial, Elba: SLB Score



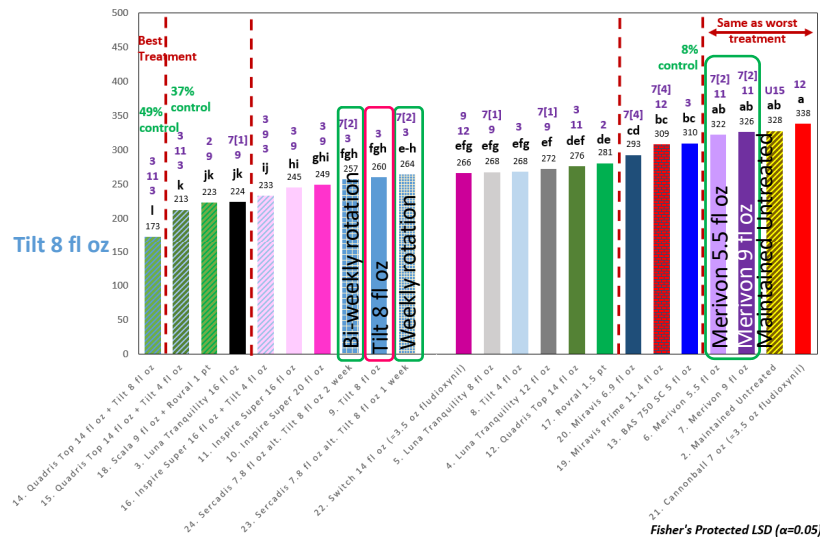
FRAC 7(2)

Sercadis
Sercadis
Tilt 8 fl oz
Tilt 8 fl oz
repeat

Sercadis
Tilt 8 fl oz
Sercadis
Tilt 8 fl oz
repeat

Sercadis did not
improve control over
Tilt 8 fl oz

Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
5 point SLB Score



2019 SLB Fungicide Trial, Sodus: SLB Index

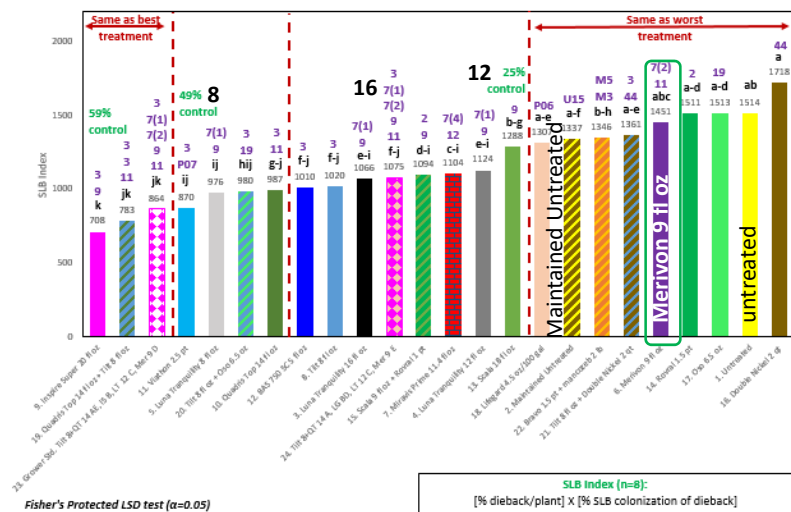


FRAC 7(2)

Merivon 9 fl oz

Merivon is no different
than untreated check.
Looks like Fungicide
resistance!

Fungicide Evaluation in Wayne (Abe Datthyn), 2019: 5 Sprays
SLB Index (% leaf dieback x % SLB colonization of necrotic tissue)/plant (n=8)



2019 SLB Fungicide Trial, Elba: SLB Score



Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
5 point SLB Score

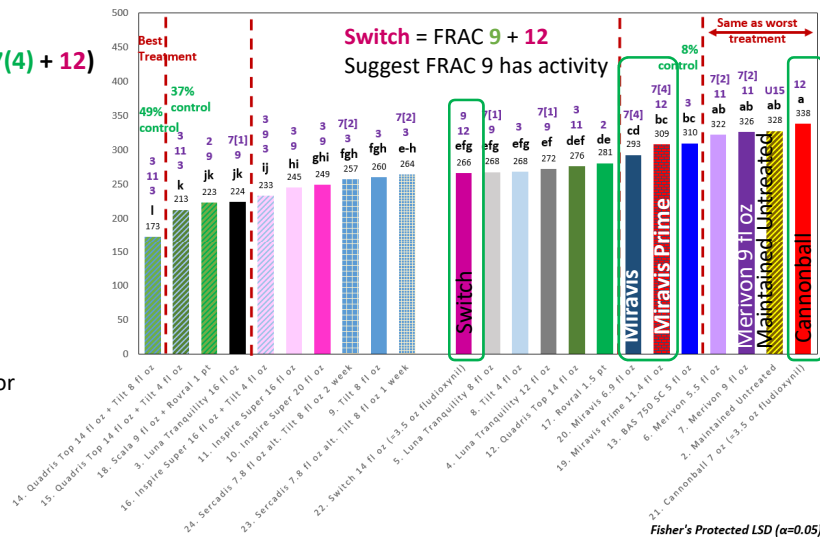
FRAC 7(4)
Miravis Prime (FRAC 7(4) + 12)
Miravis – FRAC 7(4)
Cannonball – FRAC 12

Miravis Prime and
 Miravis are not
 significantly different
 than Merivon.

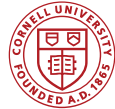
Cross Resistance?

Cannonball FAILED

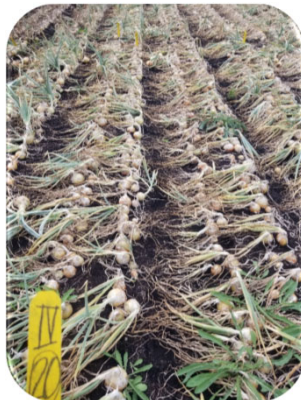
FRAC 12 has no activity or
 developed resistance?



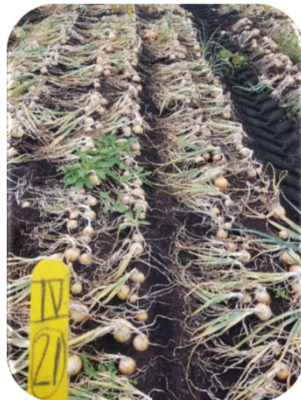
2019 SLB Fungicide Trial – Elba, Sep 15



Miravis Prime



Miravis



Cannonball



Switch

2019 SLB Fungicide Trial, Elba-CY: SLB Score

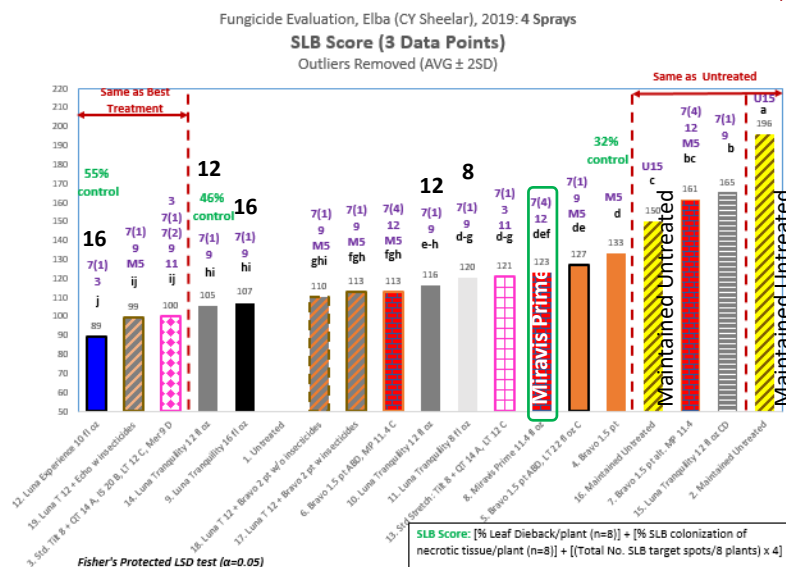


FRAC 7(4)

Miravis Prime

POOR –

Disappointing for a new FRAC 7



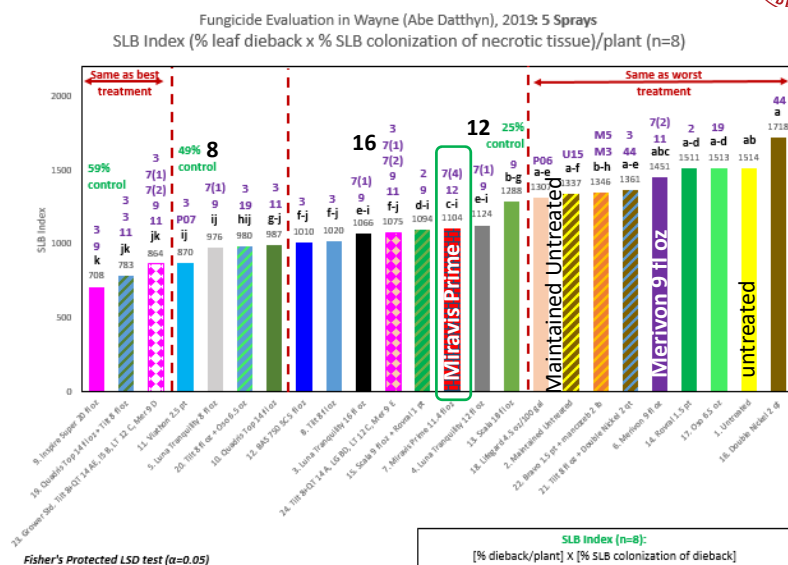
2019 SLB Fungicide Trial, Sodus: SLB Index



FRAC 7(4)

Miravis Prime

Middle-of-the-pack is disappointing for a new FRAC 7



2018 SLB Fungicide Trial, Oswego: SLB Severity

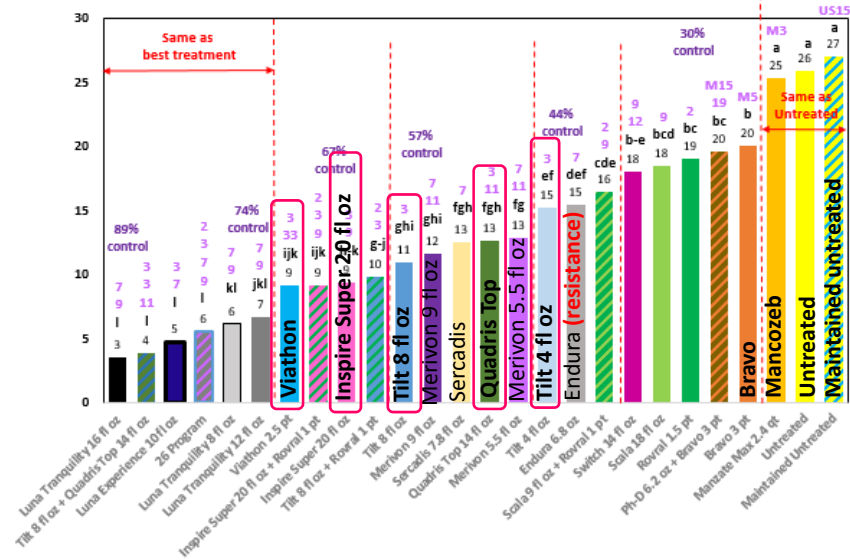


Oswego Fungicide Trial, 2018:
Stemphylium Leaf Blight (SLB) Severity Rating (Scale: 0-100) - Aug 30 & 31

FRAC 3

Consistently
"middle-of-the-pack"

Tilt 8 fl oz significantly
less SLB than **Tilt 4 fl oz**
Use high rate.



2019 SLB Fungicide Trial, Elba: SLB Score



Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
5 point SLB Score

FRAC 3

Inspire Super 20 fl oz

Inspire Super 16 fl oz

No difference between rates

Tilt 8 fl oz

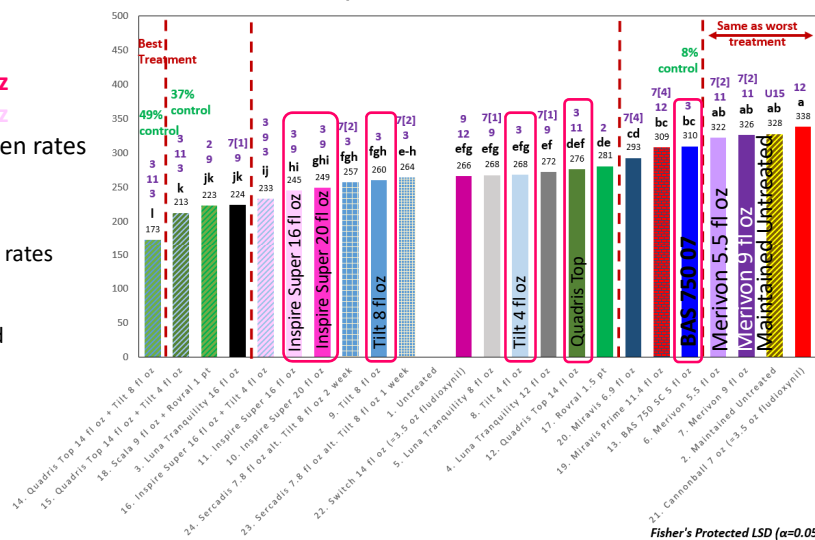
Tilt 4 fl oz

No difference between rates

Quadris Top 14 fl oz

Statistically not as good
as Inspire Super

BAS 750 07 - POOR



Fisher's Protected LSD ($\alpha=0.05$)

2019 SLB Fungicide Trial, Sodus: SLB Index



FRAC 3

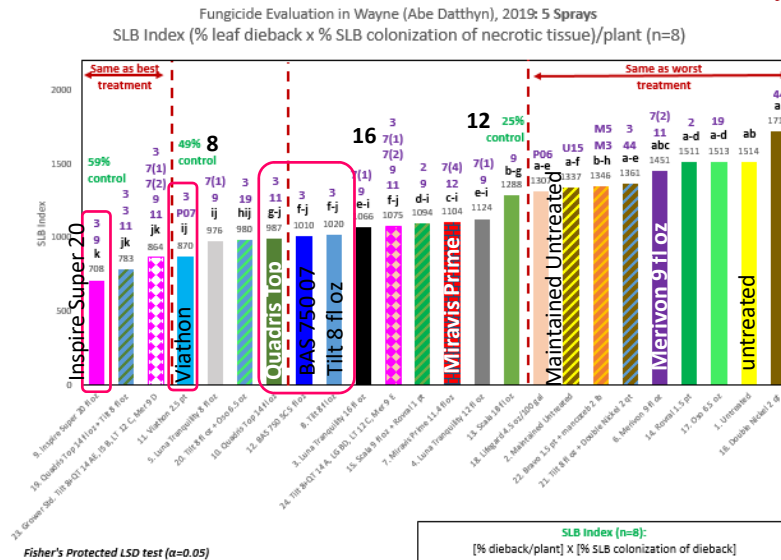
Inspire Super 20 fl oz – BEST!

Viathon 2.5 pt

Quadris Top

BAS 750 07

Tilt 8 fl oz



2018 SLB Fungicide Trial, Oswego: SLB Severity

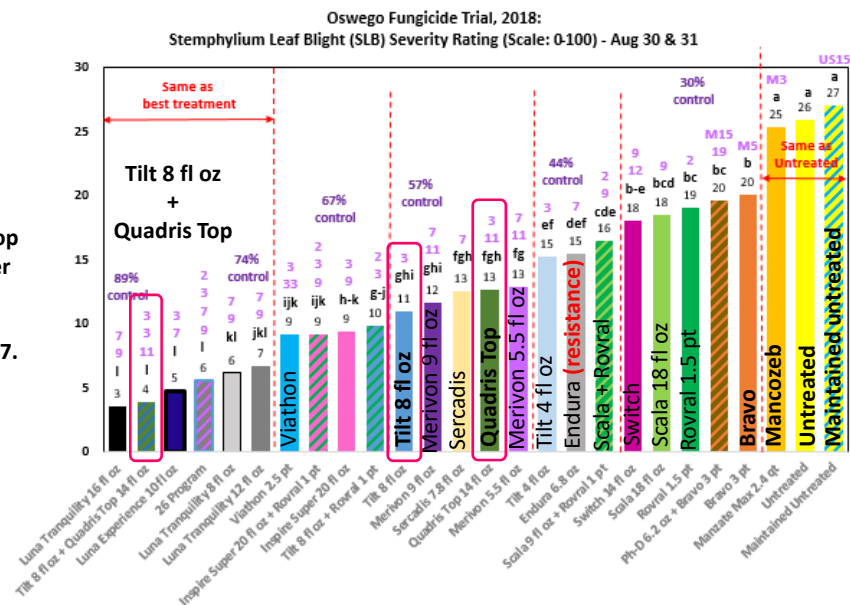


Is FRAC 3 + 3 as good as Luna?

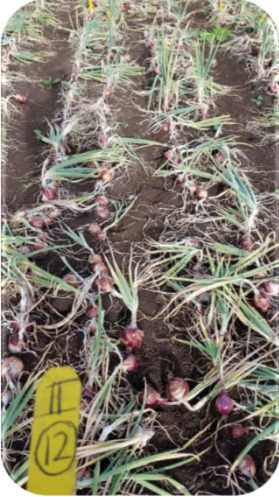
YES!

Tilt 8 fl oz + Quadris Top was significantly better than either alone.

As good as Luna FRAC 7.



2018 SLB Fungicide Trial – Oswego (Sep 6)



Tilt 8 fl oz



Quadris Top 14 fl oz

Tilt 8 fl oz
+ Quadris Top 14 fl oz

Luna Tranquility 16 fl oz

2019 SLB Fungicide Trial, Elba: SLB Score



Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
5 point SLB Score

FRAC 3 + 3

BEST in Trial!

Quadris Top 14 fl oz

+ Tilt 8 fl oz

Significantly better than

Quadris Top 14 fl oz

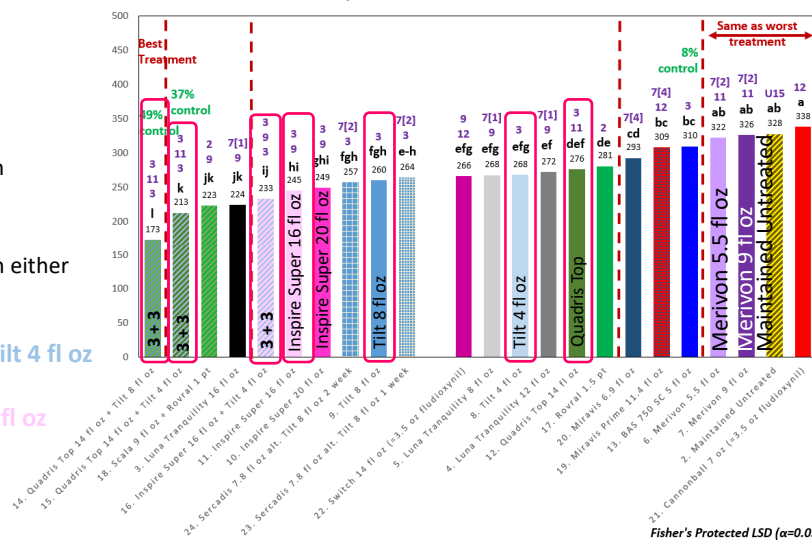
+ Tilt 4 fl oz

Significantly better than either
alone or Inspire Super.

Inspire Super 16 fl oz + Tilt 4 fl oz

Better than **Tilt 4 fl oz**,

but not **Inspire Super 16 fl oz**



Fisher's Protected LSD ($\alpha=0.05$)

2019 SLB Fungicide Trial – Elba (Sep 15)



Quadris Top
14 fl oz

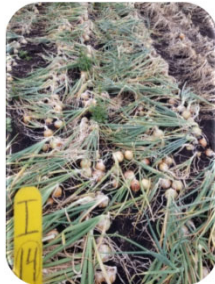


Tilt 8 fl oz



Tilt 4 fl oz

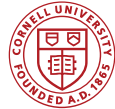
Quadris Top 14 fl oz
+ Tilt 8 fl oz



Quadris Top 14 fl oz
+ Tilt 4 fl oz



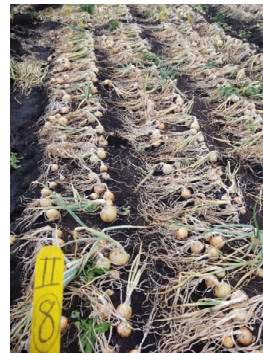
2019 SLB Fungicide Trial – Elba (Sep 15)



Inspire Super 20 fl oz



Inspire Super 16 fl oz



Tilt 4 fl oz



Inspire Super 16 fl oz +
Tilt 4 fl oz

2019 SLB Fungicide Trial, Elba-CY: SLB Score



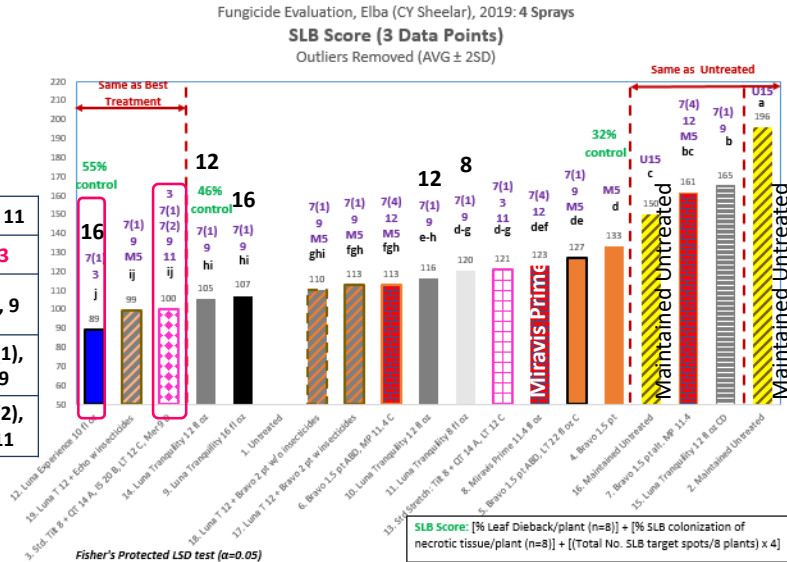
FRAC 3 + 3

**Luna Experience
(FRAC 7(1) + 3)**

Program:

Week 1	Quadris Top 14 fl oz	3, 11
	+ Tilt 8 fl oz	3
Week 2	Inspire Super 20 fl oz	3, 9
Week 3	Luna Tranquility 12 fl oz	7(1), 9
Week 4	Merivon 9 fl oz	7(2), 11

Treatments with **FRAC 3**
BEST in trial!



2019 SLB Fungicide Trial, Sodus: SLB Index



FRAC 3 + 3

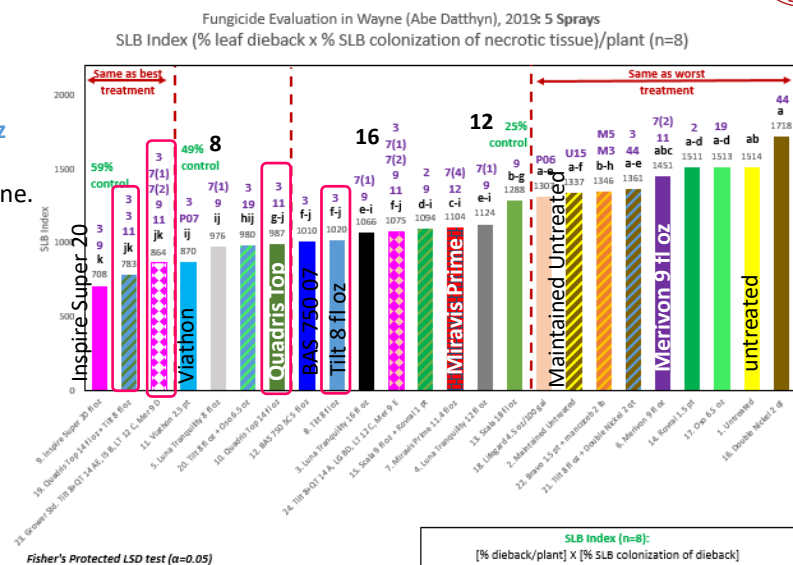
**Quadris Top 14 fl oz
Tilt 8 fl oz**

**Quadris Top 14 fl oz + Tilt 8 fl oz
- BEST!**

Numerically better than either alone.

Program - **BEST!**

Week 1	Quadris Top 14 fl oz	3, 11
	+ Tilt 8 fl oz	3
Week 2	Inspire Super 20 fl oz	3, 9
Week 3	Luna Tranquility 12 fl oz	7(1), 9
Week 4	Merivon 9 fl oz	7(2), 11
Week 5	Quadris Top 14 fl oz	3, 11
	+ Tilt 8 fl oz	3



2017 SLB Fungicide Trial, Elba: % Green Foliage



FRAC 2

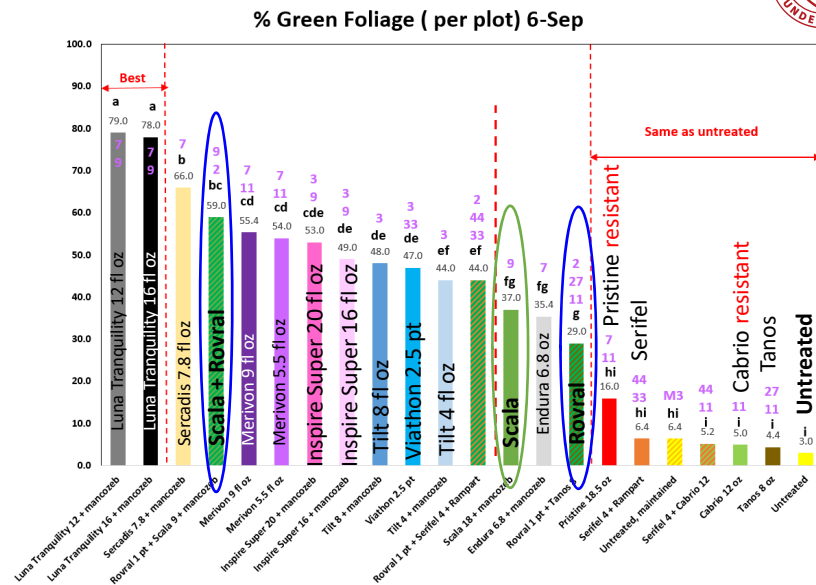
Rovral **Poor**

FRAC 9

Scala **Poor**

Scala + Rovral

As good as FRAC 7



2017 SLB Fungicide Trial – Elba, Sep 6



Luna Tranquility 16 fl oz



Scala 18 fl oz



Scala 9 fl oz + Rovral 1 pt

2018 SLB Fungicide Trial, Oswego: SLB Severity



FRAC 2

Rovral **POOR** control

FRAC 9

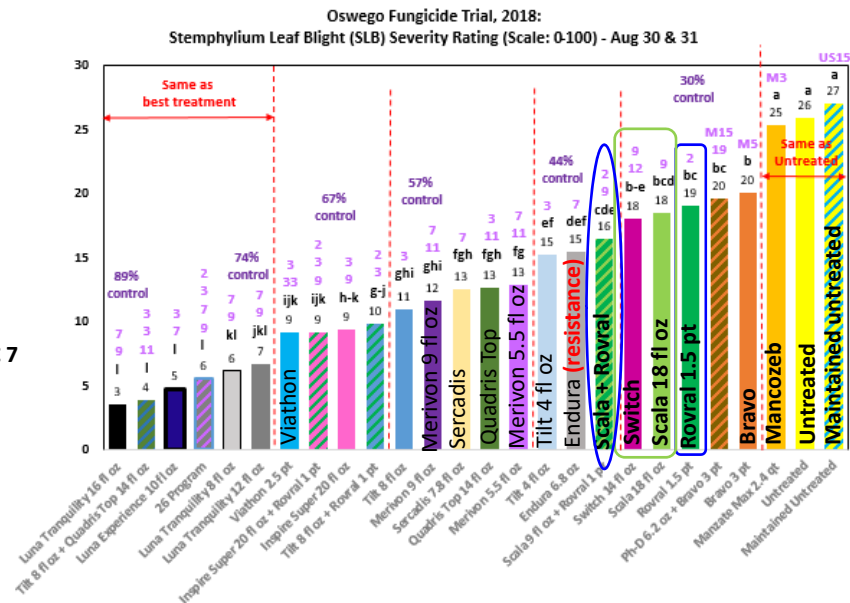
Scala **POOR** control

Switch **POOR** control

Scala + Rovral

= **NO synergy**

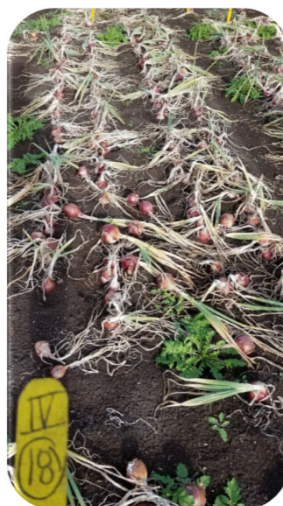
Not as good as a FRAC 7



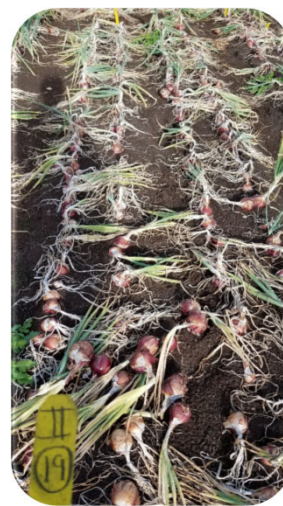
2018 SLB Fungicide Trial – Oswego (Sep 6)



Rovral 1.5 pt



Scala 18 fl oz



Scala 9 fl oz + Rovral 1 pt

2018 Fungicide Sensitivity Bioassay (Hay) iprodione (Rovral) = FRAC 2



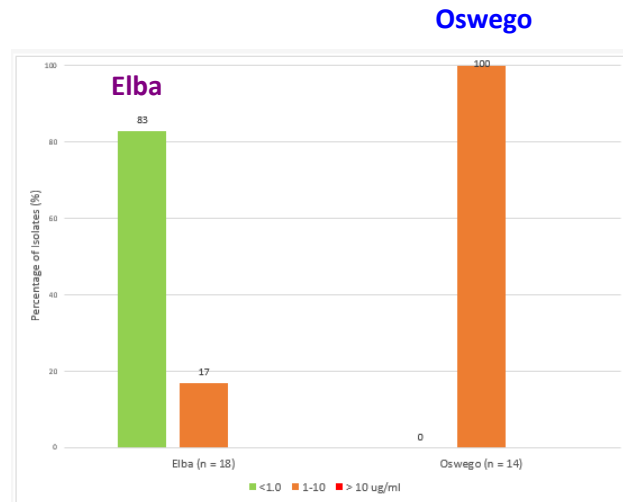
Oswego:

- 100% of SLB isolates were moderately insensitive
- Rovral is slipping

Elba:

- Rovral still working
- 83% of SLB isolates were sensitive.

	Sensitive (fungicide works)
	Moderately insensitive (fungicide slipping)
	Insensitive (fungicide does NOT work)



MANY MORE RESULTS TO COME!

2018 Fungicide Sensitivity Bioassay (Hay) pyrimethanil (Scala) = FRAC 9



Figure 4. Sensitivity of 78 isolates of *S. vesicarium* collected from around NY in 2018 to the fungicide active ingredient pyrimethanil (by region).

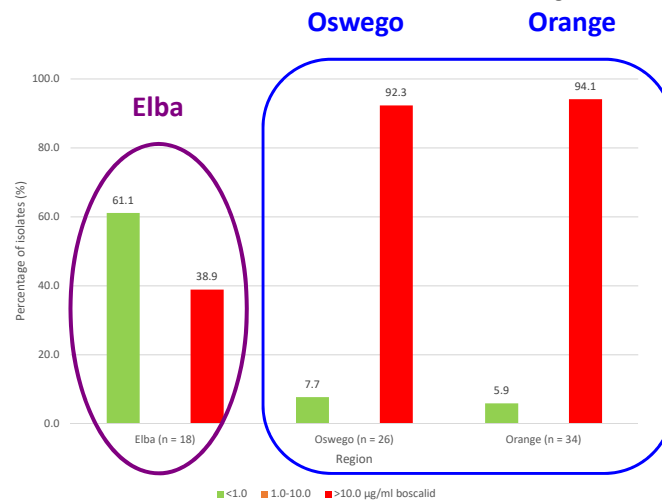
Oswego & Orange:

- SLB has developed resistance to SLB in Oswego – 92% of isolates insensitive

- Scala does NOT work

Elba:

- Scala still has utility
- No change in insensitive isolates since 2016



MANY MORE RESULTS TO COME!

2019 SLB Fungicide Trial, Elba: SLB Score

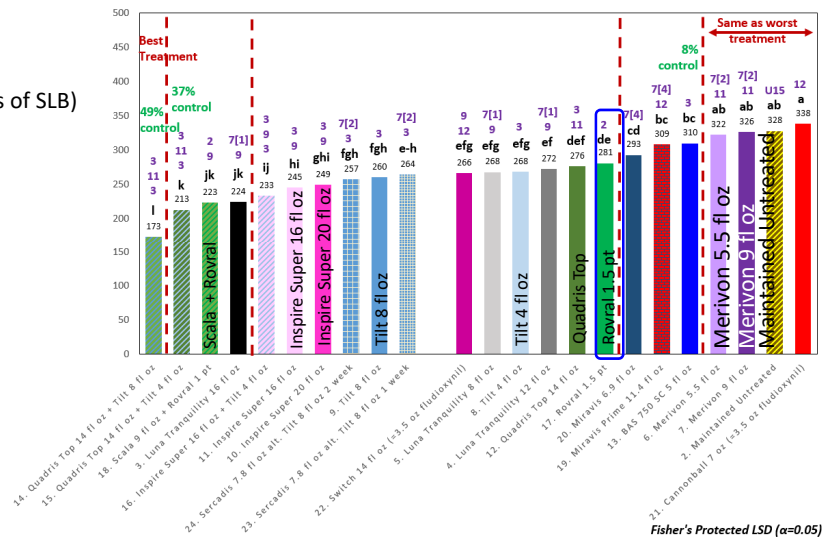


Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
5 point SLB Score

FRAC 2

Rovral ??

(healthy foliage, but lots of SLB)



2019 SLB Fungicide Trial, Elba



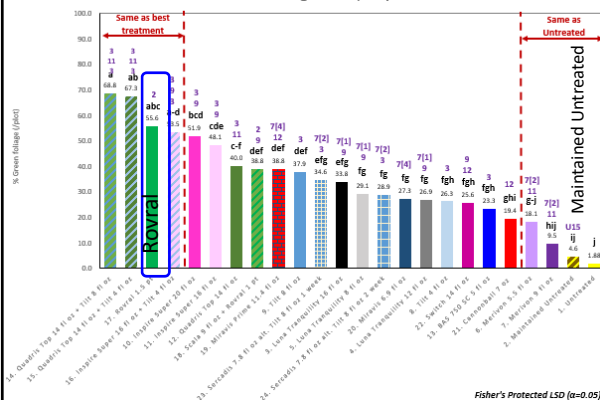
FRAC 2

Rovral ??

(healthy foliage, but lots of SLB)

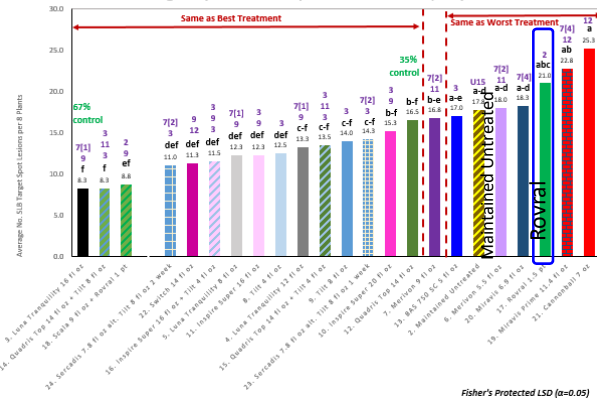
Plant Health - % Green Foliage (Sep 15)

Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
% Green Foliage/Plot, Sep 15



Total No. SLB Target Spot Lesions/8 plants

Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
No. SLB Target Spot Lesions per 8 Plants/Plot, Sep 10-11



2019 SLB Fungicide Trial, Elba: SLB Score



Fungicide Evaluation, Elba (Torrey Blue Barn), 2019: 7 Sprays
5 point SLB Score

FRAC 2

Rovral ??

(healthy foliage, but lots of SLB)

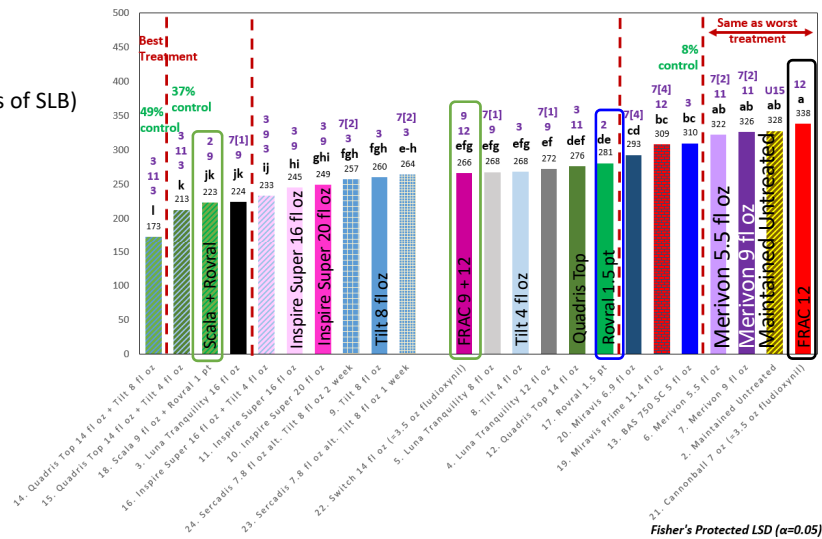
FRAC 9 + FRAC 2

Scala + Rovral

One of best in trial!

Suggests **FRAC 9** still working in Elba.

FRAC 12 FAILED



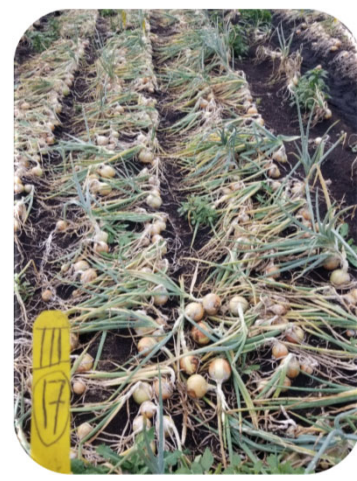
2019 SLB Fungicide Trial – Elba, Sep 15



Quadris Top 14 fl oz + Tilt 8 fl oz



Scala 9 fl oz + Rovral 1 pt



Rovral 1.5 pt

2019 SLB Fungicide Trial, Sodus: SLB Index



FRAC 2

Rovral **FAILED**
SLB Resistance?

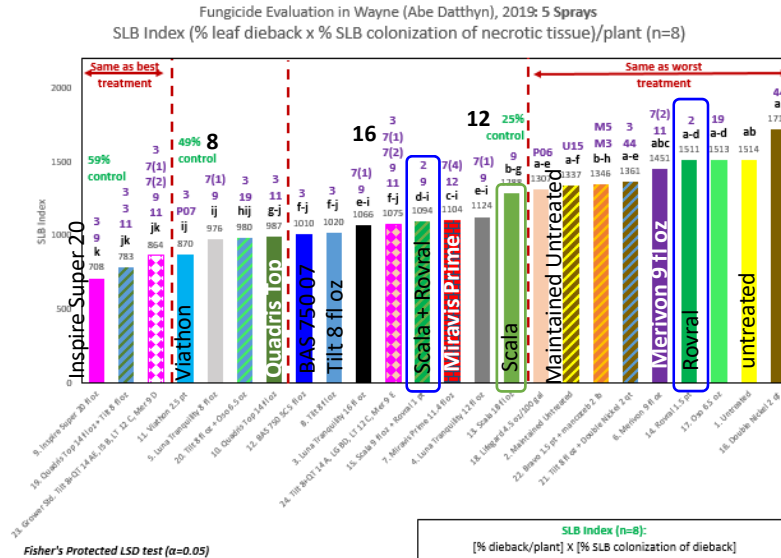
FRAC 9

Scala **some** activity

Scala + Rovral

= **NO synergy**

Not as good as best treatment



2019 SLB Fungicide Trial, Sodus: SLB Index



FRAC 44

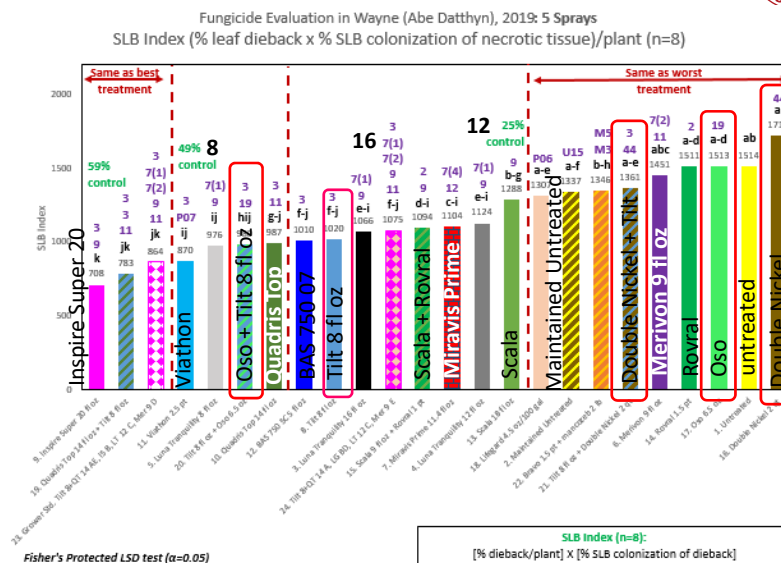
Double Nickel **FAILED**

Double Nickel + Tilt 8 fl oz
No Synergy - FAILED

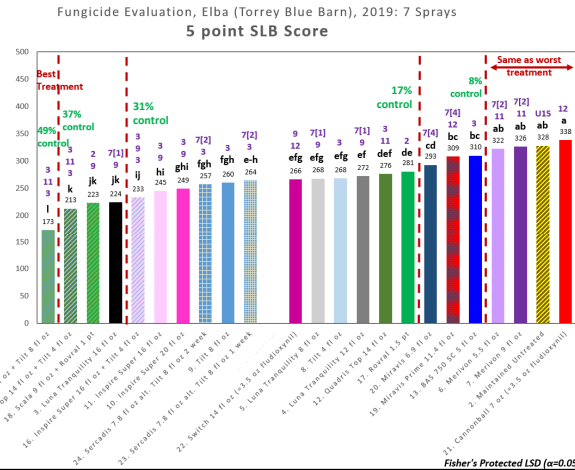
FRAC 19

Oso **FAILED**

Oso + Tilt 8 fl oz
No Synergy



2019
SLB Score
BEST – 49% Control



2019
SLB Target Lesion Counts
BEST – 67% Control

