Pacific Northwest Vegetable Association
Annual Convention & Trade Show
Kennewick, WA
16-17 November 2022

Stop the Rot

Research Update

Lindsey du Toit, Heather MacKay,
Tim Waters, Mike Derie, Jennifer Darner, &
Babette Gundersen, Washington State University

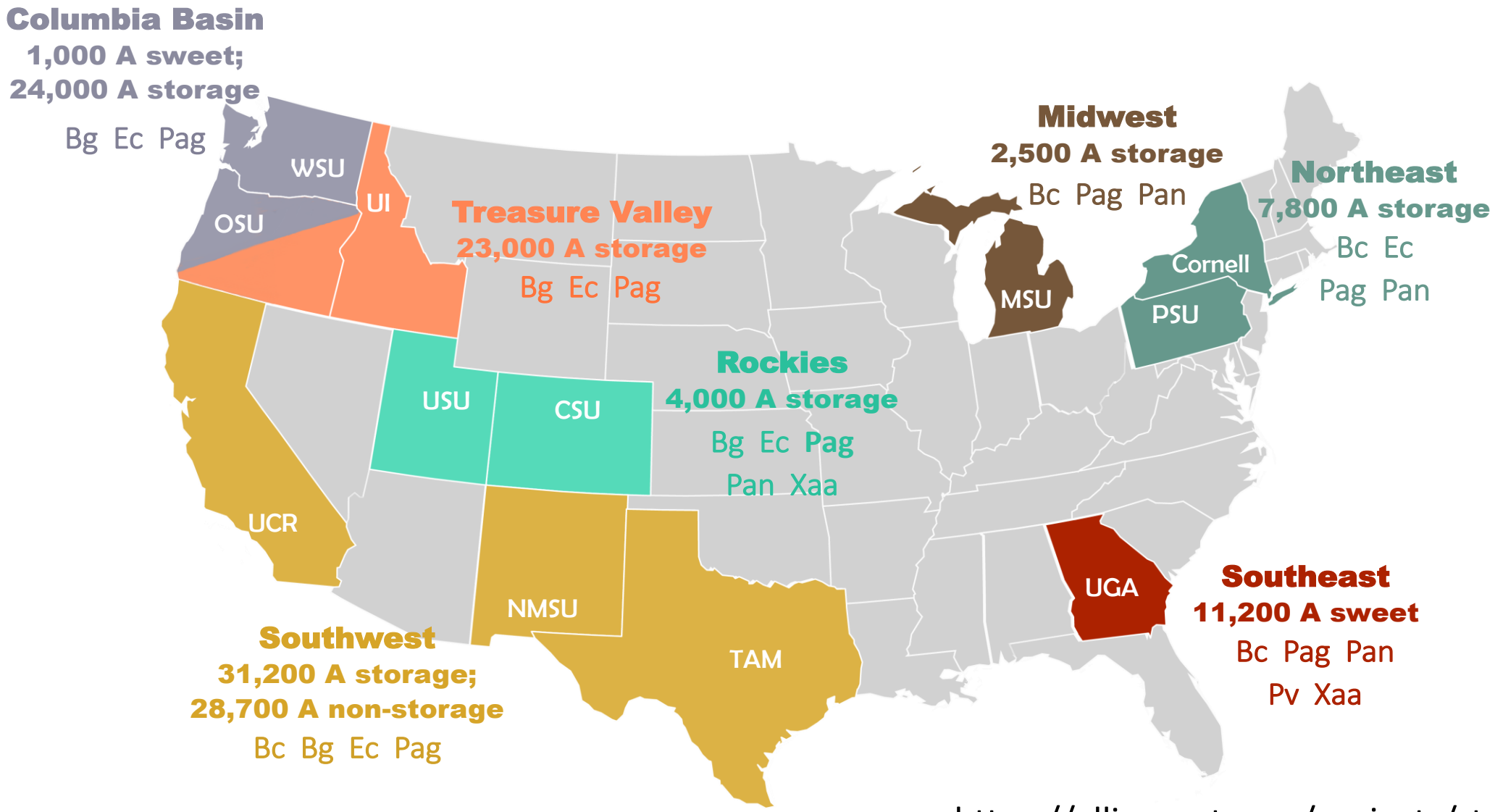
https://alliumnet.com/projects/stop-the-rot/

USDA NIFA SCRI Project No. 2019-51181-30013

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

Nature's Ninja graphic courtesy of
National Onion Association

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



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

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- $4,044,300 + $4,200,000 matching (universities, stakeholders)
- 4 year-project: September 2019-August 2023
- 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
- 14-member national Stakeholder Advisory Panel
  - Onion growers, seed company breeders & pathologists, consultants

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Washington State University team members:

- Lindsey du Toit, Plant Pathologist
- Tim Waters, Extension Specialist & Entomologist
- Gabriel LaHue, Soil Scientist
- Kirti Rajagopalan, Computer Scientist
- Ananth Kalyanamaran, Data Modeler
- Heather MacKay, Project Manager
- Graduate student, postdoctorate, & technical staff

- Onion bacterial samples, crops surveyed
- Field trial participation
- Economic assessment of bacterial issues/needs
- Bacterial disease risk modeling/prediction
- Feedback on project direction, progress, results, etc.

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- 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 – Economic assessments, Extension/outreach

MacKay, H., and du Toit, L. 2021. Onion World, May/June 2021:12-14.
MacKay et al. 2022. Onion World, May/June 2022:14-16.

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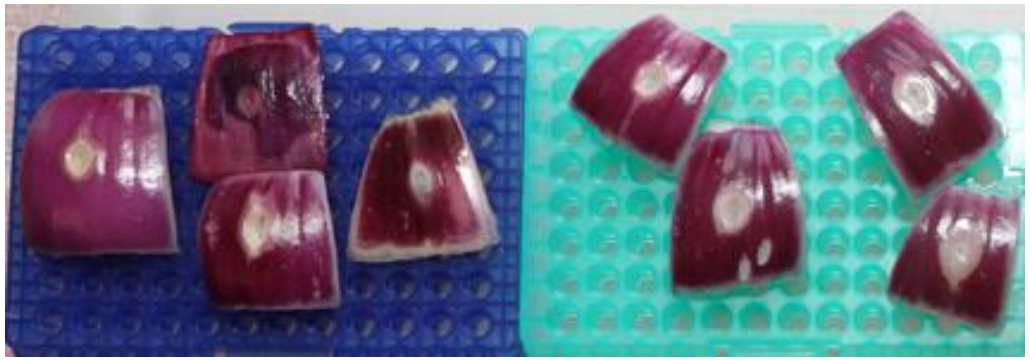
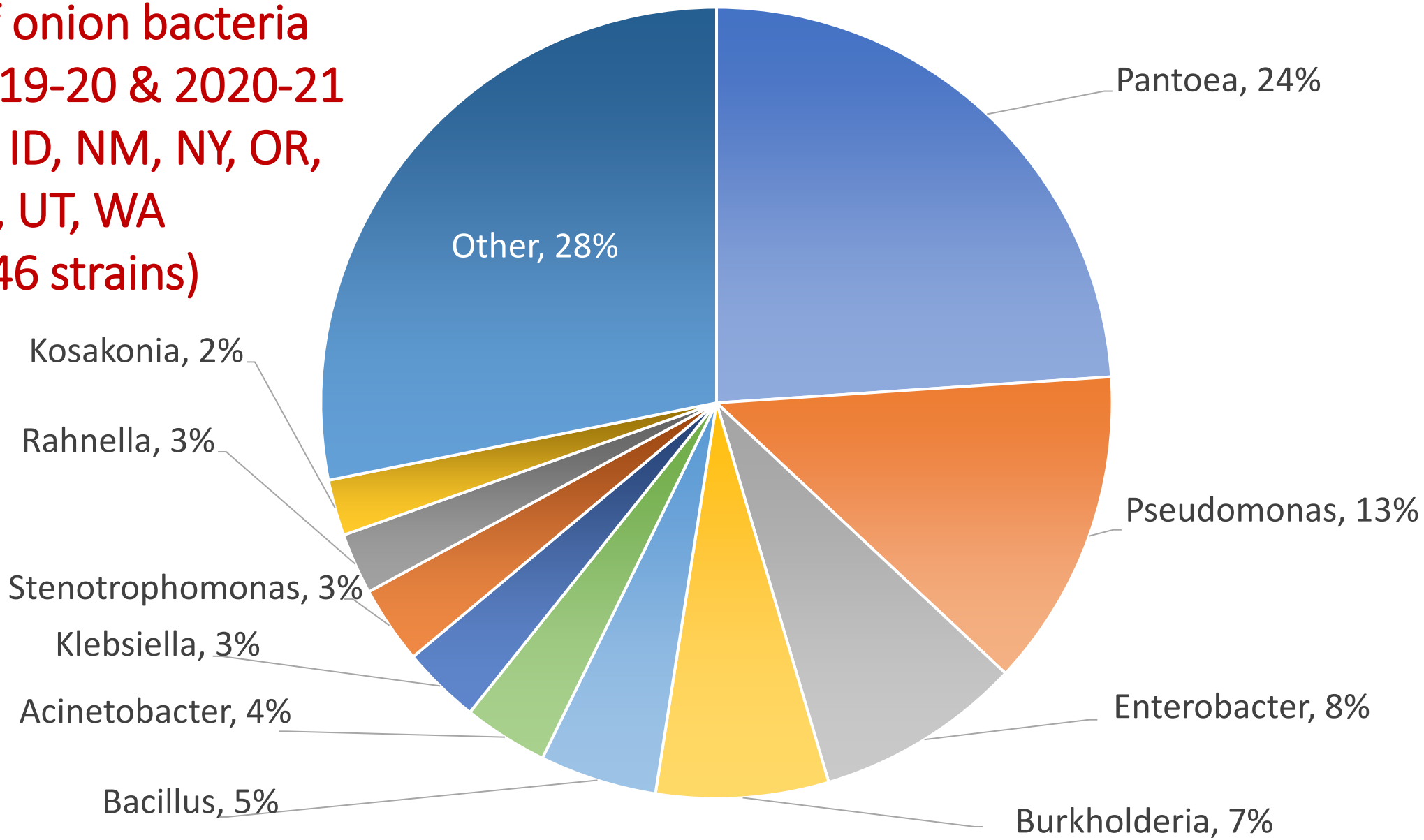
Objective A1: Survey onion crops nationally

Bacterial surveys in 12 states:

- 2020: 5 fields sampled 2x each in WA: <0.1 to 10% incidence
- 2021: 5 fields sampled 1x each in WA: <0.1% to >50% incidence (heat stress)
- 2022: 5 fields sampled 1x each in WA: <0.1% to 15% incidence
- Isolated from tissues, purified bacteria, identified to genus/species (16S rDNA sequencing), tested pathogenicity on onion (scale, foliar, & bulb tests)
- Similar surveys in 11 other states
- **Diversity of bacteria recovered, but most are NOT pathogens of onion**
- Pathogenic & non-pathogenic strains sent to National Onion Bacterial Strain Collection at UGA

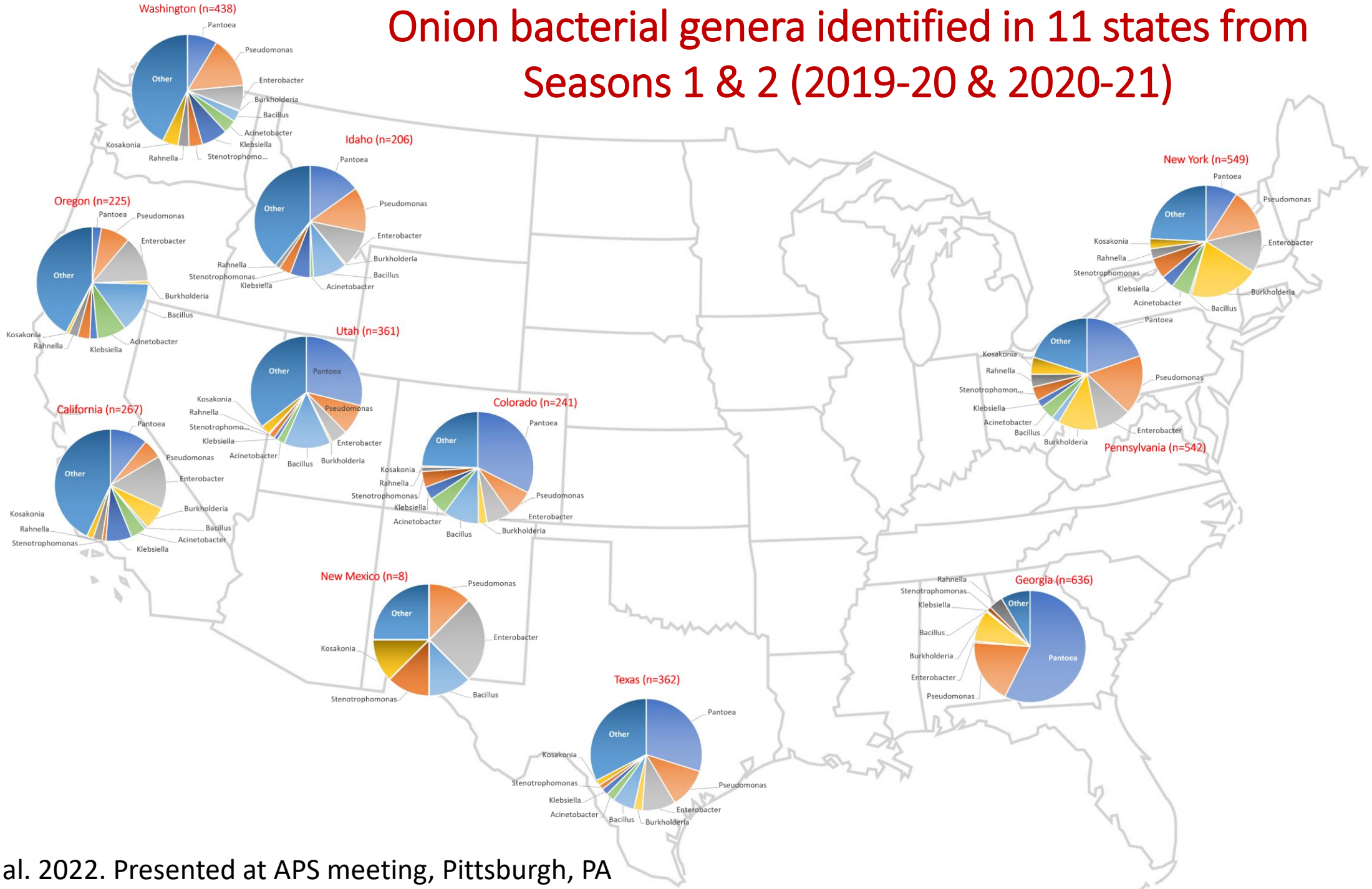


Prevalence of onion bacteria identified in 2019-20 & 2020-21 in CA, CO, GA, ID, NM, NY, OR, PA, TX, UT, WA (n = 3,846 strains)



du Toit et al. 2022. Presented at APS meeting, Pittsburgh, PA

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



du Toit et al. 2022. Presented at APS meeting, Pittsburgh, PA

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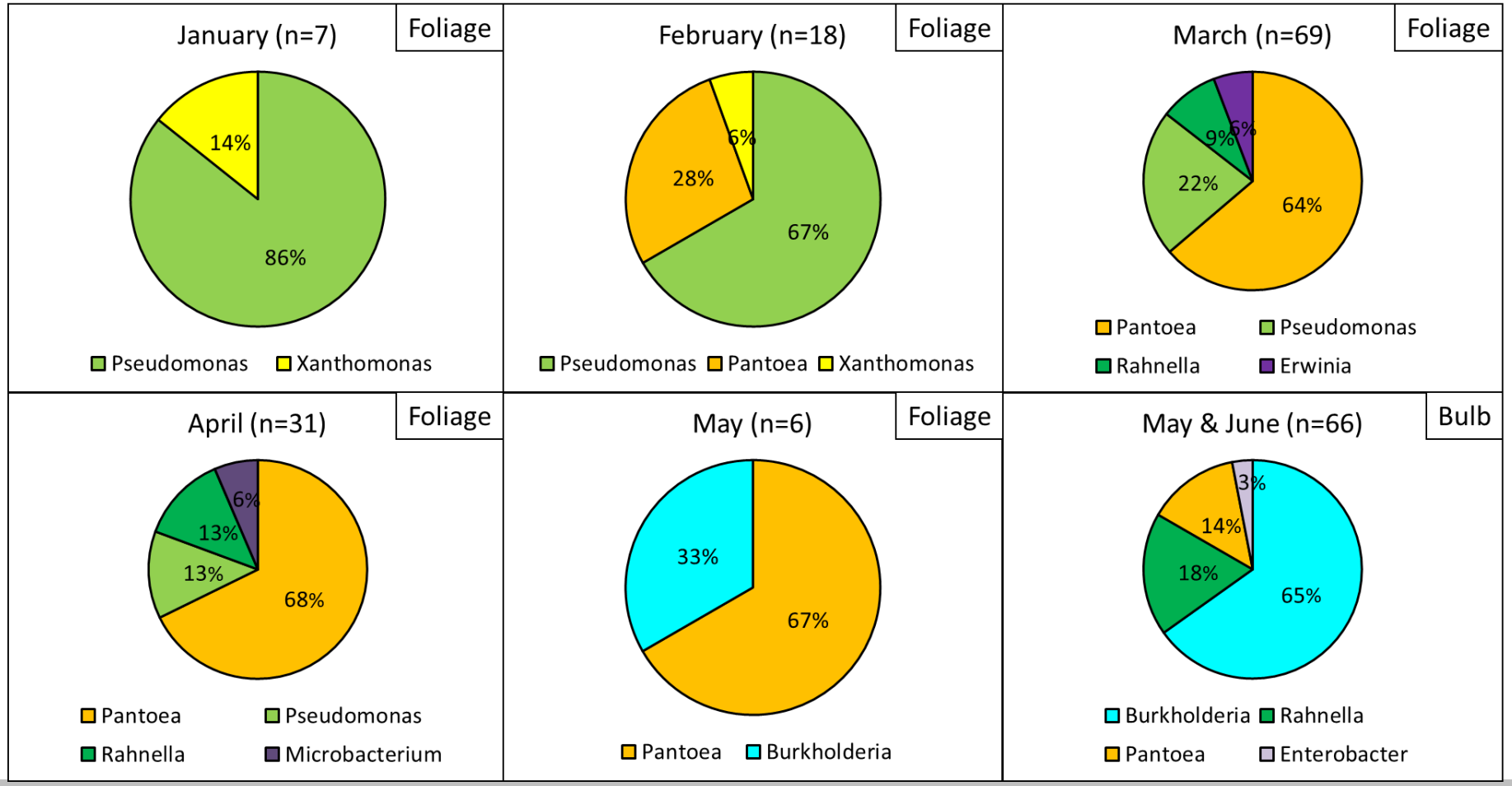
Bacterial genera isolated from symptomatic onion leaves & bulbs monthly in Georgia from January to June 2020 (Dutta and Zhao, UGA)



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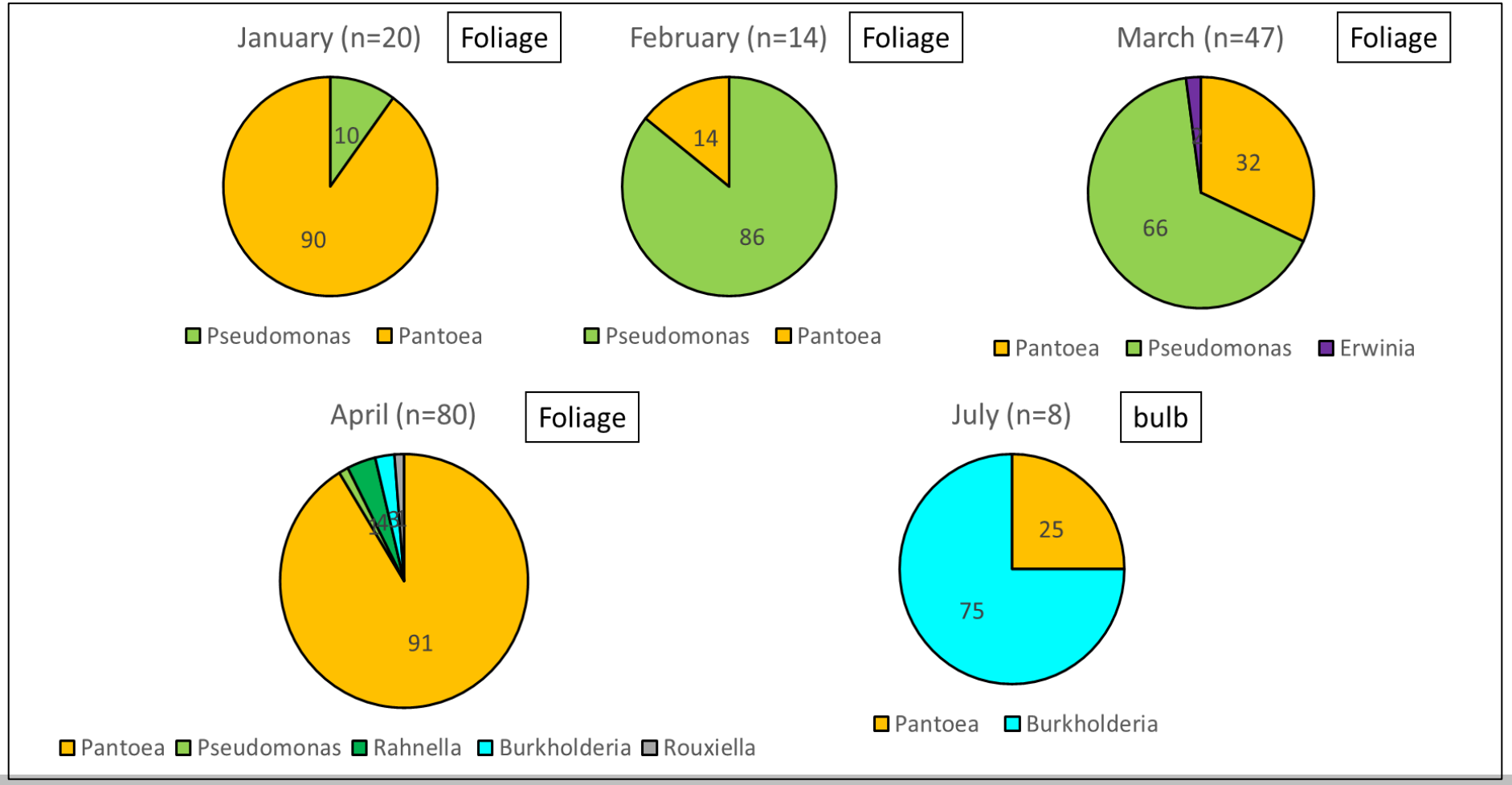
Bacterial genera isolated from symptomatic onion leaves & bulbs monthly in Georgia from January to June 2021 (Dutta and Zhao, UGA)

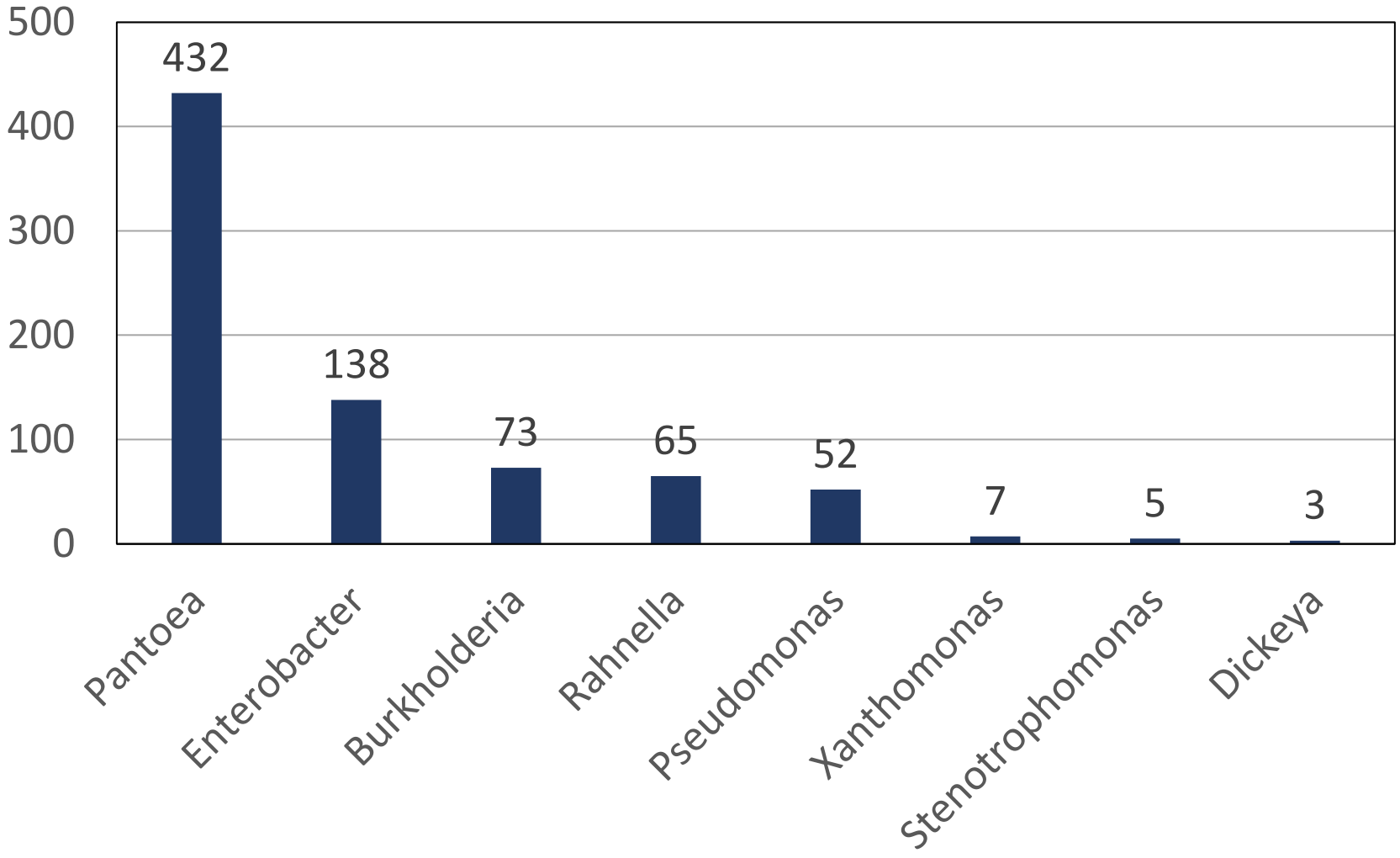


Pathogenicity test results for strains of the 5 most prevalent genera collected from symptomatic onion crops in 2020 and 2021.

Genus	All states reporting as of July 2022		Georgia		New York		Texas		Washington	
	No. of isolates	**RSN+**	Strains identified	RSN+	Strains identified	RSN+	Strains identified	RSN+	Strains identified	RSN+
Burkholderia	**271**	**83%**	58	90%	111	83%	9	100%	1	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%
Bacillus	**184**	**5%**	2	0%	3	0%	23	0%	14	0%

RSN+ = Red scale necrosis assay positive result
Follow up with foliar and bulb pathogenicity tests

Bacterial genera submitted to the National Onion Bacterial Strain Collection (NOBSC) at UGA as of Feb. 2022



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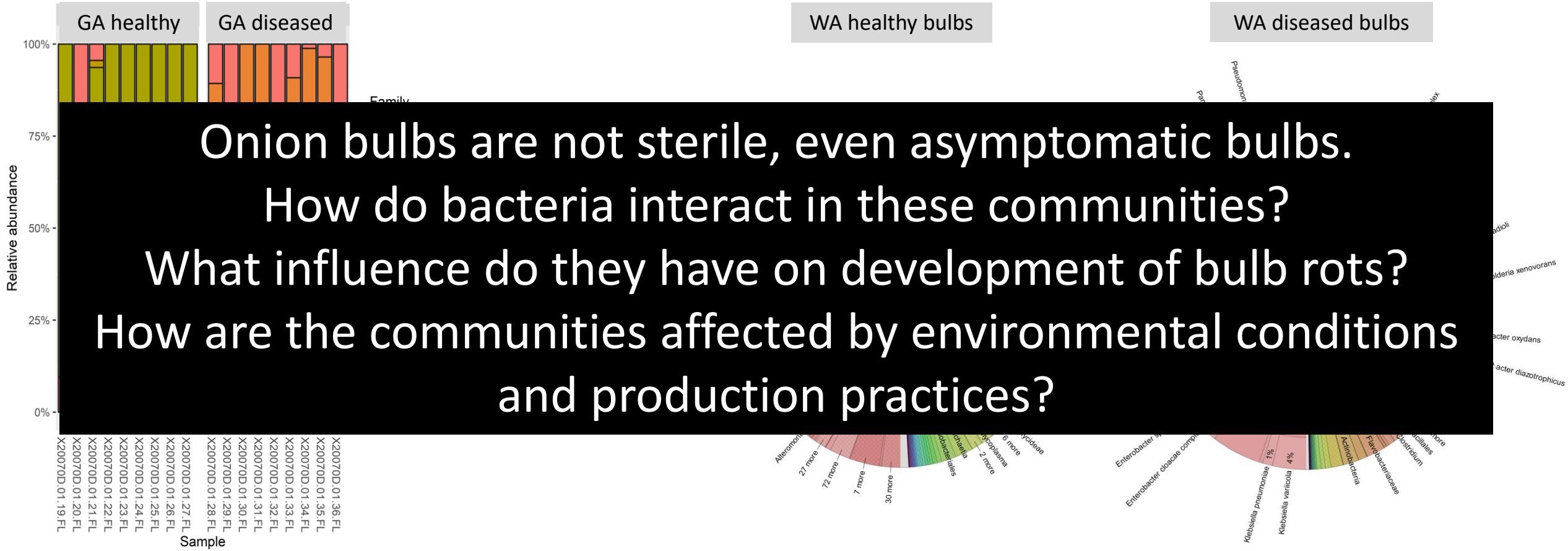
Objective A2: Bacterial communities in symptomatic vs. asymptomatic onion bulbs (Teresa Coutinho, University of Pretoria)



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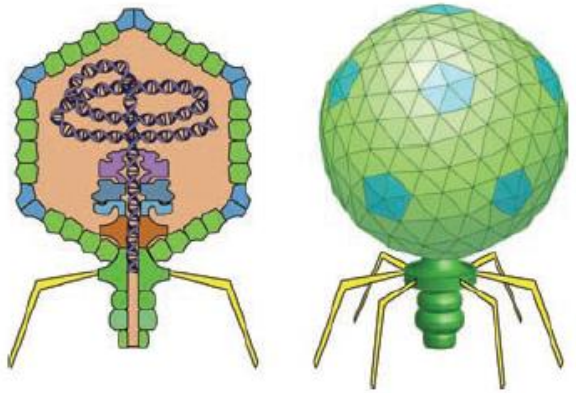
Objective A2: Bacterial communities in onion bulbs (Teresa Coutinho, Univ. of Pretoria)

- 7 *Rahnella* species identified from diseased onion bulbs and leaves (based on 4 housekeeping genes: *rpoB, infB, gyrB* and *atpD*):
  - *R. perminowiae* and *R. aceris* (most frequent), *R. aquatilis, R. victoriana, R. variigena, R. rivi*, and *R. bonaserana*

- Purified, sequenced, and characterized a bacteriophage (virus) that infects and kills *Pantoea ananatis* but not *P. agglomerans* or other onion bacterial pathogens
  - In the virus family *Autographiviridae*, similar to phages isolated in South Korea for control of *Erwinia pyrifoliae*



Objective A3: Pathogenomics and Diagnosis

1. **Genetic analysis** to identify virulence factors (Brian Kvitko, Bhabesh Dutta, Gina Shin, Mei Zhao at UGA) - what enables some bacteria to cause disease in onions
2. Develop **molecular diagnostic tools** for onion bacterial pathogens (James Woodhall, UI)

Whole genome analysis of *Pantoea* strains:

- Find genes associated with pathogenicity on onion
- *Pantoea agglomerans* is everywhere but few strains are onion pathogens
  - 58 *Pantoea* genomes assembled
  - 48 *P. agglomerans*, of which 24 are pathogens of onion
- Pathogenic strains have the HiVir gene cluster (11 genes) that produces pantaphos, a phytotoxin that rots onion bulbs
- Design molecular diagnostic tools based on specific genes in the HiVir cluster
- Test for detection of *Pantoea* strains pathogenic on onion

Asselin et al. 2018; Palidore et al. 2021

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Objective A4: Develop methods to screen for resistance to bacterial diseases

Season 1 (2020):

- **Georgia:** Greenhouse test of 2 inoculation methods on 2 cultivars (Bhabesh Dutta)
  - Inability to differentiate susceptibility of cultivars effectively
- **New York:** Various methods of screening in a growth chamber (Steve Beer)
  - Inconsistent results
- **Washington:** Field trial in Columbia Basin with 12 cultivars (3 in each of 4 maturity groups, each group inoculated at early tops down & 2 weeks later)

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Objective A4: Develop methods to screen for resistance to bacterial diseases

Season 2 (2021):

- **Georgia:**
  1. Compare short-day sweet, long-day sweet, short-day dehydration, & long-day dehydration cultivars in greenhouse with 2 inoculation methods – cut leaf-tip method & spray inoculation with *P. ananatis*
  2. Field screening of USDA Allium germplasm collection with *P. ananatis* inoculated on seed & in field
- **New York:**
  - 16 onion cultivars planted in Elba, NY on 2 dates (2 trials), half of each plot treated with insecticides
  - Cultivar characteristics and weather data evaluate for risk assessment (Objective B6)
- **Washington:**

  Repeated field trial with 12 cultivars (4 maturity groups), inoculated based on maturity, **irrigated with sprinklers** to terminate irrigation at same maturity for each group.

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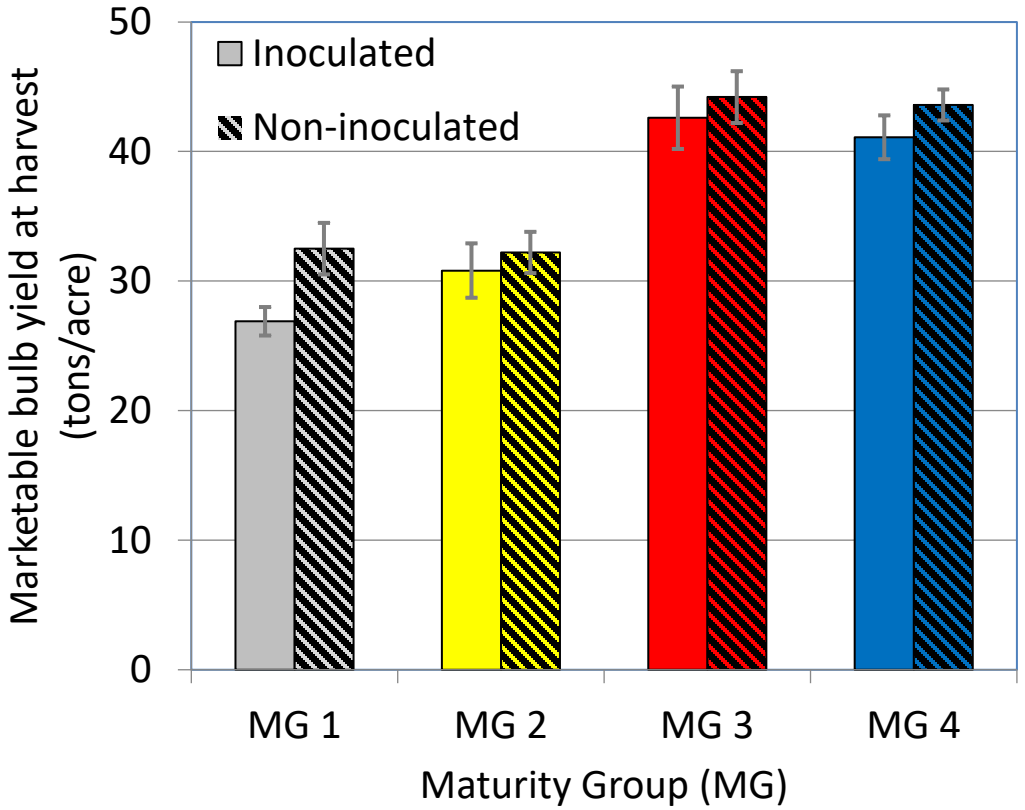
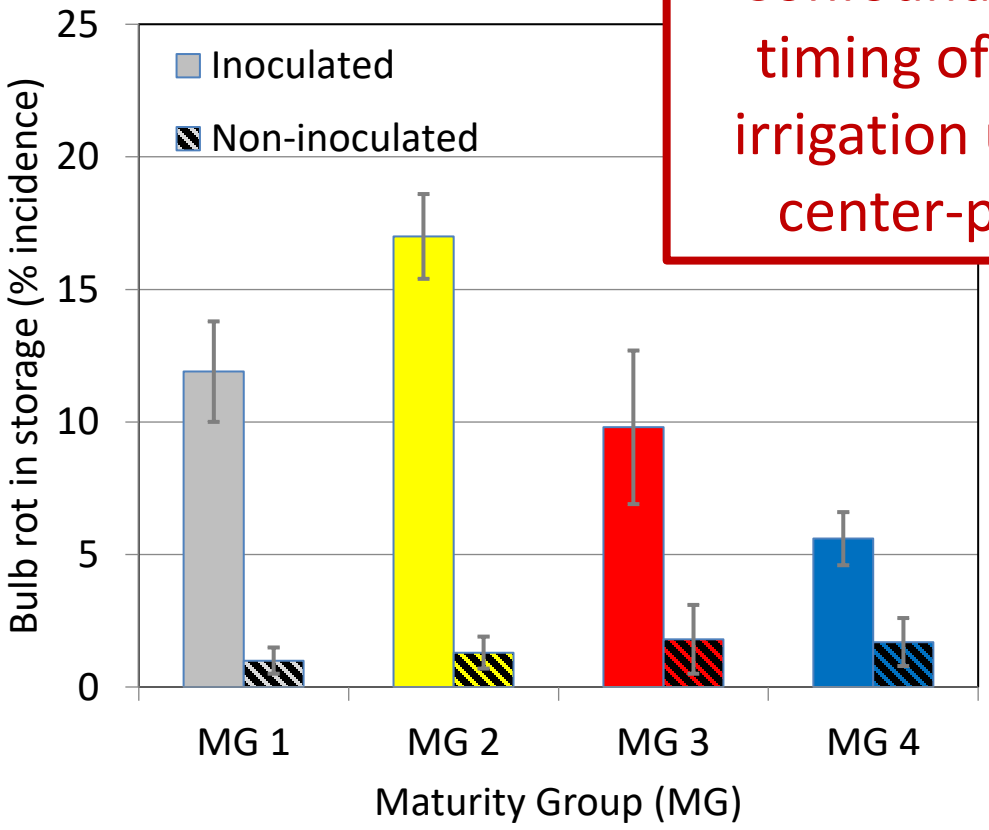
Objective A4: Develop methods to screen for resistance to bacterial diseases

2020 Washington Cultivar Trial





Confounded by timing of final irrigation under center-pivot

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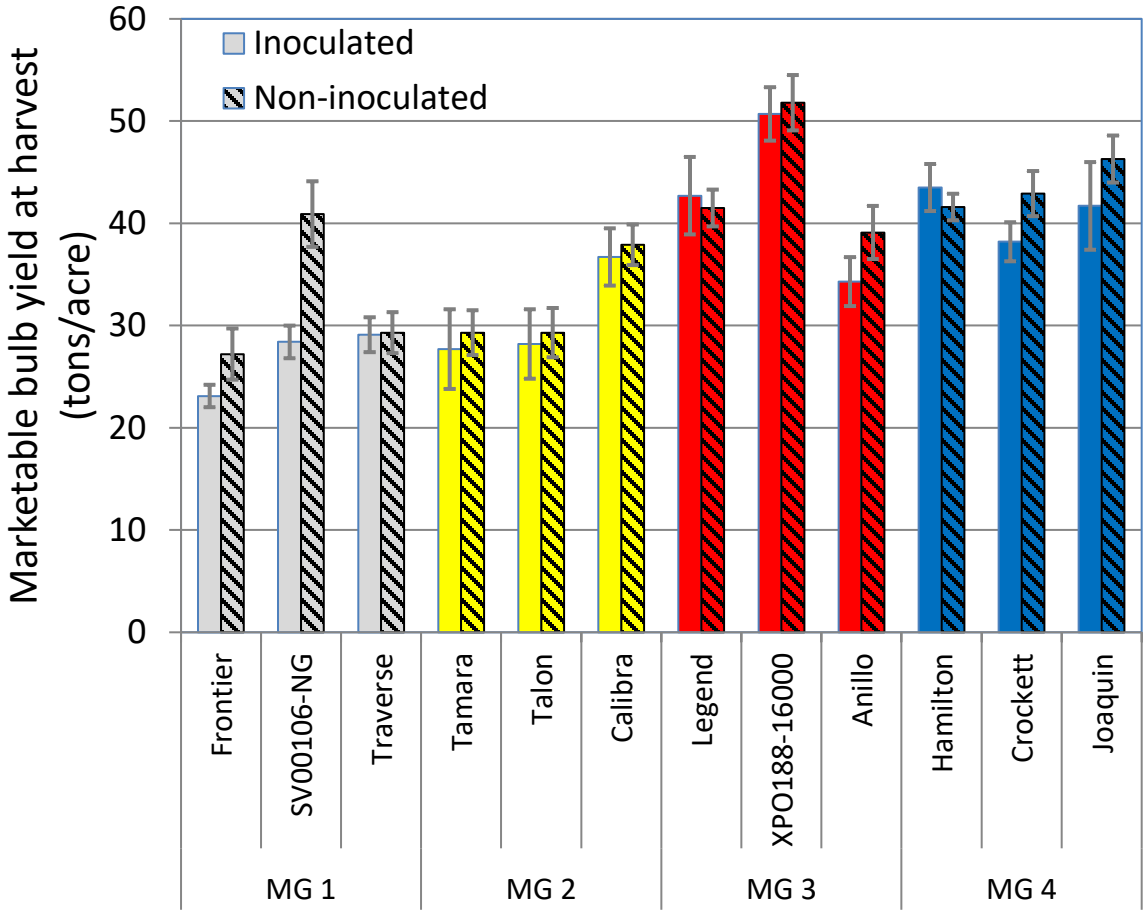
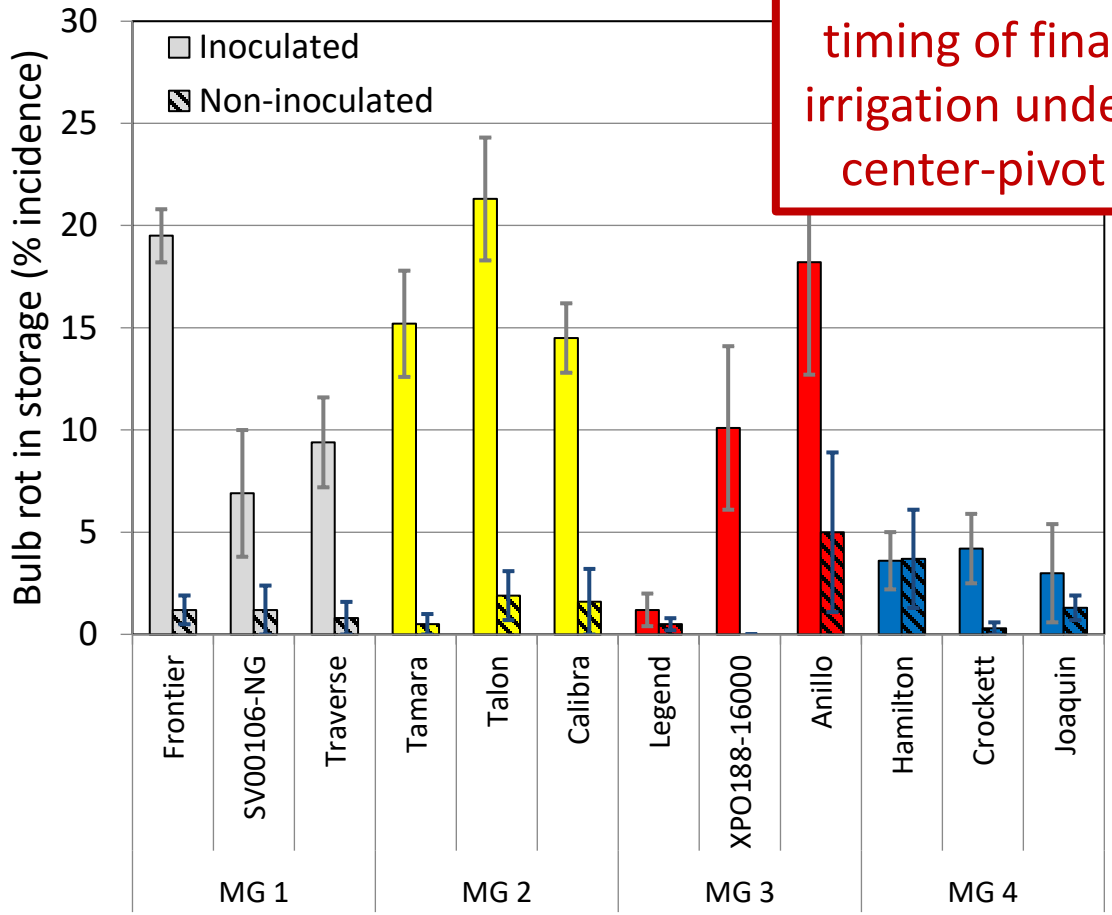
Objective A4: Develop methods to screen for resistance to bacterial diseases

2020 Washington Cultivar Trial





Confounded by timing of final irrigation under center-pivot

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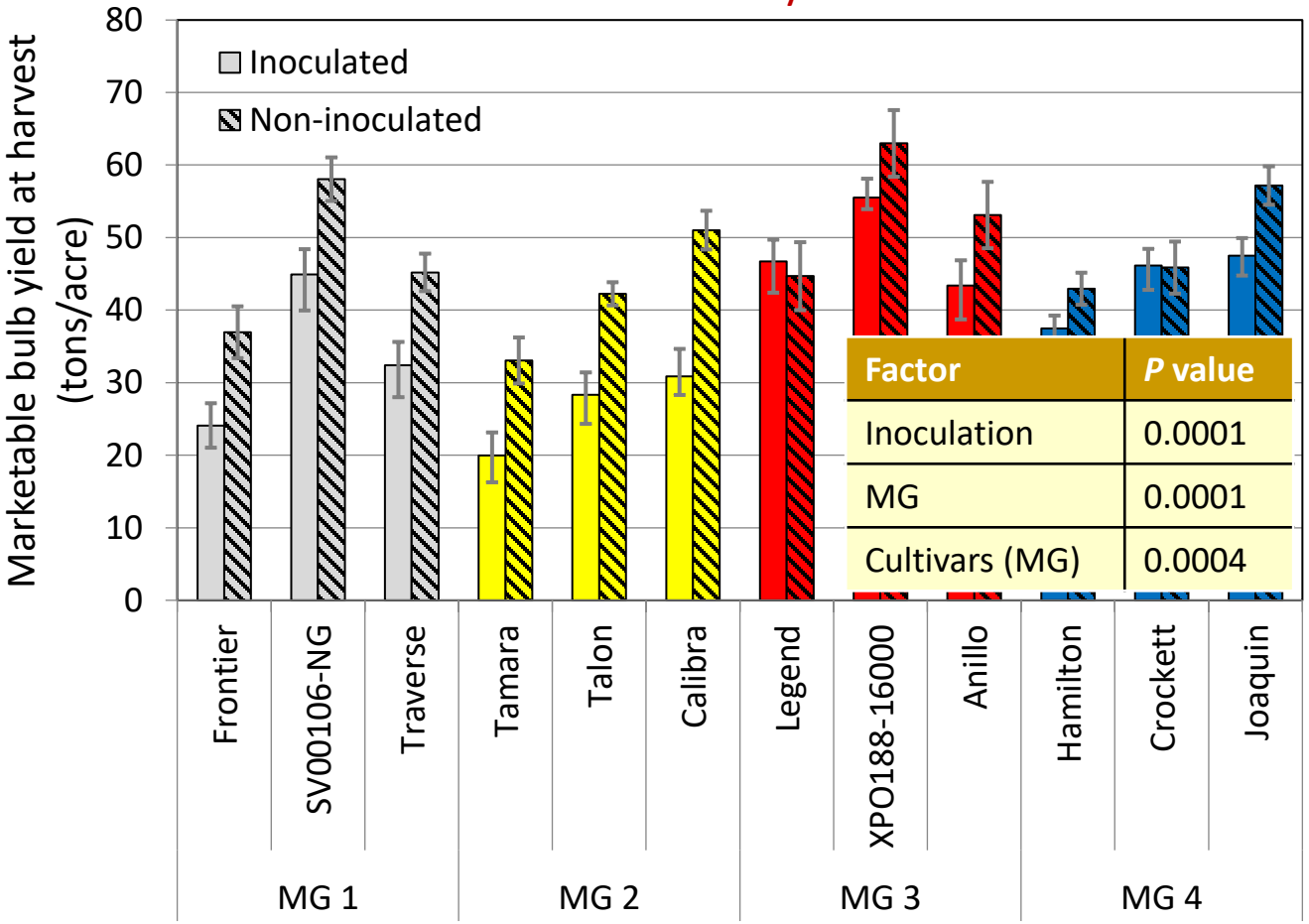
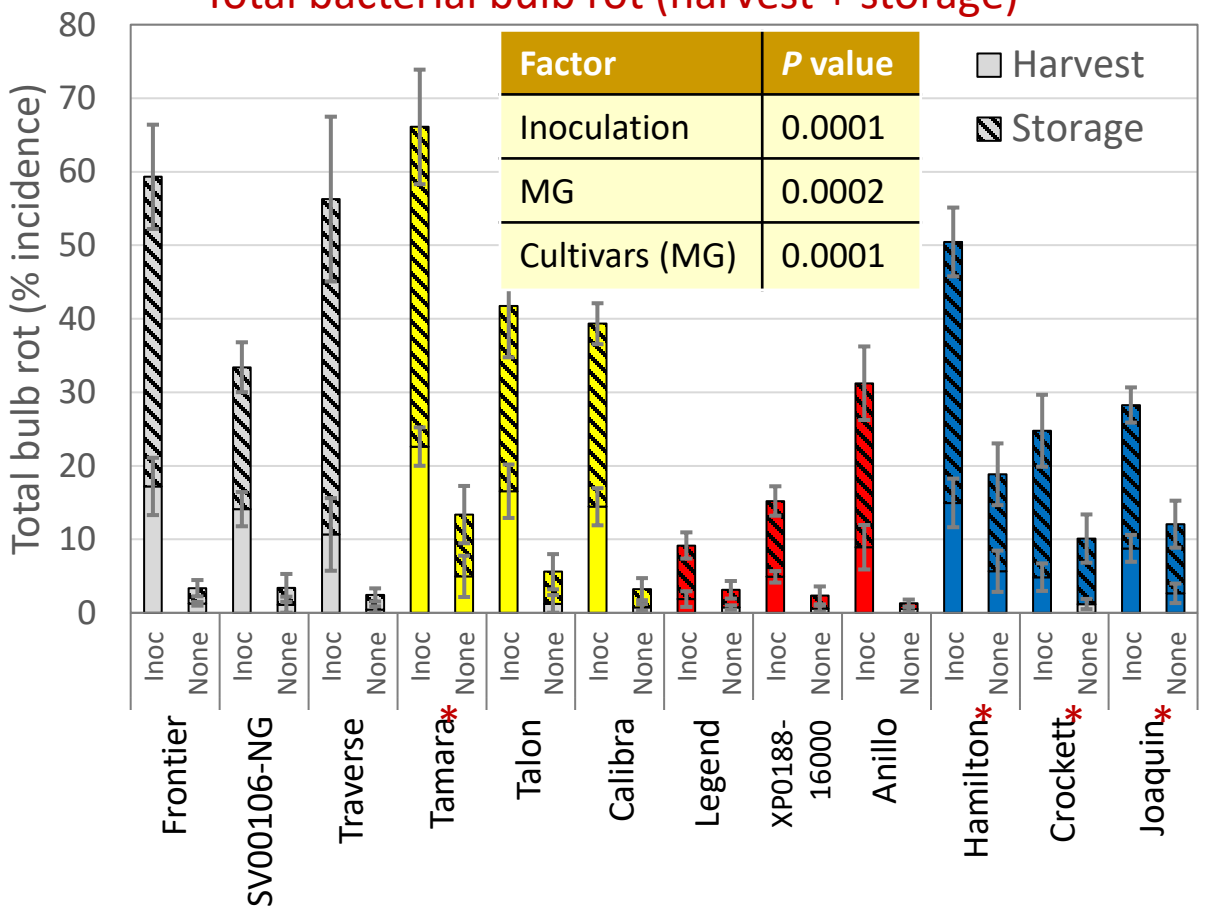
Objective A4, Season 2 (2021): Washington State Cultivar Field Trial

Marketable bulb yield at harvest



Total bacterial bulb rot (harvest + storage)



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

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Objective A4: Develop methods to screen for resistance to bacterial diseases

Season 3 (2022)

Georgia:

- Evaluate USDA onion germplasm, including species other than *Allium cepa*, for resistance to *P. ananatis* in inoculated field trial

New York:

- Cultivar trial with 2 planting dates

Washington:

- Repeated cultivar field trial
- Assess consistency in susceptibility of cultivars over seasons
- Bulbs in storage to be evaluated in Feb. 2023

Objective B1: Effects of irrigation practices on bacterial diseases

Irrigation methods:

- Sprinkler vs. drip irrigation compared in **GA** (Seasons 1 and 2) and **CA** (Season 2)
- **GA:** Drip irrigation reduced total yield in Season 2 but not in Season 1, and reduced internal bacterial bulb rot in Season 1 (not in Season 2)
- **CA:** Drip irrigation increased bulb yield, and decreased bacterial leaf blight and bulb rots

Irrigation frequency:

- Shorter, more frequent vs. longer, less frequent irrigation under drip irrigation in **OR** and sprinkler irrigation in **WA** in Seasons 1 and 2
- **WA:** Irrigation frequency had no effect on marketable yield or bacterial bulb rot
- **OR:** More frequent irrigation increased Botrytis neck rot by 50% in Season 1, but not bulb yield or incidence of bacterial bulb rots; marketable yield decreased with more frequent irrigation

Timing of final irrigation:

- Ending irrigation early, normal, vs. late under drip irrigation in **OR** and sprinkler irrigation in **WA**
- **WA:** Timing of final sprinkler irrigation did not affect yield, but the late timing of final irrigation increased bacterial bulb rot
- **OR:** Ending drip irrigation earlier reduced bulb yield compared to normal and late timings, but timing of final drip irrigation did not impact the bacterial bulb rots

Belo et al. 2021. Plant Disease Management Reports 15:V109.

Objective B1: Effects of irrigation practices on bacterial diseases

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.

Objective B2: Effects of fertility practices on bacterial diseases

Nitrogen application rates:

- **GA:** 75–135 lb N **applied** acre^{-1} increased bulb yield with increasing N, but no effect on bacterial bulb rot
- **NY:** No difference in bulb yield or bacterial bulb rot at 60–120 lb N **applied** acre^{-1}
- **OR:** Bacterial bulb rot not affected by 50, 100, and 150% of recommended N application rate (52–170 lb N **applied** acre^{-1}) in Season 1, but high N increased Botrytis neck rot, and yield decreased with increasing N
- **WA:** 8–168 and 0–319 lb N **applied** acre^{-1} (194–354 and 41–360 lb N **available** acre^{-1}) in Seasons 1 and 2, respectively (high irrigation water nitrate in Season 1), had no effects on bulb yield or bacterial bulb rot

Nitrogen application timing:

- **GA:** Making the final N application before bulb initiation increased bulb yield and reduced bacterial bulb rot compared to final N application at or after bulb initiation
- **NY:** Applying all N at planting, side-dressing at 3-4 leaf stage, or side-dressing after bulb initiation had no effect on bulb yield or bacterial bulb rot on muck soil
- **WA:** Timing of final N application (at bulb initiation, 1 week after, or 2 weeks after) did not affect bulb yield or bacterial bulb rots

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Objective B3: Effects of pesticide programs on bacterial diseases of onion

- 7 field trials in 2020: CO, GA, NY, OR, TX, UT, WA
- 6 onion cultivars planted: Avalon, Calibra, Century, Granero, Salute, Vaquero
- 22 products evaluated:

  Actigard 50WG, Agrititan, Aliette, Badge SC, BlightBan A506, Champ, Cueva, Cuprofix Ultra 40 Disperss dry flowable, Harbour, Kocide 3000 (+Manzate Max or +Lifegard), Leap, Lifegard WG, ManKocide, Mastercop (2 rates), Nano-MgO, Nordox, Nucop hb coppers, 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: GA, NY, TX trials not inoculated; CO, OR, WA, UT inoculated 2x late season
- Inoculum: *Burkholderia gladioli* pv. *alliicola, Pantoea agglomerans*, & *Pantoea ananatis*
- Data collected: Foliar disease incidence & severity, phytotoxicity from treatments, marketable bulb yield, bulb rot incidence & severity

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Objective B3: 2020 Washington bactericide trial

Main plot and split plot treatments	Foliar phyto-toxicity (4 Aug)	Foliar bacterial symptoms (18 Aug)	
		Incidence (% of plants)	Severity (% of canopy)
Main plot treatment			
Inoculated	8.2	17.4 a	3.7 a
Non-inoculated	8.3	4.5 b	0.5 b
LSD	2.9	Rank[x]	Rank
P value	0.9335	0.0001	0.0001
Split-plot treatment and rate/A			
Kocide 3000 1.5 lb	**7.0 b**[y]	22.4	3.8
ManKocide 2.25 lb	**16.9 b**	12.0	3.5
Badge SC 2.75 pt	**33.0 a**	14.4	3.0
Cuprofix Ultra 40 Disperss Dry Flowable 2.5 lb	**9.0 b**	11.2	2.2
Oxidate 2.0 1.25 fl oz/2 gal water	0.0 c	16.8	3.4
Lifegard WG4.5 oz/100 gal	0.0 c	22.4	3.5
Nano-MgO 1,000 ppm	0.0 c	22.4	5.0
Control	0.0 c	17.6	4.8
LSD	Rank	Rank	Rank
P value	0.0001	0.5242	0.7184

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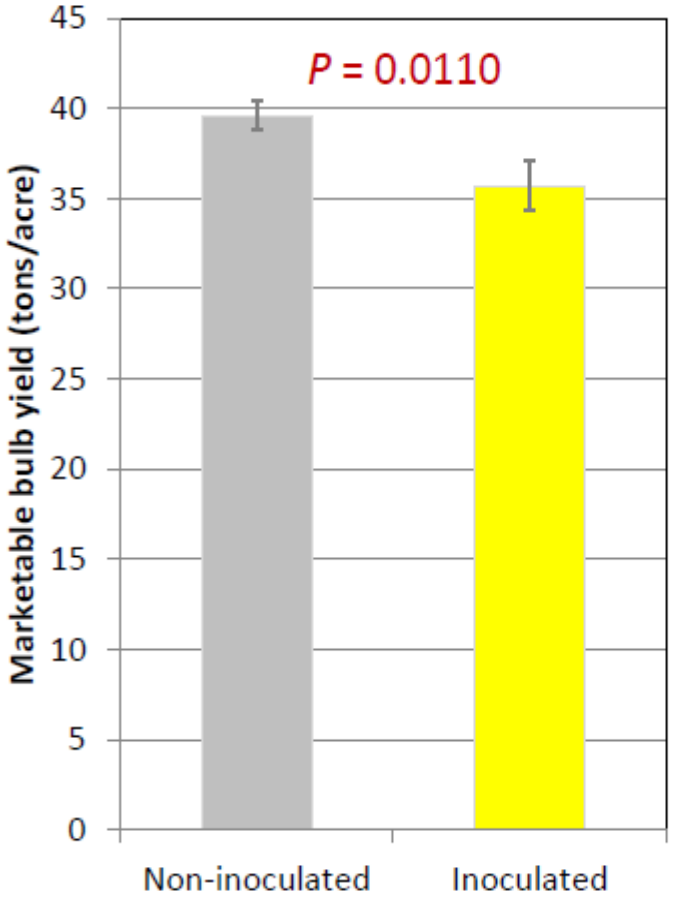
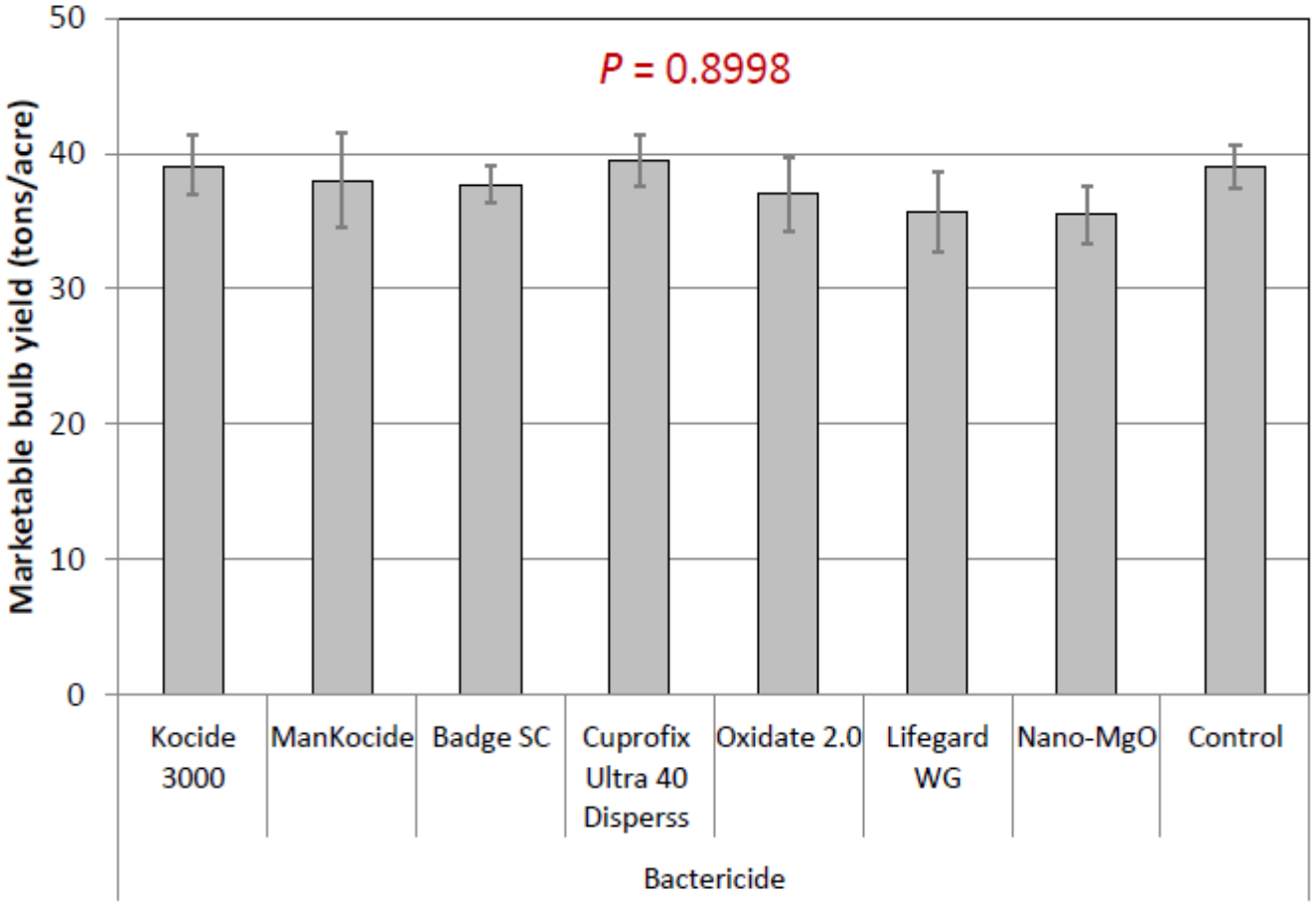
Objective B3: 2020 WSU Bactericide Trial – Marketable bulb yield





du Toit, Derie, Gundersen, Waters, and Darner. 2021. Plant Disease Management Reports 15:V107.

du Toit, Waters, Derie, and Darner. 2020. Battling onion bacterial diseases with bactericides. Onion World, Dec. 2020:6-11.

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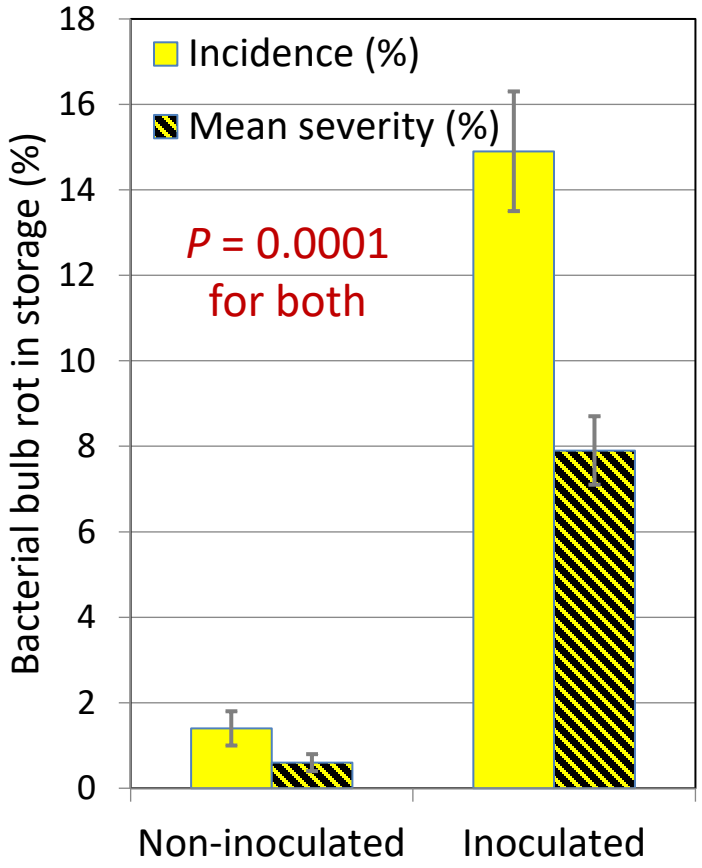
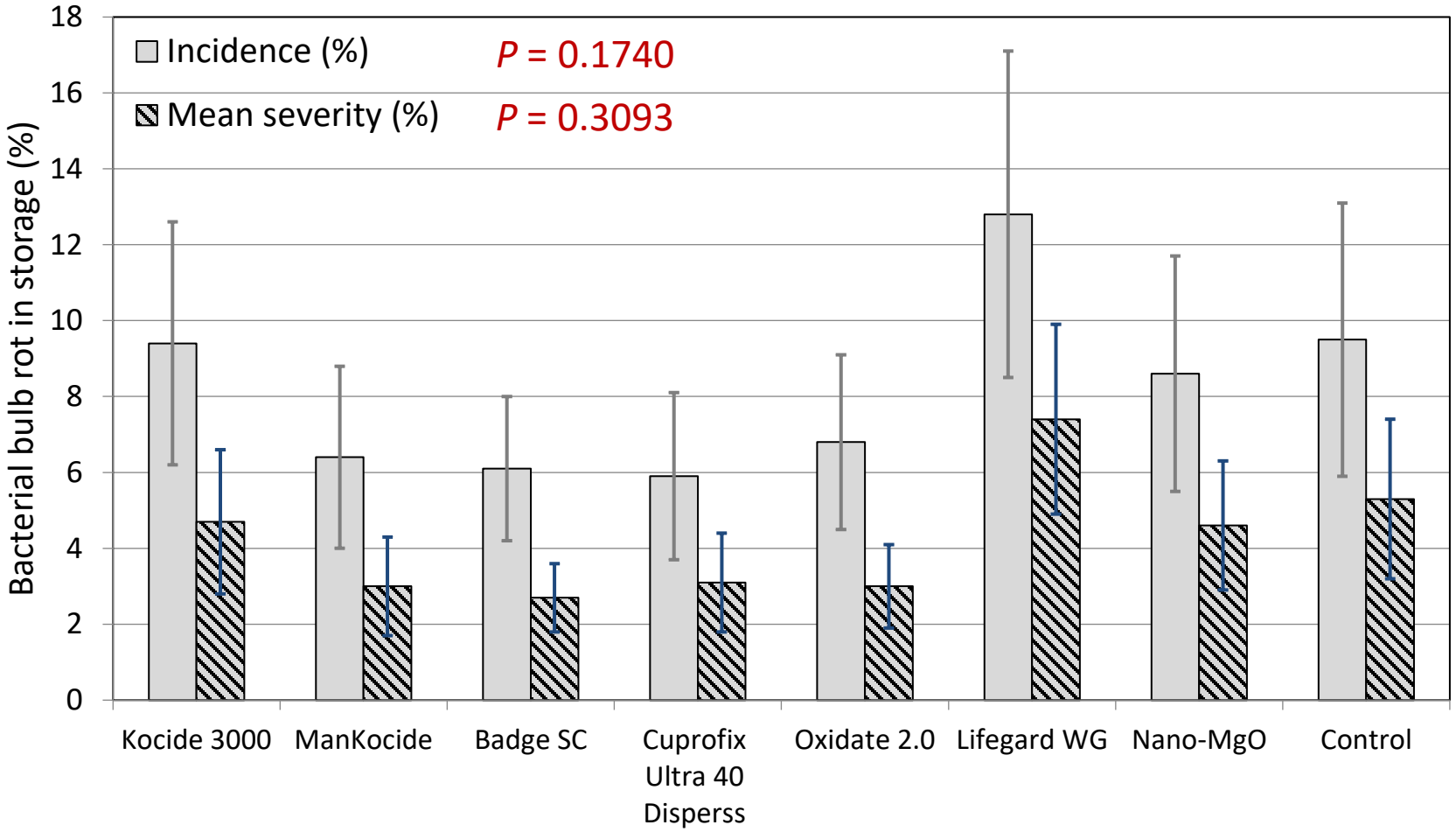
Objective B3: 2020 WSU Bactericide Trial – Bacterial bulb rot at harvest





du Toit, Derie, Gundersen, Waters, and Darner. 2021. Plant Disease Management Reports 15:V107.

du Toit, Waters, Derie, and Darner. 2020. Battling onion bacterial diseases with bactericides. Onion World, Dec. 2020:6-11.

Stop the Rot: Washington State Season 2 Field Trials

Objective B3: Bactericide trials for management of onion bacterial diseases

2021 WA Bactericide-Herbicide Trial:

- Location: Pasco
- Split-split plot RCBD
  - Main plots: Inoculated (*Burkholderia gladioli* & *Pantoea agglomerans*) or not inoculated
  - Split plots: Herbicide (Outlook on 12 July) or not
  - Split-split plots: Bactericides (5x, 7-day intervals)
    1. Badge SC
    2. ManKocide
    3. LifeGard WG
    4. Control (no treatment)
- Inoculation at early tops down & 2 weeks later
- Trial under center pivot irrigation
- Extremely hot, dry season (117°F in late June)

du Toit et al. 2022. Plant Disease Management Reports 16:V150.

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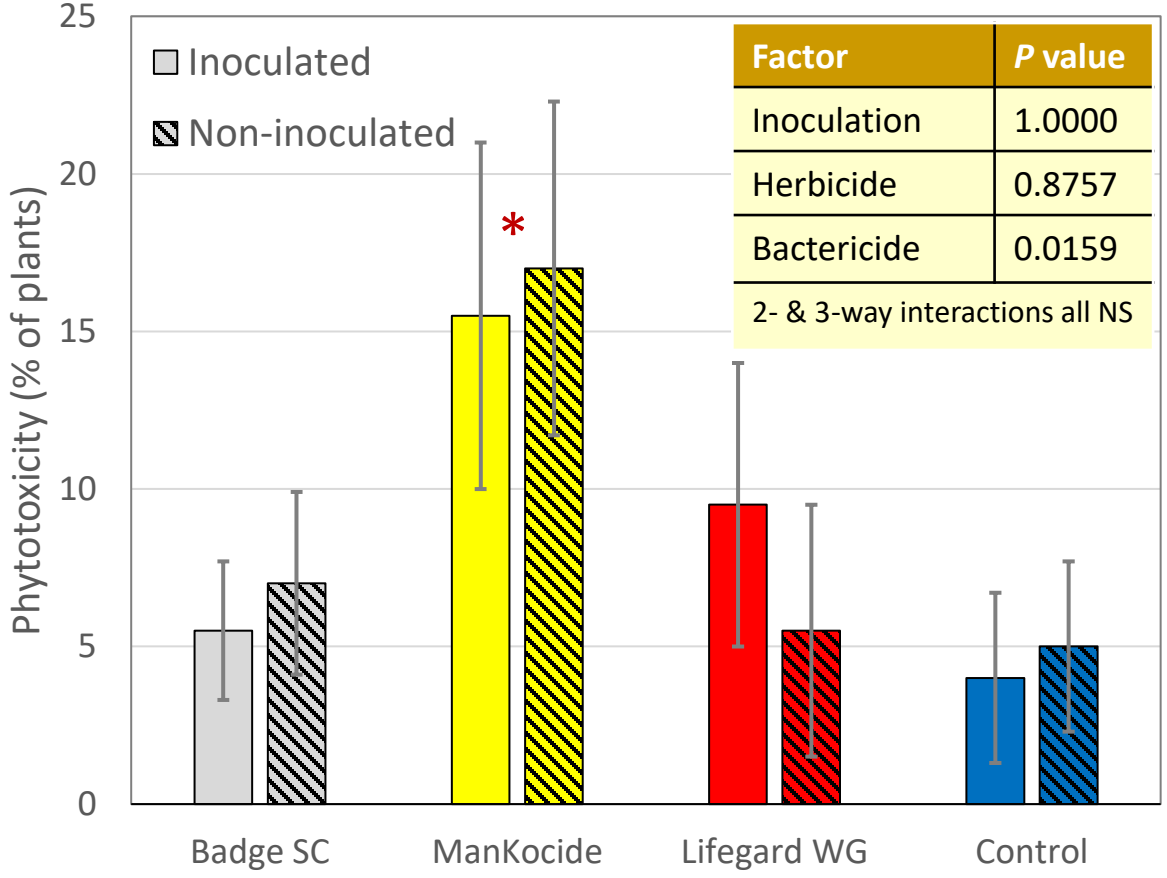
Objective B3, Season 2 (2021): Washington State Bactericide Trial

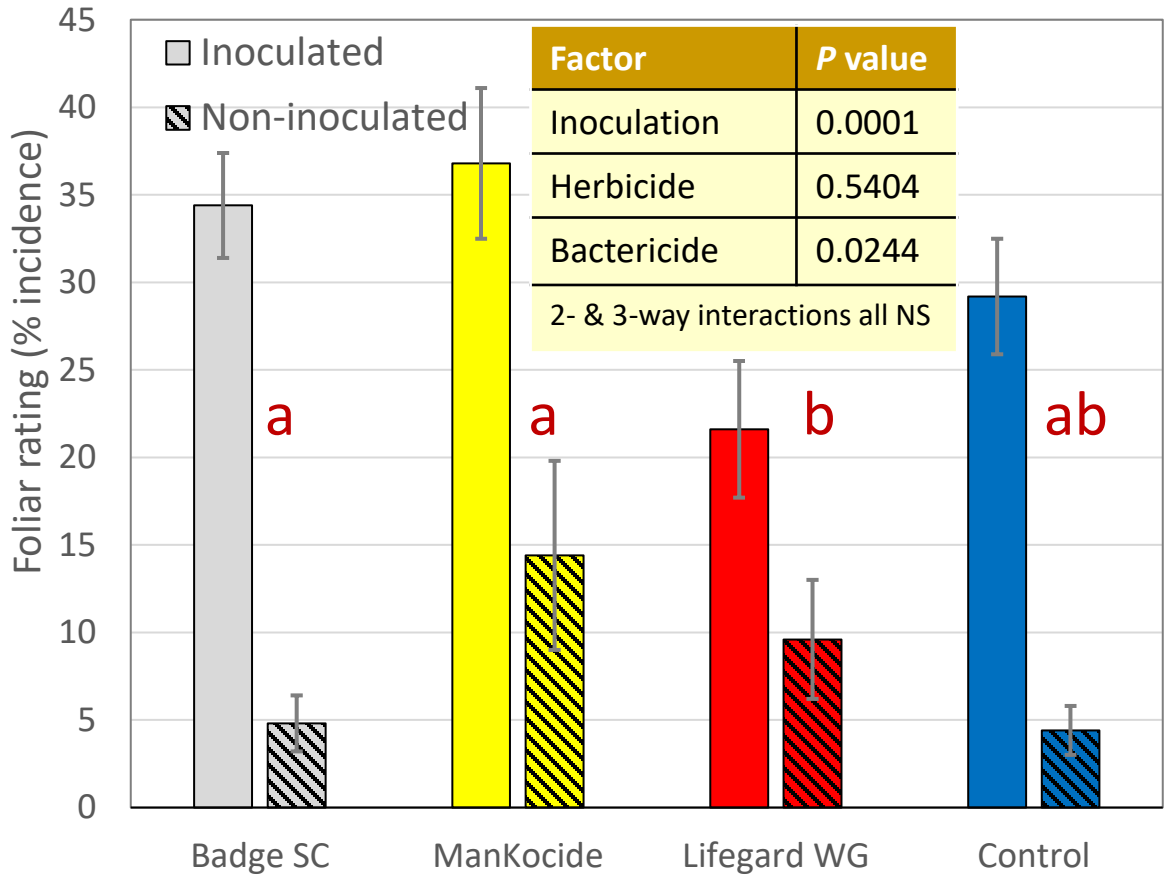
Incidence (%) of plants with phytotoxicity (20 August)



Factor	*P* value
Inoculation	1.0000
Herbicide	0.8757
Bactericide	0.0159

2- & 3-way interactions all NS

Incidence (%) of bacterial leaf blight (4th rating)



Factor	*P* value
Inoculation	0.0001
Herbicide	0.5404
Bactericide	0.0244

2- & 3-way interactions all NS

du Toit et al. 2022. Plant Disease Management Reports 16:V150.

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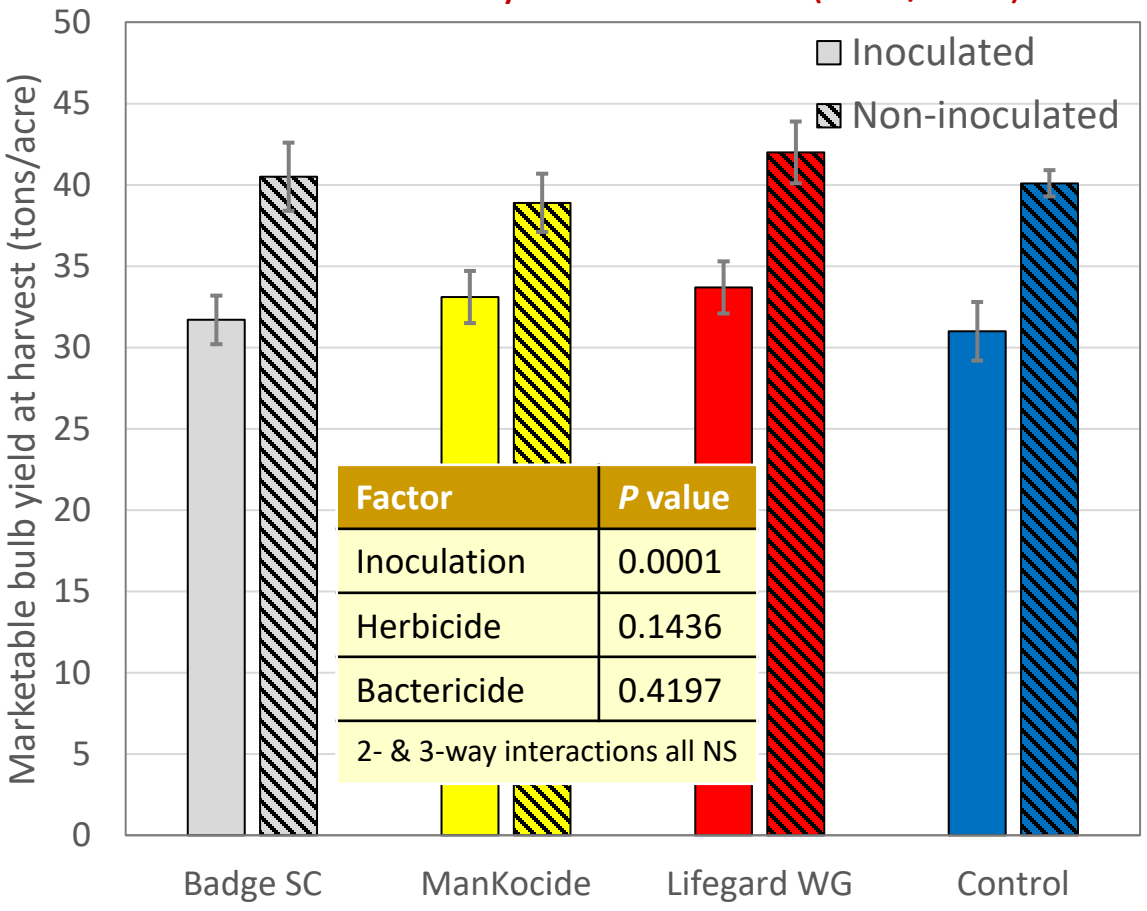
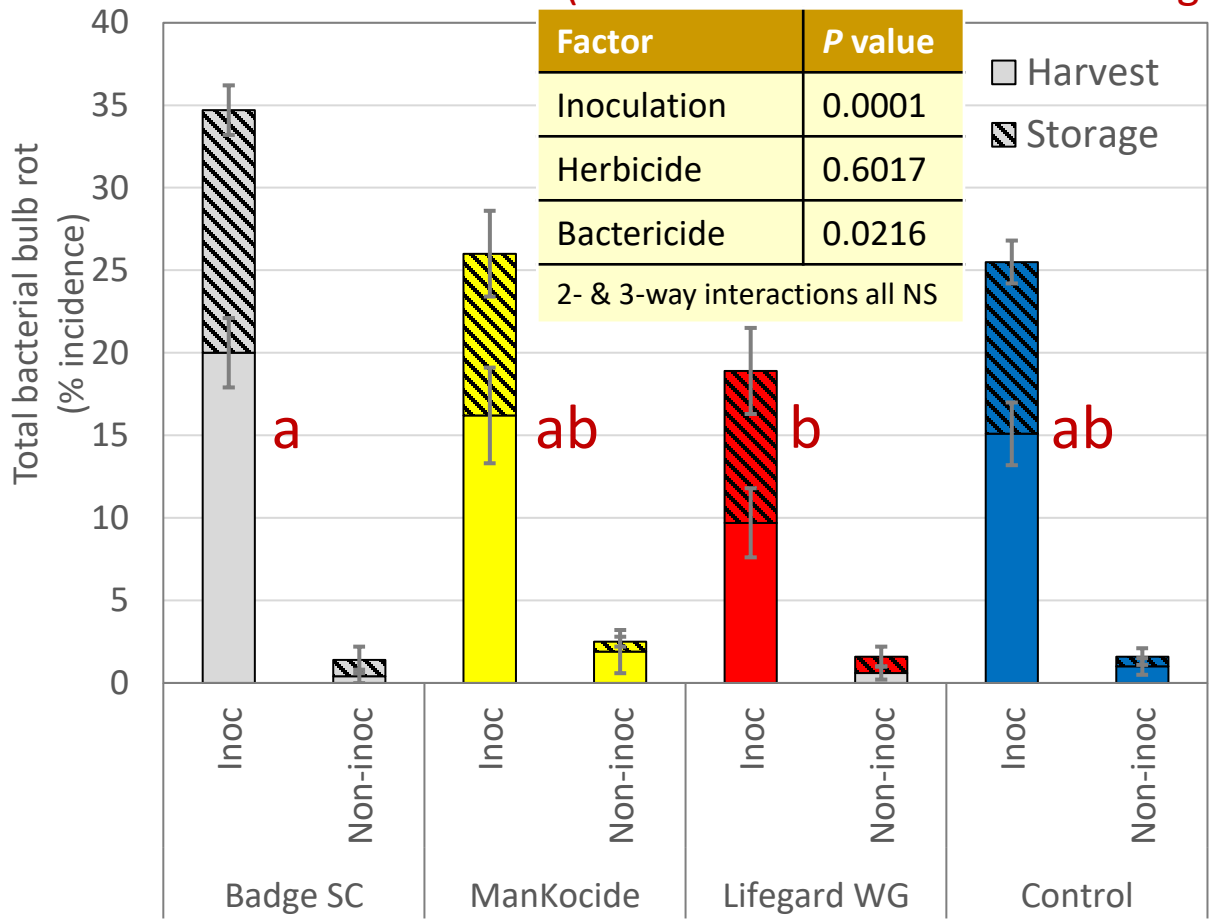
Objective B3, Season 2 (2021): Washington State Bactericide Trial

Marketable bulb yield at harvest (tons/acre)



Factor	*P* value
Inoculation	0.0001
Herbicide	0.1436
Bactericide	0.4197
2- & 3-way interactions all NS	

Total bacterial bulb rot (% of bulbs at harvest + in storage)



Factor	*P* value
Inoculation	0.0001
Herbicide	0.6017
Bactericide	0.0216
2- & 3-way interactions all NS	

du Toit et al. 2022. Plant Disease Management Reports 16:V150.

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**

2021 Bactericide trial for management of onion center rot in Georgia

Treatment and rate of product/acre	Active ingredient(s)	Internal bulb rot (%)
Mankocide 2.5 lb	Mancozeb + CuOH	8.3 b
Kocide 3000 1.5 lb	CuOH	9.0 b
Champ 1.5 lb	CuOH	10.3 b
Oxidate 5.0 1.28 fl oz/gal	H_2O_2 + peroxyacetic acid	9.5 b
Forticept 1.28 fl oz/gal	Thyme oil	13.4 b
Agrititan 800 ppm	TiO_2/Zn	10.7 b
LifeGard 2 fl oz	*Bacillus mycoides* strain J	7.0 b
Nordox 1 lb	Cu_2O	4.7 b
Mastercop 1 pt	$CuSO_4$	14.3 b
Howler 5 lb	*Pseudomonas chlororaphis* strain AFS009	8.6 b
Theia 3 lb	*Bacillus subtilis* strain AFS032321	18.6 ab
NUCop 1.5 lb	Cupric Hydroxide	5.5 b
Non-treated check		**37.3 a**

- 6 applications at 10- to 14-day interval; first application at first leaf senescence (first week of March 2021)
- Spring 2021 in Vidalia, GA was cool and drier than 2020, bacterial foliar symptoms did not appear until a week before harvest
- Foliar symptom appearance coincided with senescence of leaves
- Bulbs were harvested and stored 1 month at 4°C
- Sub-samples of symptomatic bulbs were confirmed to be infected with *P. ananatis*
- **2020 trial results:** More bulb rot (75% incidence in check plots); ManKocide was the most effective, then other copper products, AgriTitan, & Lifegard

Stop the Rot

Objective B4: Effects of cultural practices

Washington:

- Effects of rolling onion tops or not (2020 & 2021)
- Effects of undercutting bulbs or not (2020 & 2021)
- Effects of timing of topping onion bulbs (2020 & 2021 trials)
    - Inoculated with *B. gladioli* & *P. agglomerans*
    - 2021: Earlier initiation of treatments, 2 undercutting times & check, 2 topping times & check

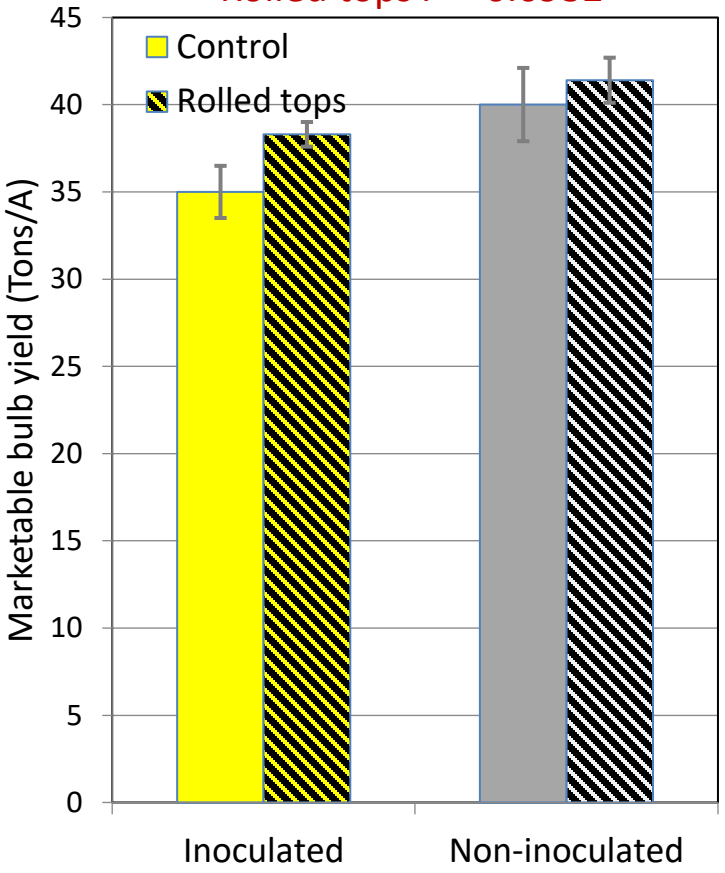
Georgia:

- Manual vs. mechanical harvest (2020 & 2021 trials)
- Two different mechanical harvesters (2020 & 2021 trials)
- Length of necks with manual topping (2021 trial)
    - Natural infection

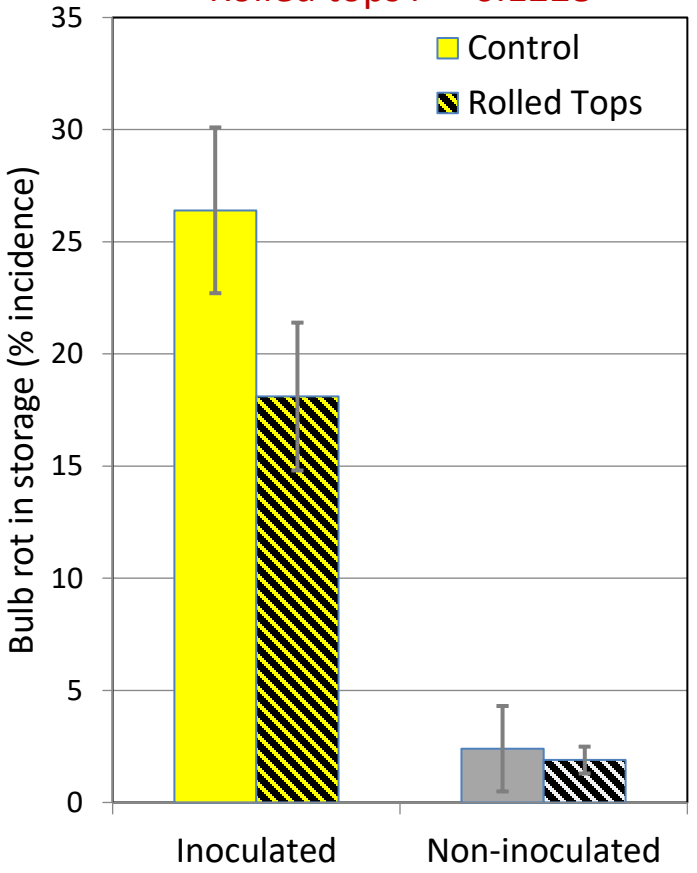
Stop the Rot

Objective B4: 2020 WSU trial evaluating rolling of onion tops

Inoculation *P* = 0.0155
Rolled tops *P* = 0.0932



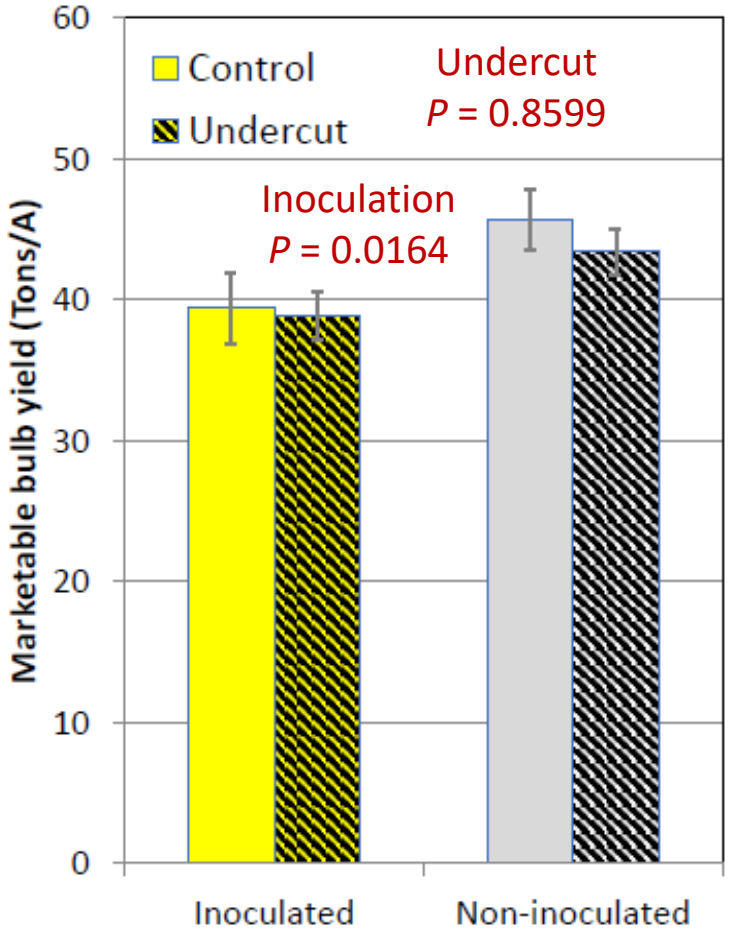
Inoculation *P* = 0.0001
Rolled tops *P* = 0.1228

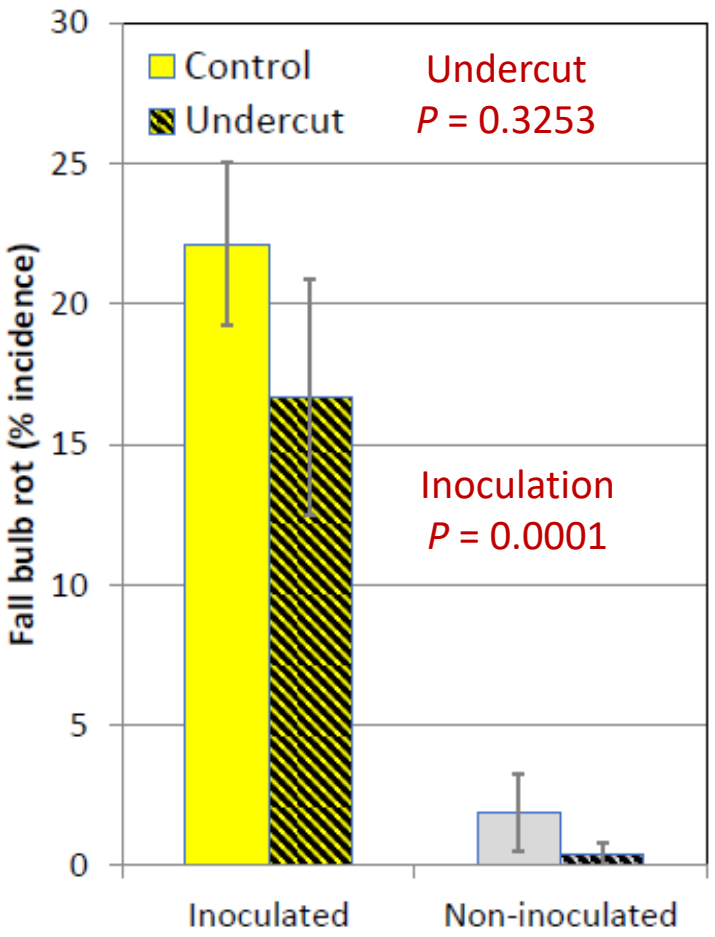


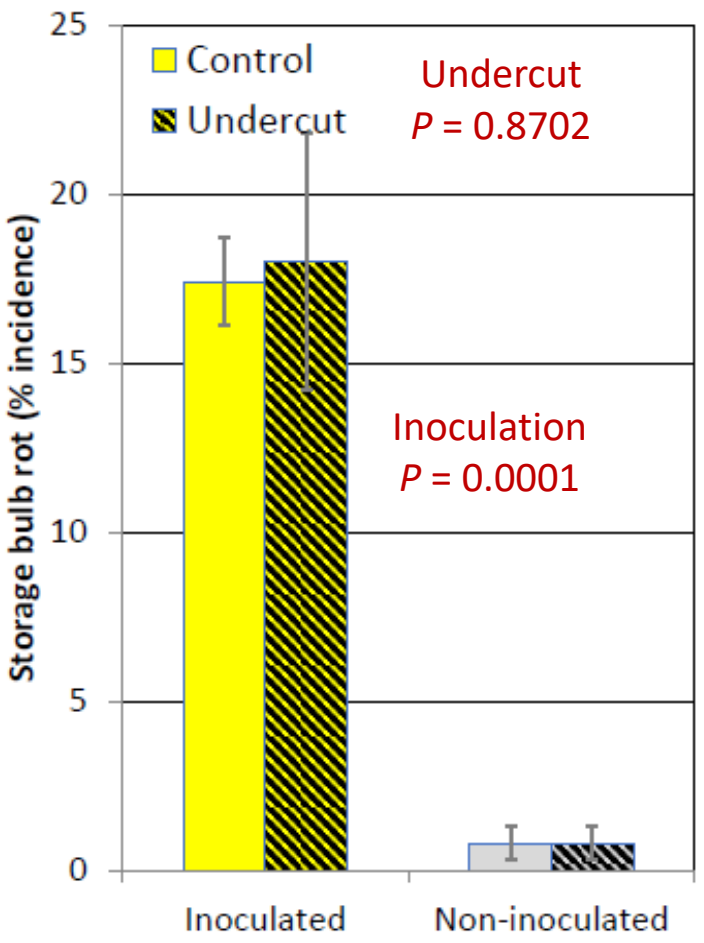
du Toit, Derie, Gundersen, Waters, and Darner. 2021. Plant Disease Management Reports 15:V100.

Stop the Rot

Objective B4: 2020 WSU trial evaluating undercutting of bulbs





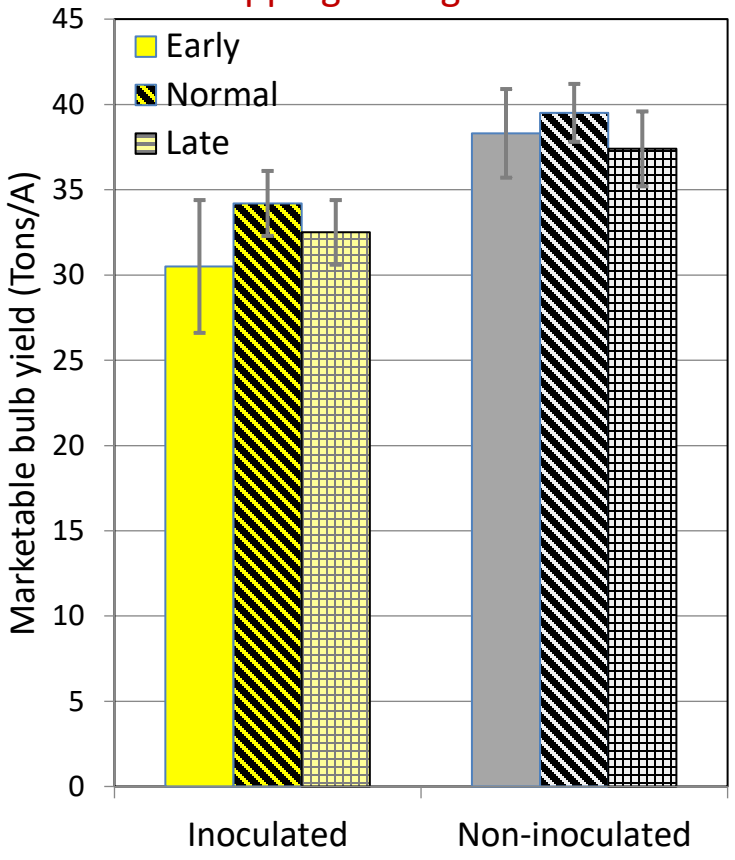


du Toit, Derie, Gundersen, Waters, and Darner. 2021. Plant Disease Management Reports 15:V100.

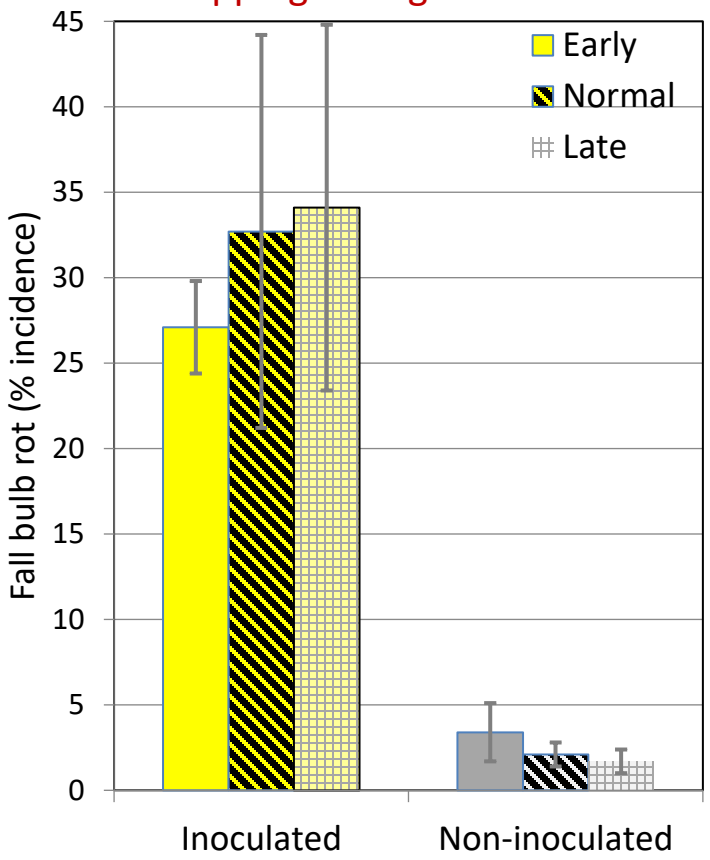
Stop the Rot

Objective B4: 2020 WSU trial evaluating the timing of topping bulbs

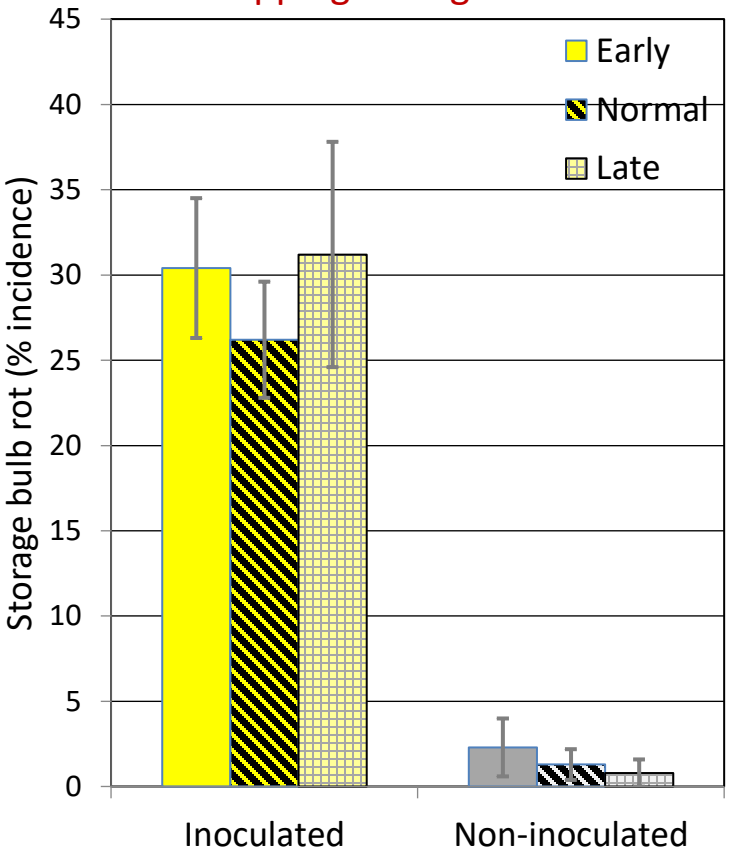
Inoculation *P* = 0.0035
Topping timing *P* = 0.4339



Inoculation *P* = 0.0001
Topping timing *P* = 0.7458



Inoculation *P* = 0.0001
Topping timing *P* = 0.3513



du Toit, Derie, Gundersen, Waters, and Darner. 2021. Plant Disease Management Reports 15:V100.

Stop the Rot: Washington State Season 2 Field Trials

Objective B4: 2021 WA cultural practice trials

1. **Rolling the tops of onion bulbs**
2. **Timing of undercutting onion bulbs**
3. **Timing of topping onion bulbs**
   - Pasco, WA
   - Each trial was a split plot RCBD, 5 replications

     Main plots: Inoculated (*B. gladioli* & *P. agglomerans*) or not

     Split plots:
     1. Tops rolled (30 Jul.) or not rolled
     2. Early (11 Aug.), normal (25 Aug.), or not undercut
     3. Early (11 Aug.), normal (25 Aug.), or late (8 Sep) topping
   - Inoculation at early tops down & 2 weeks later
   - Trials under center pivot irrigation
   - Extremely hot, dry season (117°F in late June!)

Stop the Rot

Objective B4, Season 2 (2021): Washington State 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 27-35%)
- Rolling tops trial:
  - Increased bacterial leaf blight in inoculated plots: 70.4% vs. 41.6% if tops not rolled
  - Bulb yield and bacterial bulb rot in storage not affected
- Undercutting trial:
  - No effect of early, normal, or no undercutting on BLB, bulb yield, or bacterial bulb rot
- Timing of topping trial:
  - 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 marketable bulb yield at harvest

3 trials repeated in 2022 season, with bulbs to be evaluated in Feb. 2023.

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

Stop the Rot

Objective B4: 2020 & 2021 UGA trials on onion bulb 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

Method of onion 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.

Stop the Rot

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

Objective B4: 2021 UGA trial evaluating the length of topping bulbs

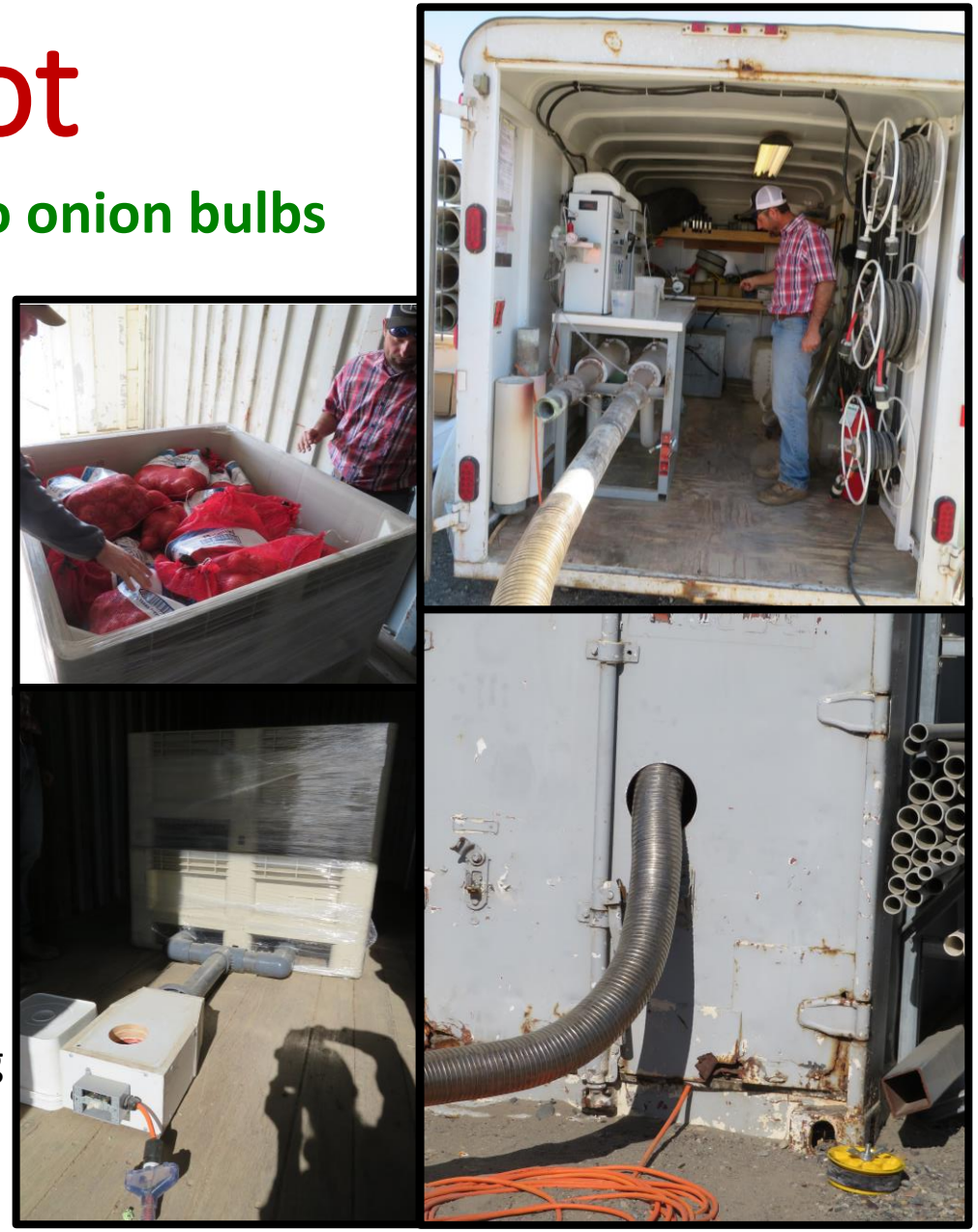
Length of neck after topping manually	Internal bacterial bulb rot incidence (%)
5-inches	4.5 y
3-inches	4.0 y
1-inch	19.0 z

Stop the Rot

Objective B5: Postharvest applications of disinfectants to onion bulbs

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



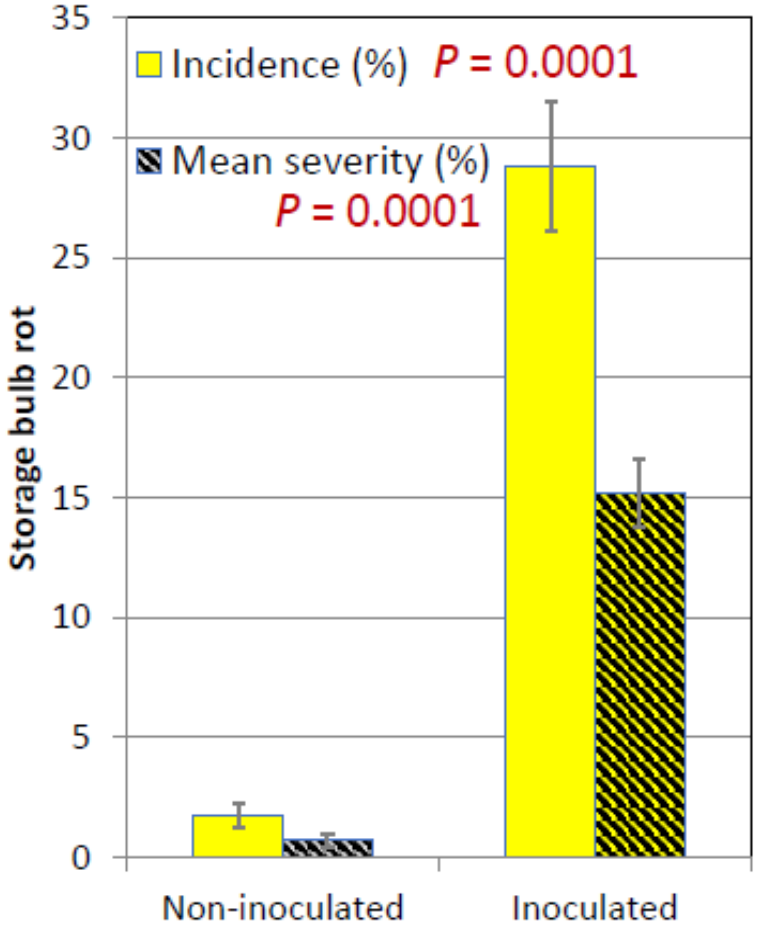
2021-22 and 2022-23 WA trials

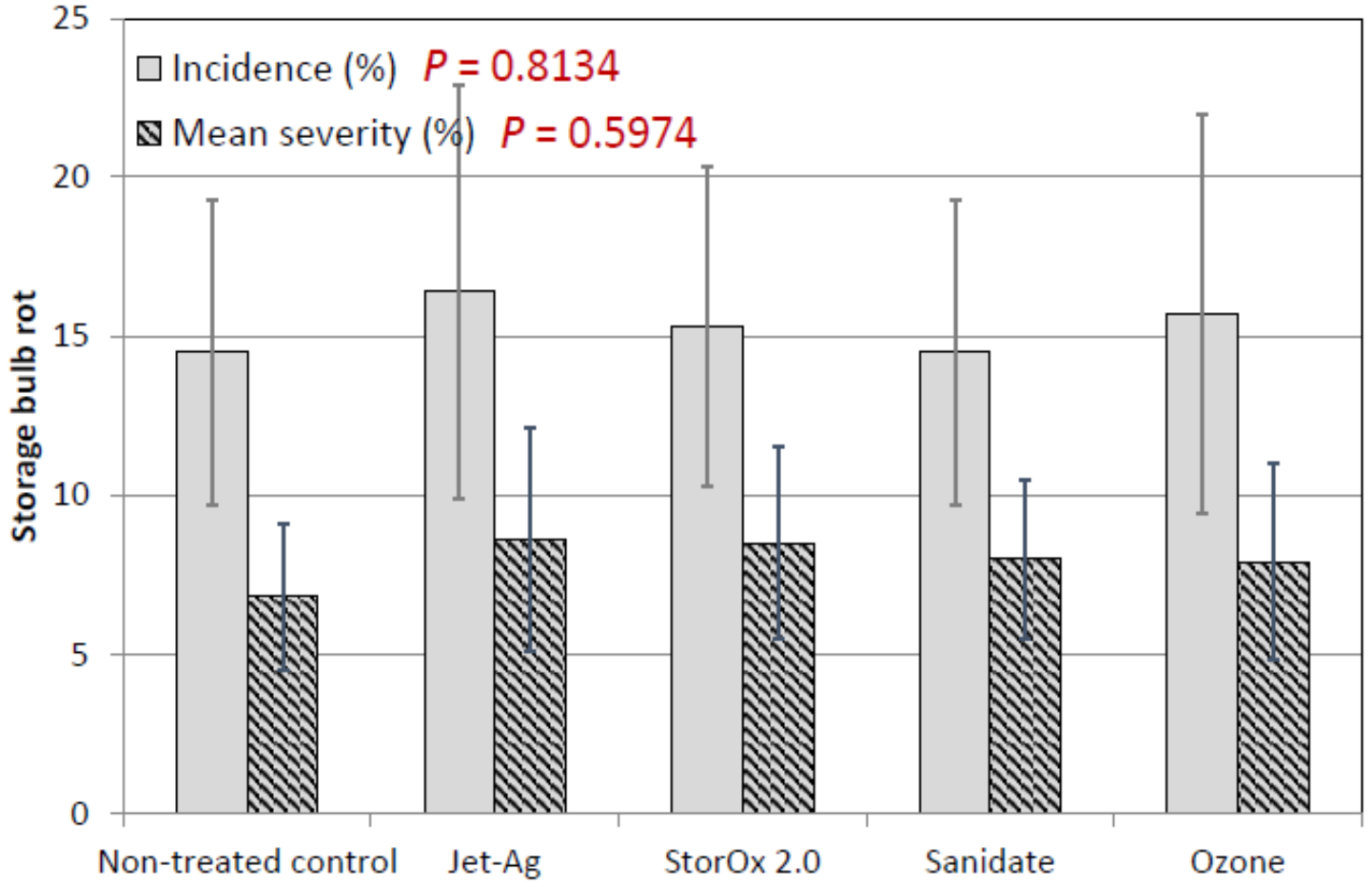
- Repeat treatments
- **Commercial storage evaluations:** Growers remove sample of bulbs during treatment, replace non-treated bulbs, evaluate for storage rots

2021-22 CO trial - Mark Uchanski, CSU

Stop the Rot

Objective B5: 2020 WA trial evaluating postharvest applications of disinfectants



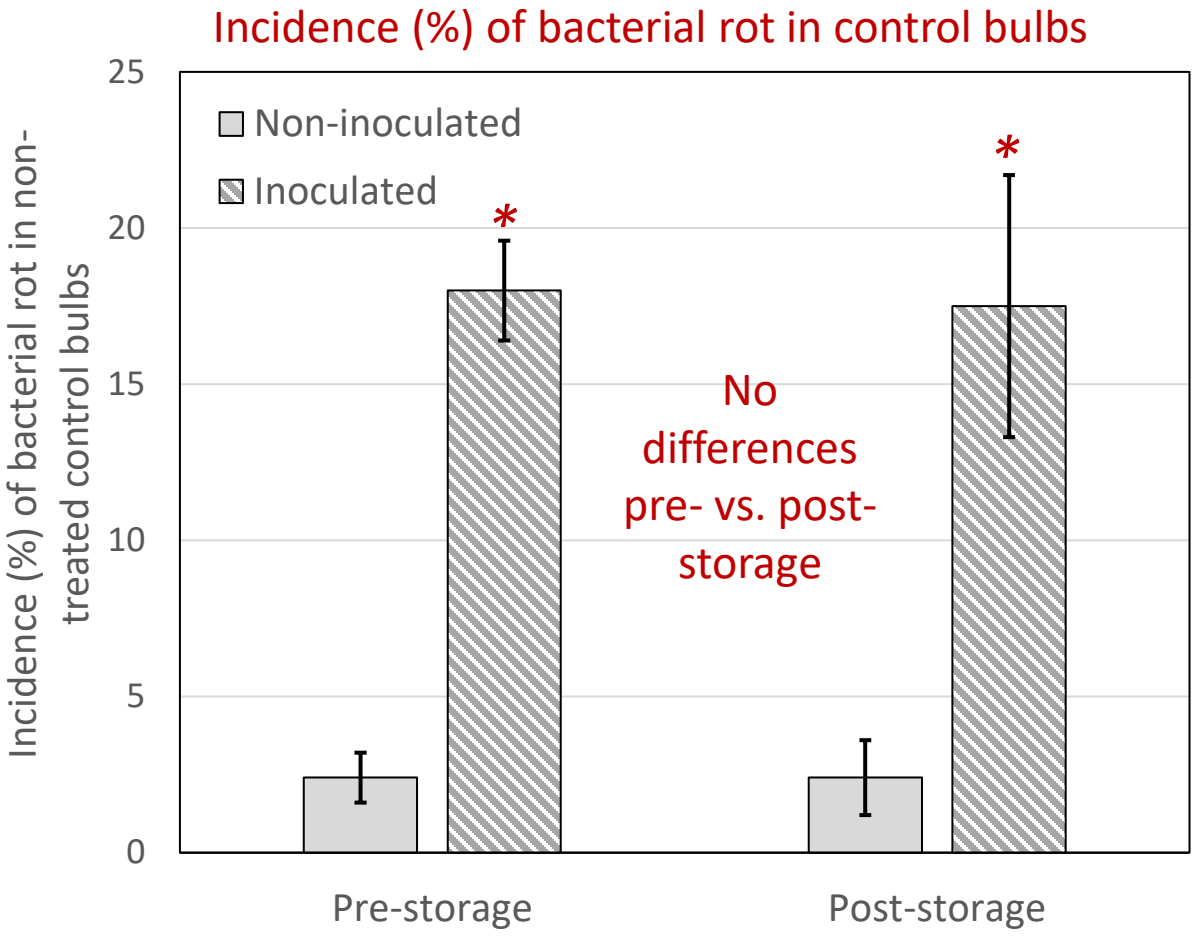


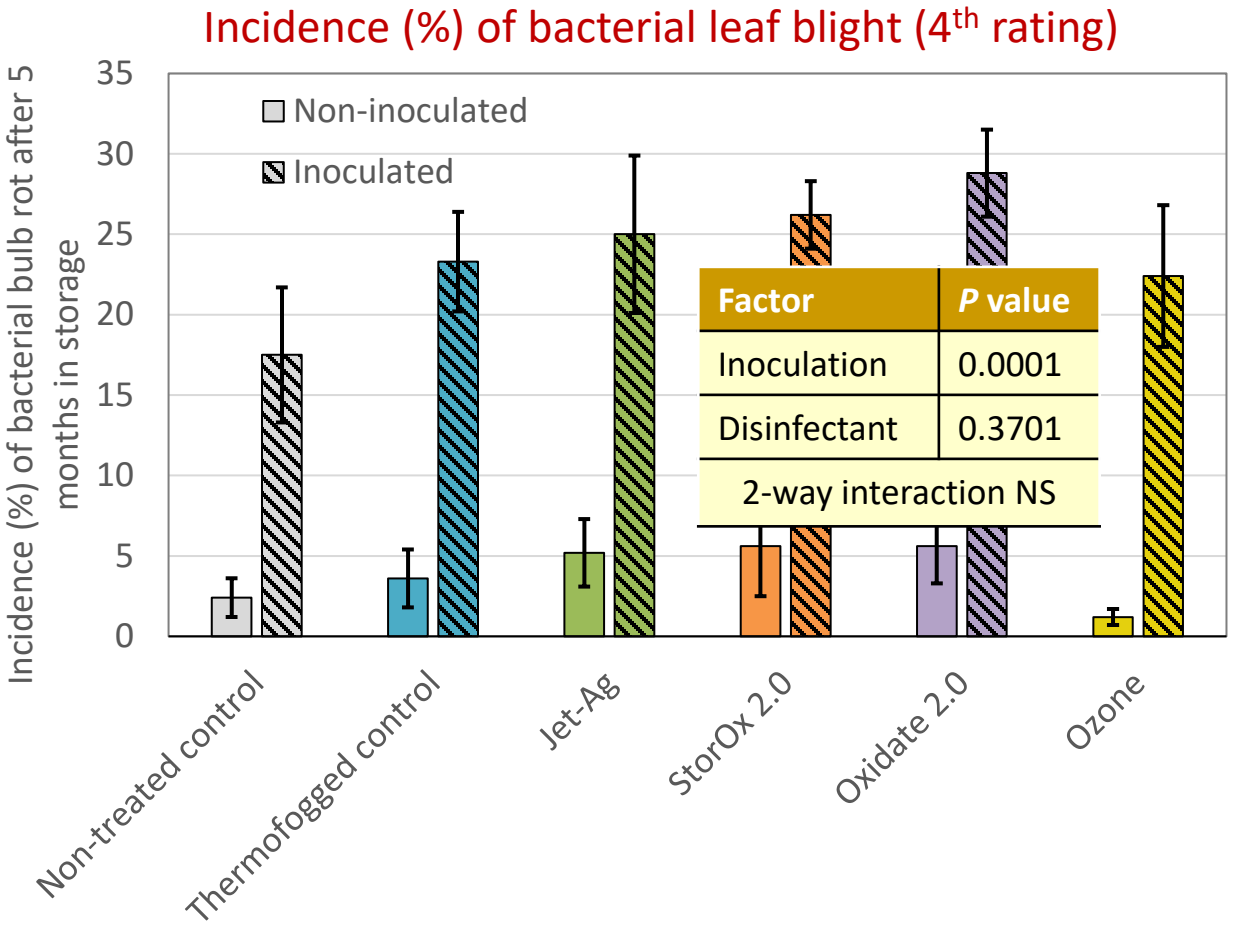
du Toit et al. 2021. Plant Disease Management Reports 15:V102.

du Toit and Waters. 2021. To disinfect or not? Onion World, July/August 2021:6-9.

Stop the Rot

Objective B5, Season 2 (2021): WA Postharvest Disinfectant Trial

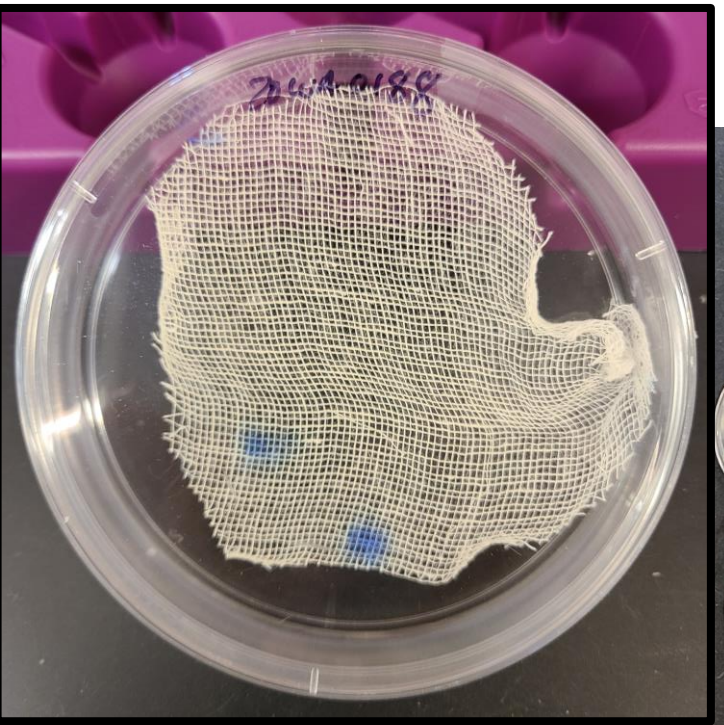




du Toit et al. 2022. Plant Disease Management Reports 16:V148.

Objective B5: 2021 WA trial evaluating postharvest applications of disinfectants

Potential efficacy of treatments to surface of bulbs?



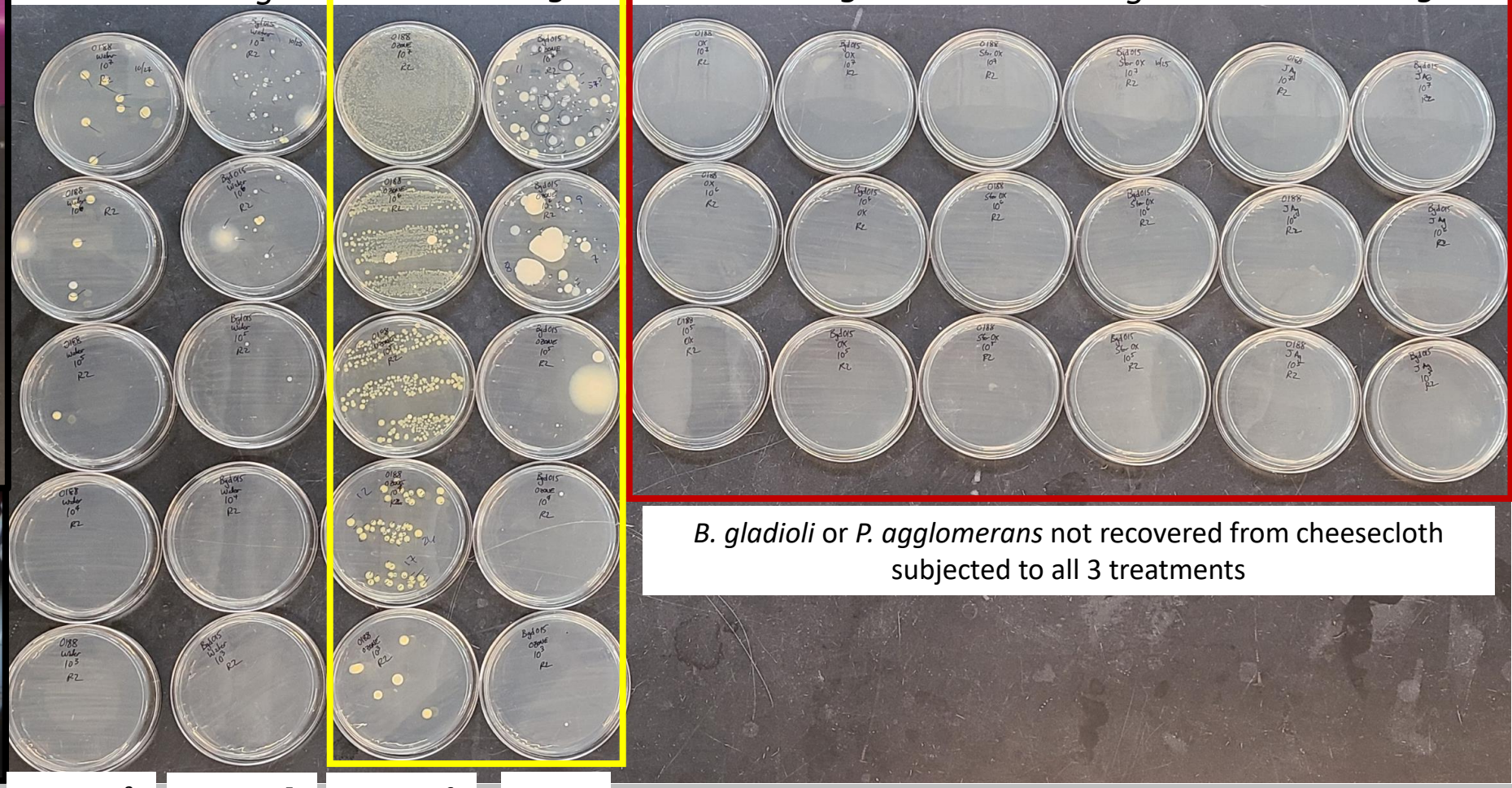
Water thermofog — *Pa* *Bg*

Ozone — *Pa* *Bg*

Oxidate 2.0 — *Pa* *Bg*

Storox 2.0 — *Pa* *Bg*

Jet-Ag — *Pa* *Bg*



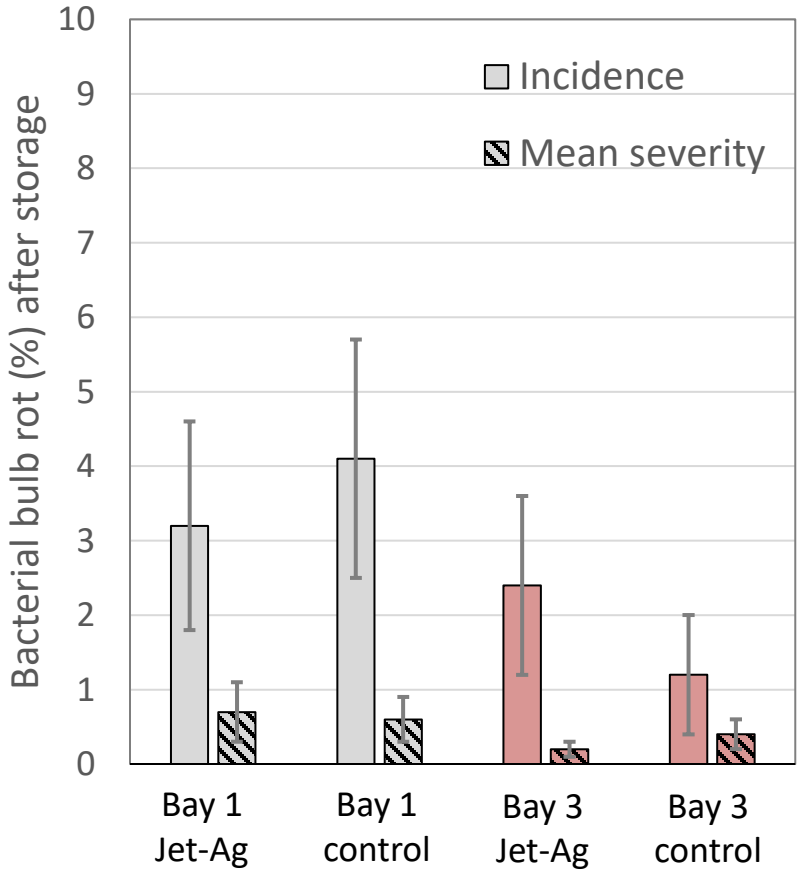
B. gladioli or *P. agglomerans* not recovered from cheesecloth subjected to all 3 treatments

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

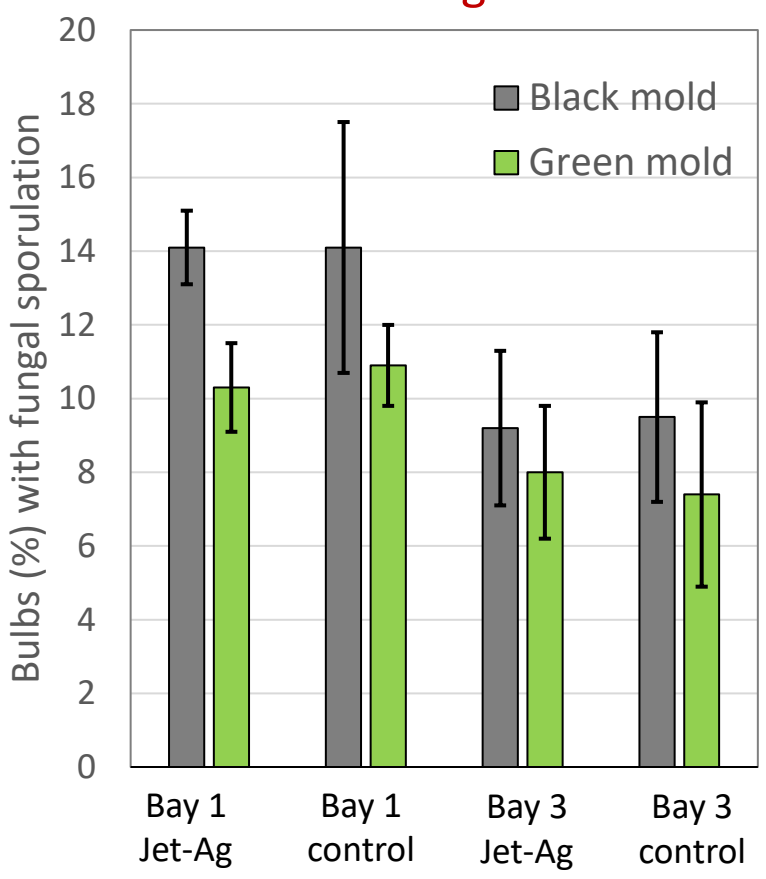
Stop the Rot

Objective B5, Season 2 (2021): WA Grower-Cooperator Disinfectant Trial

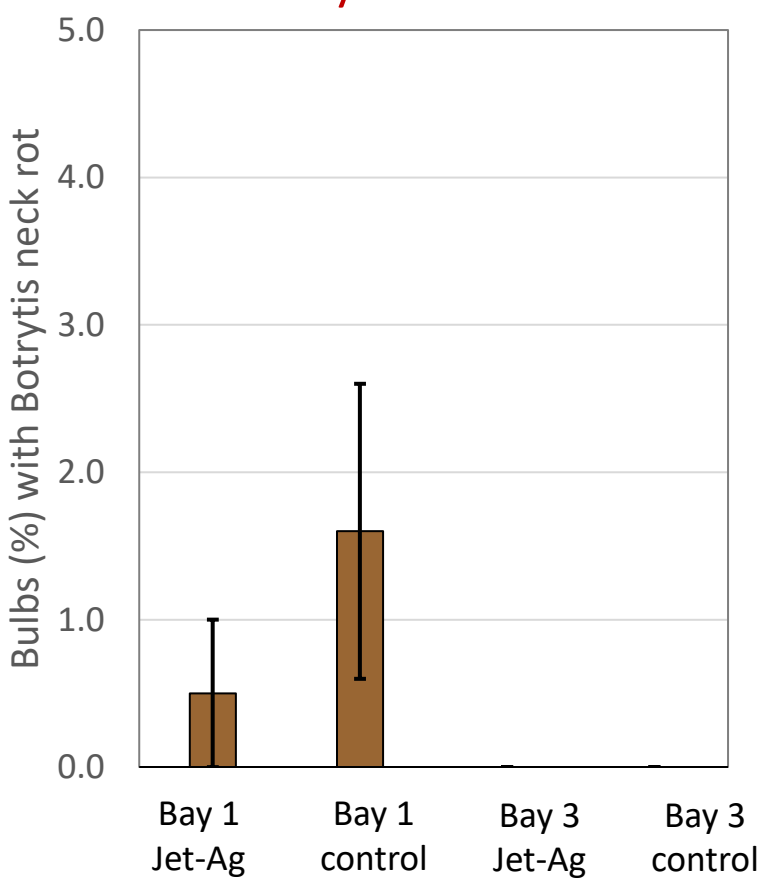
Bacterial bulb rot



Black mold & green mold



Botrytis neck rot



No effects of postharvest application of disinfectants on bacterial or fungal bulb rots (as in 2020-21)

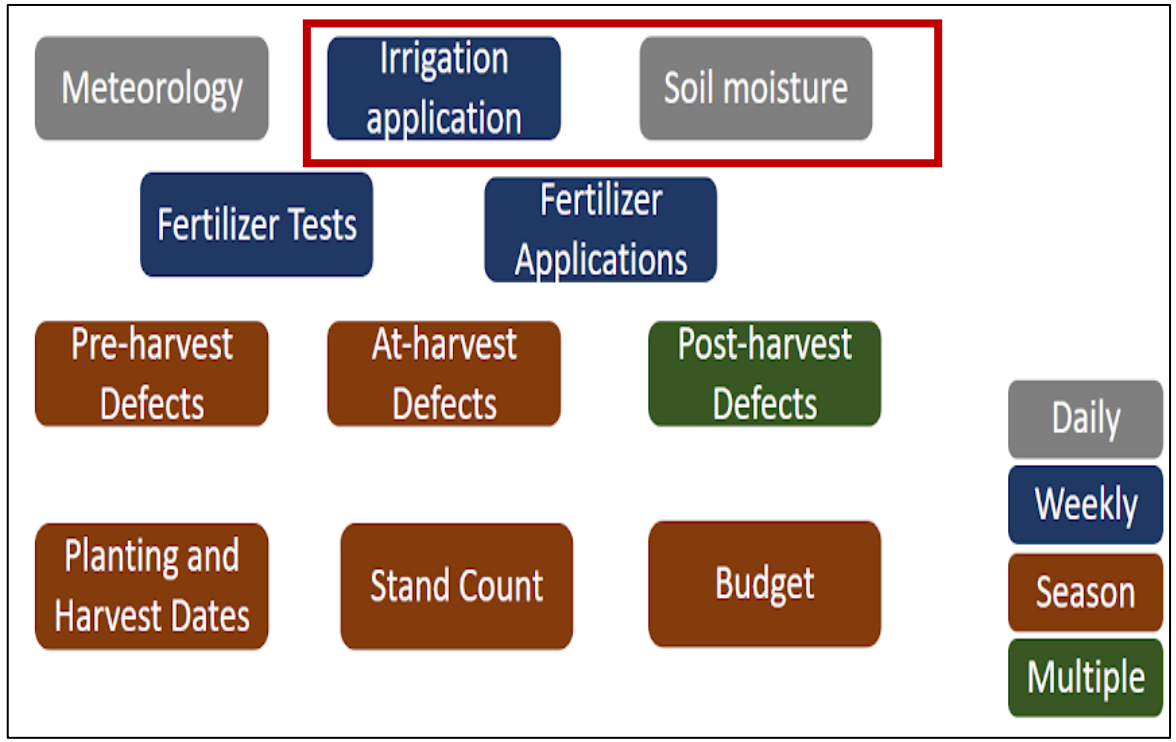
Stop the Rot

Objective B6: Bacterial disease modeling and risk prediction

(Noorazar, Rajagopalan, Kalyanaraman, LaHue, Waters, du Toit, MacKay)

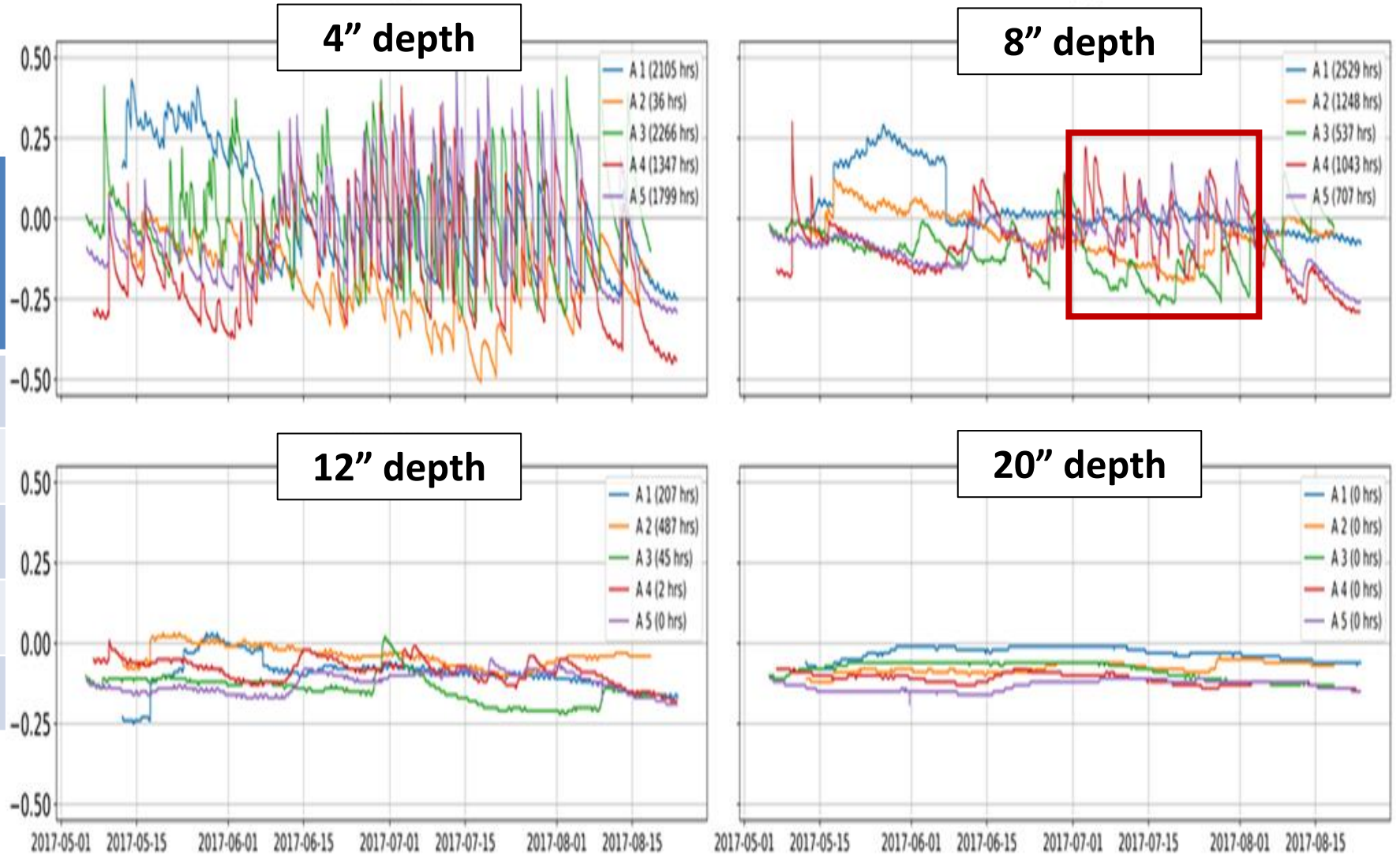
Five onion bulb crops grown in 2017 in Columbia Basin with same cultivar

Field	Internal bulb rot (%)	External bulb rot (%)
A1	7.3	4.7
A2	3.1	1.9
A3	4.8	2.9
A4	25.5	12.4
A5	15.1	8.2



Soil moisture status at different depths

Field	Internal bulb rot (%)	External bulb rot (%)
A1	7.3	4.7
A2	3.1	1.9
A3	4.8	2.9
A4	25.5	12.4
A5	15.1	8.2



Stop the Rot

Objective B6: Bacterial disease modeling and risk prediction

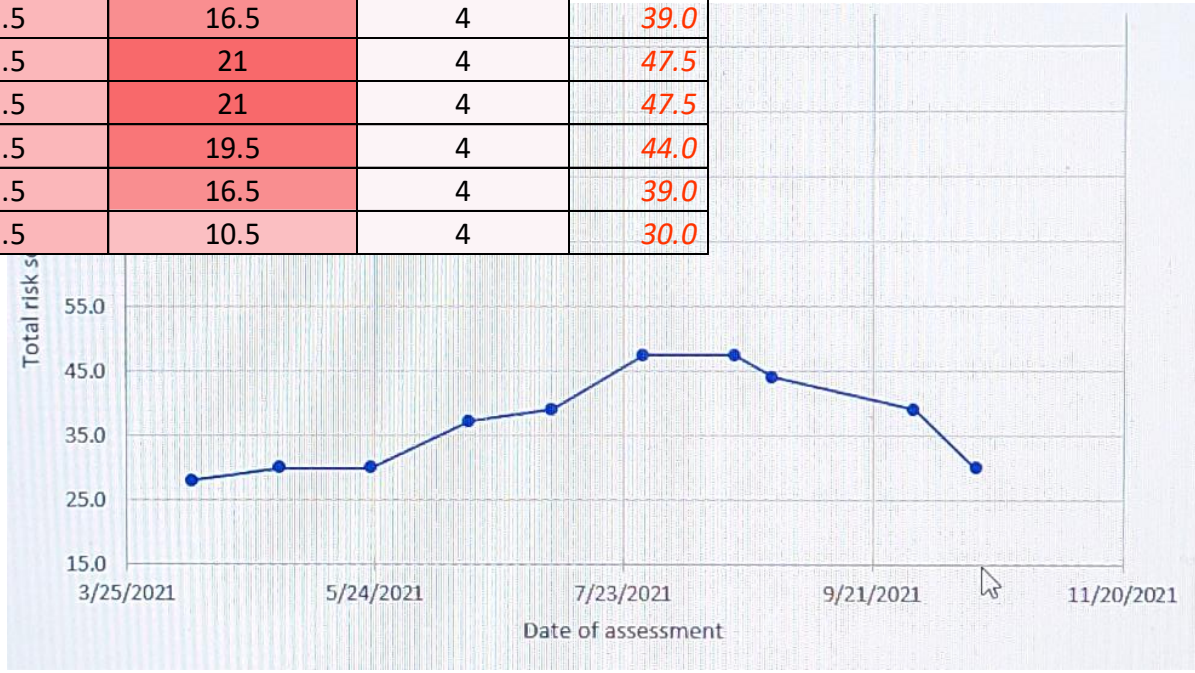
Four categories of variables for calculating risk:

1. Current/cumulative risk variables
    a. Last week's risk score
    b. Crop growth stage today
    c. Bacterial disease symptoms observed?
2. Field variables
    a. Soil type
    b. Irrigation type
    c. Rotation (years out of onion)
    d. Cultivar
    e. Planting density
3. Environmental variables
    a. Air temperature
    b. Wind speed
    c. Humidity
    d. Precipitation amount
    e. Precipitation timing
    f. Hail damage
    g. Crop soil moisture status
    h. Etc.
4. Production variables
    a. Cumulative nitrogen
    b. Timing of nitrogen application
    c. Bactericide program
    d. Weed pressure

Stop the Rot

Objective B6: Bacterial disease modeling and risk prediction

Plot output (looks up values in V4.0 sheet):				Breakdown of risk scores by category (looks up values in V4.0 sheet):				
Week	Crop growth stage	Assessment date	Total risk score	Current/cumul risk	Field variables	Environmental variables	Production variables	*check calc*
1	(1) Seedling -1 leaf	4/10/2021	28.0	3	12	9	4	*28.0*
2	(2) 1-4 leaves	5/1/2021	30.0	4	11.5	10.5	4	*30.0*
3	(3) 4-8 leaves	5/23/2021	30.0	4	11.5	10.5	4	*30.0*
4	(4) Bulbing, 8-14 leaves	6/16/2021	37.3	6	11.5	15.75	4	*37.3*
5	(4) Bulbing, 8-14 leaves	7/6/2021	39.0	7	11.5	16.5	4	*39.0*
6	(5) 'Soft necks' stage: leaf g	7/28/2021	47.5	11	11.5	21	4	*47.5*
7	(6) 5-50% tops down	8/19/2021	47.5	11	11.5	21	4	*47.5*
8	(7) 50-100% tops down	8/28/2021	44.0	9	11.5	19.5	4	*44.0*
9	(8) At harvest, prior to stora	10/1/2021	39.0	7	11.5	16.5	4	*39.0*
10	(9) In storage, post-harvest	10/16/2021	30.0	4	11.5	10.5	4	*30.0*



Looking for growers/agronomists willing to test this risk model in 2023 field season (Columbia Basin or Treasure Valley)

Acknowledgements

- USDA NIFA SCRI
- 'Stop the Rot' team, including technical staff, students, postdoctorates
- Stakeholder Advisory Panel
- Onion growers/packers

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

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WSU technical support:

Jennifer Darner, Maddie Spets, Alfredo Torres, Isidro Garcia, Ashley Spralding, Carol Hernandez, Jeff Lambert, Erika Ramirez Garcia, Eduardo Sallas, Andrea Vallejo Gutierrez, Don Kinion

Mike Derie, Babette Gundersen, Tomasita Villarroel, Alex Batson, Kayla Spawton, Ryan Solemslie, Sanjaya Gyawali

Tessa Belo, Betsy Schacht, Navdeep Singh, and others in Gabe LaHue's soils program

June 8, 2021

July 22, 2021

July 29, 2021

August 12, 2021

February 8, 2022