Southeast Regional Fruit & Vegetable Conference, Savannah, GA
5-7 January 2023

Nature's Ninja graphic courtesy of National Onion Association

Stop the Rot

A National Perspective on Bacterial Diseases of Onion

Lindsey du Toit
Washington State University

https://alliumnet.com/projects/stop-the-rot/

USDA NIFA SCRI Project No. 2019-51181-30013

USDA United States Department of Agriculture National Institute of Food and Agriculture

Current situation

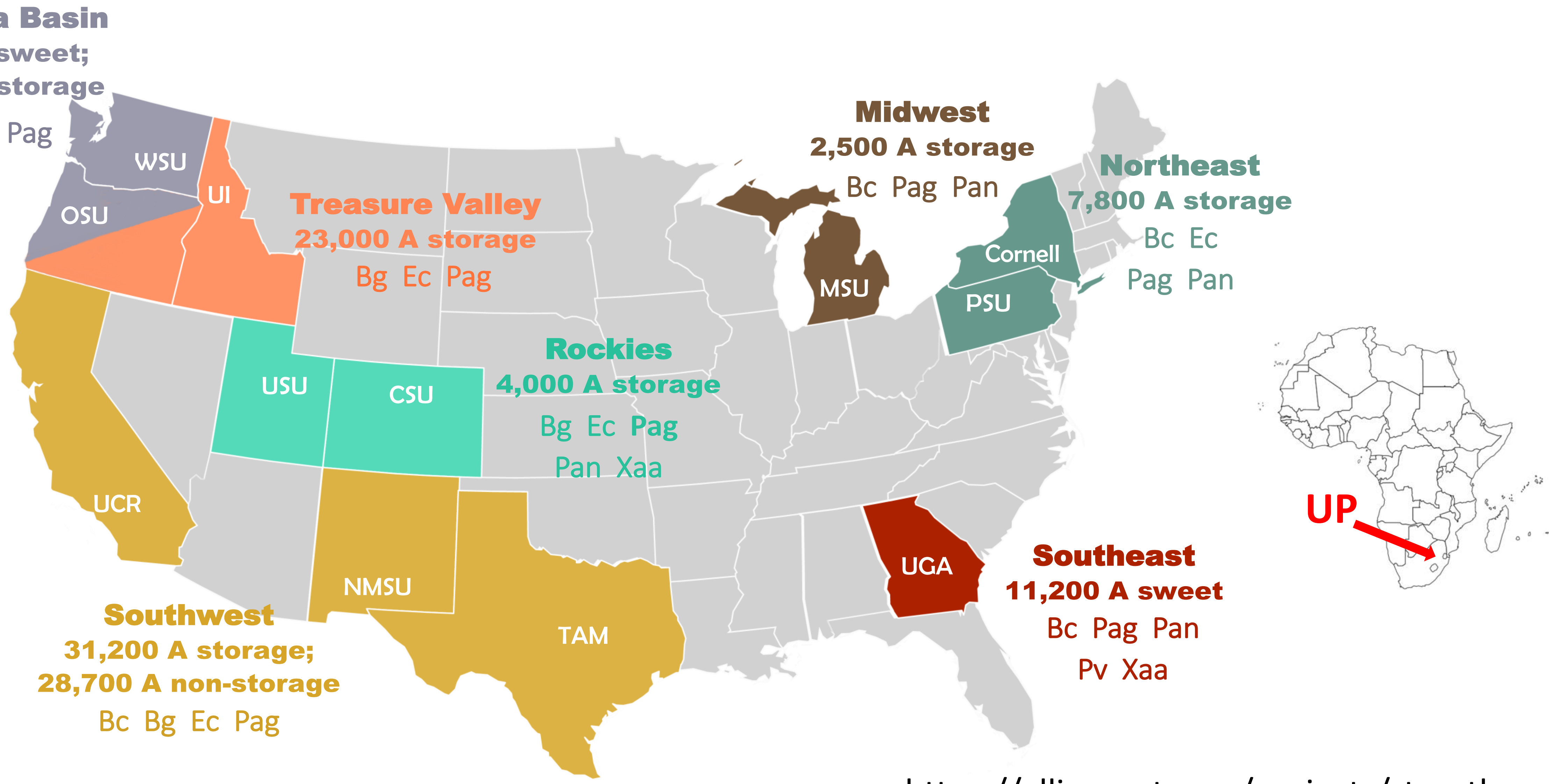
- Bacterial diseases of onion occur across the USA
- Bacterial diseases are difficult to manage:
  - Lack of effective, rapid detection methods
  - Poor understanding of the genetic basis of pathogenicity, and epidemiology of complex of bacteria associated with onions
  - Few/no resistant onion cultivars
  - No systemic, curative, highly effective bactericides

Stop the Rot

https://alliumnet.com/projects/stop-the-rot/

- $4,044,300 + $4,200,000 matching (universities, stakeholders)
- 4 year-project: September 2019-August 2023 (+ 1-yr no-cost extension)
- 24 collaborators
  - PD = Lindsey du Toit, WSU
  - Co-PI's = Bhabesh Dutta & Brian Kvitko, University of Georgia; Christy Hoepting, Cornell Extension; Brenna Aergerter, University of California; Mark Uchanski, Colorado State University
  - 12 states + Teresa Coutinho, University of Pretoria, South Africa
- 13-member national Stakeholder Advisory Panel
  - Onion growers, seed company breeders & pathologists, consultants

Stop the Rot: Combating onion bacterial diseases with pathogenomic tools & enhanced management strategies



https://alliumnet.com/projects/stop-the-rot/

Stop the Rot – Stakeholder Advisory Panel (SMART)

Pacific Northwest:
Michael Locati
Peter Rogers (BASF)
Juan Carlos Brevis (BASF)

Midwest:
Gumz Farms, WI
Greg Bird, MI Onion Committee
Scott Hendricks (Bayer)

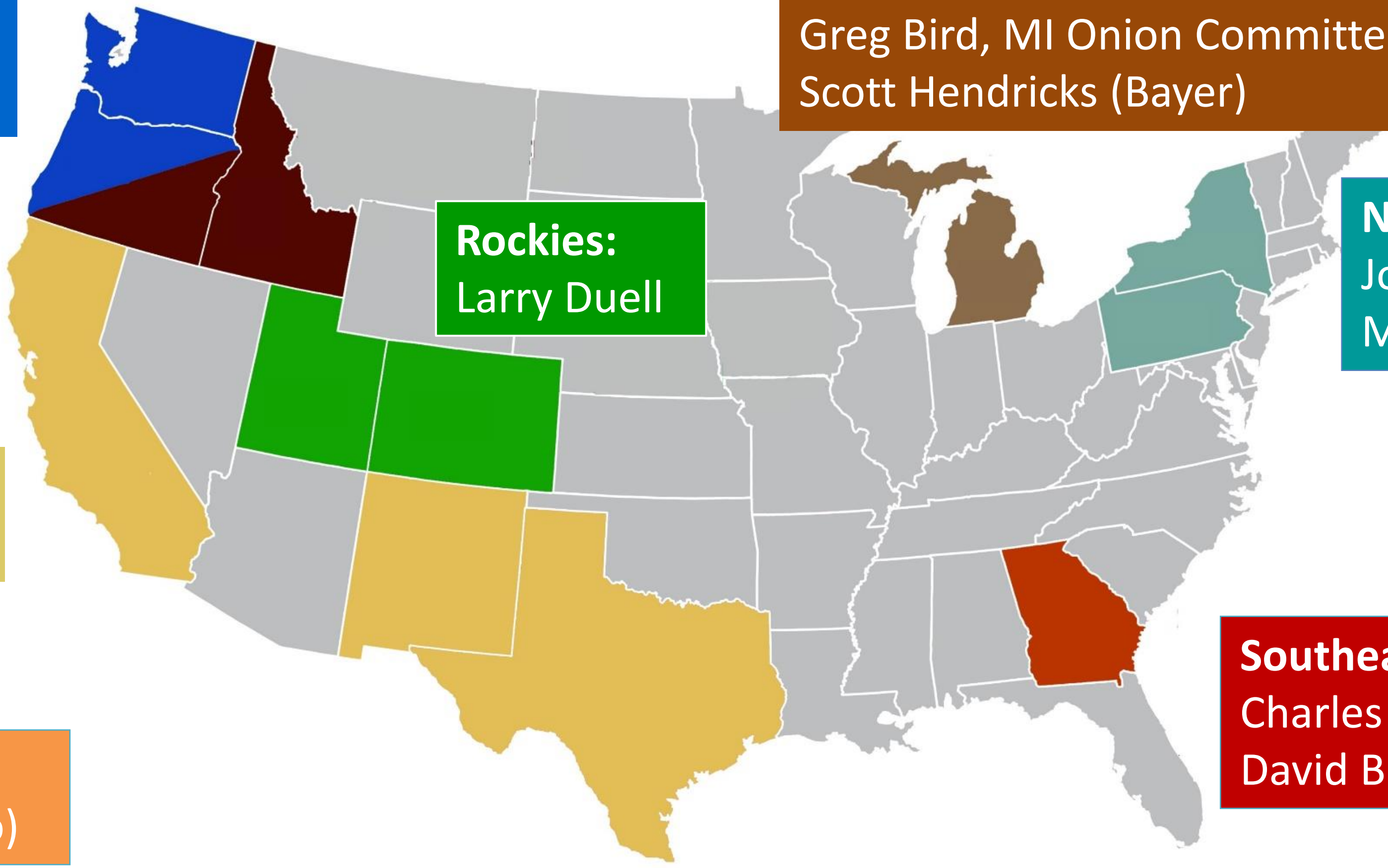
Rockies:
Larry Duell

Northeast:
Joe DiSalvo
Maxwell Torrey

Southwest:
Bob Ehn, CGORAB

Southeast:
Charles Hall, GFVGA
David Burrell

International:
Margreet Asma (Bejo)



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https://alliumnet.com/projects/stop-the-rot/

- Objective A: Onion bacterial disease characterization
  - A1 – Survey onion crops nationally for bacterial pathogens
  - A2 – Genetic analyses, virulence factors, bacterial communities
  - A3 – Develop molecular diagnostic tools
  - A4 – Develop methods to screen for resistance to bacterial diseases
- Objective B: Onion bacterial disease management
  - B1 – Irrigation practices
  - B2 – Fertility practices
  - B3 – Pesticide programs
  - B4 – Cultural practices
  - B5 – Postharvest practices
  - B6 – Bacterial disease modeling/risk prediction
  - B7 – Extension/outreach
  - B8 – Economic assessments

MacKay, H., du Toit, L., Havey, M., and Rogers, P. 2022. Onion World May/June 2022:14-16.
https://issuu.com/columbiamediagroup/docs/onion_world_may-june_2022/14

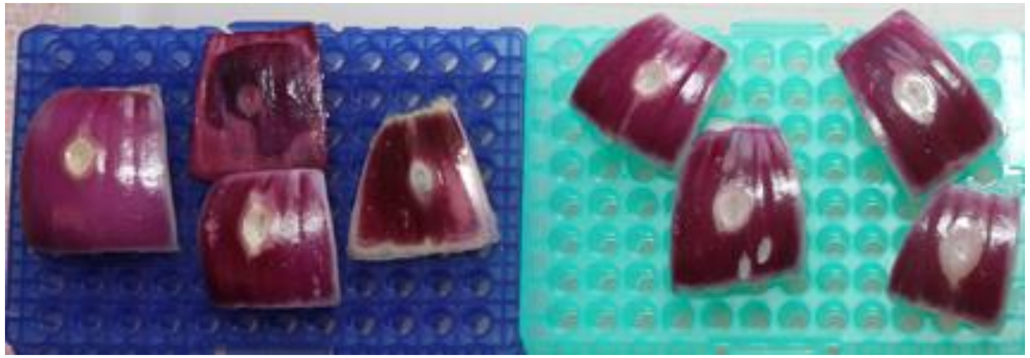
Stop the Rot

https://alliumnet.com/projects/stop-the-rot/

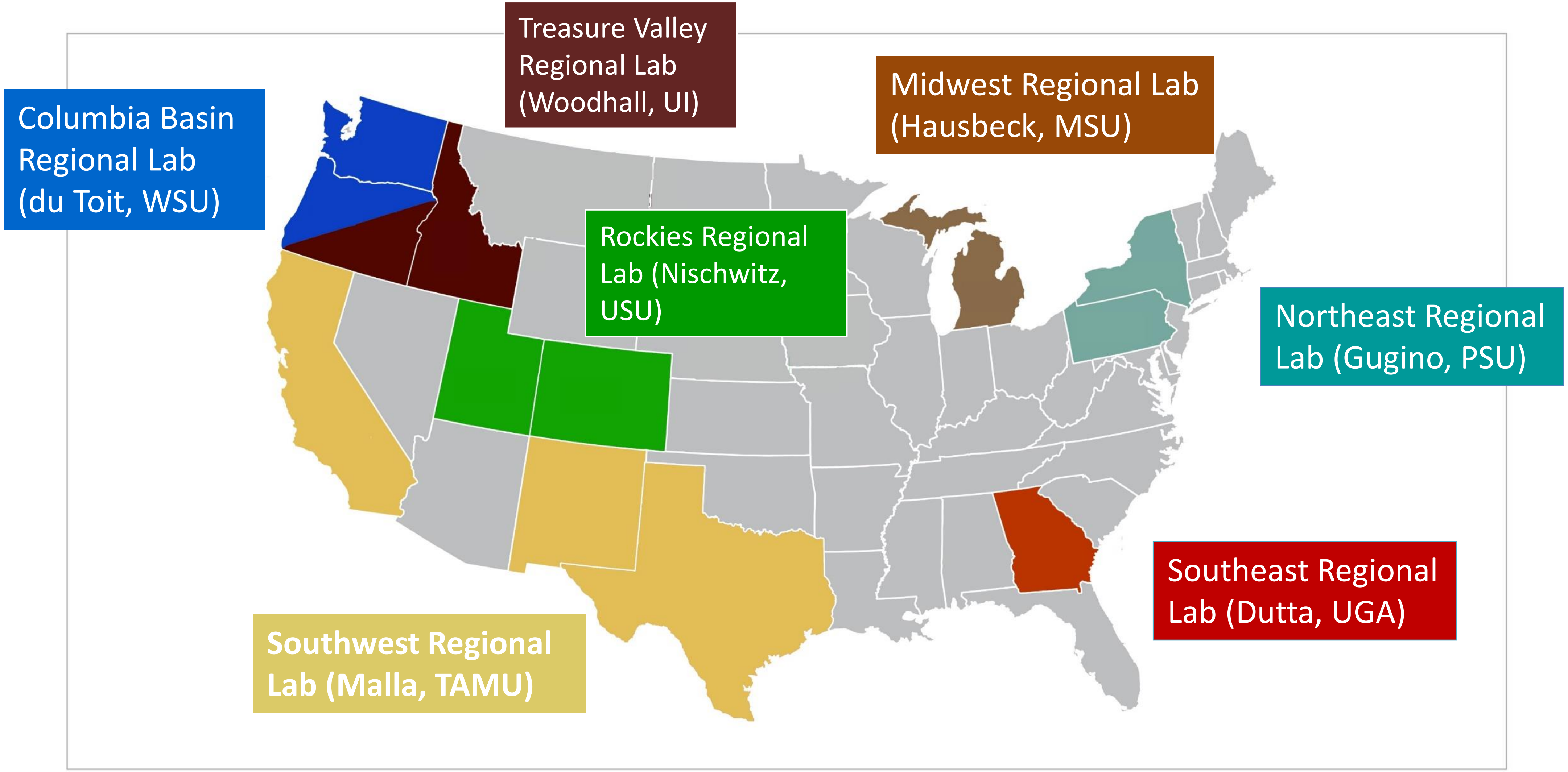
Objective A1: Survey onion crops nationally

Bacterial surveys in 11 states:

- 2020: 5 fields sampled 2-3x in each state
- 2021 & 2022: 5 fields sampled at least 1x in each state, each year
- Isolated from tissues, purified bacteria, identified to genus/species (16S rDNA sequencing), test pathogenicity on onion (scale, foliar, bulb tests)
- **Wide diversity of bacteria recovered, but most NOT onion pathogens**
- Pathogenic & non-pathogenic strains sent to National Onion Bacterial Strain Collection (NOBSC) at UGA



Stop the Rot – Regional Labs



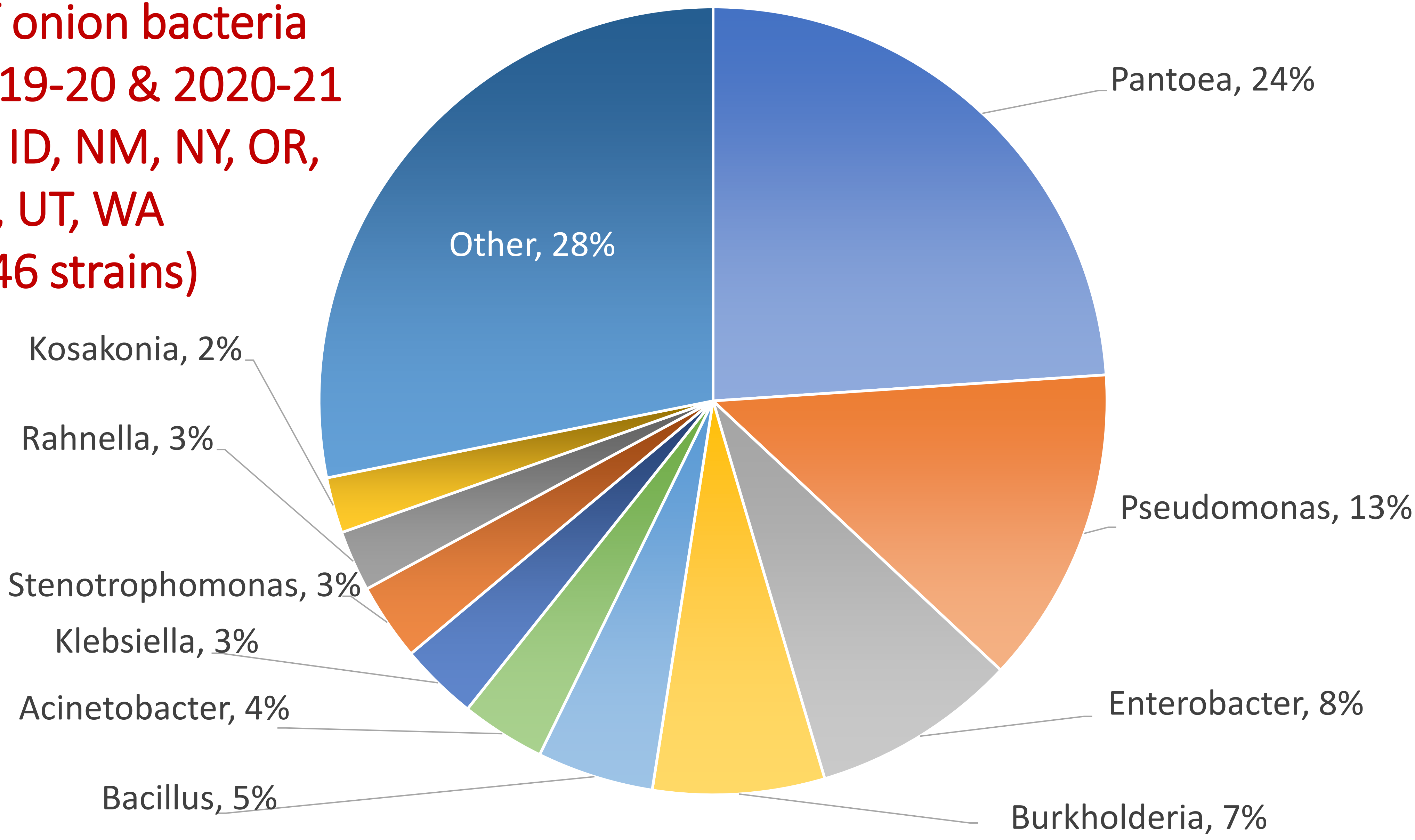
Stop the Rot

Objective A1: Survey onion crops nationally

Season 1 + Season 2 + Season 3 to date (as of Dec. 2022):

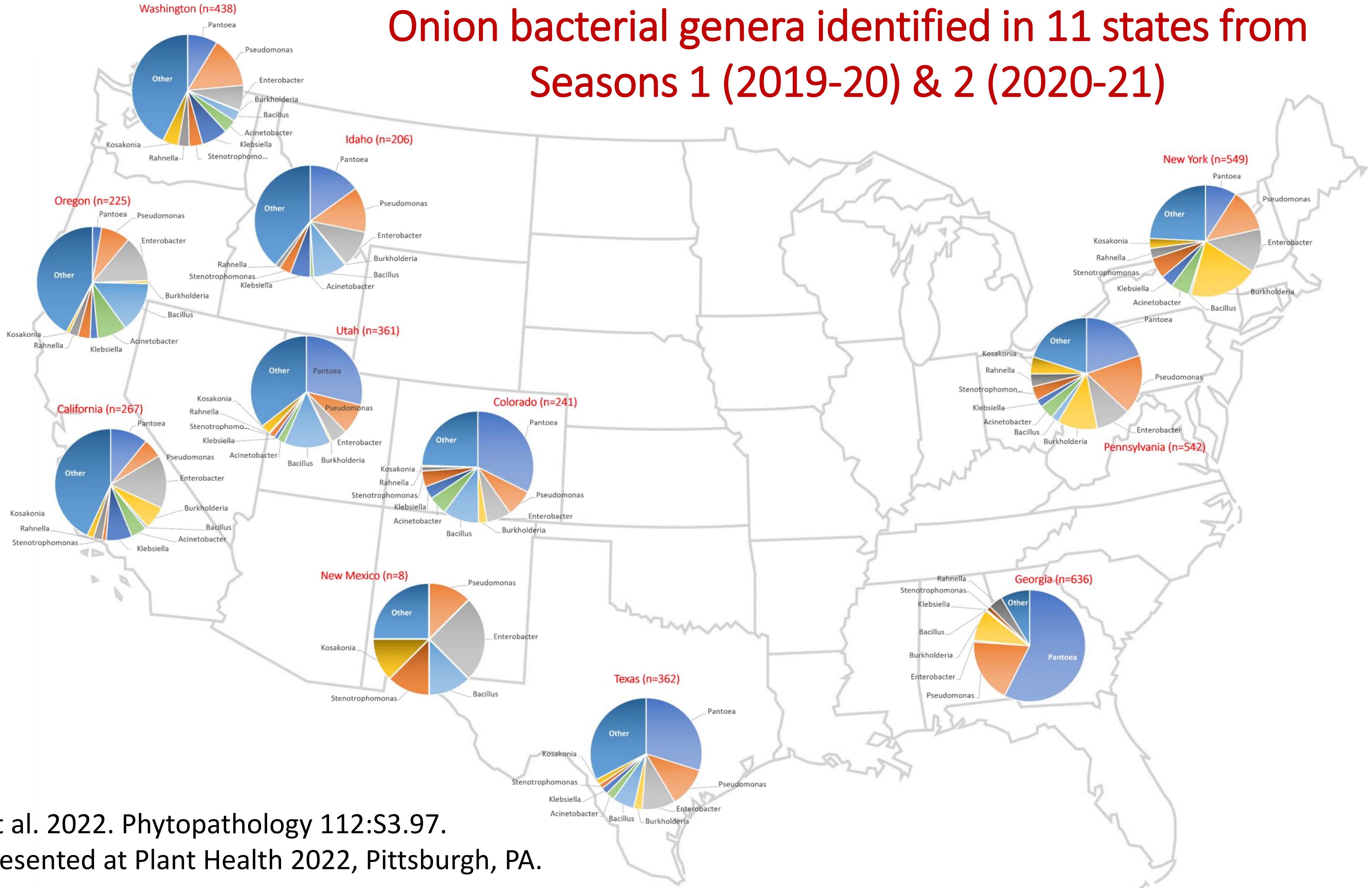
- 174 field and storage locations in 11 states (*7 states have not reported 2022 results*)
- >3,500 onion samples
- 3,515 bacterial strains so far
- 116 bacterial genera identified so far
- Distribution & pathogenicity vary across onion production regions in the US
- Most prevalent genera across states to date:
    - *Pantoea* (921 strains to date)
    - *Pseudomonas* (501 strains to date)
    - *Burkholderia* (271 strains to date)
    - *Enterobacter* (325 strains to date)
    - *Bacillus* (184 strains to date)

Prevalence of onion bacteria identified in 2019-20 & 2020-21 in CA, CO, GA, ID, NM, NY, OR, PA, TX, UT, WA (n = 3,846 strains)



du Toit et al. 2022. Phytopathology 112:S3.97. Poster presented at Plant Health 2022, Pittsburgh, PA.

Onion bacterial genera identified in 11 states from Seasons 1 (2019-20) & 2 (2020-21)



du Toit et al. 2022. Phytopathology 112:S3.97.
Poster presented at Plant Health 2022, Pittsburgh, PA.

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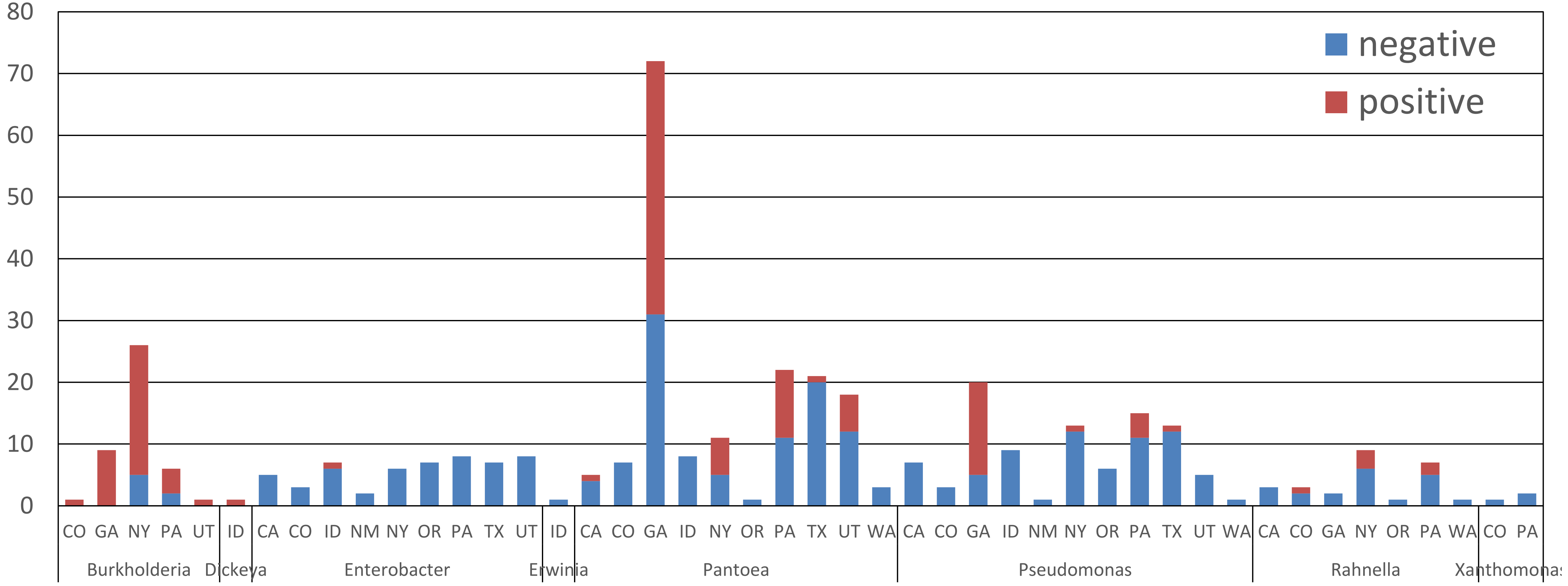
Onion pathogenicity test results for the 4 most prevalent genera isolated from symptomatic onion crops in 2020 and 2021 in 4 of 11 states surveyed										
			Georgia		**New York**		**Texas**		**Washington**	
Genus	No. of isolates	RSN+ results	Strains identified	RSN+ results	Strains identified	RSN+ results	Strains identified	RSN+ results	Strains identified	RSN+ results
Burkholderia	271	83%	58	90%	111	83%	9	100%	7	100%
Enterobacter	325	2%	3	33%	69	6%	35	0%	32	0%
Pantoea	921	30%	365	47%	50	36%	108	6%	38	8%
Pseudomonas	501	17%	119	51%	68	10%	42	7%	65	0%

RSN+ = Red scale necrosis assay positive result

Following up with foliar and bulb pathogenicity tests
2022 survey isolates being processed

Pathogenicity to onion of bacterial strains submitted to the National Onion Bacterial Strain Collection (NOBSC) to date (red scale assay)



Objective A2. Pathogenomics of *Pantoea* onion pathogens

Brian Kvitko and Gina Shin, UGA

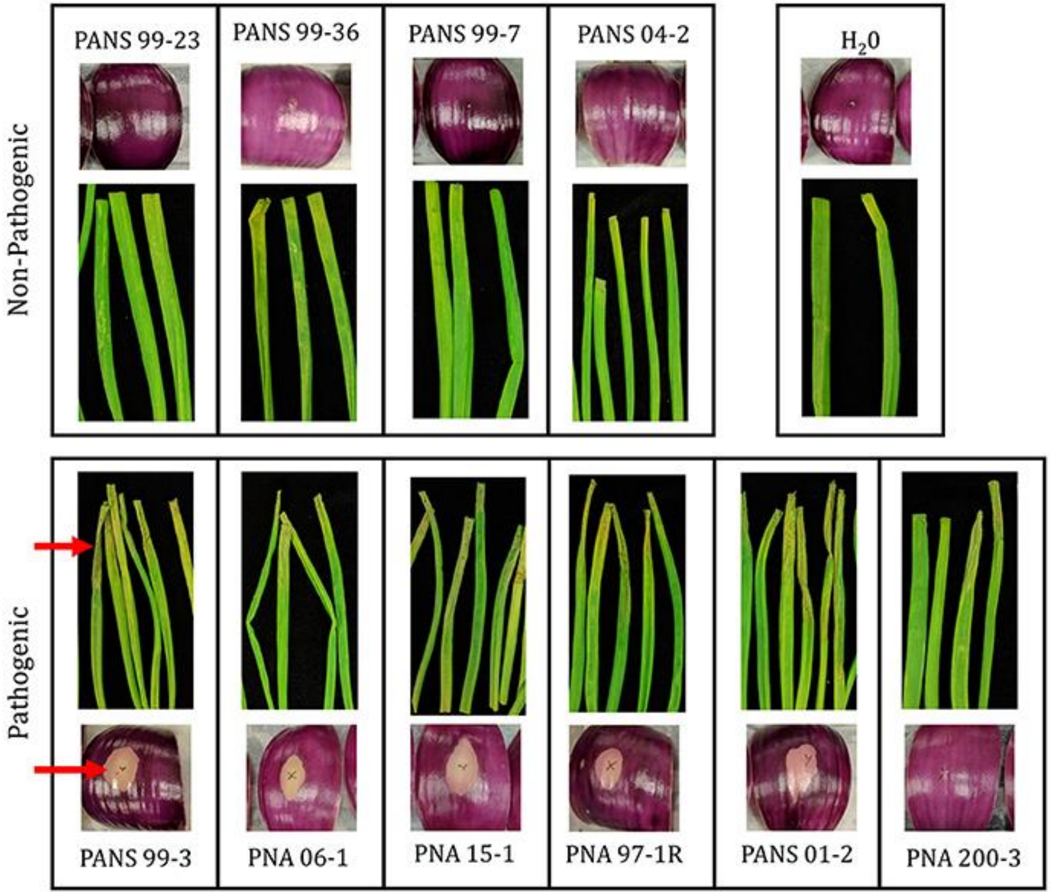
Why *Pantoea* spp.?

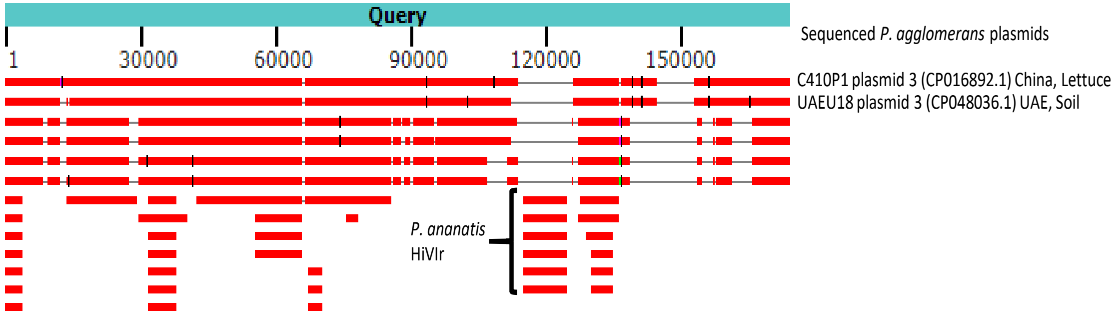
- *Pantoea* spp. are common onion pathogens
- *P. agglomerans* is isolated routinely from onions nationwide, while *P. ananatis* is more common in the eastern USA
- Some *P. agglomerans* and *P. ananatis* strains do not cause symptoms on onion

- **Short term goal:** Identify genes unique to onion pathogenic strains of *Pantoea* for development of molecular diagnostic tools
- **Long term goal:** Accurate, rapid diagnosis to develop pathogen-specific disease management strategies for various regions of onion production around the USA

A2. Pathogenomics of *Pantoea* onion pathogens

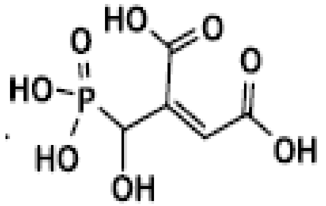
- Identify pathogenic and non-pathogenic strains of onion that are closely related
- Sequence and analyze the genomes for strains of each phenotype to identify genes unique to pathogenic vs. non-pathogenic strains
- Test the roles of these target genes in the ability to cause disease on onion





A2. Pathogenomics of *Pantoea* onion pathogens

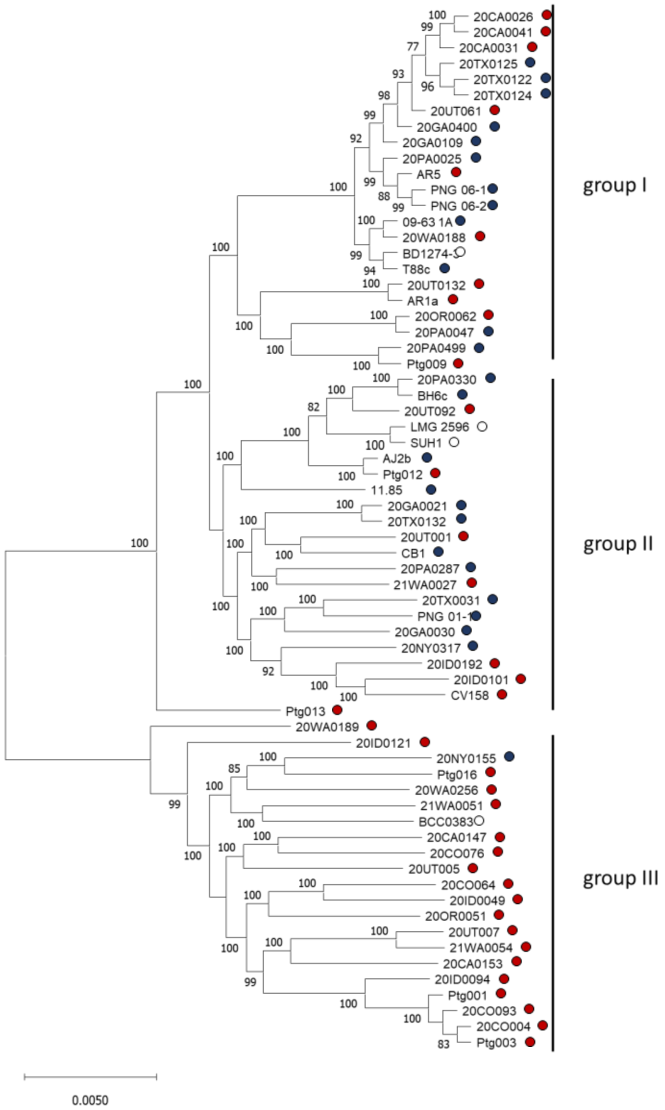
- The onion red scale necrosis phenotype of *P. agglomerans* correlates with the presence/absence of the **HiVir genes** that synthesize the phytotoxin **pantaphos**
- True for >200 *P. agglomerans* strains

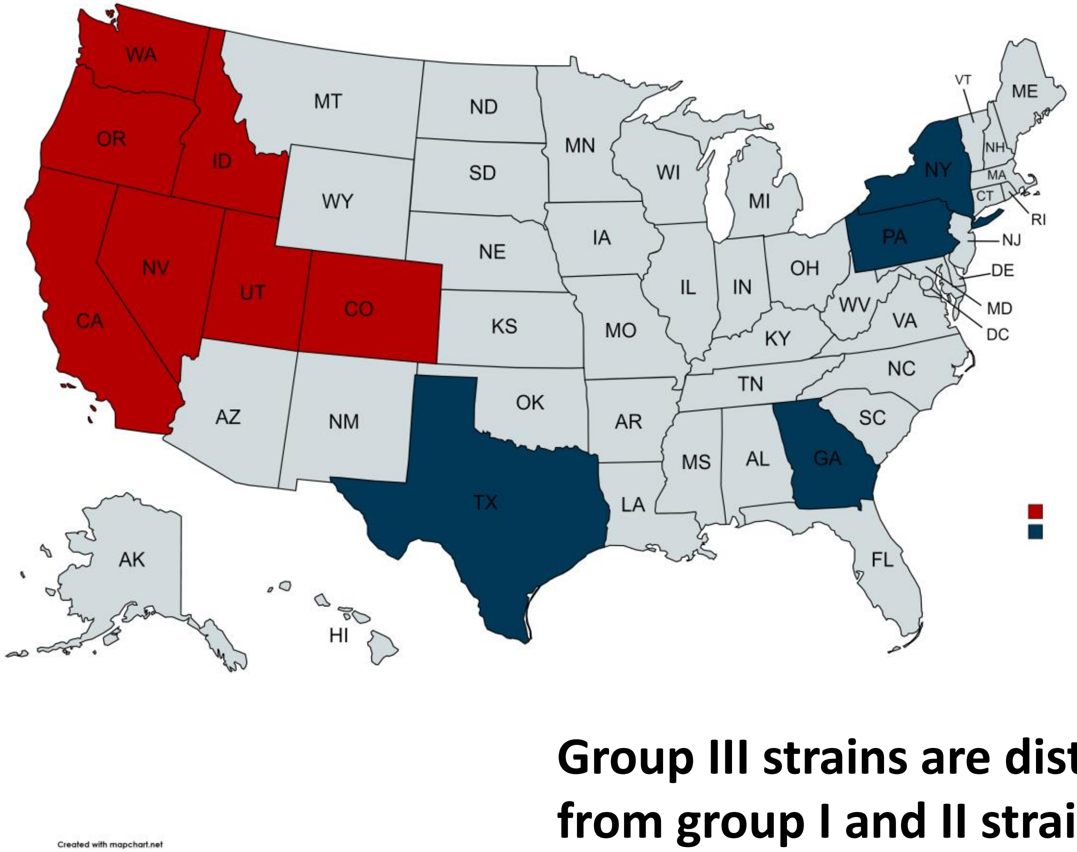


2-hydroxyphosphonomethyl-maleate (pantaphos)

Polidore et al. 2021

A2. Multiple lineages of *Pantoea agglomerans* from onions in the USA

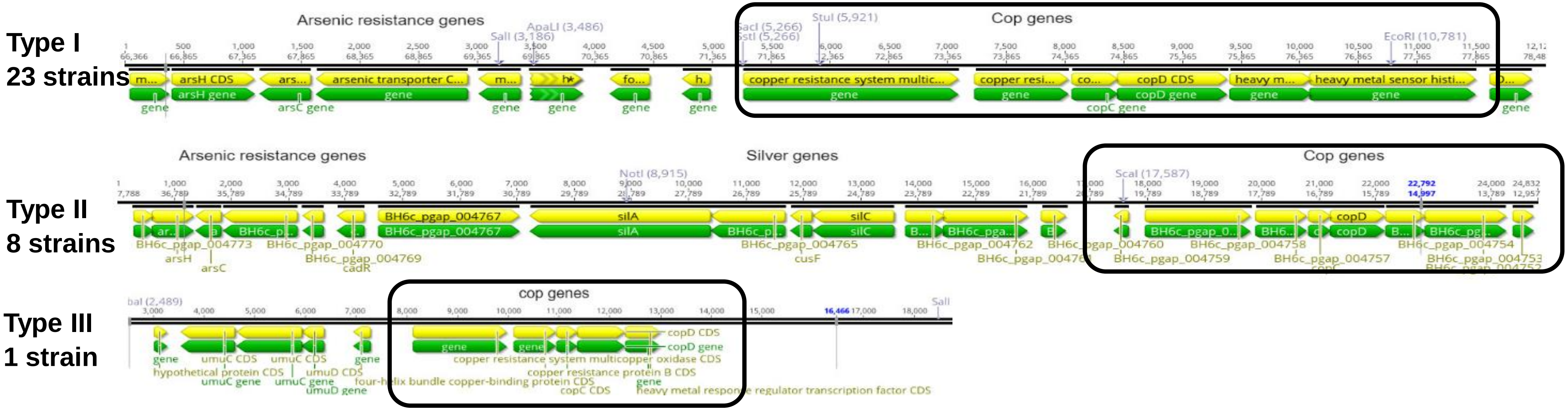




Group III strains are distinct from group I and II strains, and were isolated predominantly from western states

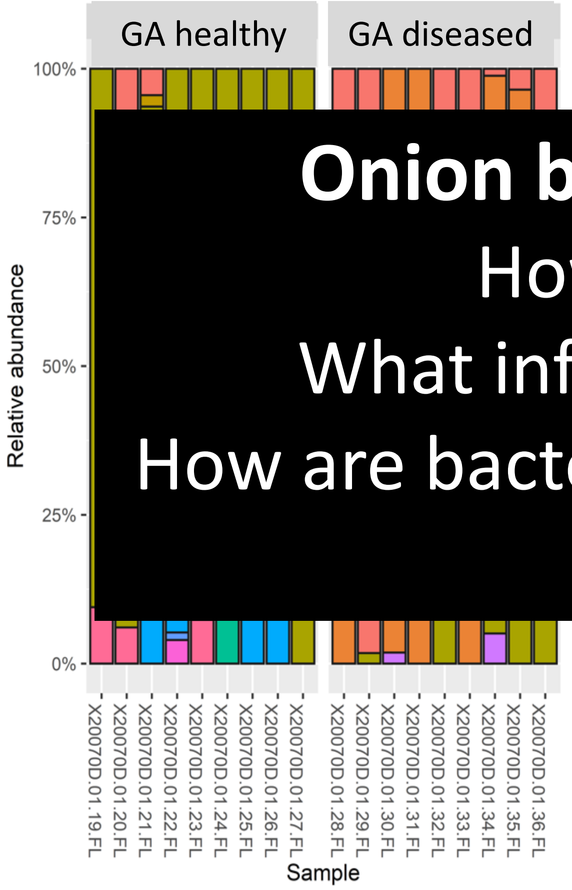
A2. Copper resistance genes are common in onion isolates of *Pantoea agglomerans*

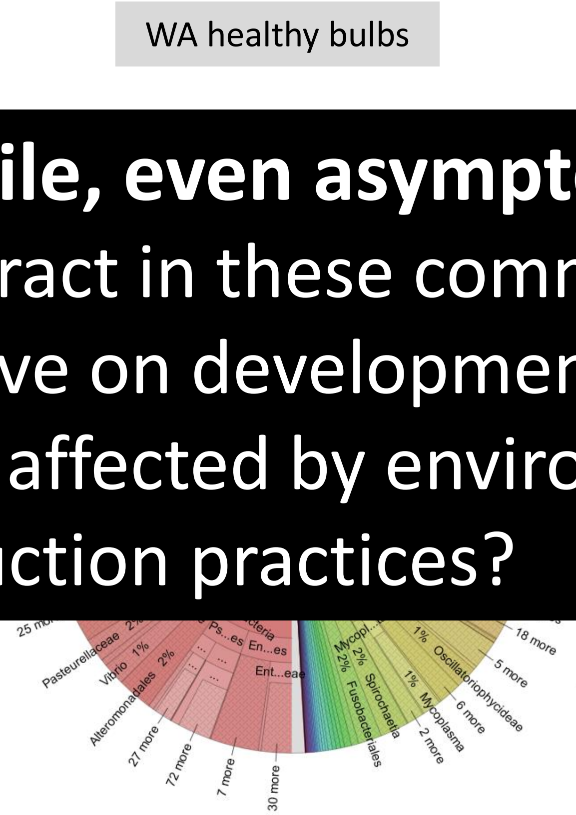
- ~50% of *P. agglomerans* strains sequenced to date have **copper resistance (*cop*) genes** on accessory plasmids, similar to those in other bacterial plant pathogens
- *cop* genes and *alt* genes (confer tolerance to onion sulfur compounds) are often on the same plasmids
- *cop* genes have not been found in *P. ananatis* strains sequenced to date
- *cop*+ strains are resistant to at least 100 ppm copper sulfate on CYE agar medium

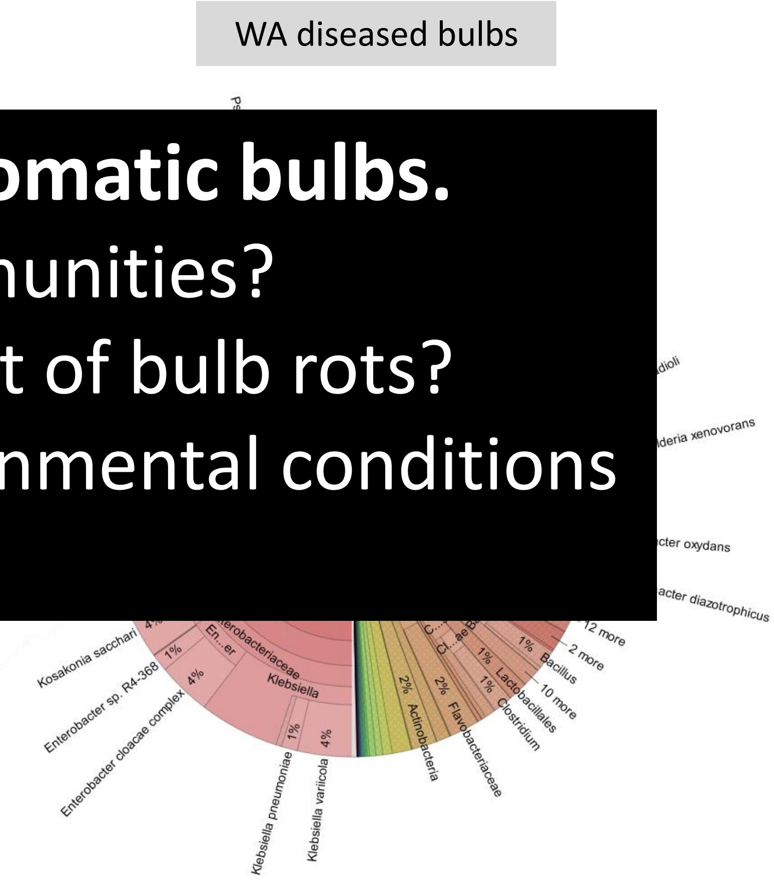


Objective A2: Bacterial communities in onion bulbs

Teresa Coutinho, University of Pretoria







Onion bulbs are not sterile, even asymptomatic bulbs.

How do bacteria interact in these communities?

What influence do they have on development of bulb rots?

How are bacterial communities affected by environmental conditions and production practices?

Objective A3: Molecular diagnostic tools for onion bacterial pathogens

James Woodhall, University of Idaho

- Design rapid, sensitive detection tools based on genes associated with pathogenicity to onion
- Develop species-specific assays for key pathogens
- Use DNA-based detection tools to detect plants infected latently, and to test potential sources of inoculum:
  - Soil, water, seed, weeds, …
  - Symptomatic and asymptomatic leaves and bulbs
  - CA, GA, ID, NY, OR, WA

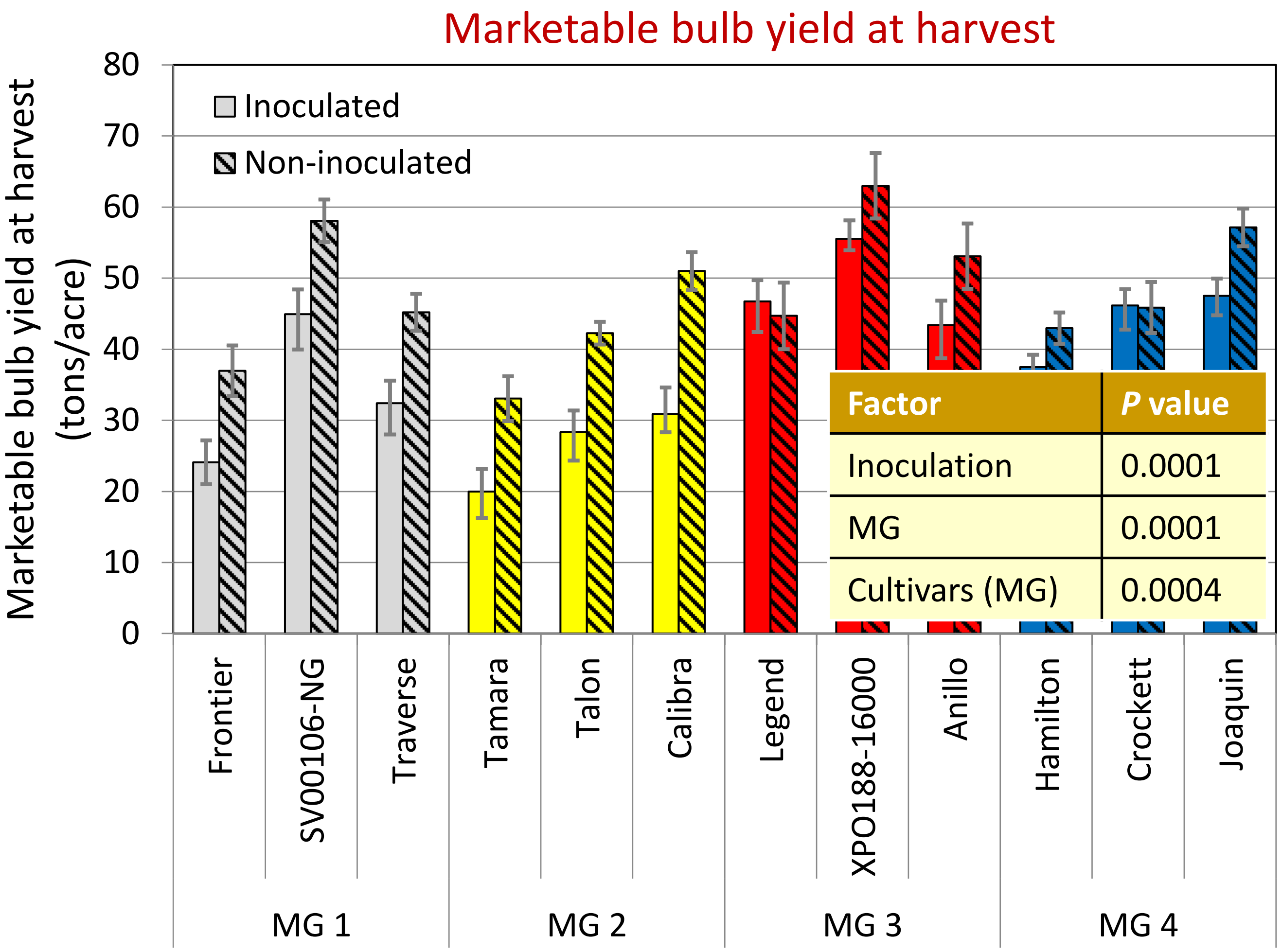
Objective A4: Develop methods to screen onion cultivars for resistance

Lindsey du Toit (WSU), Bhabesh Dutta (UGA), Steve Beer & Christy Hoepting (Cornell), Brenna Aegerter & Jas Sidhu (UC), Claudia Nischwitz (USU)

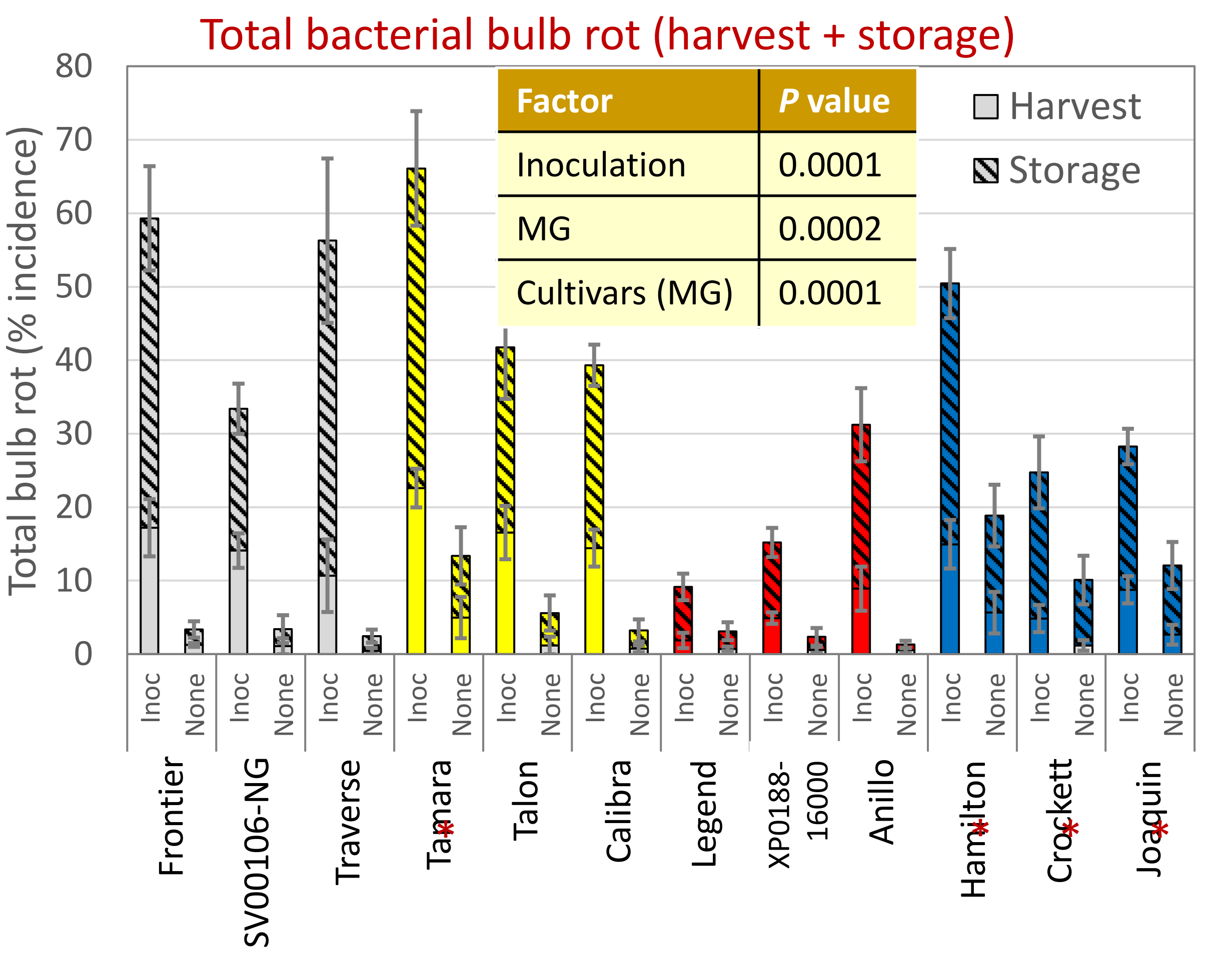
Seasons 1 (2020), 2 (2021), and 3 (2022):

- **Georgia:**
  - Greenhouse test of 2 inoculation methods did not differentiate susceptibility among cultivars
  - Field screening of USDA *Allium* germplasm collection: Differences in susceptibility to *P. ananatis*
- **New York:**
  - Various methods of screening in a growth chamber had inconsistent results (2020)
  - Field trial: 16 cultivars planted on 2 dates (trials), & half plots treated with insecticides (2021, 2022)
- **Washington:**
  - Field trial: 12 cultivars, 3/maturity group, each group inoculated at early tops down & 2 weeks later (2020 pivot irrigation; 2021 & 2022 sprinklers)
  - Comparison of bulb injection vs. scale assay for 54 cultivars (2022)
- **California:**
  - Field trial: 10 cultivars (2022) - bulb rot at harvest vs. bulb injection vs. scale assay
- **Utah:**
  - Field trial: 10 cultivars (2022)

Objective A4, Season 2 (2021-22): Washington Cultivar Trial



Factor	*P* value
Inoculation	0.0001
MG	0.0001
Cultivars (MG)	0.0004



Factor	*P* value
Inoculation	0.0001
MG	0.0002
Cultivars (MG)	0.0001

du Toit et al. 2022. Plant Disease Management Reports 16:V151.

Objective A4, Season 3 (2022): California Cultivar Trial (Brenna Aergerter, Jas Sidhu)

- **Field trial:** Some cultivars (e.g., Derby, Joaquin) had less bacterial bulb rot
- **Postharvest assays:** Significant differences in bulb rot and scale lesion size among cultivars, but results of 2 bulb injection vs. scale inoculation were poorly correlated, and poorly correlated with bulb rot in field trial

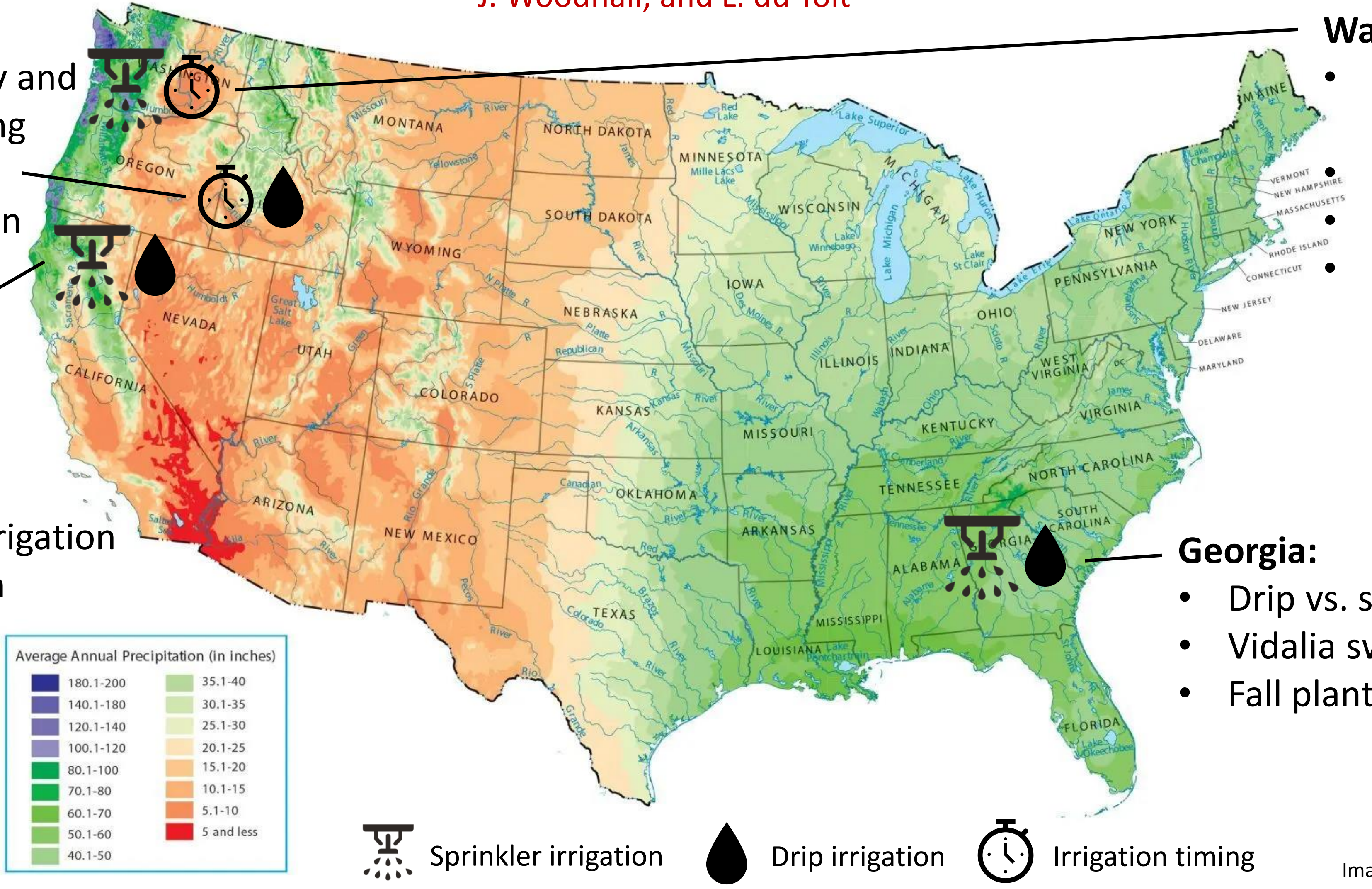
			Field trial, 9-Aug		Field trial, at harvest				Postharvest assays			
Cultivar	Type	Days to maturity (listed)	Foliar bacterial disease incidence (%)		Bulb rot incidence (%)		Marketable yield (t/A)		Bulb rot severity (%)		Scale lesion area (mm²)	
Tannat	LD mid to late, Red	115	12.5	e*	48.4	a	19.6	bcd	53.9	e	79.9	cd
Minister	INT early, Yellow	107	13.8	e	38.1	ab	27.3	abc	65.5	bc	112.9	b
Marenge	LD mid to late, Red	115	16.3	de	34.7	bc	15.5	d	63.2	cd	185.3	a
Vaquero	LD mid to late, Yellow	118-120	35.6	ab	30.2	bcd	22.3	bcd	72.0	ab	91.3	bc
Caliber	LD late, Yellow	122	20.6	bcde	28.5	bcd	22.3	bcd	58.3	de	82.3	cd
Red Angel	INT early, Red	110	29.4	abcd	26.0	cde	28.5	ab	44.8	f	62.7	d
Granero	LD mid to late, Yellow	115-118	38.8	a	24.4	cde	22.3	bcd	70.5	abc	89.2	c
Campero	LD early, Yellow	100	35.0	abc	22.0	def	17.8	cd	66.8	bc	85.9	c
Derby	INT early, Yellow	??	18.8	cde	16.6	ef	34.3	a	65.5	bcd	93.4	bc
Joaquin	LD late, Yellow	135	24.4	bcde	12.1	f	24.4	abcd	75.0	a	94.9	bc
		P value	0.012		<0.0001		0.043		<0.0001		<0.0001	

Objective B1. Effects of irrigation practices

G. LaHue, B. Aegerter, T. Belo, S. Caldwell, T. Coolong, M. Derie, B. Dutta, E. Feibert, H. de Jesus, S. Reitz, A. da Silva, T. Waters, R. Wilson, J. Woodhall, and L. du Toit

Oregon:
- Irrigation frequency and final irrigation timing
- Irrigated with drip
- Yellow storage onion
- Spring planted

Washington:
- Irrigation frequency / final irrigation timing
- Sprinkler irrigation
- Yellow storage onion
- Spring planted



California:
- Drip vs. sprinkler irrigation
- Fresh-market onion
- Spring planted

Georgia:
- Drip vs. sprinkler irrigation
- Vidalia sweet onion
- Fall planted

Image credits: GIS Geography, SUBPNG

B1. Summary of results: Irrigation methods

- **GA:** Drip irrigation reduced bulb yield in Season 2 (not in S1), and reduced internal bacterial bulb rot in S1 (not in S2)
- **CA:** Drip irrigation increased bulb yield and decreased bacterial leaf blight and bulb rot in S2 and S3
- **Preliminary conclusion:** Drip irrigation can reduce bacterial bulb rot in drier climates but results are mixed in humid climates

2021 California irrigation trial: Drip vs. solid-set irrigation

Treatment	Foliar bacterial disease incidence AUDPC*	Foliar bacterial disease severity AUDPC	Total bulb yield (t/A)	Average bulb size (oz)	Bacterial bulb rot incidence (% by weight)	Onion stand at harvest (# / bed-ft)
Solid-set irrigation	339 a**	269 a	48.5 b	9.5 b	22.25 a	11.3 a
Drip irrigation	96 b	24 b	59.1 a	11.1 a	0.67 b	11.8 a

Wilson et al. 2022. Plant Disease Management Reports 16:V154.

B1. Summary of results: Irrigation frequency

- **OR:** More frequent irrigation did not impact bulb yield or bacterial bulb rot in S1, but increased Botrytis neck rot and reduced yield in S2
- **WA:** Irrigation frequency did not affect bulb yield or bacterial bulb rot in S1 & S2
- **Preliminary conclusion:** Results differ based on irrigation method and, more importantly, soil moisture threshold for irrigation

B1. Summary of results: Timing of final irrigation

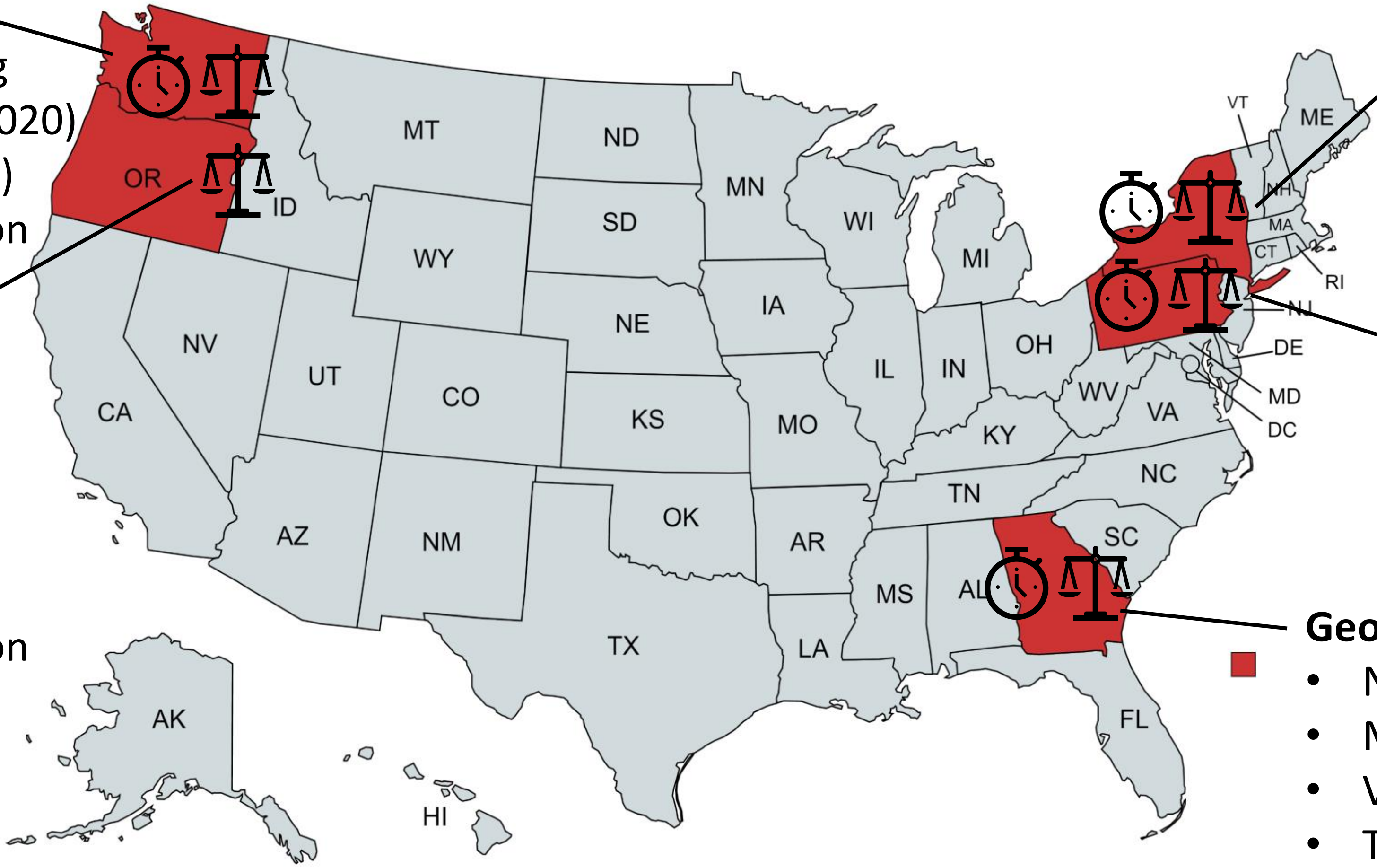
- **OR:** Ending drip irrigation earlier reduced bulb yield in S1. There was not enough bacterial bulb rot to test the effect of final irrigation timing on bacterial rot.
- **WA:** Ending sprinkler irrigation earlier did not affect bulb yield but reduced bacterial bulb rot in inoculated plots (S1 & S2)
- **Preliminary conclusion:** Ending irrigation early more likely reduces bacterial bulb rot under sprinkler vs. drip irrigation, & care should be taken not to end irrigation too early

Objective B2. Effects of soil fertility practices

G. LaHue, T. Belo, S. Caldwell, T. Coolong, M. Derie, B. Dutta, B. Gugino, E. van der Heide, C. Hoepting, H. de Jesus, J. Mazzone, M. Murdock, B. Nault, K. Nicholson, K. Regan, S. Reitz, A. Rivera, A. da Silva, I. Trenkel, T. Waters, K. Wieland, R. Wilson, J. Woodhall, and L. du Toit

Washington:
- N rate and N timing
- Loamy fine sand (2020) and silt loam (2021)
- Yellow storage onion
- Spring planted

Oregon:
- N application rate
- Silt loam soil
- Yellow storage onion
- Spring planted



New York:
- N rate and N timing
- **Many field sites**
- Muck soil
- Yellow storage onion
- Spring planted

Pennsylvania:
- N rate and timing
- Mineral soil
- Transplanted onions
- Spring planted

Georgia:
- N rate and N timing
- Mineral soil
- Vidalia sweet onion
- Transplanted
- Fall planted

N application timing   N application rate

Image credits: Map Chart

B2. Summary of results: N application rates

- **GA:** A bulb yield response to N was observed in Season 1 & S2, but not S3. N application rates did not impact bacterial bulb rots
- **PA:** Bulb yield and bacterial leaf blight were less in control plots with 0 N applied, but there was no difference for other N rates tested
- No response to N application rates observed for bulb yield or bacterial bulb rot in **NY** (S1 & S2), **OR** (S1), or **WA** (S1 & S2), though the percentage of the bulb yield that was marketable decreased with increasing N in **OR**

B2. Summary of results: N application timing

- **GA:** Earlier final N application increased bulb yield in S2, & reduced bacterial bulb rot in S1
- There was no effect of N application timing on bulb yield or bacterial bulb rot in **NY** (S1 & S2), **PA** (S2 & S3), or **WA** (S1 & S2)

Preliminary conclusions: Due to indirect mechanisms by which N rate or application timing impacts onion bacterial diseases, effects of N treatments were not consistent across trials. Residual available N in soil likely affected N rate treatments in some trials.

Objective B3: Effects of pesticide programs

- 7 trials in 2020 & 2021, 3 in 2022: CA, CO (3), GA (3), NY, OR, TX, UT (2), WA (3)
- Various onion cultivars: Avalon, Calibra, Century, Granero, Salute, Vaquero
- Many products evaluated alone or in combinations:

  Actigard 50WG, Agrititan, Aliette, Badge SC, BlightBan A506, Champ, Cueva, Cuprofix Ultra 40 Disperss dry flowable, Harbour, Kocide 3000, Leap, Lifegard WG, ManKocide, Mastercop, Nano-MgO, Nordox, NuCop, Oxidate 2.0, Oxidate 5.0, Serenade, Water control, Zerotol 2.0
- Applications: 4 to 6 applications at 7- to 10-day application intervals, maximum label rate
- Inoculation: CO, OR, WA, & UT trials inoculated twice late in the season
- Inoculum: *Burkholderia gladioli* pv. *alliicola, Pantoea agglomerans*, & *Pantoea ananatis*
- **Results:**

  CA, CO, NY, OR, TX, & UT: Insufficient bacterial disease to see if treatments worked

  WA: No treatment reduced bacterial bulb rot (2 seasons), coppers caused phytotoxicity in 2020 (Season 1)

  GA: Most treatments reduced bacterial bulb rot to some degree in all 3 seasons

2020 Bactericide trial for management of onion center rot in Georgia

Dutta, B., and Foster, M. J. 2021. Plant Disease Management Reports 15:V027.

Treatment and rate of product per acre	Application No. [z]	Initial disease severity (%) on 25 Mar	Final disease severity (%) on 28 Apr[y]	AUDPC[x]	Center rot incidence in bulb (%)[w]
Mankocide 2.5 lb	1-6	10.7 b[x]	43.8 c	358.8 c	9.1 c[v]
Kocide 3000 1.5 lb	1-6	28.9 ab	50.0 bc	540.7 bc	29.8 bc
Champ 1.5 lb	1-6	15.1 ab	51.3 b	464.8 bc	18.0 c
Oxidate 5.0 32 fl oz per 100 gal	1-6	40.0 a	71.3 a	791.2 ab	55.2 a
Agrititan 800 ppm	1-6	29.4 ab	58.8 b	602.8 bc	19.5 c
LifeGuard 2 fl oz	1-6	22.7 ab	48.8 bc	469.2 bc	26.8 bc
Nordox 1 lb	1-6	18.0 ab	53.8 b	502.4 bc	17.2 c
Mastercop 1 pt	1-6	23.7 ab	48.9 bc	489.6 bc	12.2 c
Leap 1 qt	1-6	32.4 ab	70.0 a	703.8 ab	52.5 ab
Actigard 0.5 fl oz	1-6	34.9 ab	70.0 a	699.5 ab	57.5 ab
NUCop 1.5 lb	1-6	15.2 ab	55.0 b	485.4 bc	18.8 c
Non-treated check	**-**	**44.9 a**	**87.5 a**	**1012.2 a**	**74.8 a**

Objective B4: Effects of cultural practices on onion bacterial diseases

Lindsey du Toit (WSU), Bhabesh Dutta, UGA), Christy Hoepting (Cornell)

Washington: Trials inoculated with *B. gladioli* & *P. agglomerans*

- Effects of rolling onion tops or not (2020, 2021, 2022)
- Effects of (timing of) undercutting bulbs or not (2020, 2021, 2022)
- Effects of timing of topping onion bulbs (2020, 2021, 2022)
- 2021 & 2022: Earlier initiation of treatments than 2020

Georgia: Natural infection

- Manual vs. mechanical harvest (2020, 2021, 2022)
- Two different mechanical harvesters (2020, 2021, 2022)
- Length of necks with manual topping (2021, 2022)

New York: Natural infection

- Rolling tops that died ‘standing up’ (2020, 2021, 2022)
- Outdoor curing vs. forced air indoor curing (2020, 2021, 2022)

Season 2 (2021-22): Washington Cultural Practice Trials

- In all three trials, inoculation:
  - Increased bacterial leaf blight
  - Decreased marketable bulb yield at harvest (by 7 to 10 tons/acre)
  - Increased bacterial bulb rot at harvest & in storage (by 27 to 35%)
- Rolling tops trial (Aug. 11):
  - Increased bacterial leaf blight in inoculated plots from 41.6 to 70.4%
  - Bulb yield and bacterial bulb rot in storage not affected
- Undercutting trial (Aug. 11, Aug. 25, or not undercut):
  - No effect of early, normal, or no undercutting on BLB, bulb yield, or bacterial bulb rot
- Timing of topping trial (Aug. 11, Aug. 25, or Sep. 8):
  - Early topping increased bacterial bulb rot (harvest + storage)
    - 69% of bulbs vs. 42% for standard and late topping in inoculated plots
  - Timing of topping did not affect bacterial leaf blight or bulb yield at harvest

du Toit et al. 2022. Plant Disease Management Reports 16:V149.

2020, 2021, & 2022 Georgia trials on onion harvest methods

Incidence (%) of bulbs with internal bacterial rot

Method of digging onion bulbs	2020	2021	2022
Chain digger (TopAir)	3.5 b	9.0 b	1.3 b
Straight-blade undercutter (TopAir)	10.2 a	20.5 a	10.7 a
P value	<0.001	<0.001	<0.0001

Dutta, B., and Tyson, C. 2020. Plant Disease Management Reports 15:V025.

Mechanical vs. manual harvest	2020	2021	2022
Mechanical harvest (TopAir)	2.2 b	4.5 b	3.0 b
Manual harvest	10.5 a	14.5 a	12.5 a
P-value	0.024	0.031	<0.0001

Dutta, B., and Tyson, C. 2020. Plant Disease Management Reports 15:V026.

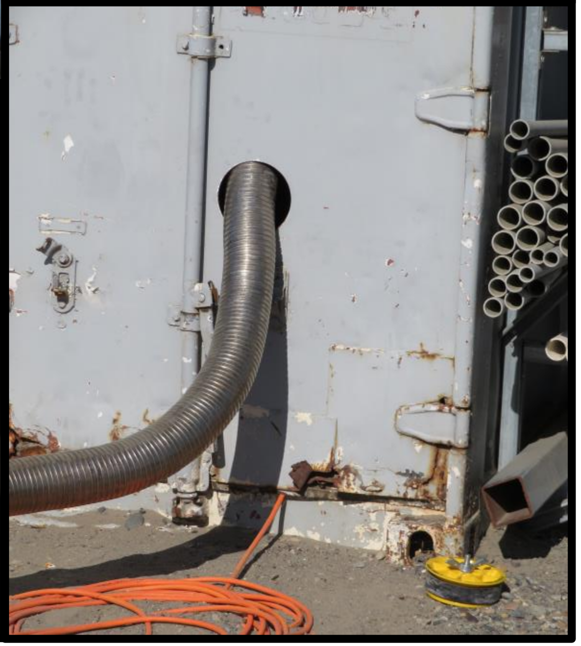
2021 & 2022 GA trials evaluating the length of topping bulbs

2021 trial on length of neck after topping manually	Internal bacterial bulb rot incidence (%)
5 inches	4.5 y
3 inches	4.0 y
1 inch	19.0 z

2022 trial	Internal bacterial rot incidence (%)
3 inches	10.0 b
2 inches	11.5 b
1 inch	18.0 a
0 inches	19.5 a

Objective B5: Postharvest application of disinfectants to onion bulbs

Tim Waters & Lindsey du Toit (WSU), Mark Uchanski & Jane Davey (CSU)



2020-21 WA trial

- Bulbs harvested from:
  1. Plots inoculated with bacteria (*B. gladioli* & *P. agglomerans*)
  2. Non-inoculated plots
- Disinfectants applied postharvest by IVI with commercial equipment:
  1. Jet-Ag at 24 fl oz thermofogged for 1 h, container sealed for 8 h
  2. Sanidate 5.0 at 24 fl oz thermofogged for 1 h, container sealed for 8 h
  3. StorOx 2.0 at 24 fl oz thermofogged for 1 h, container sealed for 8 h
  4. Ozone applied at 8,500 mg ozone/hour for 8 h
  5. Non-treated control bulbs thermofogged with water
  6. Non-treated control bulbs not thermofogged
- Bulbs in commercial storage, evaluated for bacterial rot in February 2021

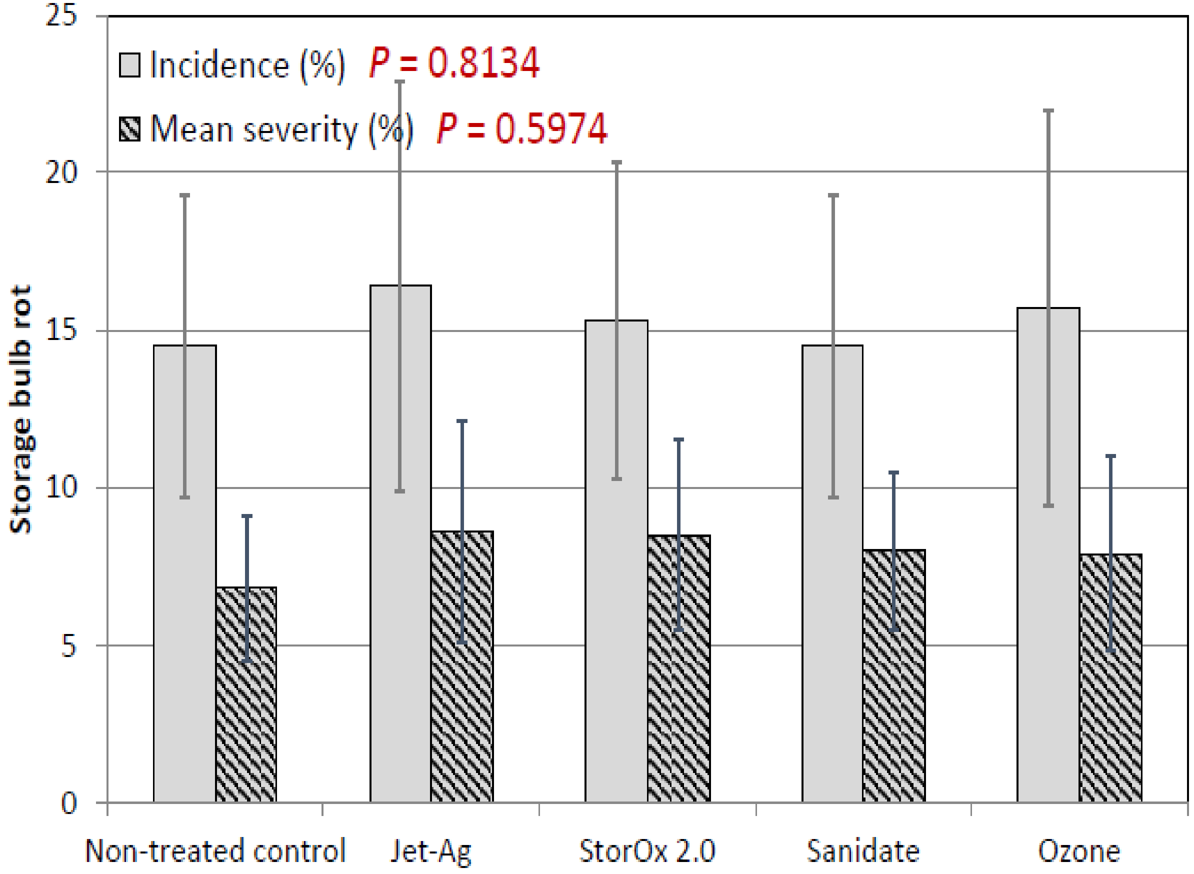
2021-22 and 2022-23 WA trials

- Repeat treatments
- **Commercial storage evaluations:** Growers remove sample of bulbs during treatment, replace non-treated bulbs, evaluate for storage rots

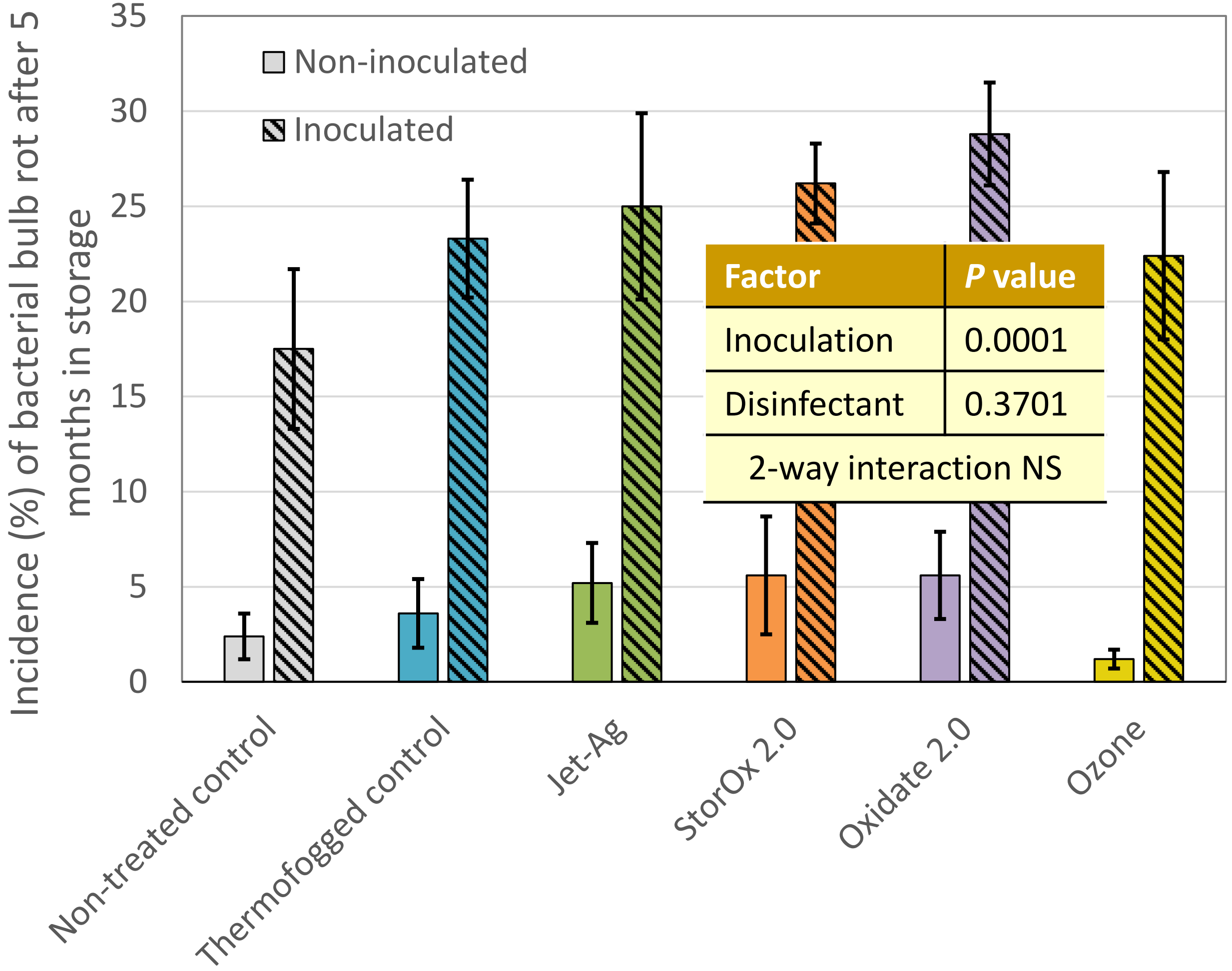
2021-22, 2022-23 CO trials - Mark Uchanski, CSU

WA trials evaluating postharvest applications of disinfectants

2020-21 trial: Incidence (%) of bacterial rot



2021-22 trial: Incidence (%) of bacterial rot

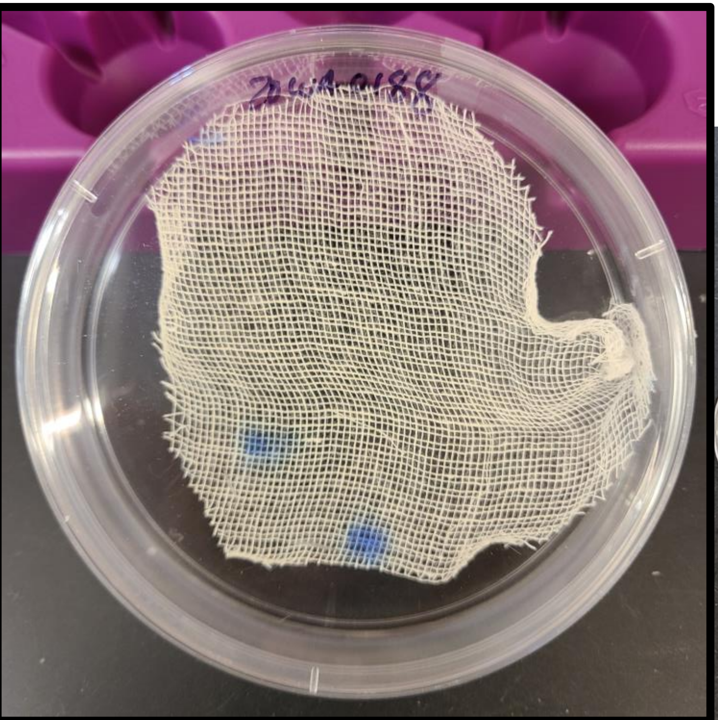


Factor	***P* value**
Inoculation	0.0001
Disinfectant	0.3701
2-way interaction NS	

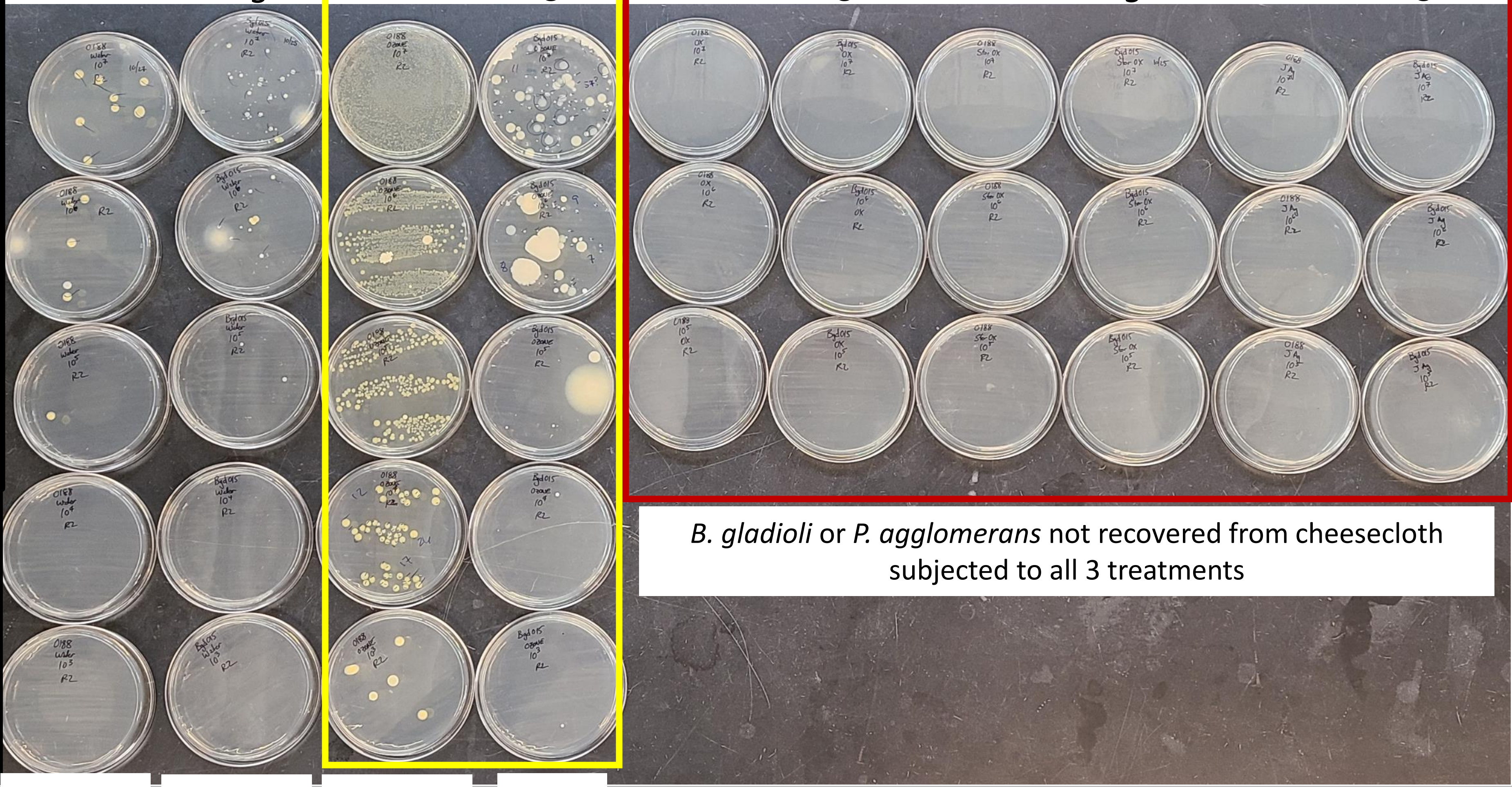
du Toit et al. 2021. Plant Dis. Management Reports 15:V102.
du Toit and Waters. 2021. Onion World, July/August 2021:6-9.

du Toit et al. 2022. Plant Disease Management Reports 16:V148.

2021-22 WA trial evaluating postharvest application of disinfectants



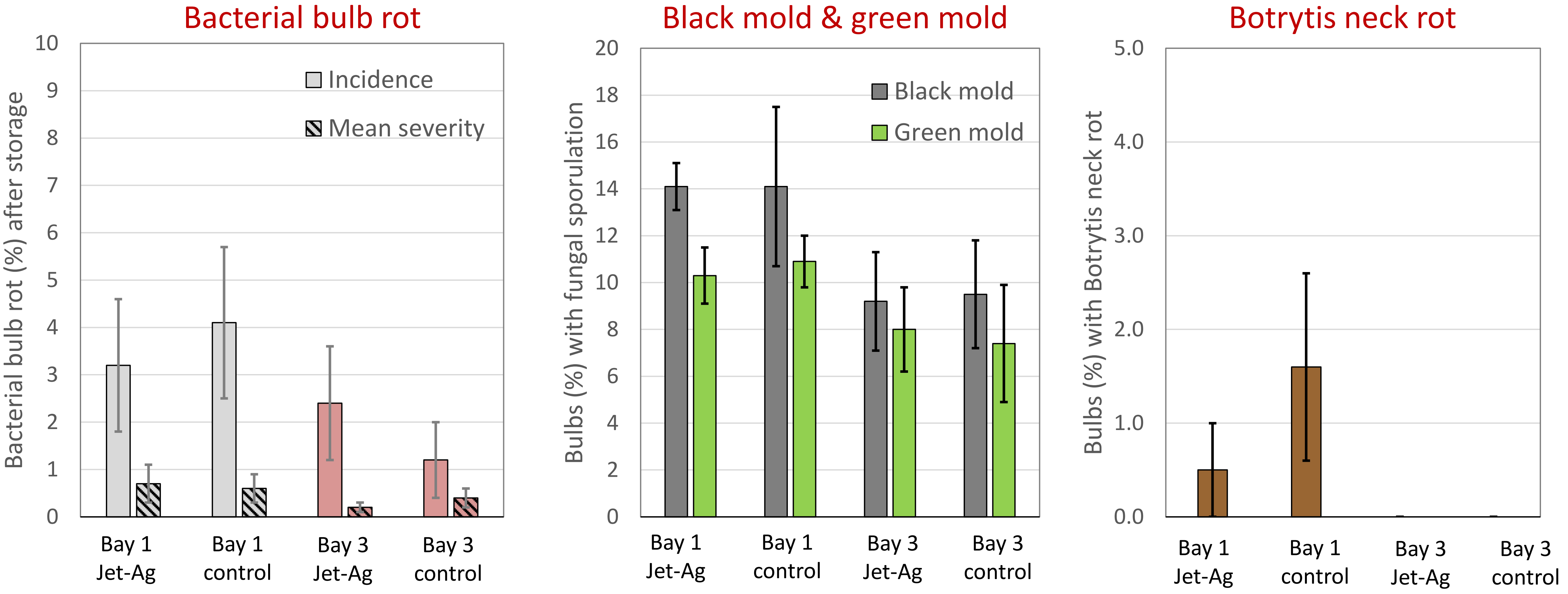
Water thermofog		Ozone		Oxidate 2.0		Storox 2.0		Jet-Ag	
Pa	*Bg*	*Pa*	*Bg*	*Pa*	*Bg*	*Pa*	*Bg*	*Pa*	*Bg*



1.7 x 10^3	3.1 x 10^5	1.6 x 10^6	0

B. gladioli or *P. agglomerans* not recovered from cheesecloth subjected to all 3 treatments

Season 2 (2021): WA Grower-Cooperator Disinfectant Trial



No effect of postharvest application of disinfectants on bacterial or fungal bulb rots

Objective B6: Modeling the risk of onion bacterial diseases

Heather MacKay, Lindsey du Toit, Kirti Rajagopalan, Supriya Savalkar, & Tim Waters (WSU), Stuart Reitz (OSU)

Aim: Generate predictive bacterial disease models across diverse regions of onion production in the USA

Purpose: Inform risk management decisions by growers

- Management decisions in the field
- Tradeoffs - bulb storage vs. sale, based on risk of rot

Initial approach (Years 1 and 2)

1. Mine large amounts of field data for key environment- and management-related drivers of bacterial diseases
2. Identify key drivers and interactions, develop testable hypotheses
3. Develop empirical predictive models for bacterial diseases of onion

Adapted approach (Years 3 and 4)

1. Develop a simple, field-scale, risk scoring model based on prior Onion ipmPIPE project
2. Calibrate the model using expert knowledge, stakeholder input, and results of Stop the Rot field trials
3. Map key regional-scale environmental drivers of risk of bacterial diseases

Onion bacterial risk assessment score has 4 main components

1. Current/Cumulative risk
- Previous week's risk score
- Confirmed disease symptoms
- Crop stage

2. Field variables
- Soil type (light/heavy/muck)
- Irrigation type & strategy
- Rotation
- Variety
- Plant density

3. Environmental variables
- Max daily air temperatures
- Windspeed
- Relative humidity
- Precipitation
- Hail damage

4. Production variables
- Fertility (cumulative N)
- Fertility (N timing)
- Bactericide program
- Weed pressure

Week	Crop growth stage	Assessment date	Total risk score	Current/cumul risk	Field variables	Environmental variables	Production variables
1	(1) Seedling -1 leaf	4/10/2021	28.0	3	12	9	4
2	(2) 1-4 leaves	5/1/2021	30.0	4	11.5	10.5	4
3	(3) 4-8 leaves	5/23/2021	30.0	4	11.5	10.5	4
4	(4) Bulbing, 8-14 leaves	6/16/2021	41.8	6	11.5	20.25	4
5	(4) Bulbing, 8-14 leaves	7/6/2021	43.5	7	11.5	21	4
6	(5) 'Soft necks' stage: leaf	7/28/2021	57.5	12	11.5	30	4
7	(6) 5-50% tops down	8/19/2021	48.5	12	11.5	21	4
8	(7) 50-100% tops down	8/28/2021					
9	(8) At harvest, prior to sto	10/1/2021					
10	(9) In storage, post-harve	10/16/2021					

Objective B7. Extension and Outreach

Christy Hoepting (Cornell), Joe LaForest (UGA), Lindsey du Toit and Heather MacKay (WSU), and Stop the Rot team

https://alliumnet.com/stop-the-rot/
https://alliumnet.com/stop-the-rot-publications-and-resources/

- Technical reports
- Presentations
- Plant Disease Management Reports
- Extension Bulletins & Educational Materials
- Videos
- Peer-reviewed journal articles
- Popular articles (Onion World, …)
- Other resources (National Onion Association newsletter)

Developed, maintained, and hosted by the Southern IPM Center and Center for Invasive Species and Ecosystem Health, University of Georgia (Joe LaForest)

Objective B8 : Economics Component

Greg Colson, UGA

Baseline Survey of Onion growers, Stakeholder Advisory Panel, & Project Team

- Prevalence and severity of bacterial rots of onion
- Effectiveness of existing management strategies for bacterial diseases

Economic analysis of bactericide trials

- Profit/loss comparison of commercial products compared to non-treated control

Preliminary economic analysis of harvest equipment trials in GA

- Comparison of straight-blade undercutter vs. chain differ for harvesting onions

Economic analysis of nitrogen trials

- Assessed the impact of nitrogen price spikes on optimal input usage

Economic analysis of cultural practice, irrigation, and postharvest treatment trials

- Assessed the economic impacts of various practices

Endline survey to complement Year 1 baseline survey and assess impacts of this project