2024 Pacific Northwest Vegetable Association
Annual Convention & Trade Show
Kennewick, WA
12-14 November 2024

# *Stop the Rot*

## Overview of the National Onion Bacterial Project


Nature's Ninja graphic courtesy of
U.S. National Onion Association

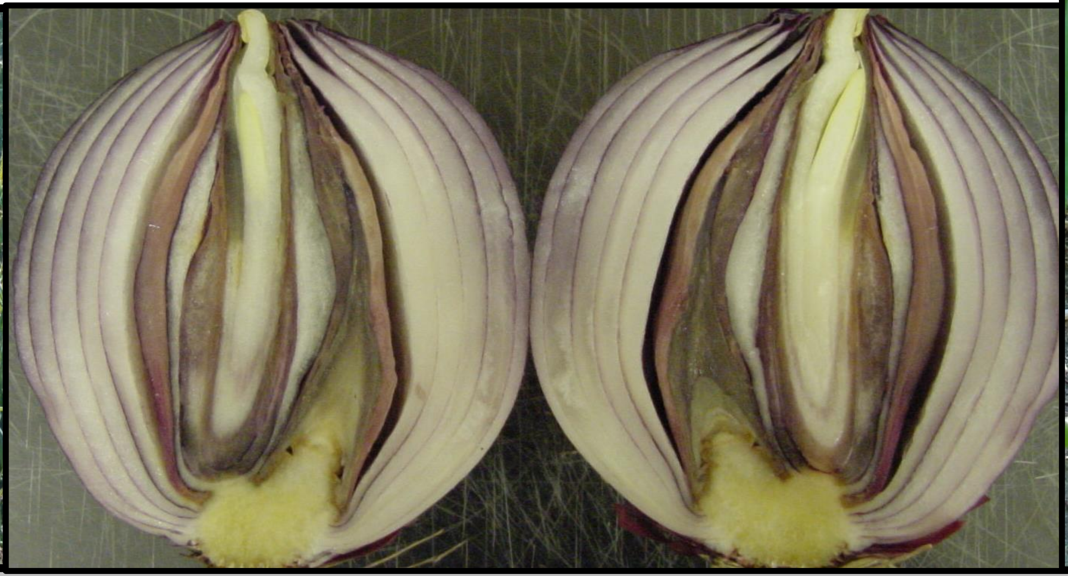
https://alliumnet.com/projects/stop-the-rot/

USDA NIFA SCRI Project No. 2019-51181-30013

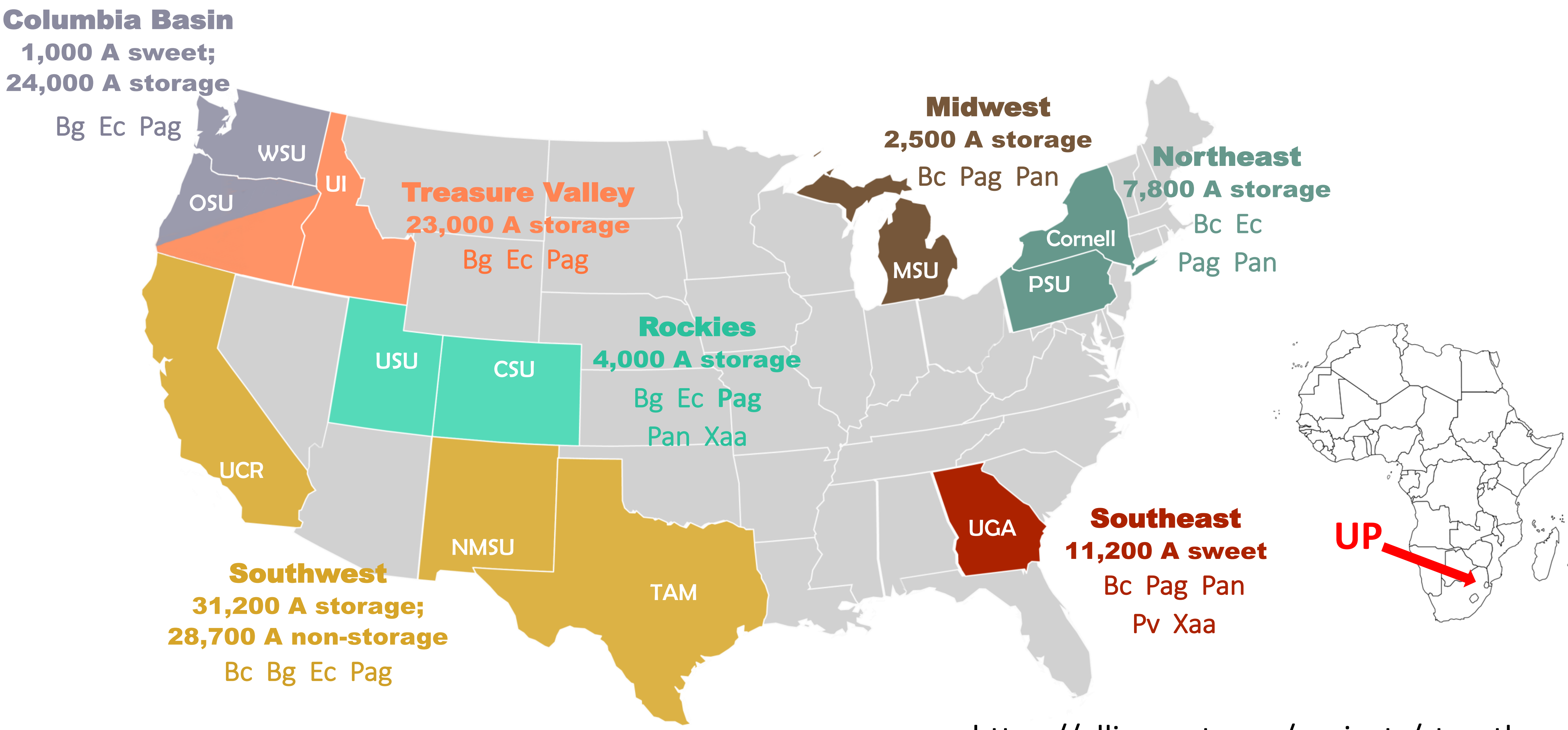
USDA United States Department of Agriculture | National Institute of Food and Agriculture

# Onion bacterial diseases

- Bacterial pathogens of onion are ubiquitous
- Difficult to manage:
  - Lack 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

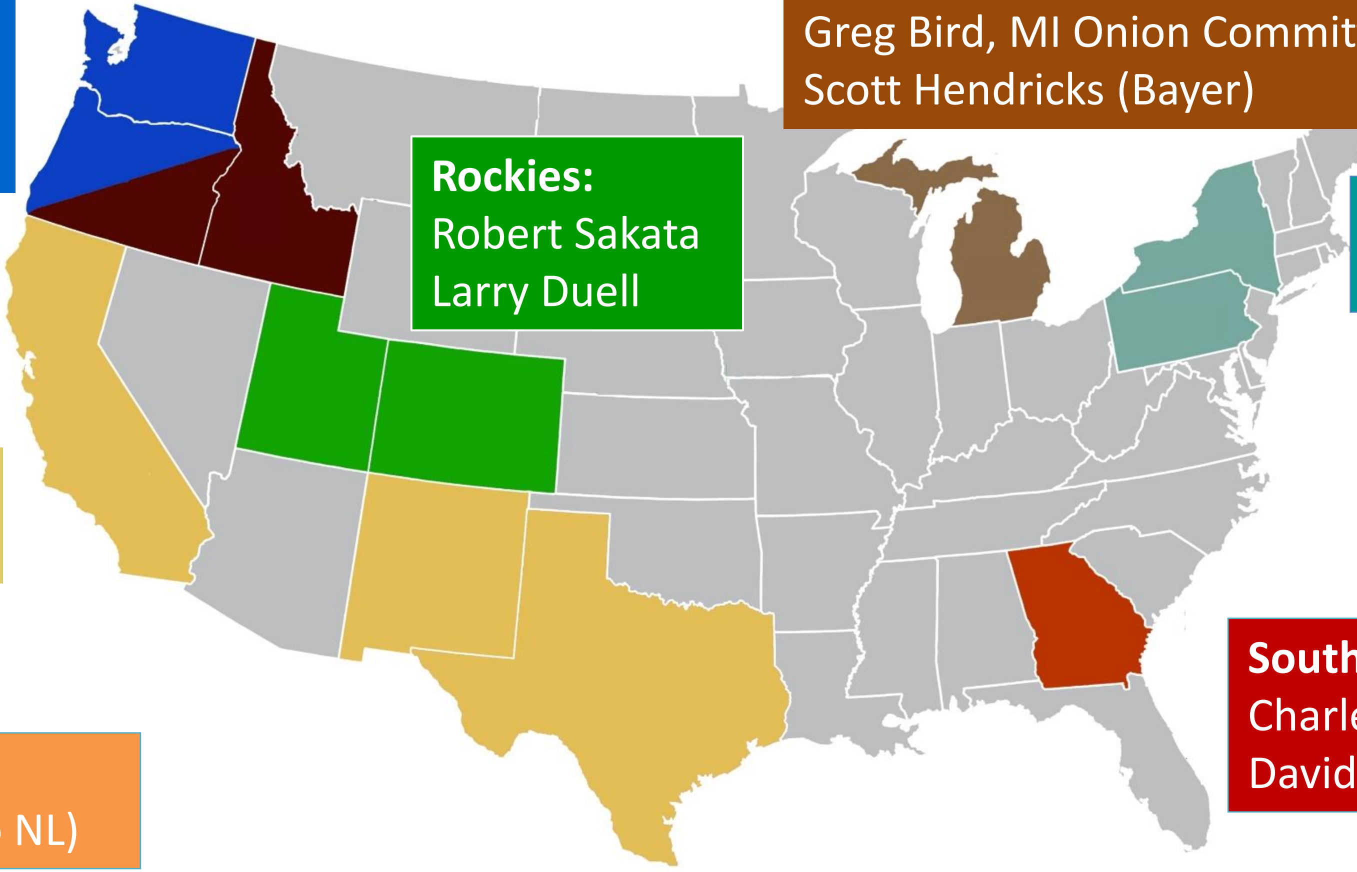


# Stop the Rot: Combating onion bacterial diseases with pathogenomic tools & enhanced management strategies: 2019-2025




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

# Stop the Rot – Stakeholder Advisory Panel



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

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

**Rockies:**
Robert Sakata
Larry Duell

**Northeast:**
Joe DiSalvo

**Southwest:**
Bob Ehn, CGORAB

**Southeast:**
Charles Hall, GFVGA
David Burrell

**International:**
Margreet Asma (Bejo NL)

# Stop the Rot

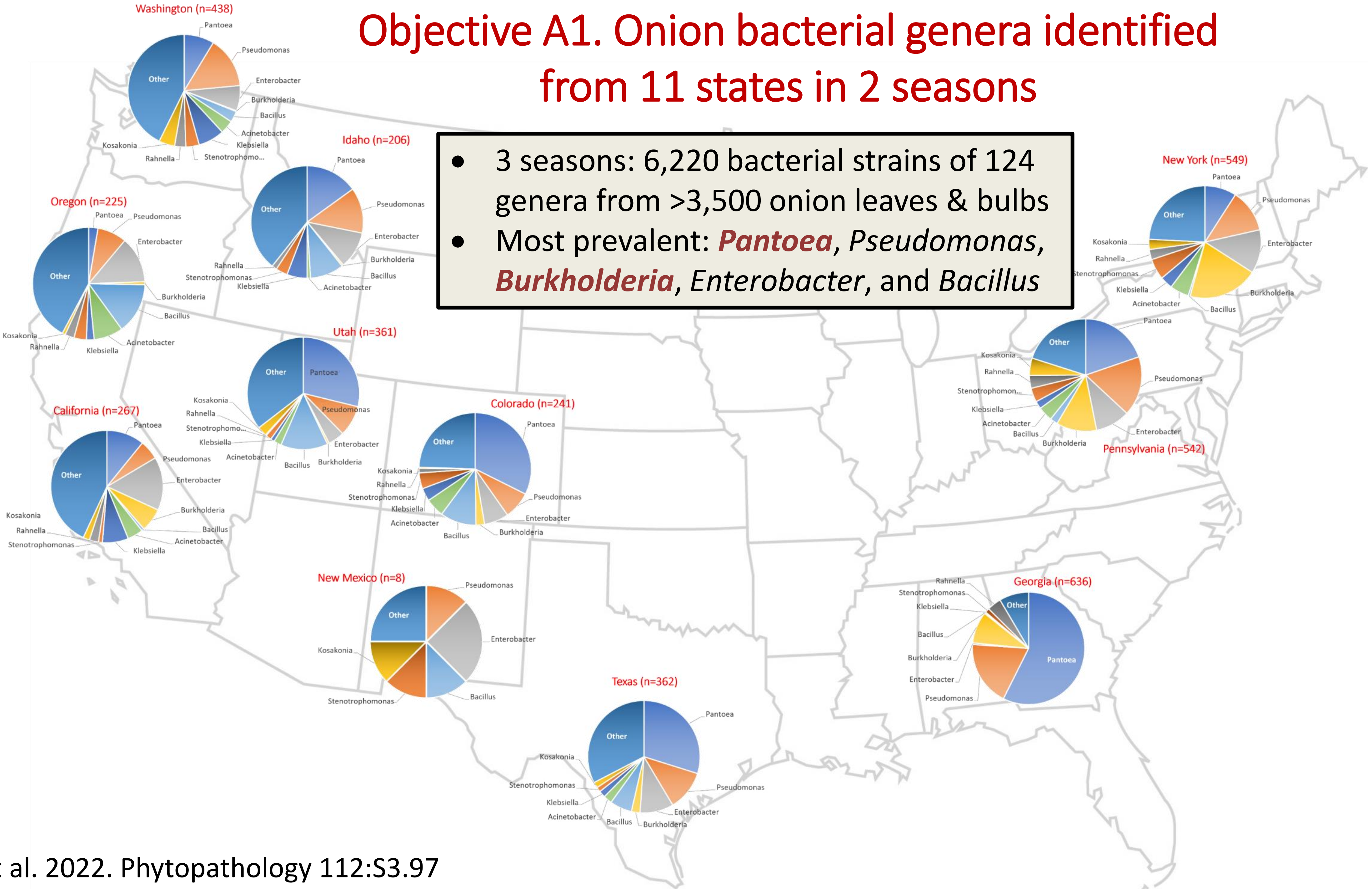
https://alliumnet.com/projects/stop-the-rot/

- 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 (application of disinfectants to bulbs)
  - B6 – Bacterial disease modeling/risk prediction
  - B7 – Extension/outreach
  - B8 – Economic assessments

MacKay, H., du Toit, L., and Hoepting, C. 2023. Onion World July/August 2023:6-7.
https://issuu.com/columbiamediagroup/docs/ow_july-august_2023?fr=sYmUxNzQ5MDQ1MjQ

# Objective A1. Onion bacterial genera identified from 11 states in 2 seasons

- 3 seasons: 6,220 bacterial strains of 124 genera from >3,500 onion leaves & bulbs
- Most prevalent: ***Pantoea***, *Pseudomonas*, ***Burkholderia***, *Enterobacter*, and *Bacillus*



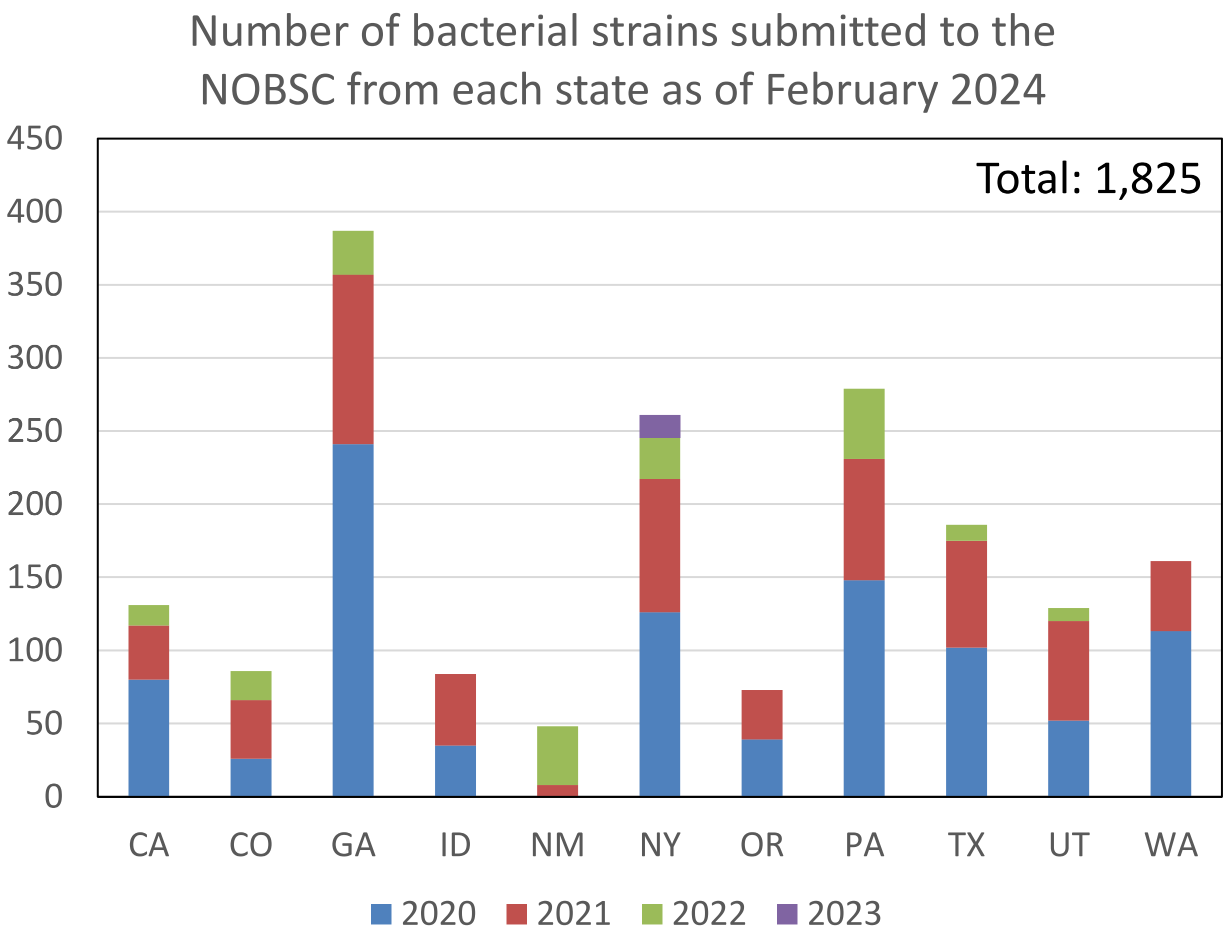

du Toit et al. 2022. Phytopathology 112:S3.97

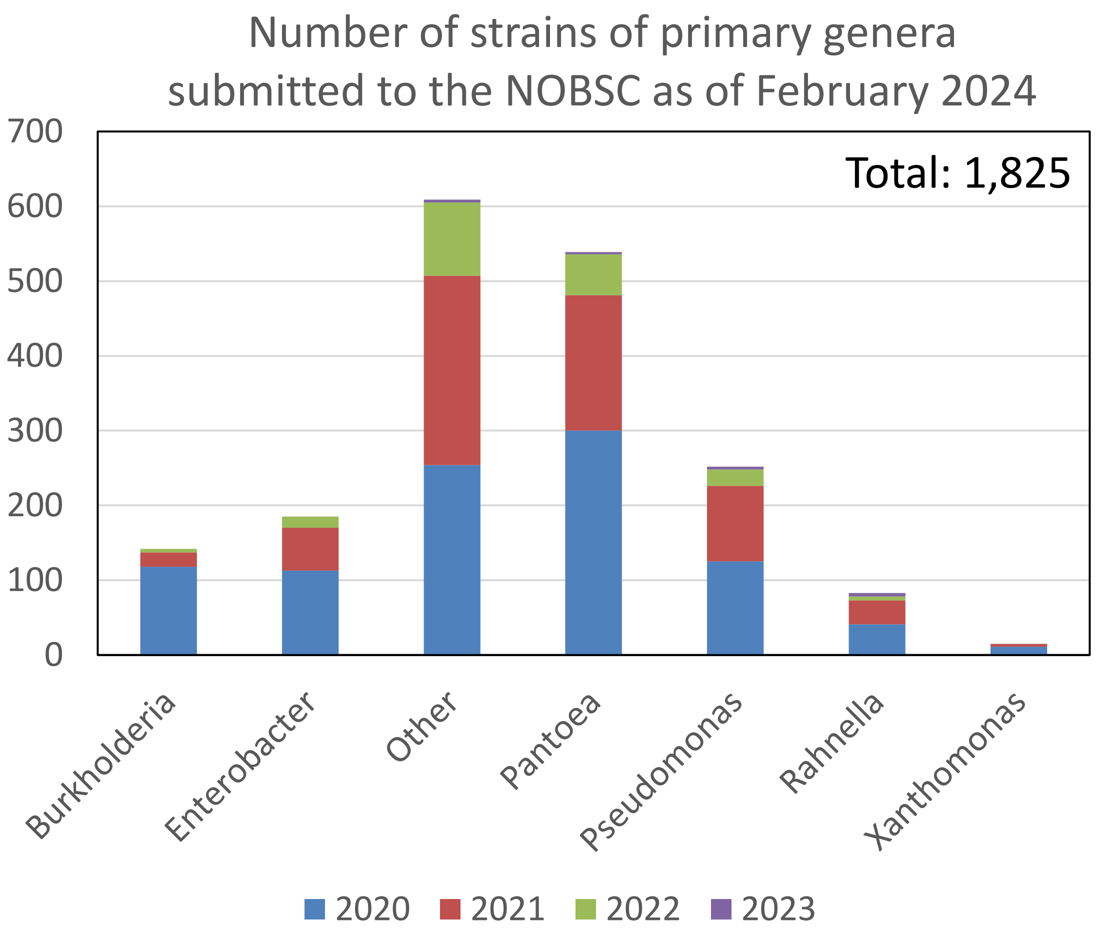
# Onion bacterial strains from surveys in 11 states in 2020, 2021, 2022 (March 2024 status)

| State | Three seasons (2020 + 2021 + 2022) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total # of isolates for 3 seasons | 16S rDNA sequence | | RSN assay | | Foliar assay | | Bulb assay | |
| | | # of isolates tested | # of isolates to be tested | # of isolates tested | # of isolates to be tested | # of isolates tested | # of isolates to be tested | # of isolates tested | # of isolates to be tested |
| CA | 288 | 284 | 0 | 287 | 0 | 226 | 3 | 154 | 106 |
| CO | 280 | 275 | 0 | 252 | 20? | 14 | 0 | 34 | ? |
| GA | 794 | 794 | 0 | 794 | 0 | 183 | 0 | 54 | 0 |
| ID | 742 | 742 | 0 | 239 | 0 | 40 | 25 | 108 | 0 |
| NM | 159 | 157 | 0 | 157 | 0 | 0 | 0 | 53 | ? |
| NY | 989 | 620 | 369 | 631 | 358 | 136 | 853 | 121 | 868 |
| OR | 713 | 713 | 0 | 211 | 0 | 34 | 0 | 92 | 0 |
| PA | 968 | 545 | 423 | 517 | 451 | 122 | 846 | 123 | 845 |
| UT | 388 | 385 | 0 | 368 | 0 | 18 | 0 | 65 | ? |
| TX | 409 | 409 | 0 | 409 | 0 | 180 | 0 | 4 | 176 |
| WA | 476 | 467 | 1 | 475 | 0 | 288 | 1 | 168 | 233 |
| OR Columbia Basin (2021) | 14 | 14 | 0 | 14 | 0 | 14 | 0 | 0 | 9 |
| Total | **6,220** | **5,405** | 793 | **4,354** | 829 | **1,255** | 1,728 | **976** | ? |

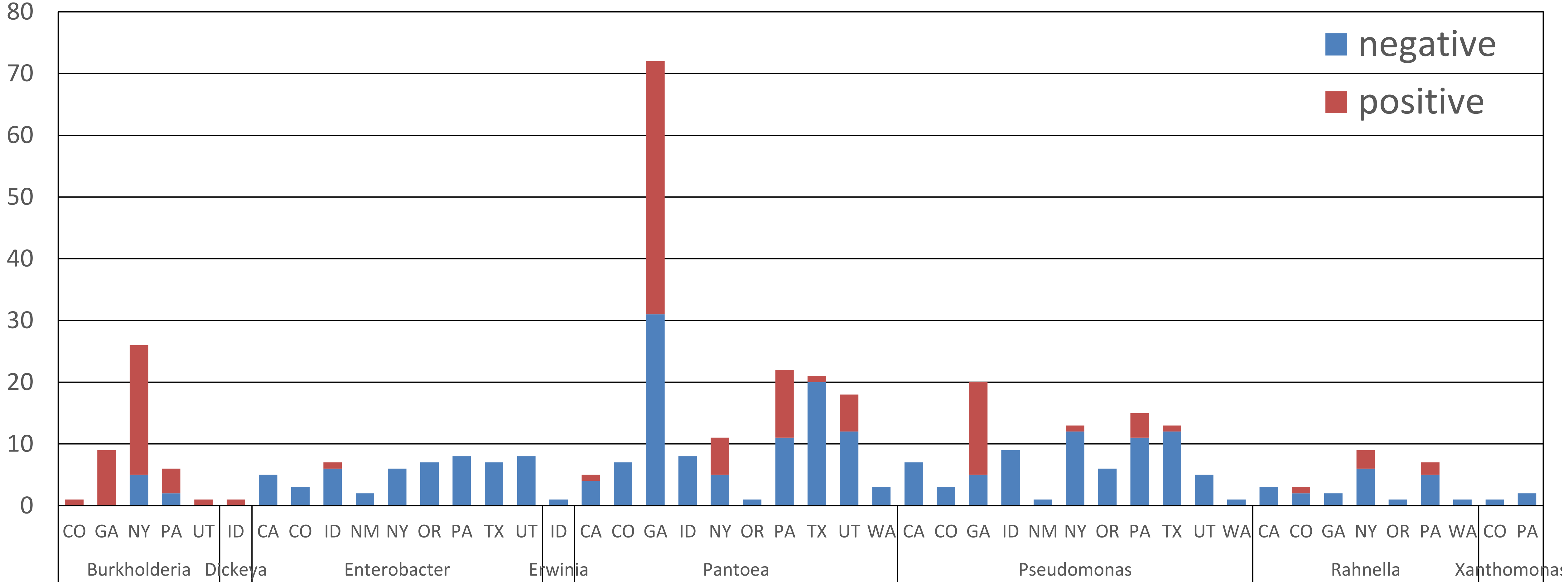
# Stop the Rot

## Status of National Onion Bacterial Strain Collection (NOBSC) at UGA (03/2024)



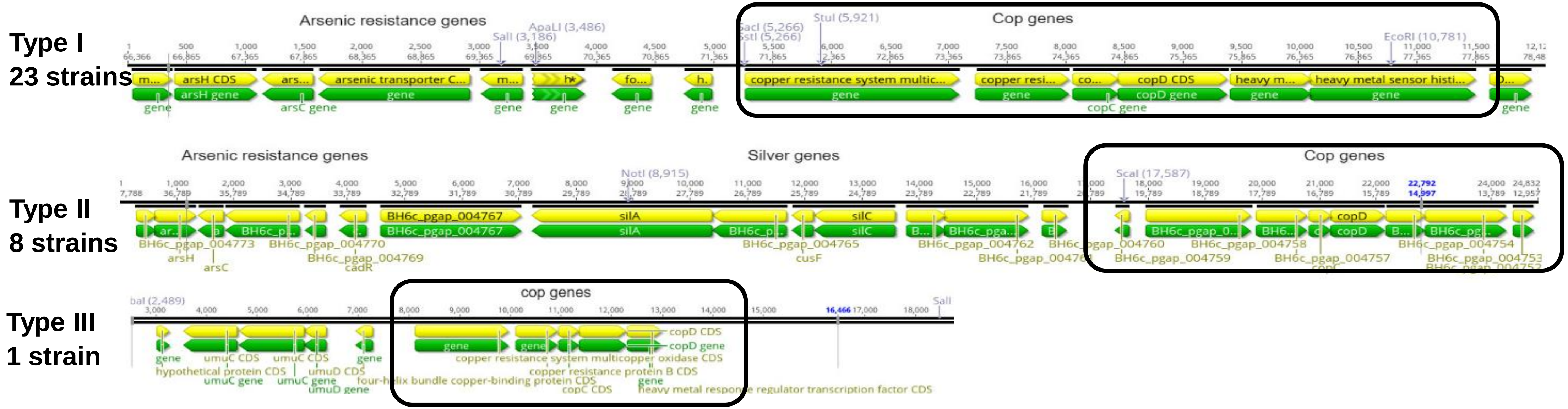



# Pathogenicity to onion of bacterial strains in the National Onion Bacterial Strain Collection (red scale necrosis assay)



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

- ~50% of *P. agglomerans* strains sequenced have **copper resistance (*cop*) genes** on accessory plasmids, similar to other bacterial plant pathogens
- *cop* genes and *alt* genes (tolerance to sulfur compounds) on same plasmids
- *cop*+ strains of *P. agglomerans* tolerant to >100 ppm copper sulfate on CYE agar medium
- *Burkholderia gladioli* strains from Columbia Basin are tolerant to >200 ppm copper sulfate



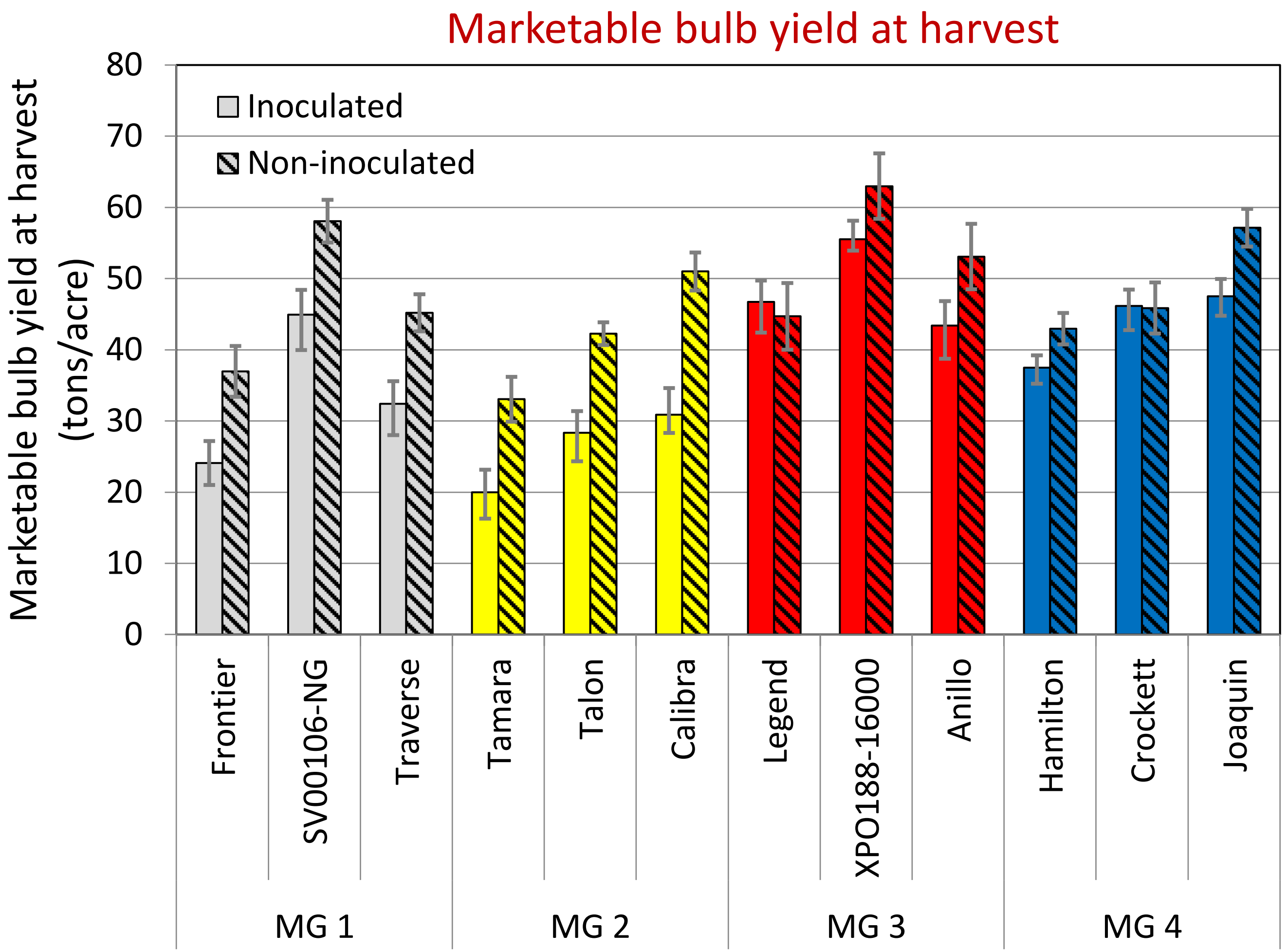
# A4: Develop methods to screen onion cultivars for resistance

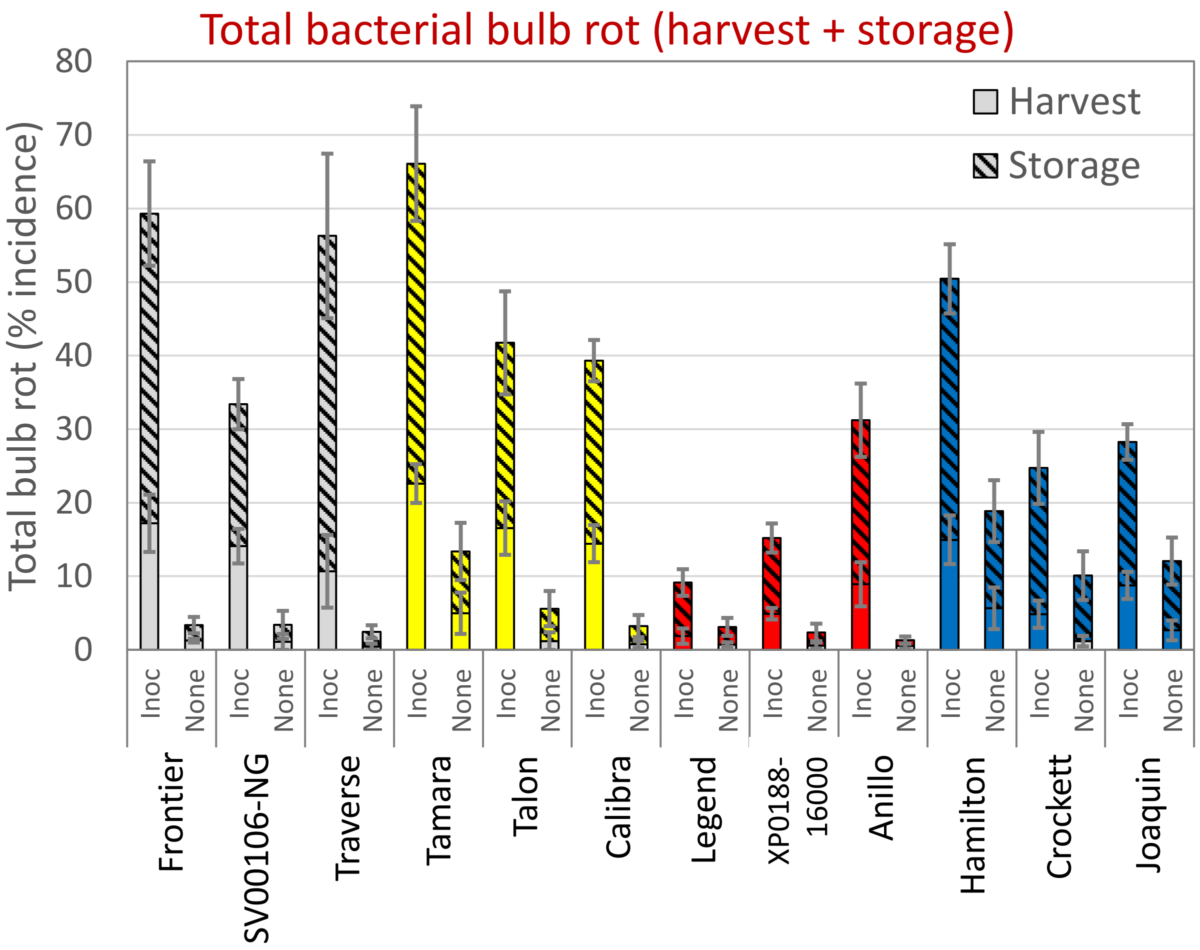
Lindsey du Toit (WSU), Bhabesh Dutta (UGA), Steve Beer & Christy Hoepting (Cornell), Brenna Aegerter & Jas Sidhu (UC), Claudia Nischwitz (USU)

## 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)

# A4: 2021-22 Washington Cultivar Trial



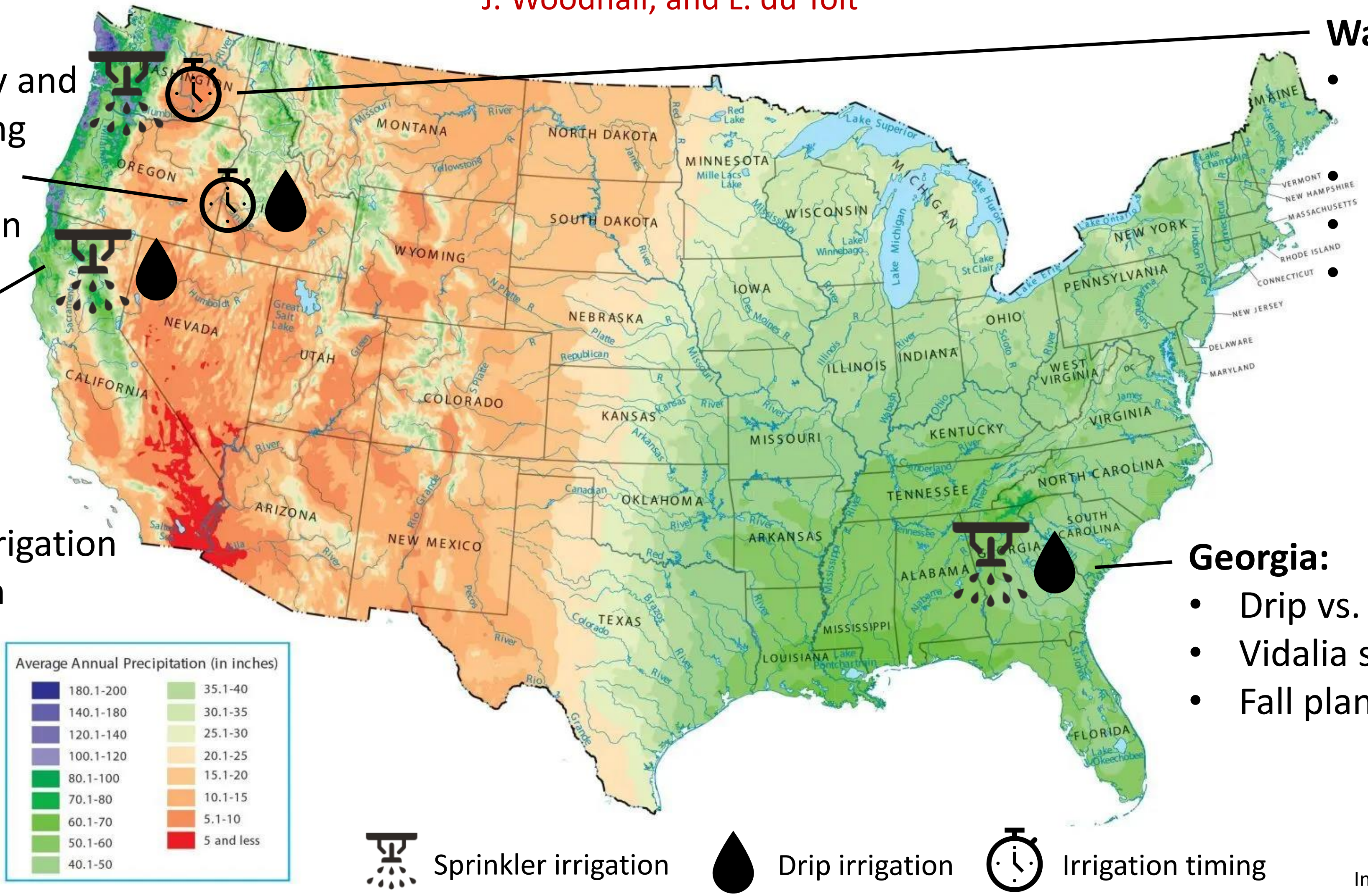

du Toit et al. 2022. Plant Disease Management Reports 16:V151.

# 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

Sprinkler irrigation Drip irrigation Irrigation timing

Image credits: GIS Geography, SUBPNG

# Objective B1. Irrigation methods

Drip irrigation reduced bacterial bulb rot in a dry climate (northern CA), but results were mixed in a humid, rainfed climate (GA)

**The influence of irrigation method on bacterial disease symptoms and onion yield across years and inoculation treatments for 2021 and 2022 field experiments in Tulelake, CA**

| Treatment | Foliar bacterial disease incidence (AUDPC)[y] | Foliar bacterial disease severity (AUDPC) | Total bulb yield (t/ha) | Average bulb weight (g) | Bulb rot incidence (%) | Onion plant population (#/m) |
|---|---|---|---|---|---|---|
| Solid-set sprinkler irrigation | 461 ± 39[z] | 197 ± 21.3 | 116 ± 3.0 | 269 ± 7.0 | 15.0 ± 2.7 | 43.3 ± 1.0 |
| Drip irrigation | 90 ± 10.8 | 16 ± 2.7 | 131 ± 1.2 | 295 ± 3.4 | 0.5 ± 0.2 | 44.7 ± 0.8 |
| *P* value | 0.0002 | 0.0002 | 0.005 | 0.029 | 0.003 | 0.322 |

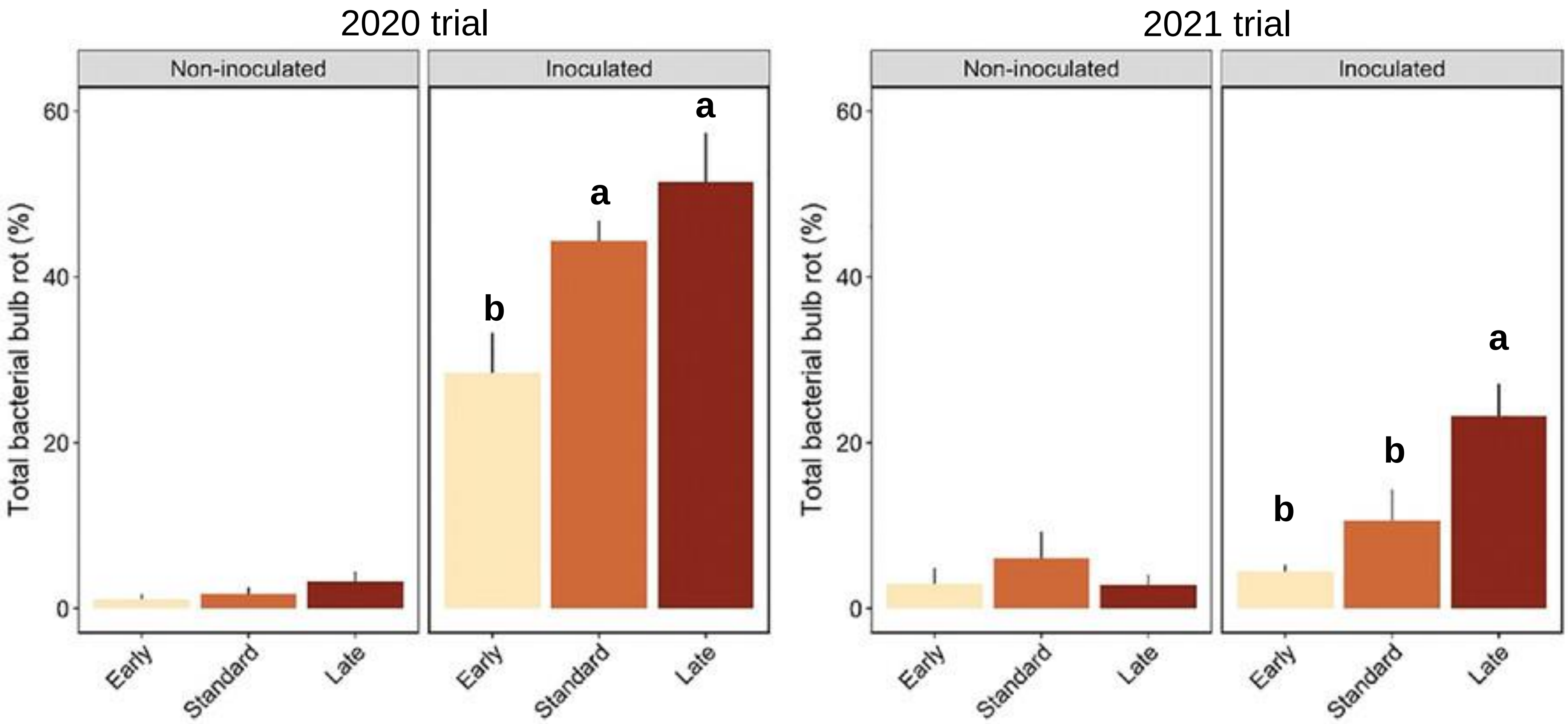
[y] Area under the disease progress curve (AUDPC) values for leaf blight incidence and severity were calculated based on weekly visual ratings from the first sign of disease in August to mid-September.

[z] Standard error of the means.

Wilson, Aegerter, and LaHue. 2024. Plant Health Progress 25:293-298.

# Objective B1. Late termination of sprinkler irrigation increased bacterial bulb rot. Irrigation frequency did not affect bacterial bulb rot.

Belo et al. 2023. Agricultural Water Management 288:108476

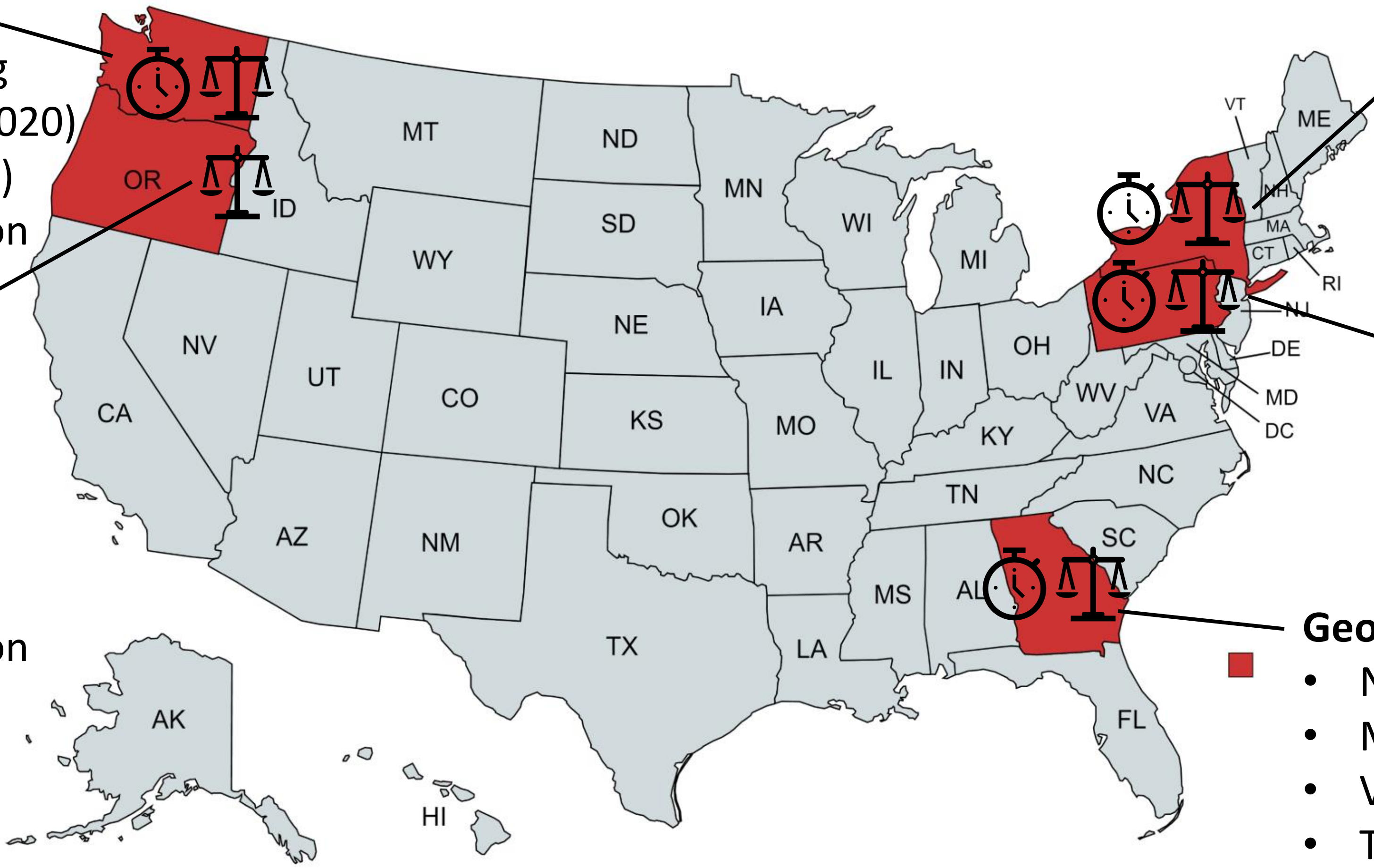


# Objective B2. Effects of soil fertility practices

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

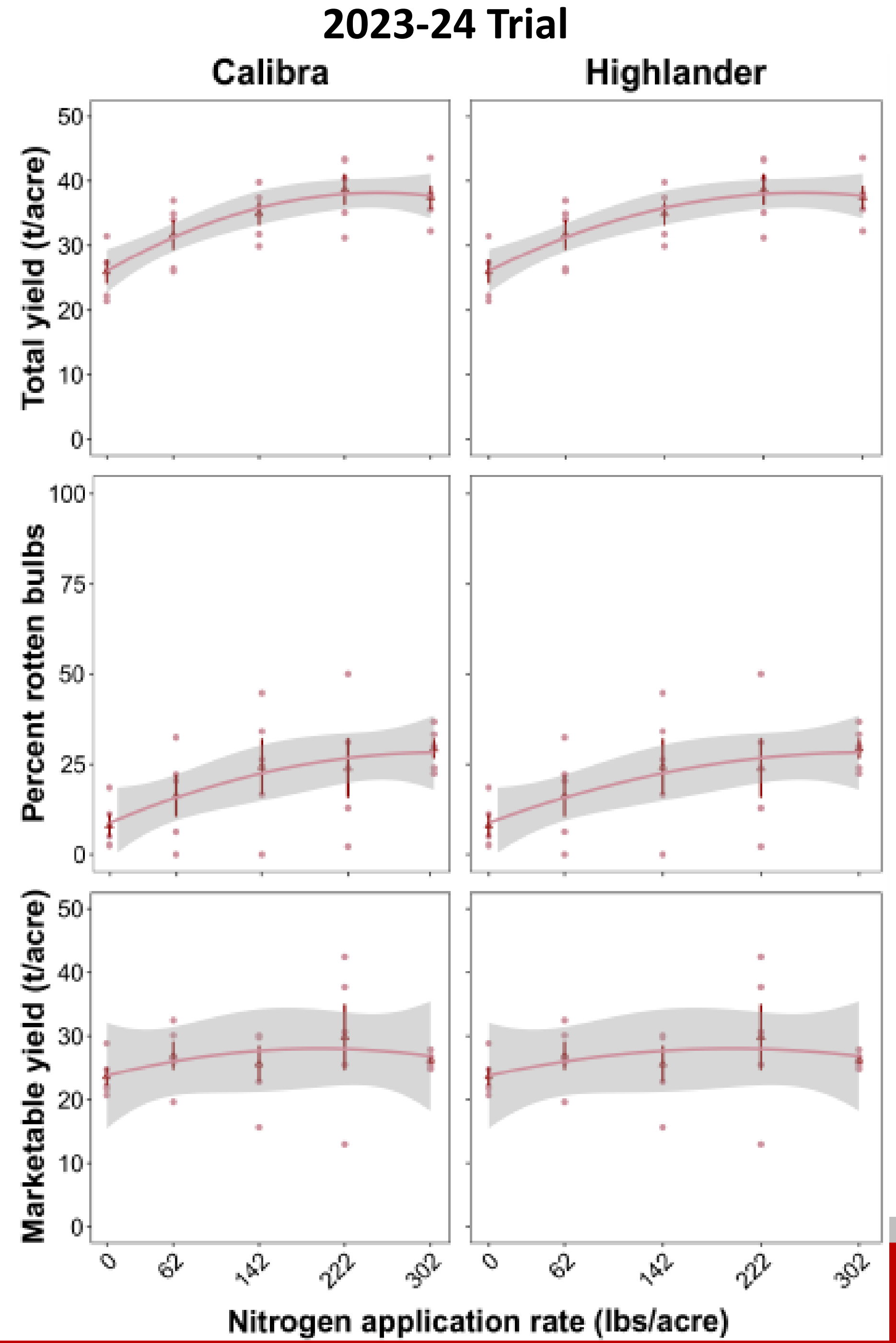
N application timing    N application rate

Image credits: Map Chart

# B2. Effect of N application rates: Columbia Basin trials in 2023 & 2024

Thapa et al. 2024. Plant Disease Management Reports.

- Total yield of Calibra increased with increasing N application rate (2023 and 2024 trials)
- Earlier-maturing Highlander was less responsive than later-maturing Calibra
- Losses to bacterial bulb rot increased with increasing N application rate (more in 2023 than 2024, especially for Calibra)
- Marketable yield (total yield – bulbs rotten) of Calibra was highest at 200 lb total available N/acre (residual + applied)
- N application rates to maximize marketable yield are less than rates to maximize total yield because of bulb rot at higher rates



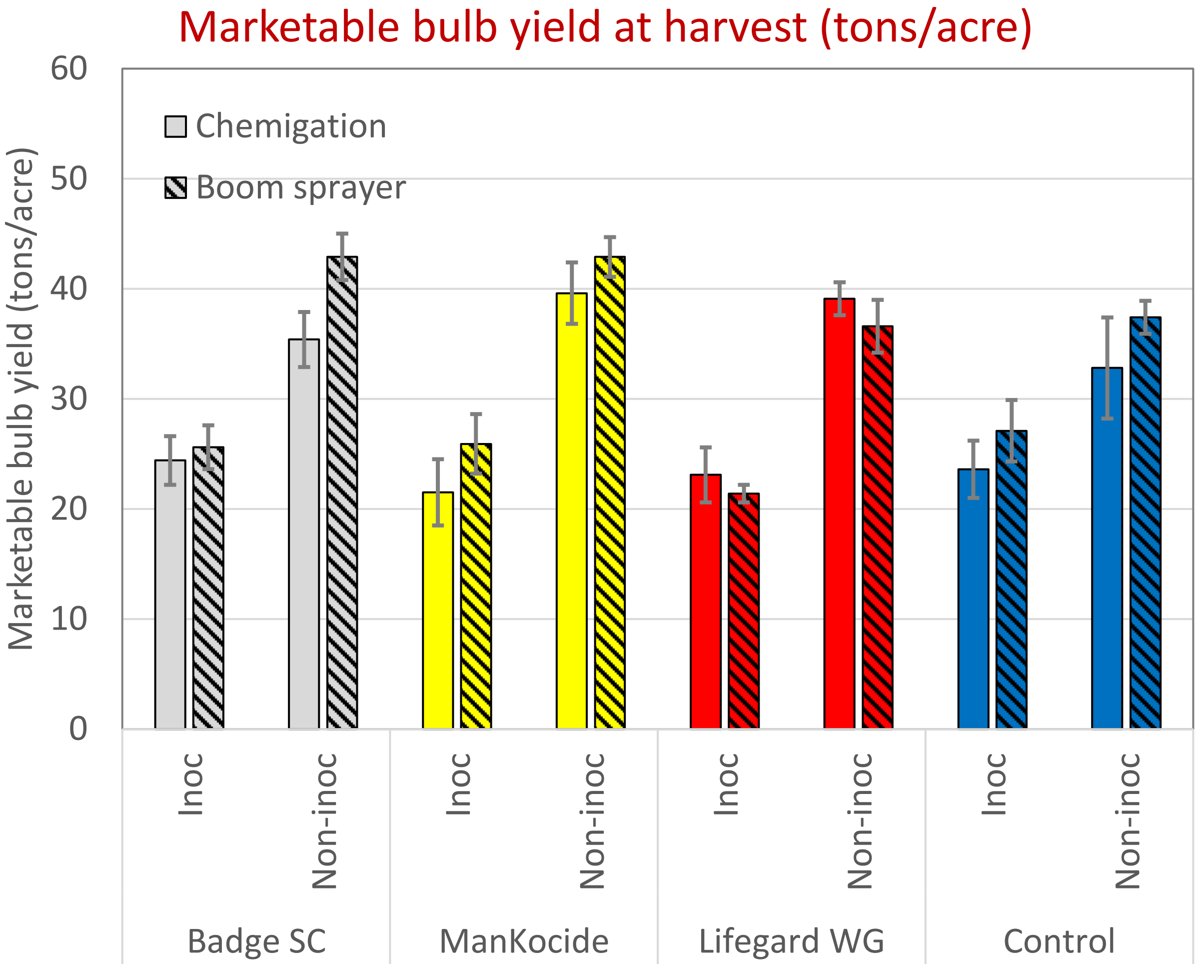
# B3. 2020 Georgia bactericide trial for onion center rot

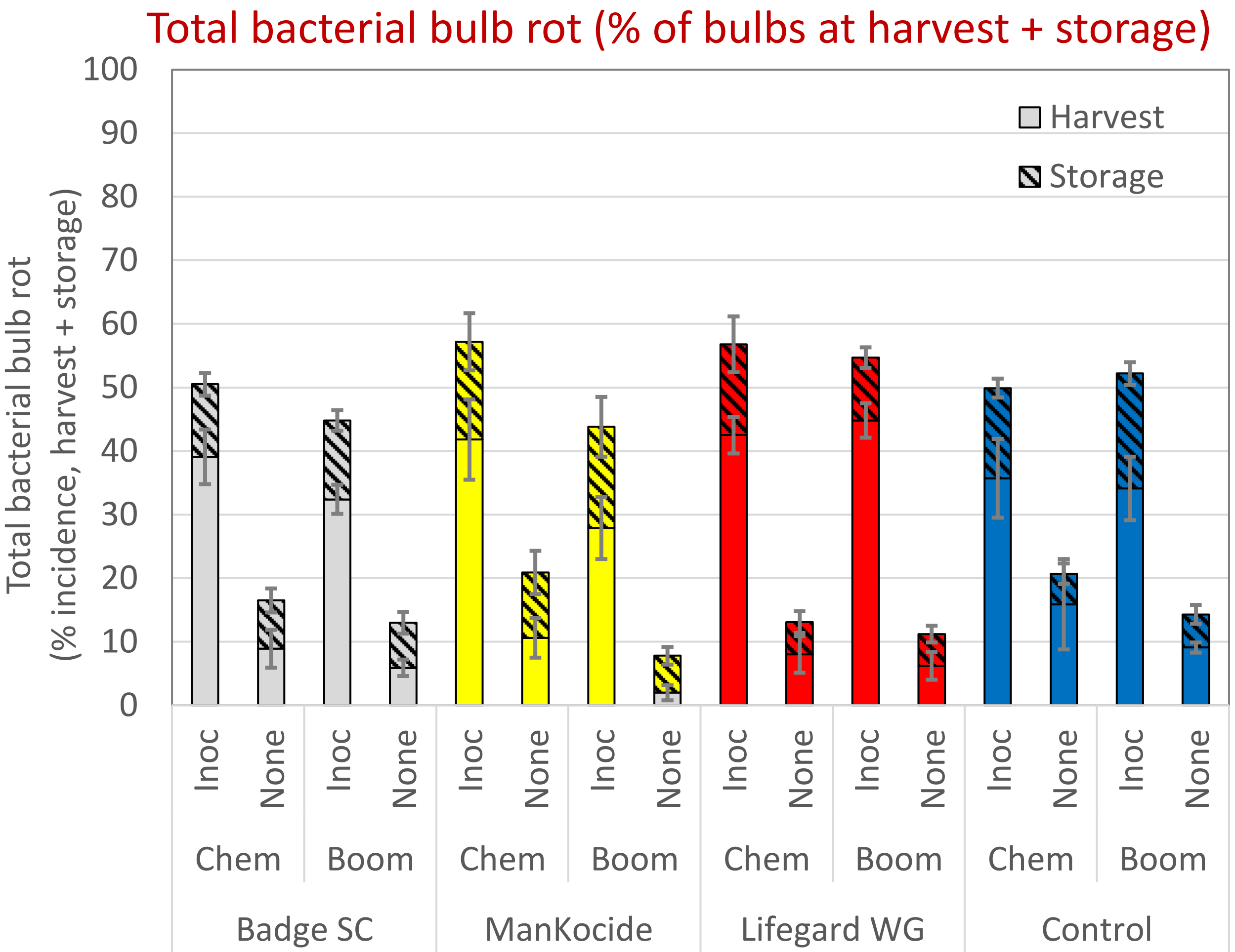
Dutta, B., and Foster, M. J. 2021. Plant Disease Management Reports 15:V027.

| 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** |

Have not seen this efficacy in other states (very poor/no efficacy in 5 years of trials in WA)

# B3: 2022-23 Washington State Bactericide Trial




du Toit et al. 2023. Plant Disease Management Reports 17:V123.

Application of a pesticide to a crop or site that is not on the label is a violation of pesticide law and may subject the applicator to civil penalties

In addition, such an application may result in illegal residues that could subject the crop to seizure or embargo action

**It is your responsibility to check the label before using any product to ensure lawful use and to obtain all necessary permits in advance**

# 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)

**Georgia:** Natural infection

- Manual vs. mechanical **harvest** (2020, 2021, 2022)
- Two **different mechanical harvesters** (2020, 2021, 2022)
- **Length of necks** at 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)

# Objective B4. 2020, 2021, & 2022 Georgia trials on onion harvest methods (Vidalia sweet onion cultivars, harvested with green tops)

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 and Tyson. 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 and Tyson. 2020. Plant Disease Management Reports 15:V026.

# Objective B4. 2021 & 2022 GA trials evaluating the length of topping bulbs (Vidalia sweet onion cultivar with green tops)

| 2021 trial on length of neck after topping | Internal bacterial bulb rot incidence (%) |
|---|---|
| 12.5 cm | 4.5 y |
| 7.5 cm | 4.0 y |
| 2.5 cm | 19.0 z |

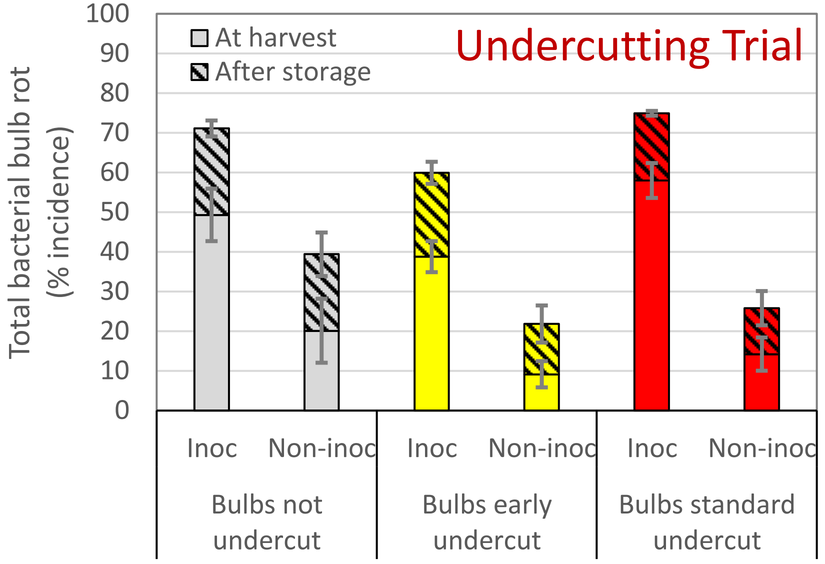
Dutta et al. 2022. Plant Disease Management Reports 16:V107.

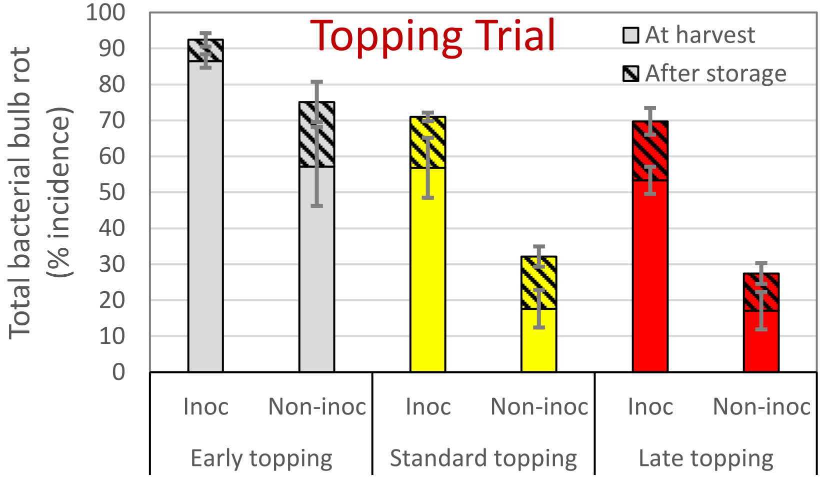
| 2022 trial | Internal bacterial rot incidence (%)7.5 |
|---|---|
| 7.5 cm | 10.0 b |
| 5.0 cm | 11.5 b |
| 2.5 cm | 18.0 a |
| 0 cm | 19.5 a |

Dutta et al. 2023. Plant Disease Management Reports 17:V008.

# Objective B4: 2022 Washington Cultural Practice Trials

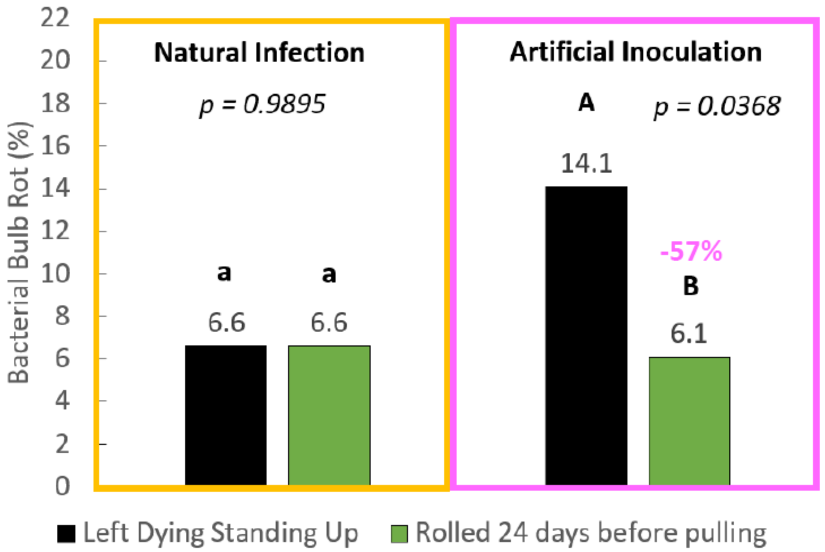
- Undercutting bulbs:
  - Early undercutting (50% tops down) increased marketable bulb yield and reduced bacterial bulb rot at harvest & in storage compared to undercutting at 100% tops down or not undercutting
- Timing of topping bulbs:
  - Early topping (~50% tops down) reduced marketable bulb yield and increased bacterial bulb rot (harvest + storage) compared to standard and late topping (in both inoculated and non-inoculated plots)
- Rolling tops:
  - Rolling tops at the start of tops down did not affect bacterial leaf blight, marketable bulb yield, or bulb rot at harvest or in storage



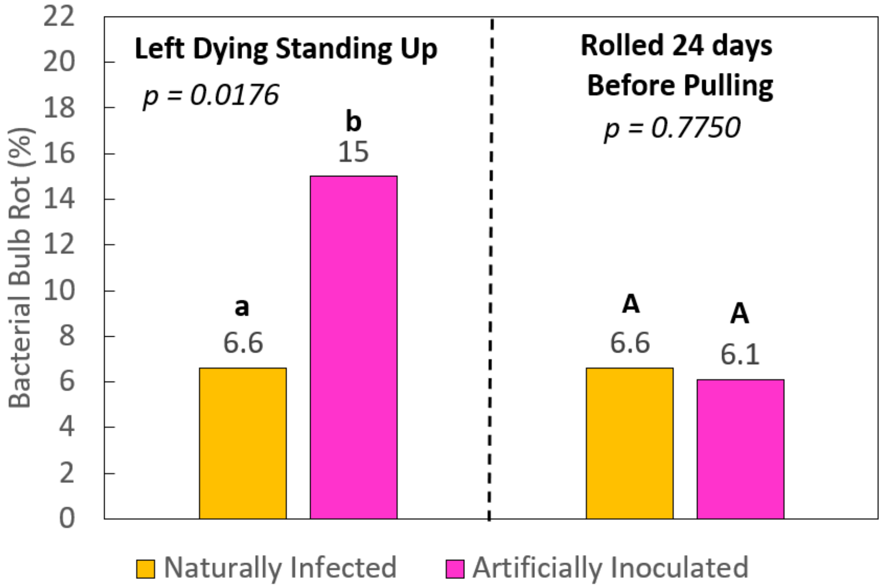



# Objective B4: 2022-23 New York trials evaluating rolling of onion tops

## 2022 Rolling Trial: Results




- Significant Cultural Practice x Inoculation Type interaction (*p = 0.0158*).
- **When onions were artificially inoculated, Rolling reduced bulb rot by 57%.**
- With natural infection, there were no significant differences. (No new infections).



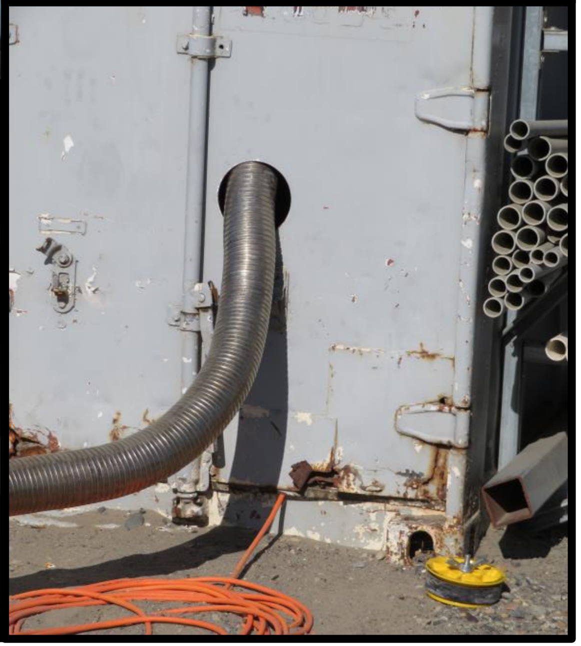

- Roll onions that are dying 'standing up' when 30-50% leaf dieback, within 2-3 weeks of pulling bulbs from field
- ~$1,000 to build a roller, $10/acre to roll, 5 acres rolled/h
- Rolling decreased bulb rot 35-57% in NY
- For every $1 invested in rolling, ROI = $12-$105!

# 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 (24 fl oz) thermofogged for 1 h, container sealed for 8 h
  2. Sanidate 5.0 (24 fl oz) thermofogged for 1 h, container sealed for 8 h
  3. StorOx 2.0 (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

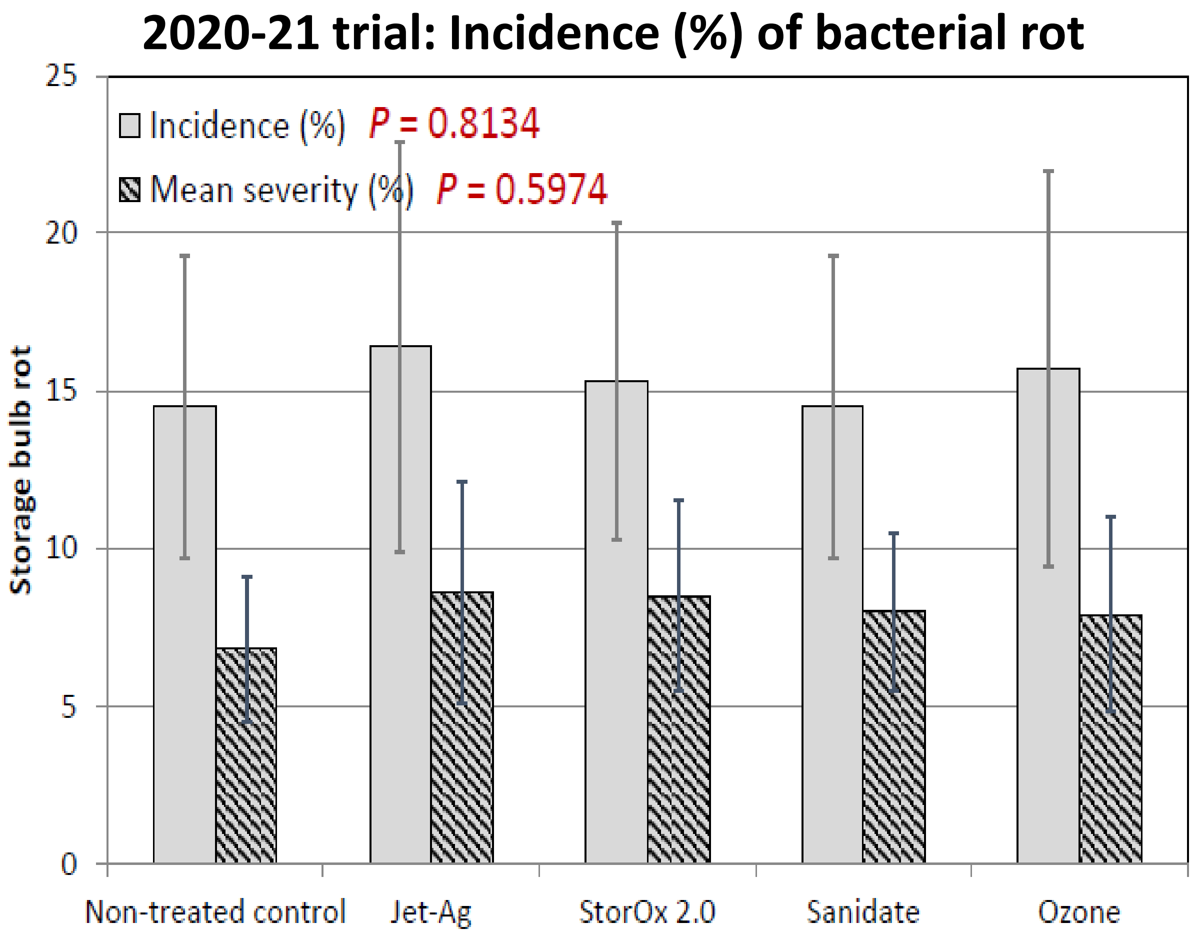


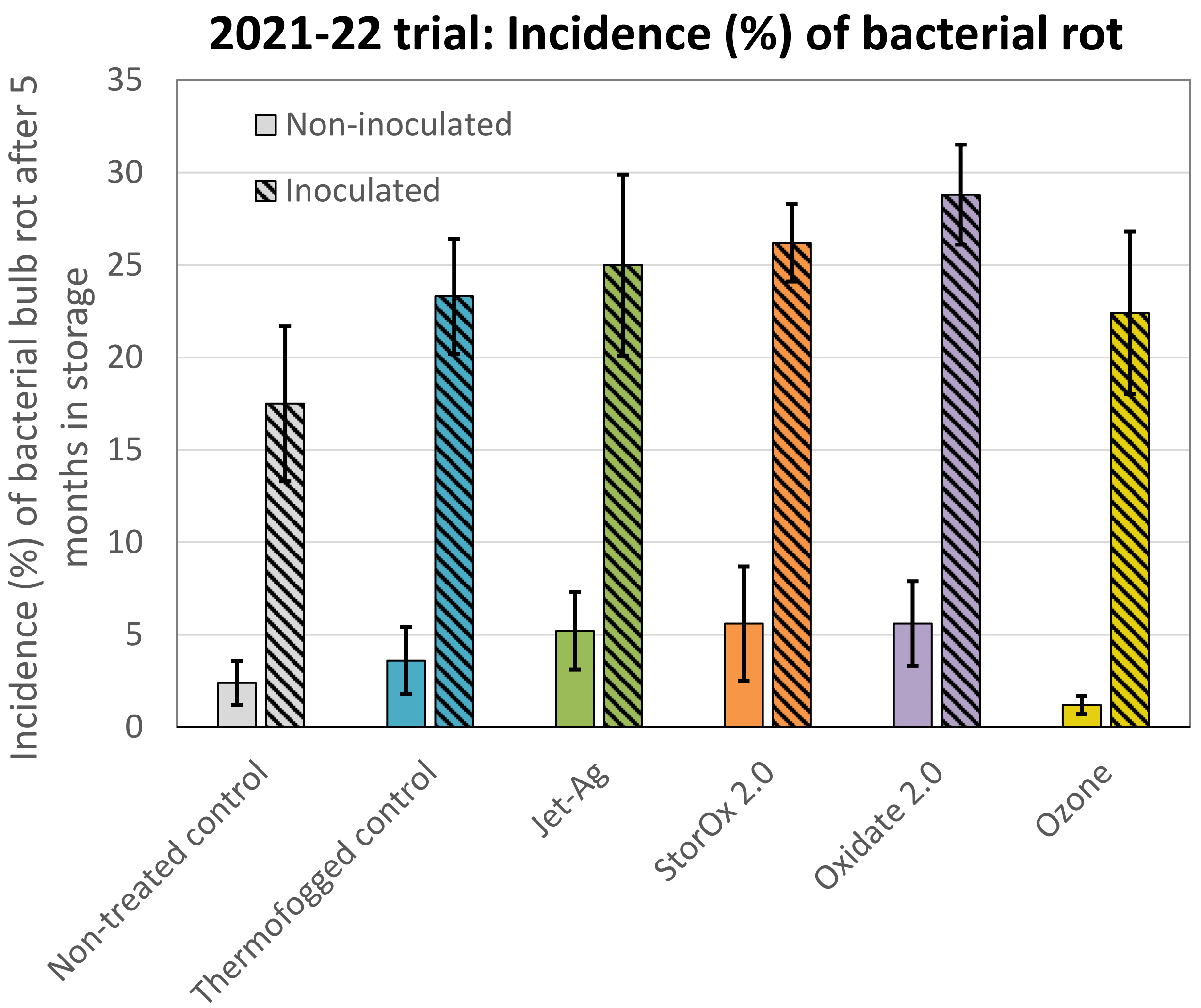
## 2021-22, 2022-23, 2023-24 WA trials

- 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

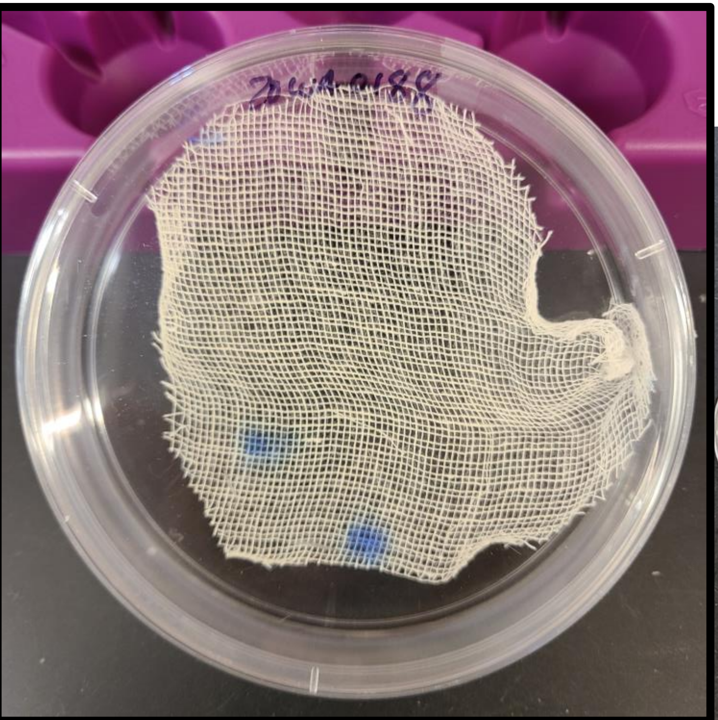


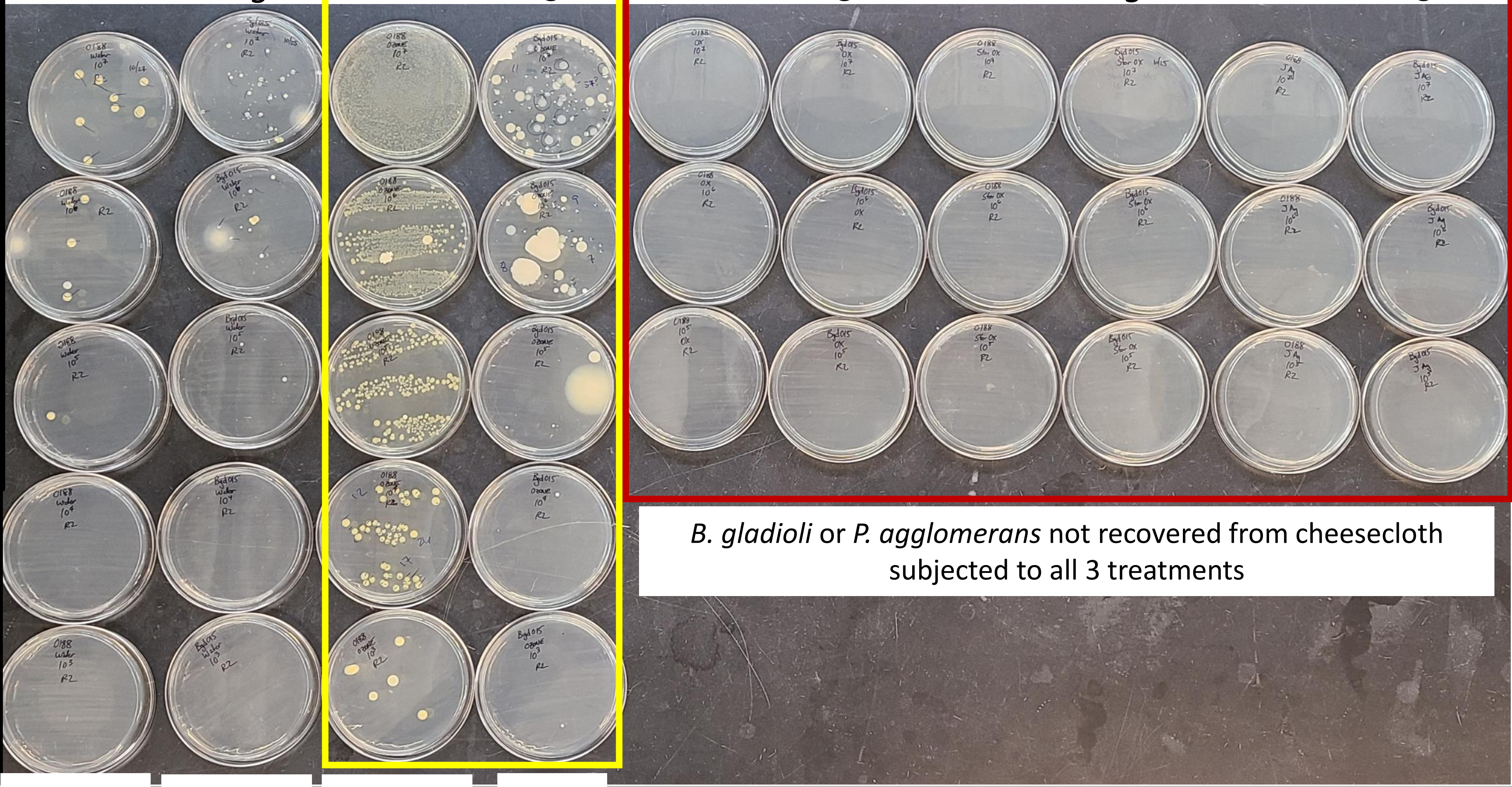

du Toit et al. 2021. Plant Dis. Management Reports 15:V102.
du Toit and Waters. 2021. Onion World, July/August 2021:6-9.

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* |



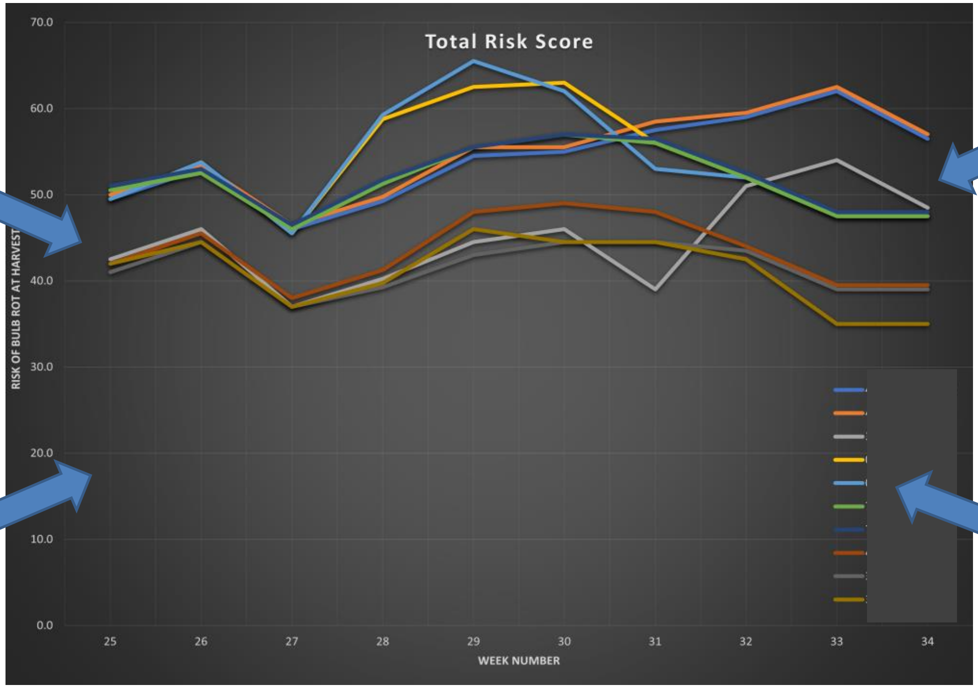
| 1.7 x $10^3$ | 3.1 x $10^5$ | 1.6 x $10^6$ | 0 |
|---|---|---|---|

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

# Objective B6. Modeling the risk of onion bacterial diseases

**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 | | | | | |

# Objectives B7 & B8. Extension/Outreach & Economics

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
- Journal articles, popular press (Onion World, …)
- Frequently Asked Questions, Other resources

Southern IPM Center and Center for Invasive Species and Ecosystem Health, University of Georgia (Joe LaForest)

## Economics (Greg Colson, UGA)

- Stakeholder surveys at start and end of project
- Economic analysis of results of management trials
- Integrate risk perception of growers into economic perspective of recommendations

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