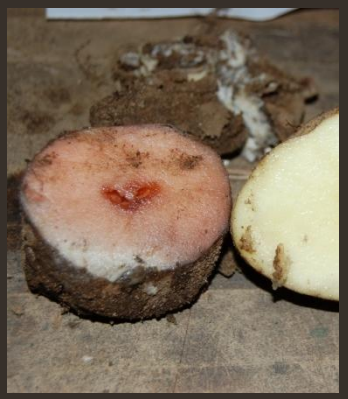
POST-HARVEST FUNGICIDES FOR MANAGEMENT OF STORAGE DISEASES



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2013 UW Extension and WPVGA Grower Education Conference, Stevens Point, WI
Wednesday, February 6, 2013

THE UNIVERSITY of WISCONSIN MADISON

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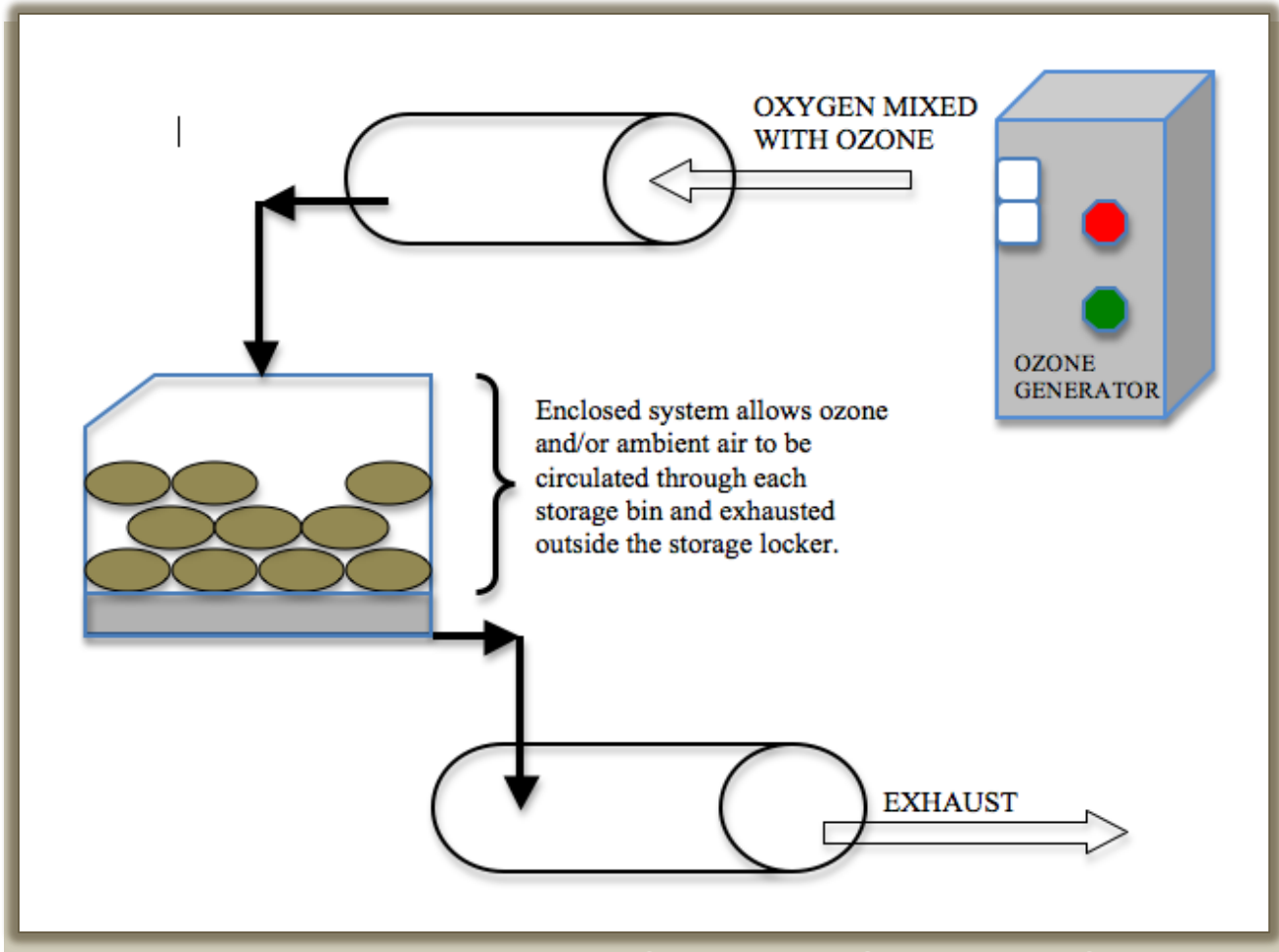
CURRENT OPTIONS FOR POST-HARVEST FUNGICIDES

- Mertect (thiabendazole)
  - Resistant populations of *Helminthosporium solani* (silver scurf) and Fusarium spp. (Fusarium dry rot) limit usefulness
- Phosphorous acid fungicides
  - Typically effective against oomycete pathogens (late blight, pink rot, pythium, and evidence of silver scurf control)
  - Crop-phite, Fosphite, Prophyt, Resist 57, Topaz, Phostrol
- Hydrogen peroxide
  - Oxidate
  - OMRI approved
- Ozone application
- New fungicides (Stadium from Syngenta)

POTATO STORAGE DISEASE MANAGEMENT RESEARCH, HANCOCK ARS

- 2 Primary areas of research:
  - Evaluation of ozone for control of diseases in storage
    2 different scales:
    small bin “tub” work, Locker #9 (SRF)
    commercial bin (SRF)
  - Evaluation of post-harvest fungicides for disease control in storage (late blight, pink rot, silver scurf, Pythium leak, Fusarium dry rot), Locker #9 (SRF)

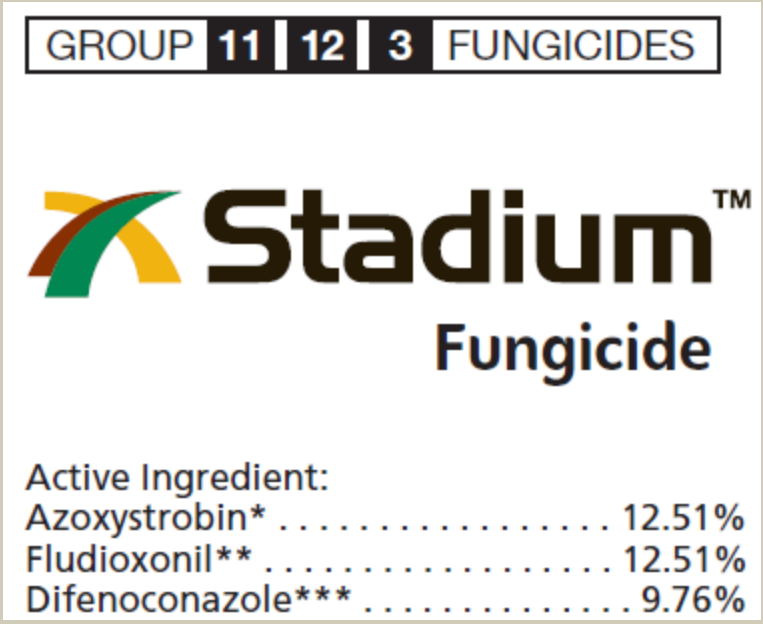
OZONE RESEARCH IN LOCKER 9



Thank you to Eugene Mancl of Ron's Refrigeration for the loan and optimization of ozone generator, as well as modification of exhaust system in Locker 9.

NEW FUNGICIDE FOR POST-HARVEST POTATO DISEASE CONTROL

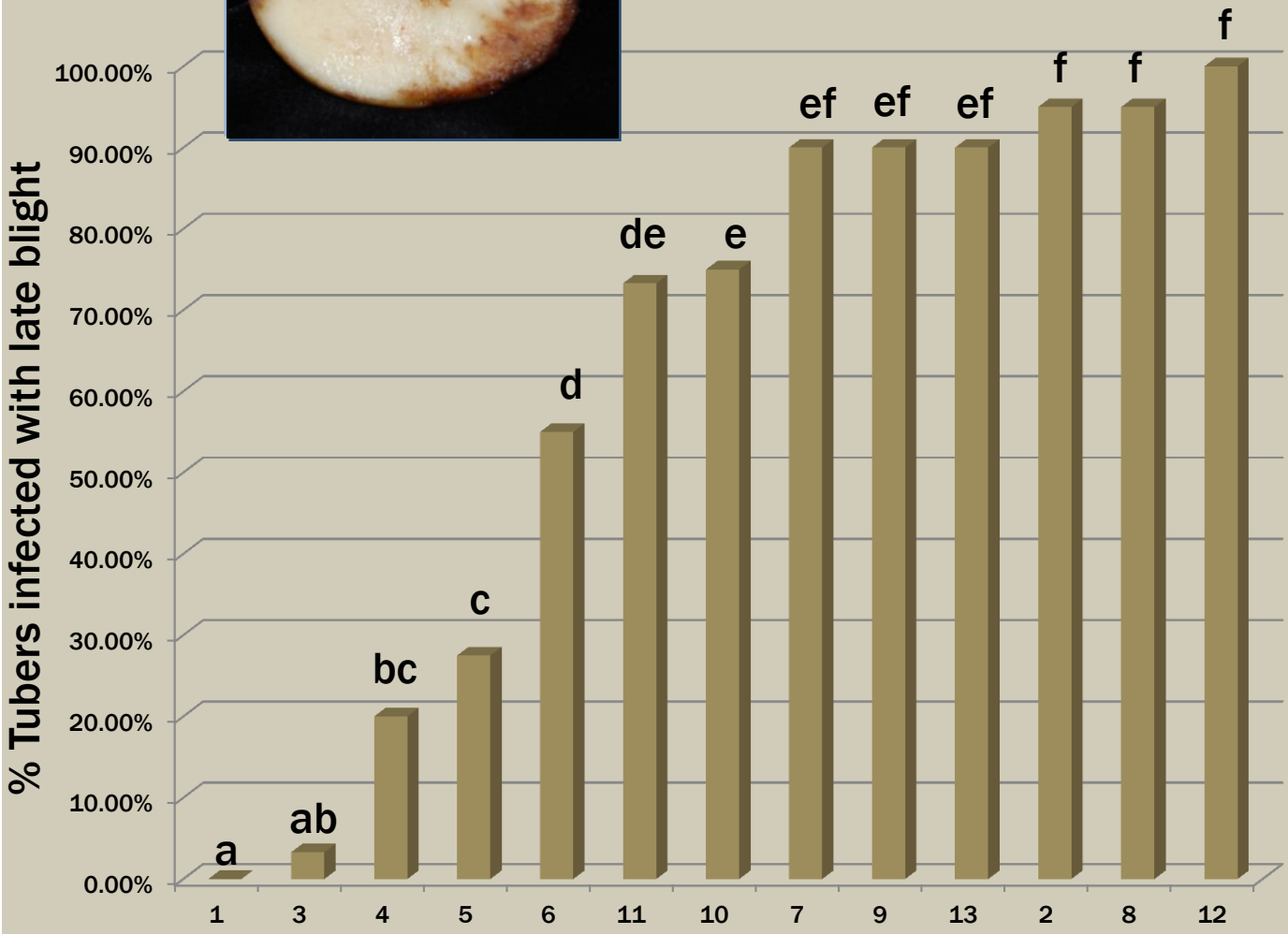
- Syngenta's Stadium
  - Labeled for use in controlling Fusarium dry rot and Silver scurf in storage
  - Our research also indicates outstanding control of Pink rot and Late blight with Stadium – not on label at this time
  - One application can be made post-harvest
  - Contains 3 active ingredients
    - Azoxystrobin (Quadris)
    - Fludioxonil (Maxim)
    - Difenoconazole (Inspire , Top)



POST-HARVEST STORAGE TRIAL LATE BLIGHT, WINTER 2010

Trt. No.	Fungicide Trade Name	Active Ingredient	Application rate (fl oz/ton)
1	Untreated/Non-inoculated	Not Applicable	
2	Untreated/Inoculated	Not Applicable	
3	A9859, Syngenta	fludioxonil	0.6
	A12705, Syngenta	azoxystrobin	0.6
	A8574, Syngenta	difenoconazole	0.15
4	A9859, Syngenta	fludioxonil	0.6
	A12705, Syngenta	azoxystrobin	0.6
	A8574, Syngenta	difenoconazole	0.3
5	Phostrol 4 SC, Nufarms	phosphorus acid salts	12.8
	Mertect 340-F, Syngenta	thiabendazole	0.42
6	Mertect 340-F, Syngenta	thiabendazole	0.42
7	Presidio, Valent	fluopicolide	4.0
8	V-10208, Valent	ethaboxam	10.0
9	V-10208, Valent	ethaboxam	10.0
	Presidio, Valent	fluopicolide	4.0
10	Phostrol 4 SC, Nufarms	phosphorus acid salts	12.8
11	Phostrol 4 SC, Nufarms	phosphorus acid salts	6.4
12	Oxidate, BioSafe Systems	hydrogen dioxide	12.6
13	Oxidate, BioSafe Systems	hydrogen dioxide	6.3

LATE BLIGHT INFECTION 90 DAYS POST-INOCULATION 2010



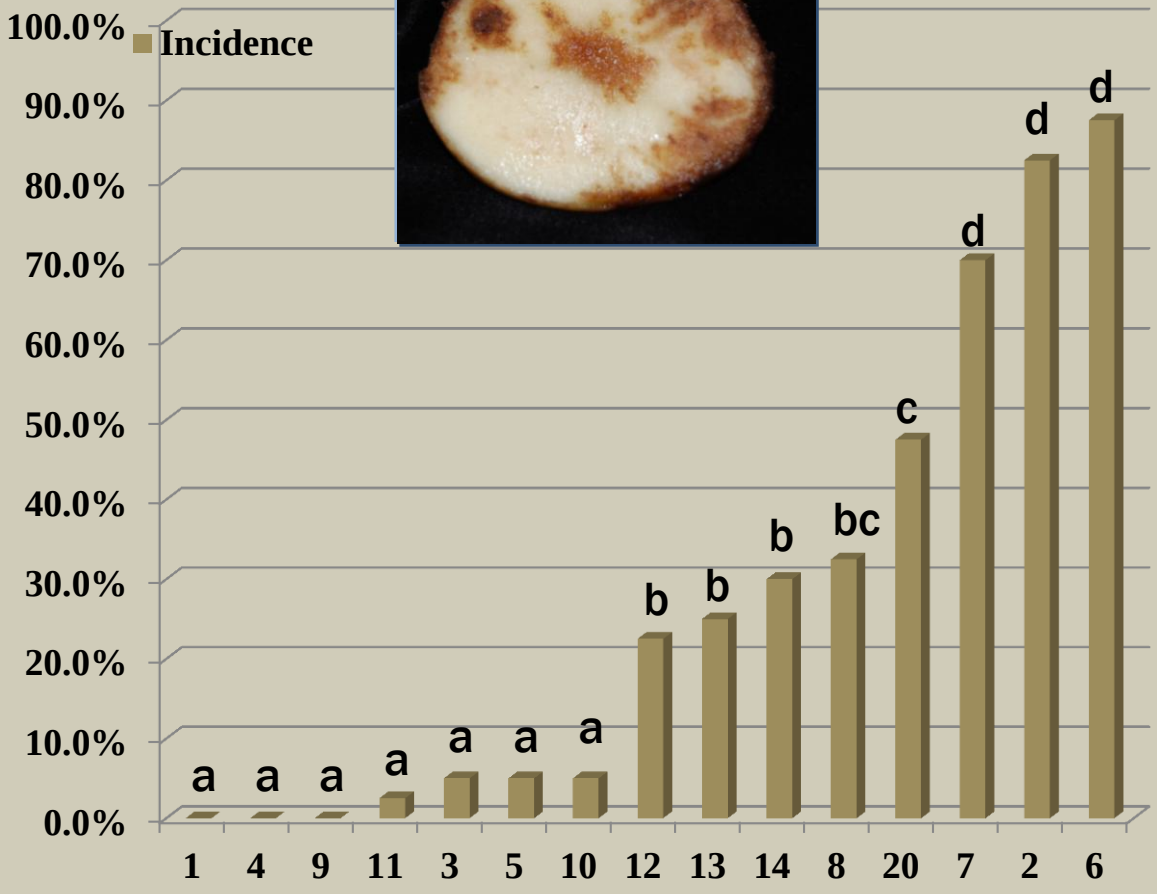
1	Untreated/non-inoculated
2	Untreated/inoculated
3	A9859
	A12705
	A8574 High rate
4	A9859
	A12705
	A8574 Low rate
5	Phostrol 4 SC
	Mertect 340-F
6	Mertect 340-F
7	Presidio
8	V-10208
9	V-10208
	Presidio
10	Phostrol 4 SC High rate
11	Phostrol 4 SC Low rate
12	Oxidate High rate
13	Oxidate Low rate

Inoculated prior to fungicide trt

POST-HARVEST STORAGE TRIAL LATE BLIGHT, WINTER 2011 60 DPI

Trt #	Fungicide Trade Name	Active Ingredient	Application Rate (fl oz/ton)
1	Untreated, Non-inoculated	Not applicable	NA
2	Pink Rot Inoculated	Not applicable	water mock treatment
3	A9859, Syngenta +	fludioxonil	0.6 fl oz
	A12705, Syngenta +	azoxystrobin	0.6 fl oz
	A8574, Syngenta	difenoconazole	0.3 fl oz
4	A18780, Syngenta	experimental	1.0 fl oz
5	A18780 B, Syngenta	experimental	1.0 fl oz
6	Phostrol, Nufarms +	salts of phosphorous acids	12.8 fl oz
	Mertect, Syngenta	thiabendazole	0.42 fl oz
7	Mertect, Syngenta	thiabendazole	0.42 fl oz
8	Phostrol, Nufarms	salts of phosphorous acids	12.8 fl oz
9	Presidio, Valent	fluopicolide	4.0 fl oz
10	V-10208, Valent	ethaboxam	10.0 fl oz
11	Presidio, Valent +	fluopicolide	4.0 fl oz
	V-10208, Valent	ethaboxam	10.0 fl oz
12	Phostrol, Nufarms	salts of phosphorous acids	6.4 fl oz
13	Oxidate , BioSafe Systems	hydrogen dioxide	1.25 fl oz
14	Oxidate , BioSafe Systems	hydrogen dioxide	6.25 fl oz
20	Ozone, Ron's Refrig.	ozone	10 ppm

POST-HARVEST STORAGE TRIAL LATE BLIGHT, WINTER 2011 60 DPI

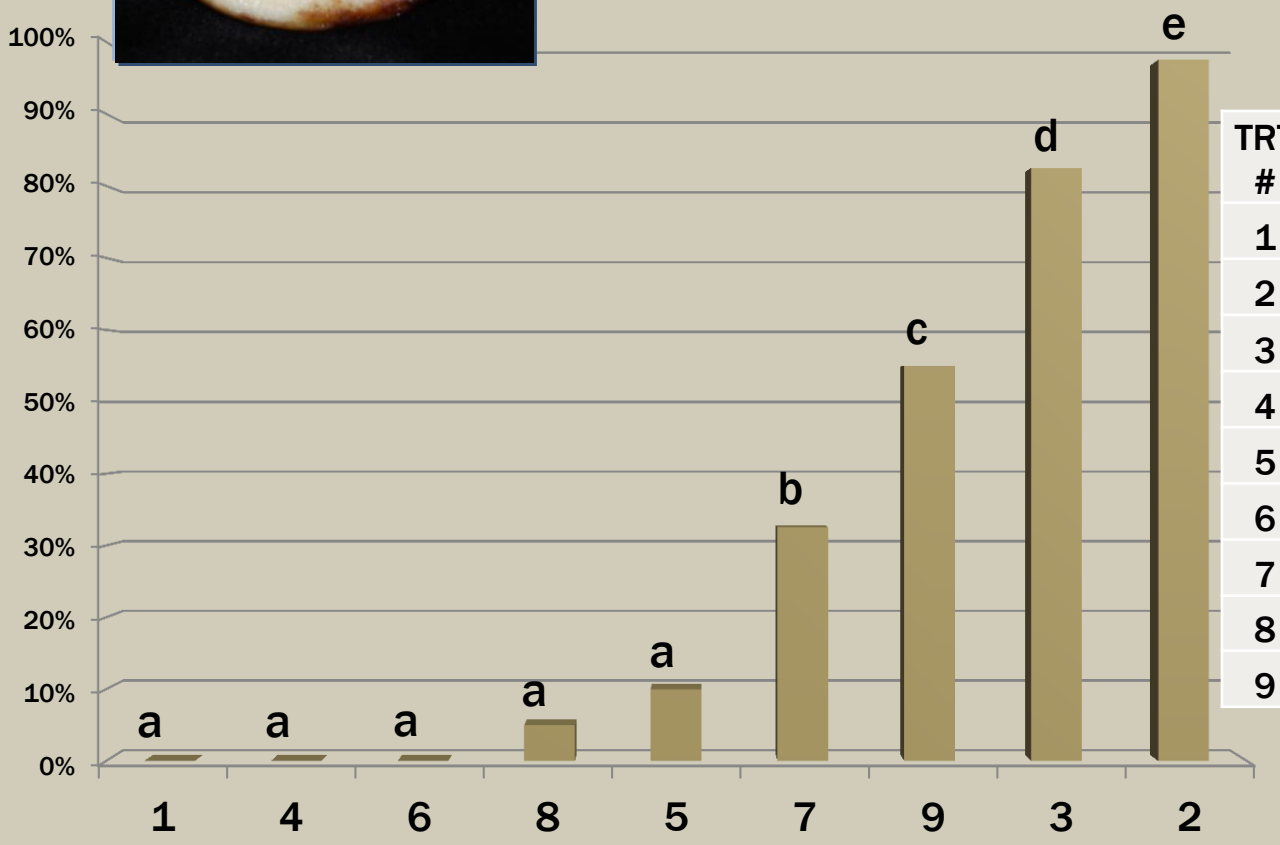


Trt #	Fungicide	Rate
1	No Inoc	NA
2	Pink Rot Inoc	NA
3	A9859 + A12705 + A8574	0.6 fl oz/ton tubers 0.6 fl oz/ton tubers 0.3 fl oz/ton tubers
4	A18780	1.0 fl oz/ton
5	A18780 B	1.0 fl oz/ton
6	Phostrol + Mertect	12.8 fl oz/ton 0.42 fl oz/ton
7	Mertect	0.42 fl oz/ton
8	Phostrol	12.8 fl oz/ton
9	Presidio	0.2 fl oz/cwt
10	V-10208	0.5 fl oz/cwt
11	Presidio + V-10208	0.2 fl oz/cwt 0.5 fl oz/cwt
12	Phostrol	6.4 fl oz/ton
13	Oxidate	1.25 fl oz/ton
14	Oxidate	6.25 fl oz/ton
20	Ozone	10 ppm

POST-HARVEST FUNGICIDE TREATMENTS FOR WINTER 2012-13 LATE BLIGHT TRIAL

Trt #	Treatment	Active ingredient	Rate/ton tubers
1	Untreated, Non-inoculated	Not applicable	
2	Untreated, Inoculated	Not applicable	
3	Ozone, Ron's Refrigeration	ozone	10 ppm
4	Phostrol, Nufarms	salts of phosphorous acid	6.4 fl oz
5	Ozone, BioSafe Systems + Phostrol, Nufarms	ozone + salts of phosphorous acid	10 ppm + 6.4 fl oz
6	Stadium, Syngenta	fludioxonil, azoxystrobin, difenoconazole	1.0 fl oz
7	Stadium Component (A9859), Syngenta	fludioxonil	0.6 fl oz
8	Stadium Component (A12705), Syngenta	azoxystrobin	0.6 fl oz
9	Stadium Component (A8574), Syngenta	difenoconazole	0.3 fl oz

LATE BLIGHT STORAGE TRIAL 2012-13
60 DPI



TRT #	Treatment	Active ingredient
1	Untr/Non-inoc	
2	Untr/Inoc	
3	Ozone	ozone
4	Phostrol	phosphorous acid
5	Ozone+Phostrol	ozone+phos acid
6	Stadium	fludi+azoxy+difen
7	Stad Comp A	fludioxonil
8	Stad Comp B	azoxystrobin
9	Stad Comp C	difenoconazole

LATE BLIGHT SUMMARY

- Ozone does significantly reduce late blight infections compared to the control (2011,2012), but not as effective as other products
  - Does limit mycelial growth on tuber surface
- Oxidate significantly reduced infection in 2011, not in 2010
  - Efficacy did not seem rate dependent
- Phostrol significantly reduces infections, shows evidence of reducing amount of infection in tubers
- V-10208 and Presidio significantly reduced infection in 2011, not in 2010
- Stadium significantly reduce late blight infections for all 3 trials
  - Azoxystrobin component likely most responsible for efficacy

SUMMARY FROM 2011-2012 LATE BLIGHT STORAGE TRIAL WITH OZONE

- Late blight progressed in all inoculated treatments
- Ozone significantly limited the progress of late blight when compared to no ozone
- Ozone limited external, mycelial development of late blight

- This benefit of ozone may be effective in limiting a disease 'hot spot' in a bulk bin setting due to
  - Reduction in advancement of disease internally and
  - Limitation of external mycelial growth of the pathogen

LATE BLIGHT CONTROL WITH OZONE IN 2012 – FINAL RATING IN MARCH

CONTROL
No inoculum+No ozone

Inoculated+No ozone

Inoculated+Ozone

LATE BLIGHT CONTROL WITH OZONE IN 2012 – FINAL RATING IN MARCH

CONTROL
No inoculum+No ozone

Inoculated+No ozone

Inoculated+Ozone

LATE BLIGHT CONTROL WITH OZONE IN 2012 – FINAL RATING IN MARCH

CONTROL

No inoculum+No ozone | **Inoculated+No ozone** | **Inoculated+Ozone**

SUMMARY FROM 2011-2012 LATE BLIGHT STORAGE TRIAL WITH OZONE

- Late blight progressed in all inoculated treatments
- Ozone significantly limited the progress of late blight when compared to no ozone
- Ozone limited external, mycelial development of late blight

- This benefit of ozone may be effective in limiting a disease 'hot spot' in a bulk bin setting due to
  - Reduction in advancement of disease internally and
  - Limitation of external mycelial growth of the pathogen

PINK ROT STORAGE TRIAL WINTER 2010

Treatment #	Fungicide	Active Ingredient	Rate/ton tubers
1	Untreated Non-inoculated control	Not applicable	
2	Untreated Inoculated control	Not applicable	
3	A9859, Syngenta	fludioxonil	0.6 fl oz
(Stadium)	A12705 Icl5504, Syngenta	azoxystrobin	0.6 fl oz
	A8574 CGA169374, Syngenta	difenoconazole	0.15 fl oz
4	A9859, Syngenta	fludioxonil	0.6 fl oz
(Stadium)	A12705 Icl5504, Syngenta	azoxystrobin	0.6 fl oz
	A8574 CGA169374, Syngenta	difenoconazole	0.3 fl oz
5	Phostrol 4 SC, Nufarms	salts of phosphorous acid	12.8fl oz
	Mertect 340-F, Syngenta	thiabendazole	0.42 fl oz
6	Mertect 340-F, Syngenta	thiabendazole	0.42 fl oz
7	Presidio, Valent	fluopicolide	4.0 fl oz
8	V-10208, Valent	ethaboxam	10.0 fl oz
9	V-10208, Valent	ethaboxam	10.0 fl oz
	Presidio, Valent	fluopicolide	4.0 fl oz
10	Phostrol, Nufarms	salts of phosphorous acid	12.8 fl oz
11	Phostrol, Nufarms	phosphorous acids	6.4 fl oz
12	Oxidate, BioSafe Systems	hydrogen dioxide	6.25 fl oz
13	Oxidate, BioSafe Systems	hydrogen dioxide	1.25 fl oz

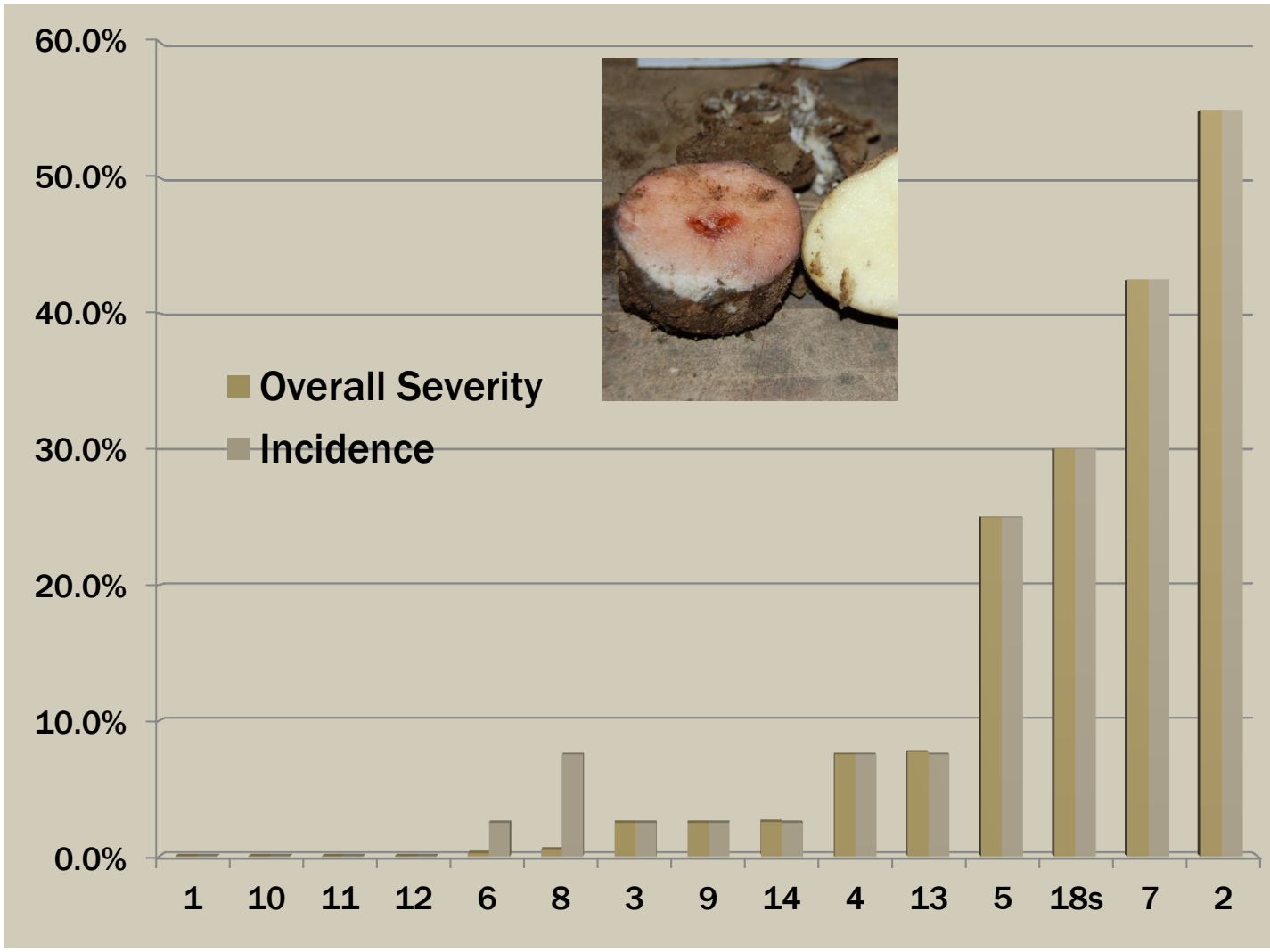
PINK ROT STORAGE TRIAL WINTER 2010

Trt #	Treatment	Rate/ton	% Pink Rot Incidence[1]	Severity Rating[2]
			30 DPI	60 DPI
1.	Untreated uninoculated	–	10abc	$.75_{a}$
2	Untreated inoculated	–	90e	3_{c}
3 (Stadium)	A9859 (Scholar)	.6 fl oz	80de	3_{c}
	A12705 Icl5504	.6 fl oz		
	A8574 CGA169374	.15 fl oz		
4 (Stadium)	A9859 (Scholar)	.6 fl oz	60cde	3_{c}
	A12705 Icl5504	.6 fl oz		
	A8574 CGA169374	.3 fl oz		
5	Phostrol 4 SC	12.8fl oz/ton	5a	$.25_{a}$
	Mertect 340-F	0.42 fl oz/ton		
6	Mertect 340-F	.42 fl oz/ton	95e	3_{c}
7	Presidio	4 fl oz	70de	2_{b}
8	V-10208	10 floz	0a	1_{a}
9	V-10208	10 fl oz	45bcd	1_{a}
	Presidio	4 fl oz		
10	Phostrol	12.8 fl oz	25abc	0.5_{a}
11	Phostrol	6.4 fl oz	30abc	0.5_{a}
12	Oxidate	6.25 fl oz	60cde	2.5_{bc}
13	Oxidate	1.25 fl ox	75de	3_{c}

PINK ROT STORAGE TRIAL
WINTER 2011

TRT #	Fungicide	Rate
1	No inoc	NA
2	Pink Rot Inoc	NA
3 (Stadium)	A9859 +	0.6 fl oz/ton tubers
	A12705 +	0.6 fl oz/ton tubers
	A8574	0.3 fl oz/ton tubers
4	A18780	1.0 fl oz/ton tubers
5	A18780 B	1.0 fl oz/ton tubers
6	Phostrol +	12.8 fl oz/ton
	Mertect	0.42 fl oz/ton
7	Mertect	0.42 fl oz/ton
8	Phostrol	12.8 fl oz/ton
9	Presidio	0.2 fl oz/cwt
10	V-10208	0.5 fl oz/cwt
11	Presidio +	0.2 fl oz/cwt
	V-10208	0.5 fl oz/cwt
12	Phostrol	6.4 fl oz/ton
13	Oxidate	1.25 fl oz/ton
14	Oxidate	6.25 fl oz/ton
18s	Ozone	10 ppm

PINK ROT STORAGE TRIAL WINTER 2011

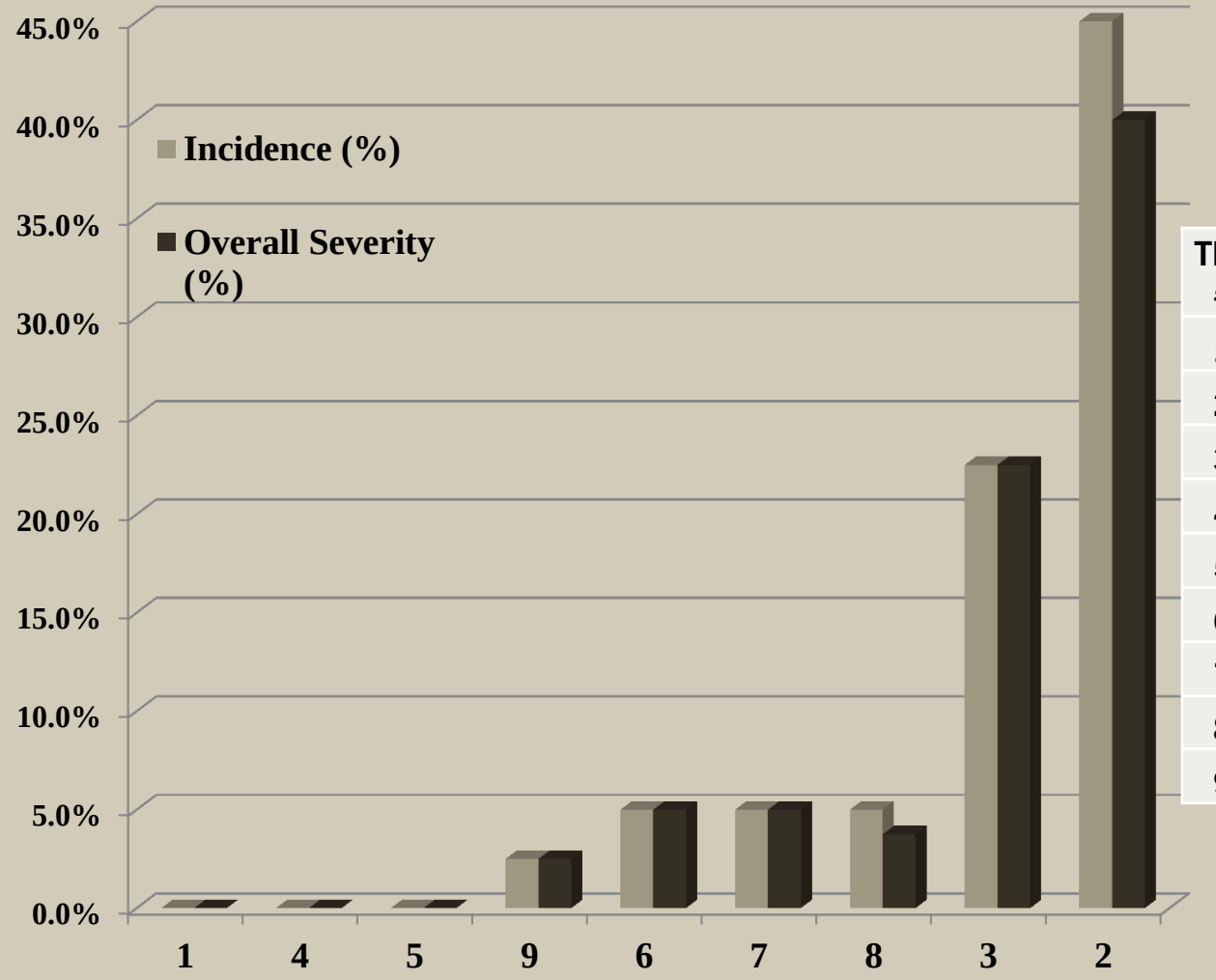


TRT #	Fungicide
1	No inoc
2	Pink Rot Inoc
3	A9859
	A12705
	A8574
4	A18780
5	A18780 B
6	Phostrol
	Mertect
7	Mertect
8	Phostrol HR
9	Presidio
10	V-10208
11	Presidio +
	V-10208
12	Phostrol LR
13	Oxidate LR
14	Oxidate HR
18s	Ozone

POST-HARVEST FUNGICIDE TREATMENTS FOR WINTER 2012-13 PINK ROT TRIAL

TRT #	Treatment	Rate	Active ingredient
1	Untreated/uninoculated	-	
2	Untreated/inoculated	-	
3	Ozone	10 ppm	
4	Phostrol	6.4 fl oz/ton	phosphorous acid salts
5	Ozone + Phostrol	10 ppm + 6.4 fl oz/ton	
6	Stadium	1 fl oz/ton	↓
7	Stadium Comp A: A9859	0.6 fl oz/ton tubers	fludioxonil
8	Stadium Comp B: A12705	0.6 fl oz/ton tubers	azoxystrobin
9	Stadium Comp C: A8574	0.3 fl oz/ton tubers	difenoconazole

PINK ROT STORAGE TRIAL WINTER 2012



TRT #	Treatment	Active ingredient
1	Untr/uninoc	
2	Untr/inoc	
3	Ozone	
4	Phostrol	phosphorous acid
5	Ozone+Phostrol	
6	Stadium	↓
7	Stad Comp A	fludioxonil
8	Stad Comp B	azoxystrobin
9	Stad Comp C	difenoconazole

PINK ROT SUMMARY

- Ozone does significantly reduce pink infections compared to the control (2011,2012), but not as effective as other products
- Oxidate significantly reduced infection in 2011, not in 2010
  - Efficacy did not seem rate dependent
- Phostrol significantly reduces infections, shows evidence of reducing % infection in tubers
- V-10208 and Presidio significantly reduced infection in 2010 and 2011, with V-10208 providing excellent control.
- Stadium (A9859 + A12705 + A8574; fludioxonil, azoxystrobin, difenoconazole) provided little control in 2010 trial, but excellent control in 2011, 2012.
  - No significant differences among components

PINK ROT CONTROL WITH OZONE IN 2012 – FINAL RATING IN MARCH

CONTROL
No inoculum+No ozone

Inoculated+Ozone

Inoculated+No ozone

PINK ROT CONTROL WITH OZONE IN 2012 – FINAL RATING IN MARCH

CONTROL

No inoculum+No ozone

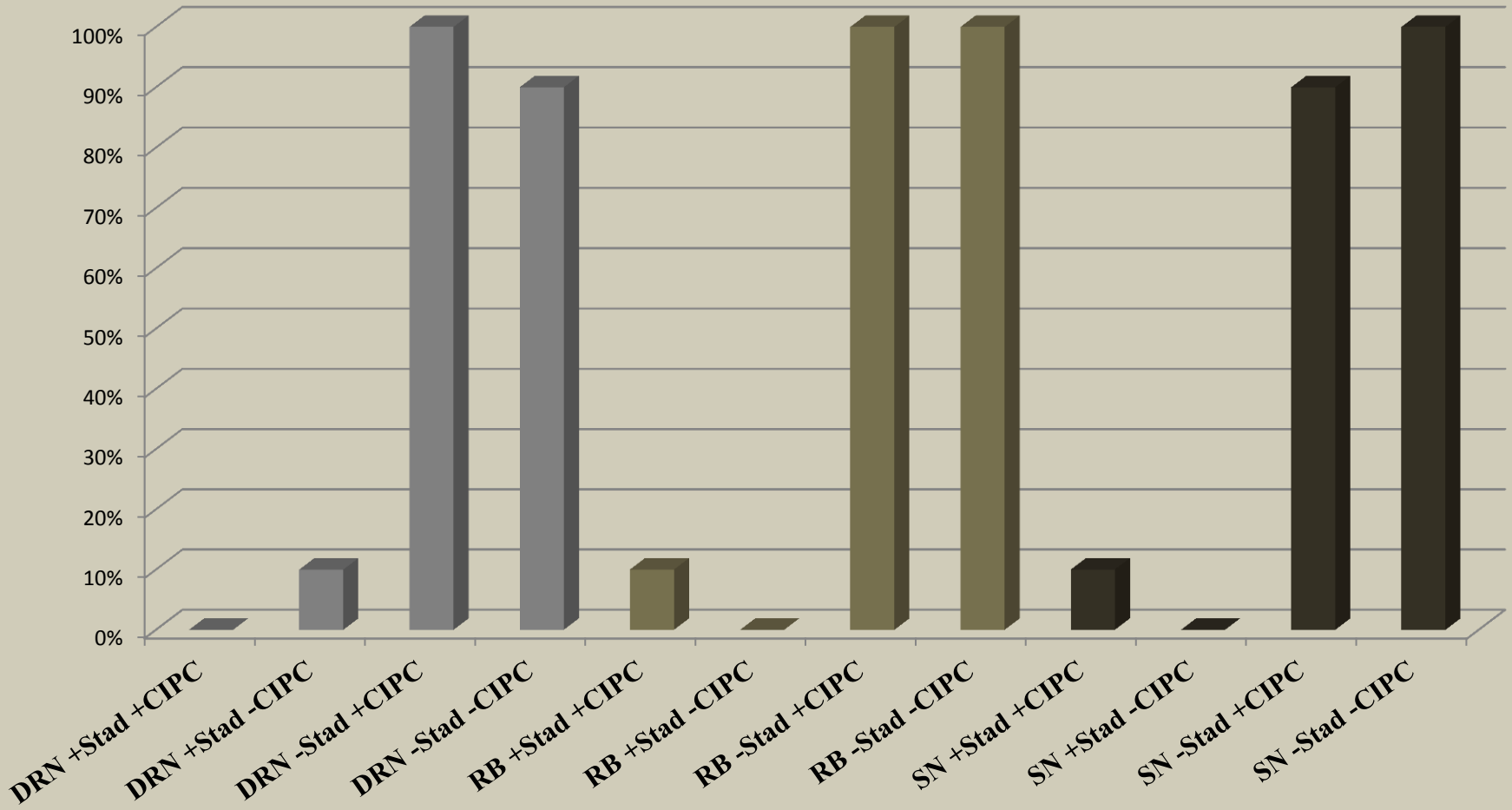
Inoculated+Ozone

Inoculated+No ozone

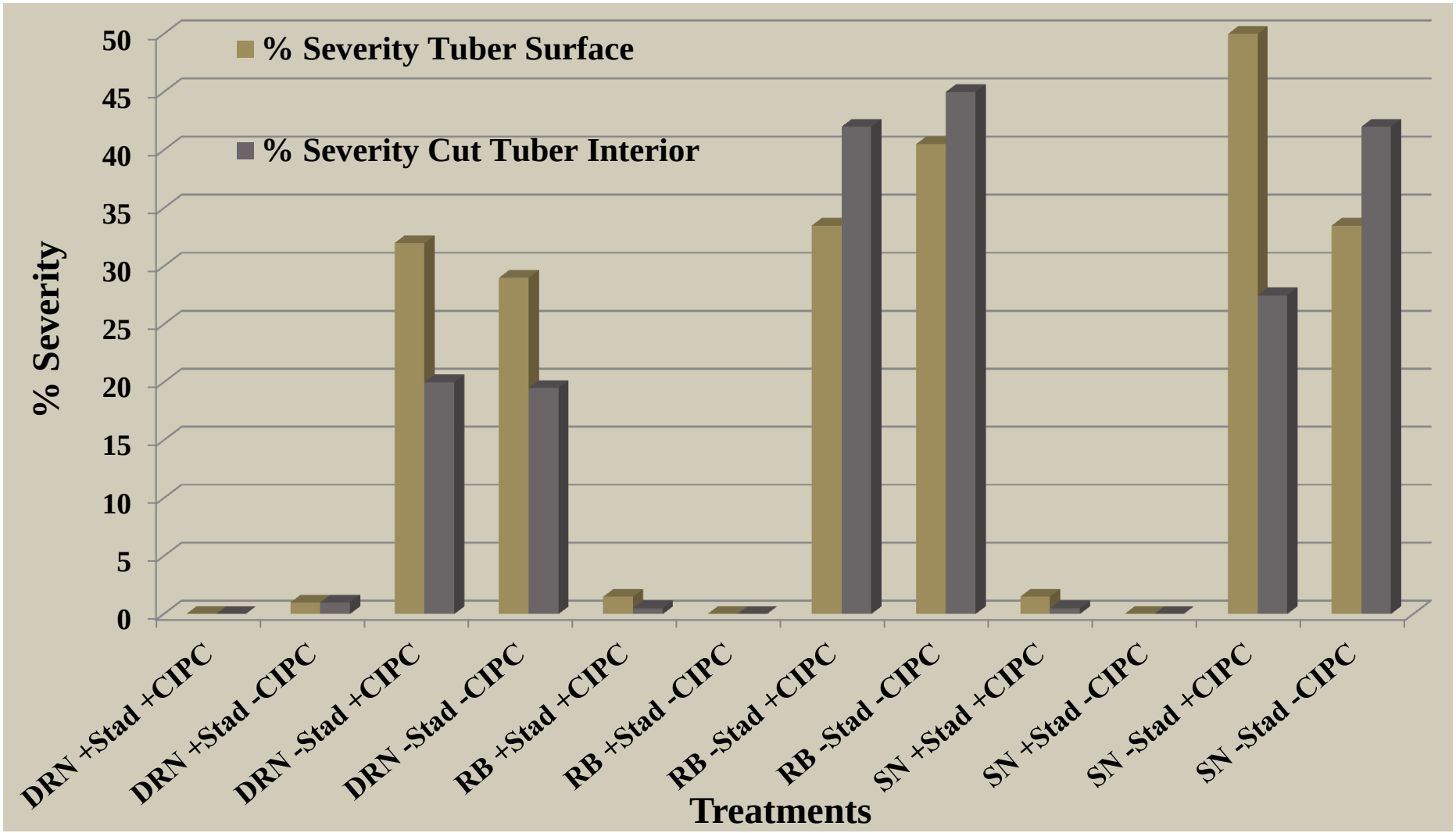
EFFICACY OF STADIUM WITH CIPC TREATMENT

- 3 cultivars tested:
  - Russet Burbank, Snowden, Dark Red Norland
- Challenged tubers with late blight inoculum
- Treated with Stadium followed by CIPC treatment
- Stored at 55°F for 30 days
- Evaluated for late blight incidence and severity

EFFICACY OF STADIUM WITH CIPC TREATMENT



EFFICACY OF STADIUM WITH CIPC TREATMENT



SUMMARY

- Similar results across the board for late bligh and pink rot trials
- Ozone does little to protect tubers in trials, but may significantly reduce spread in storage
- Phostrol is very effective and may help reduce severity in infected tubers
- Stadium provides excellent control
  - Could offer good control for a broad range of tuber pathogens
  - Efficacy seems to be unaffected by CIPC treatment post-application
- Still awaiting results from this winter's silver scurf and Fusarium dry rot trial

ONGOING RESEARCH

- Pink Rot Trial (Phostrol, ozone, & other fungicides)
- Late Blight (Phostrol, ozone, & other fungicides)
- Silver Scurf, Pythium Leak, Fusarium Dry Rot
- Effect of field applications of Phostrol on pink rot in storage (timing, rate, # of applications)
- Effect of field applications on early blight in storage (new registrations)

ACKNOWLEDGEMENTS

- Hancock ARS – SRF Team
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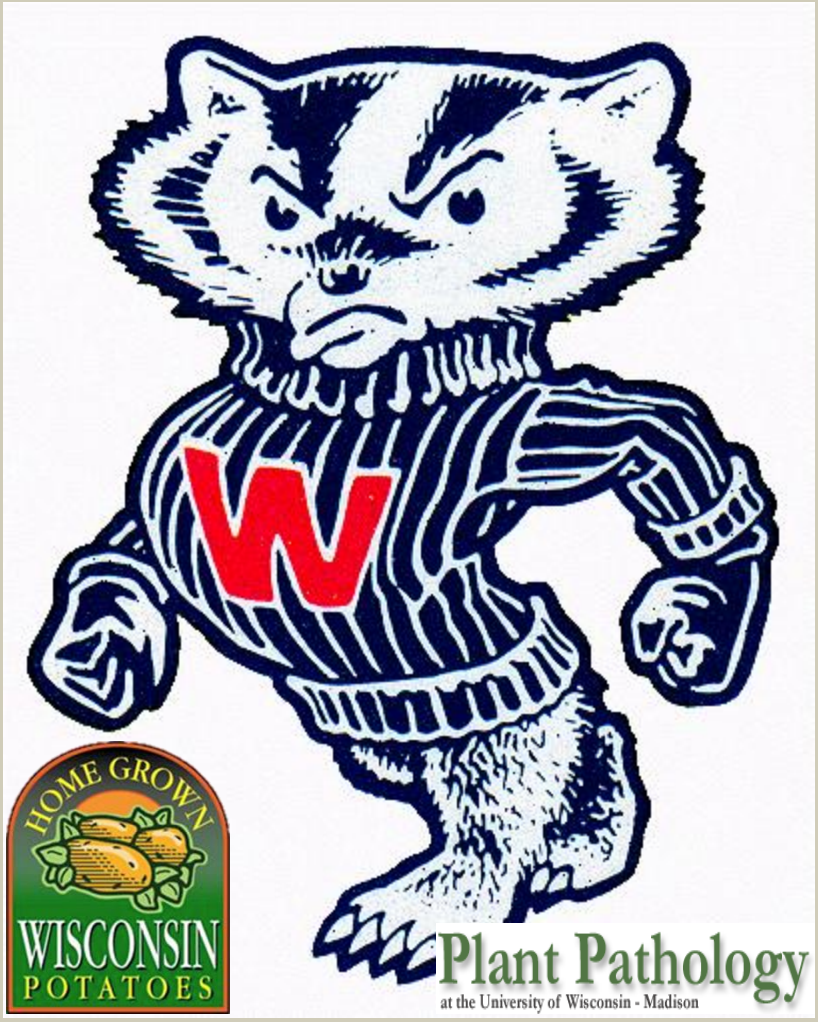
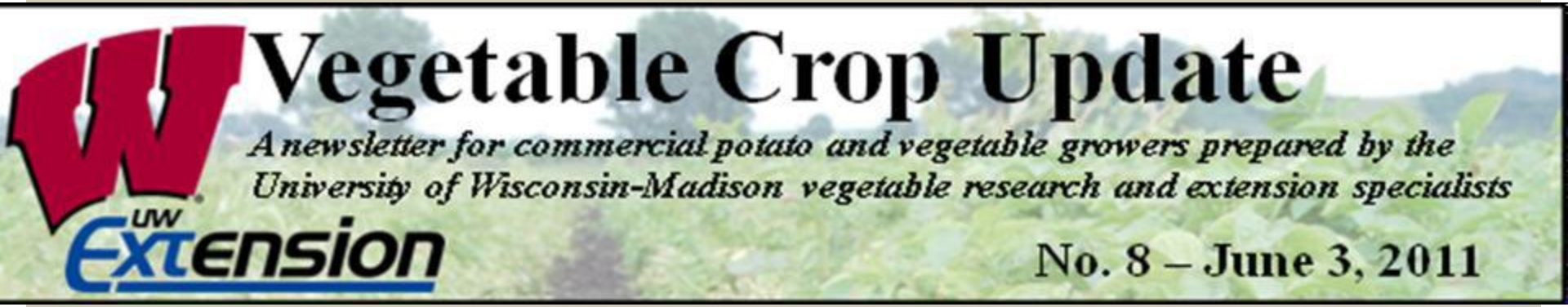


FURTHER INFORMATION

University of Wisconsin Vegetable Disease Website
http://www.plantpath.wisc.edu/wivegdis/



UW – Vegetable Team Website
http://www.vegetables.wisc.edu/vegetable-team

Presentations from this session will be posted to the Team website after the meeting