Evaluation of the Influence of Variety on Onion Bacterial Bulb Rot in New York State

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Introduction

Bacterial bulb rot of onion causes serious yield losses in New York State. Management is challenging and requires an integrated approach that considers varietal tolerance. Six field trials were conducted in 2018-2020 that investigated the influence of variety and varietal characteristics on bacterial bulb rot.

Objectives

1. Evaluate onion varieties for susceptibility to bacterial bulb rot.
2. Determine whether certain varietal characteristics are associated with increased bacterial bulb rot incidence.

On-Farm Small-Plot Field Trials

Year	Location	No. Varieties	Type of Bacterial Infection	Trial Design
2018	Oswego	12	• Natural[1]	• Split-Plot Design • Main-Plot Factor: **3 Nitrogen Rates** (37, 100, 150 lb/A) • Sub-plot Factor: **Variety**
2018	Elba	7	• Natural[1] • Artificial spray inoculation[2] • Artificial toothpick prick inoculation[3]	• Split-Split-Plot Design • Main-Plot Factor: **3 Nitrogen Rates** (37, 100, 150 lb/A) • Sub-Plot Factor: **Variety** • Sub Sub-Plot Factor: **2 Inoculation Types** (natural & artificial spray inoculation) • Sub-Set: **2 Prick Inoculations** (2 bacterial pathogens, in artificial spray inoculation sub-plots only)
2019	Oswego	11	• Natural[1]	• Split-Plot Design • Main-Plot Factor: **3 Nitrogen Rates** (10, 30, 60 lb/A) • Sub-Plot Factor: **Variety** • Sub-Set (Elba only): 2 **Prick Inoculations** (2 bacterial pathogens, in low and high N rate plots only)
2019	Elba	8	• Natural[1] • Artificial toothpick prick inoculation[3]	
2020	Elba	14	• Natural[1]	• Split-Plot Design • Main-Plot Factor: **Variety** • Sub-Plot Factor: **2 Copper bactericide treatments** (treated[4], nontreated)
2020	Elba	14	• Artificial spray inoculation[2]	

[1]**Natural bacterial infection** was predominantly caused by *Burkholderia cepacia.*
[2]**Artificial spray inoculation:** Using a manual backpack sprayer, onions were sprayed to runoff with a mixture of 10^6 cfu/ml each of *Pantoea ananatis* and *P. agglomerans* at dusk during calm conditions to encourage leaf moisture through the night to favor bacterial disease. Applied once per variety to all varieties at the same time in Elba 2018 trial, and twice per variety in each of three maturity cohorts in Elba 2020 trial.
[3]**Artificial Prick inoculation:** The second and third oldest leaves per plant were pricked 1-inch above the leaf axil with a toothpick that had been freshly dipped in a 10^9 cfu/ml solution of *P. ananatis* or *P. agglomerans.* Inoculation was performed on a sub-set of 10 consecutive plants per plot for each pathogen. Prick inoculated plants were harvested separately and not included in data for the rest of the plot.
[4]**Copper bactericide treatment:** Badge 1-2 pt/A was applied weekly 3-times prior to and 2-3 times after artificial inoculation.

Treatments were replicated four times in each trial and were randomized within each replication. Individual plot size ranged from a total of 30-60 feet of onion row, arranged in 2 or 4 rows per plot, following standard grower planting configurations. Samples collected for yield and bulb rot evaluations ranged in size from 100-160 bulbs per plot.

Onion Varieties

Variety	No. Trials	Days to Maturity	Plant Characteristics[1]: Leaf Color[2]	Plant Vigor[3]	Upright Leaf Growth Habit[4]	Neck Diameter[5]	Root Quality[6]
Trailblazer	6	100	**Bluest**	**Low**	Variable	**Thin**[9]	**Poor**
Catskill	6	105	Blue-Green	Variable[7]	Med-Upright	Medium	Medium
Pocono	6	110	Relatively Blue	Medium	Medium	**Thick**	Med-Good
Montclair	6	112	Relatively Green	Variable	Medium	**Thick**	Medium
Red Wing	6	120	Blue-Green	Med-High	Med-Poor	**Thick**	Variable
Saddleback	4	100	Relatively Green	Med-High	Medium	**Thin**	Medium
Braddock	4	107	Relatively Green	**High**	Med-Poor	Variable	Medium
Ridgeline	4	107	Blue-Green	Variable	**Upright**	**Thin**	Medium
Red Mountain	4	107*	Blue-Green	**High**	Med-Poor	**Thick**	Medium
SVNY1141	4	110	Blue-Green	Med-Low	**Upright**	Medium	Medium
Bradley	4	118	**Greenest**	**High**	**Poor**	Med-Thick	**Good**
SVNY1298	3	95*	Blue-Green	Med-High	**Poor**	Medium	Medium
Stanley	3	105*	Relatively Blue	Med-High	Medium	Medium	Medium
SVNY0023	2	115	Blue-Green	Med-Low	Med-Poor	Medium	**Good**
Hamilton	2	120	Blue-Green	Med-Low	Medium	**Thick**	**Good**
Red Nugent[8]	1	107	--	--	--	--	--
Meringue[8]	1	115	--	--	--	--	--

[1]**Plant Characteristics** presented in this table represent general categorizations based on our evaluations/observations across the six trials.
[2]**Leaf Color** was rated per plot using a 13-point scale from very green to very blue.
[3]**Plant Vigor** was rated per plot using a 5-point scale from least vigorous to most vigorous.
[4]**Upright Leaf Growth Habit** was rated per plot using a 10-point scale from least upright (e.g. leaves flop over) to most upright.
[5]**Neck Diameter** was measured when the latest maturing variety was ~90% lodged, between the bulb and the neck bend.
[6]**Root Quality** included a combination of fresh root biomass and % pink root that were measured once all varieties had lodged.
[7]**Variable for a trait** indicates that the variety fell into different categories in different trials.
[8] **Red Nugent and Meringue** were included for evaluation of bulb rot only.
[9]**Bolding** indicates the most extreme representatives for each characteristic.
*SVNY1298, Stanley and Red Mountain matured later in our trials than expected according to their listed maturity.

Results

None of the Plant Characteristics were Associated with Bulb Rot

- None of the varietal characteristics, including leaf uprightness, plant vigor, leaf color, neck diameter, root quality, and maturity, were strongly (R > 0.7) and significantly (P < 0.05) correlated with bulb rot (Pearson).

Variety was the Most Important Factor Associated with Bacterial Bulb Rot

- Nitrogen rate and protection (copper bactericide vs. nontreated) were not significant in any of the six trials. There were no significant interactions between these factors and variety on bulb rot.

Most Likely to Rot:

- **Montclair** and **Ridgeline**: Of the 11 varieties that were in 4-6 trails, Montclair and Ridgeline were not significantly different than the variety with the most rot in 4 out of 6, and in 3 out of 4 trials, respectively. Neither of these varieties were ever as good as the variety with the least rot in the trial.
- **Red Nugent, Meringue** and **SVNY0023**, although only in 1-2 trials, had high levels of bulb rot.

Least Likely to Rot:

- **Bradley** and **Braddock** were not significantly different than the variety with least bulb rot in 3 out of 4 trials.
- **Stanley** and **Hamilton**, although only in 2-3 trials, had low levels of bulb rot.

Most Variable Rot:

- **Trailblazer** either had the least bulb rot or was not significantly different than the variety with the least rot in 4 out of 6 trials, but had the highest level of bulb rot in the other 2 trials.
- **Saddleback** was not significantly different than the variety with the least rot in Elba and Oswego in 2018 trials, but was among the highest % bulb rot in the two 2020 Elba trials.
- The variability in bulb rot per variety between year and location suggests that **other factors, such as weather or interaction with another biotic factor such as disease or thrips, could also have an important role in the development of bacterial bulb rot. Variability may also be influenced by the pathogen species most prevalent in each trial.**

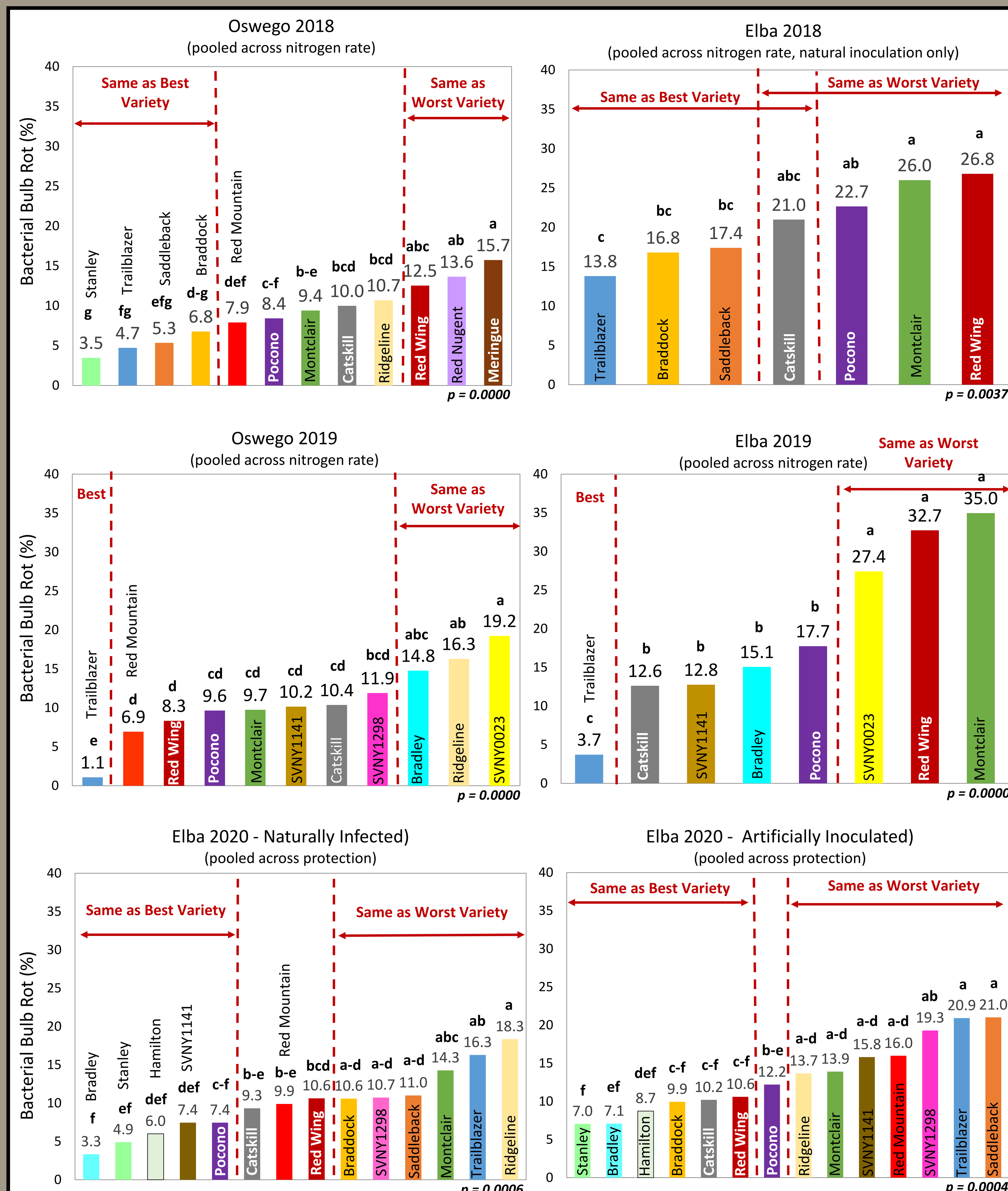

Fig. 1. **Effect of variety on bacterial bulb rot, in order from lowest to highest bulb rot per trial.** Bars within a chart labeled with the same letter are not significantly different, Fisher's Protected LSD test with 5% significance, p <0.05.

Results (continued)

Artificial Inoculation vs. Natural Infection

- Artificial spray inoculation raised the trial average for bulb rot by only 3% and 5% compared to natural infection in the Elba 2018 and 2020 trials, respectively.
- Bulb rot was numerically lower in artificially spray-inoculated plots than in naturally infected plots in 5 out of 14 varieties (36%) and 1 of the 7 varieties (14%) in Elba 2020 and 2018 trials, respectively.
- Drenching onion plants with high concentrations of bacterial pathogens did not result in significantly more bulb rot, suggesting that **factor(s) other than pathogen exposure are important for bacterial disease infection.**
- There were no consistent trends between plant maturity at time of artificial inoculation (as measured by % lodging or inoculation cohort) and varietal response to artificial inoculation in Elba 2020.
- **Artificial prick inoculation did not produce the same bulb rot profile as natural infection** (compare Fig. 2 with Elba 2018 in Fig. 1).
- **Braddock** (Fig. 1 - Elba 2018, Fig. 2) and **Bradley** (Elba 2019, data not shown) had more bulb rot with artificial prick inoculation than under natural conditions, while the opposite was the case with **Red Wing** (Fig. 1 - Elba 2018, Fig. 2).
- Differences in the rot profile when the varieties were artificially prick inoculated compared to natural infection may be related to differences in susceptibility to the pathogens; *Burkholderia cepacia* was the dominant pathogen with natural infection and *Pantoea agglomerans/ananatis* were used for artificial inoculation.
- These differences may also reflect the difference between the ability of a pathogen to infect an intact plant and the ability of a pathogen to infect a wounded plant (as in artificial prick inoculation).

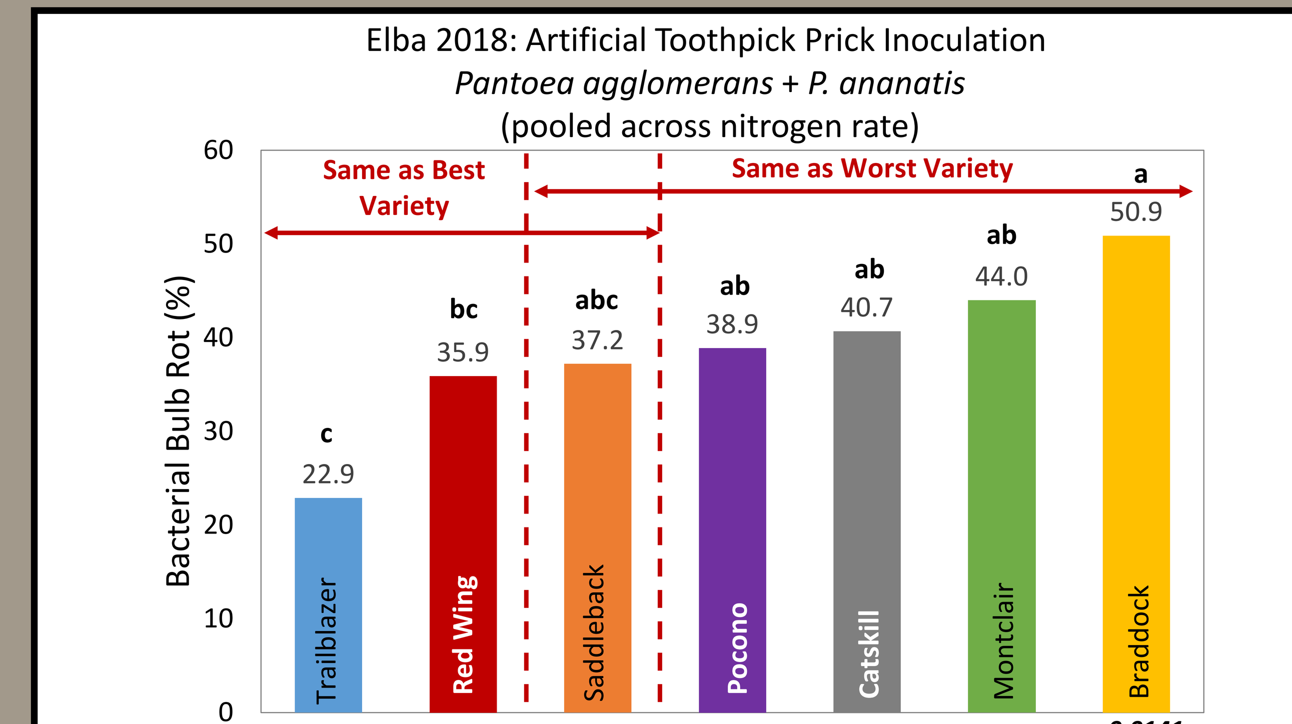

Fig. 2. Effect of variety on bulb rot when artificially prick inoculated in Elba 2018. Compare to Fig. 1 2018 Elba chart (to the left) to see how Braddock and Red Wing respond differently. Bars labeled with the same letter are not significantly different, Fisher's Protected LSD test, p < 0.05.

Bulb Rot Severity

- Bacterial bulb rot was more severe in bulbs artificially prick inoculated with *Pantoea agglomerans* than with *P. ananatis* in Elba 2019.

Bacterial Pathogen	Severity of Bulb Rot in Prick-Inoculated Plants (% Bulbs per Rot Severity Category[1]): 0	1-2	3-4
Pantoea agglomerans	44.7	48.1	7.0
Pantoea ananatis	35.8	42.6	21.5

[1]**Bacterial bulb rot severity scale (0-5): 0** – no rot; **1** – less than a single scale rotted; **2** – 1-2 scales rotted; **3** – bulb interior macerated; **4** – entire bulb macerated**.** Photos: C. Hoepting.

Conclusion

Variety is an important factor influencing bacterial bulb rot in onion. However, varietal response differs by season, location, and causal pathogen. Further research should examine how specific biotic and abiotic factors relate to bacterial bulb rot.

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