Cornell Cooperative Extension
Cornell Vegetable Program

Rotten Onions 101:
Part II – The many ways onions rot

- **Bhabesh Dutta,** Dept. of Plant Pathology, UGA
- **Christy Hoepting**, CCE – Cornell Vegetable Program
- **Brian Kvitko**, Dept. of Plant Pathology, UGA

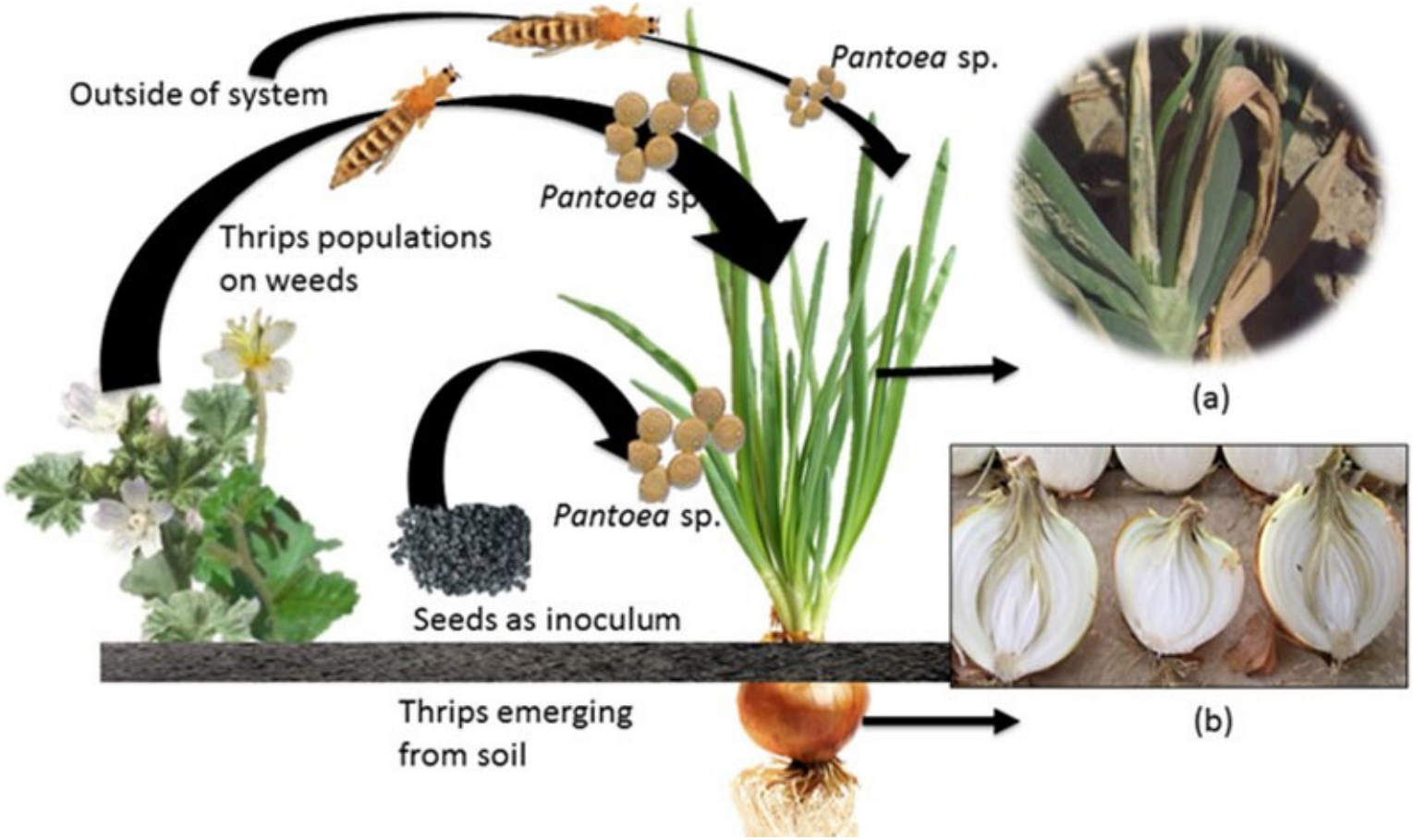
Empire State Producer's Expo – Onion Bulb Rot Session
Virtual: January 14, 2021

Outline

Rot life cycle, exploring every side of disease triangle

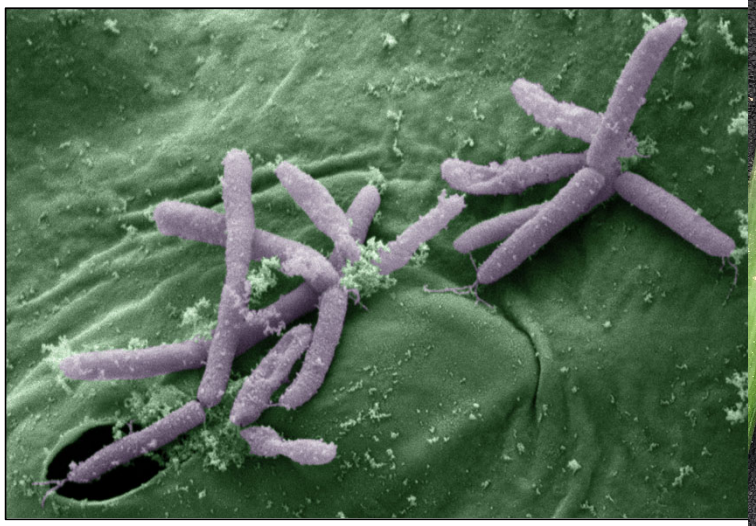
- **Disease:** Intricacies of infection, disease development within plant, microbial properties of onion.
- **Host:** Effect of plant maturity and plant architecture (growth habit and neck diameter) on susceptibility to bacterial infection. Microbial properties of onion
- **Environment:** Favorable weather conditions, relationship to nitrogen and onion thrips. Implications of different harvest and curing practices.

Life-cycle of onion-pathogenic bacteria; *Pantoea* as an example



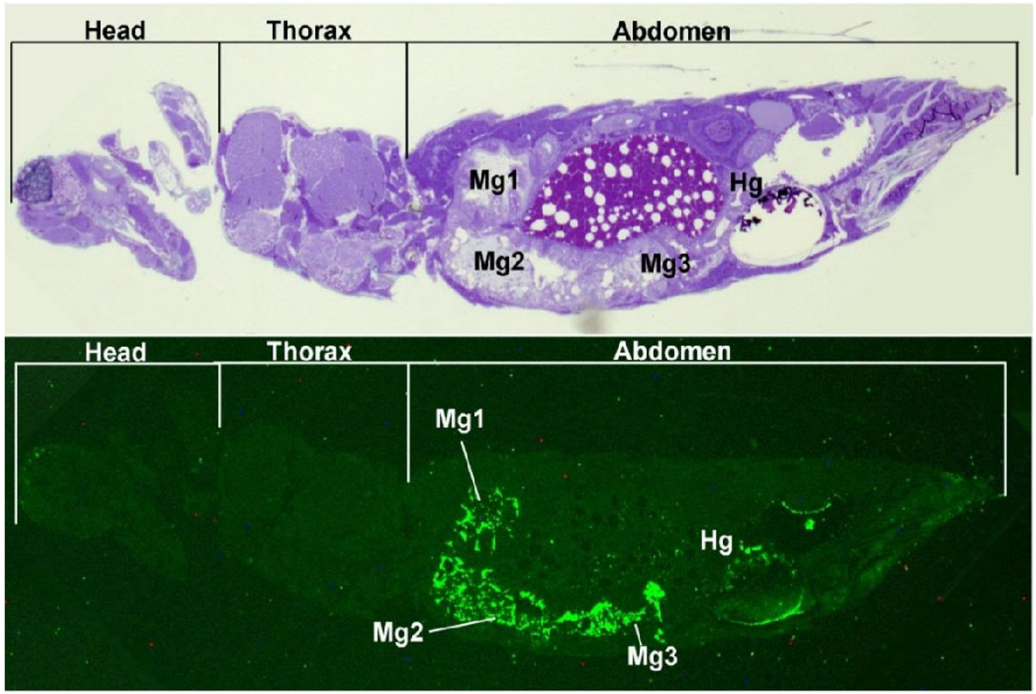
Wounding of plant foliage can be an entry point for bacterial pathogens

- **Hail-storms**
- **Sand blasting**
- **Damage to foliage during field operations**



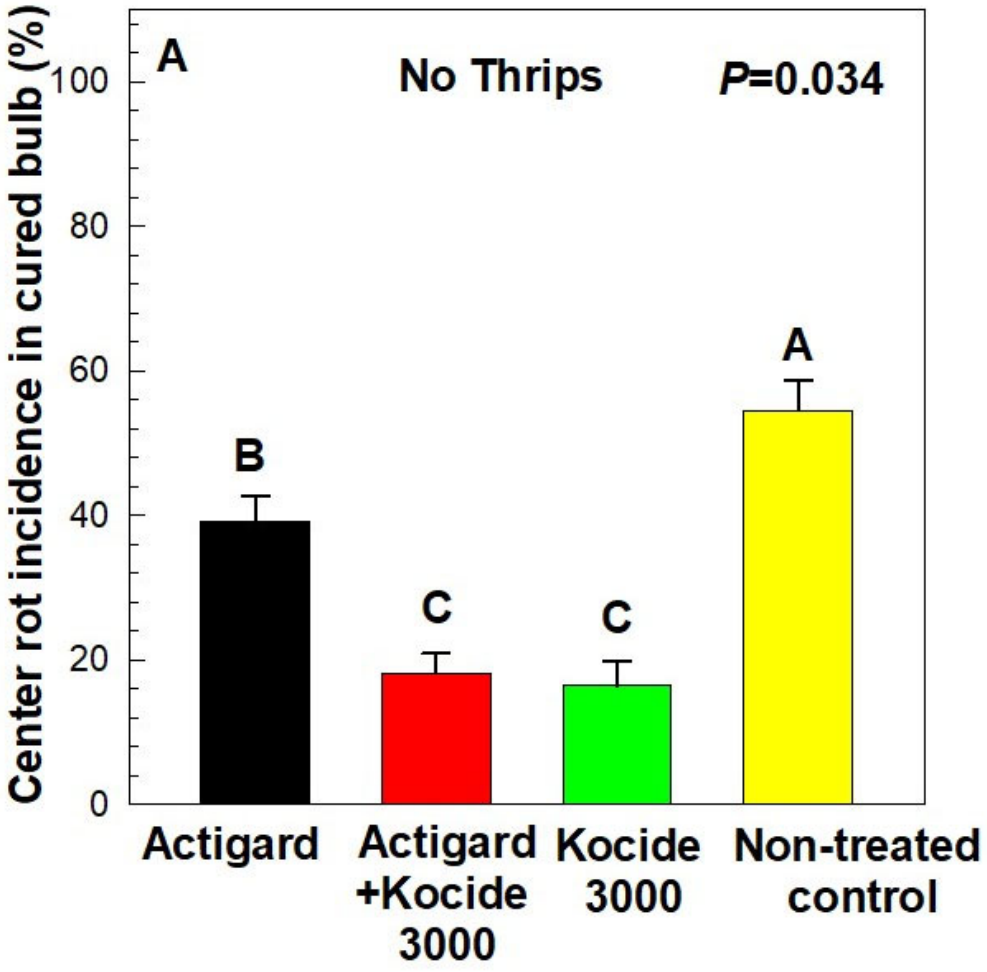
Ingress of *bacteria through stomates* (Sundin et al., 2005)

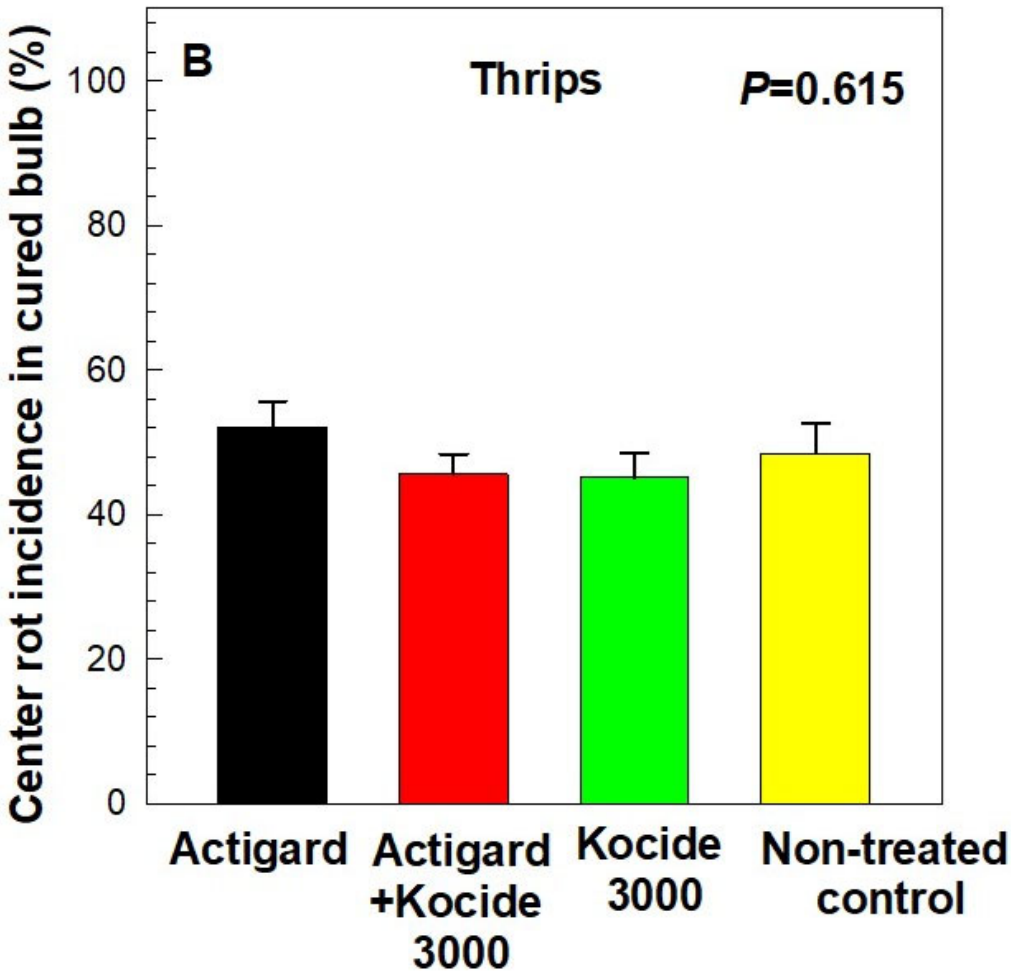
Tobacco thrips (*Frankliniella fusca*) and onion thrips (*Thrips tabaci*) transmit *Pantoea ananatis* and *Pantoea agglomerans via* feeding wound contamination with feces



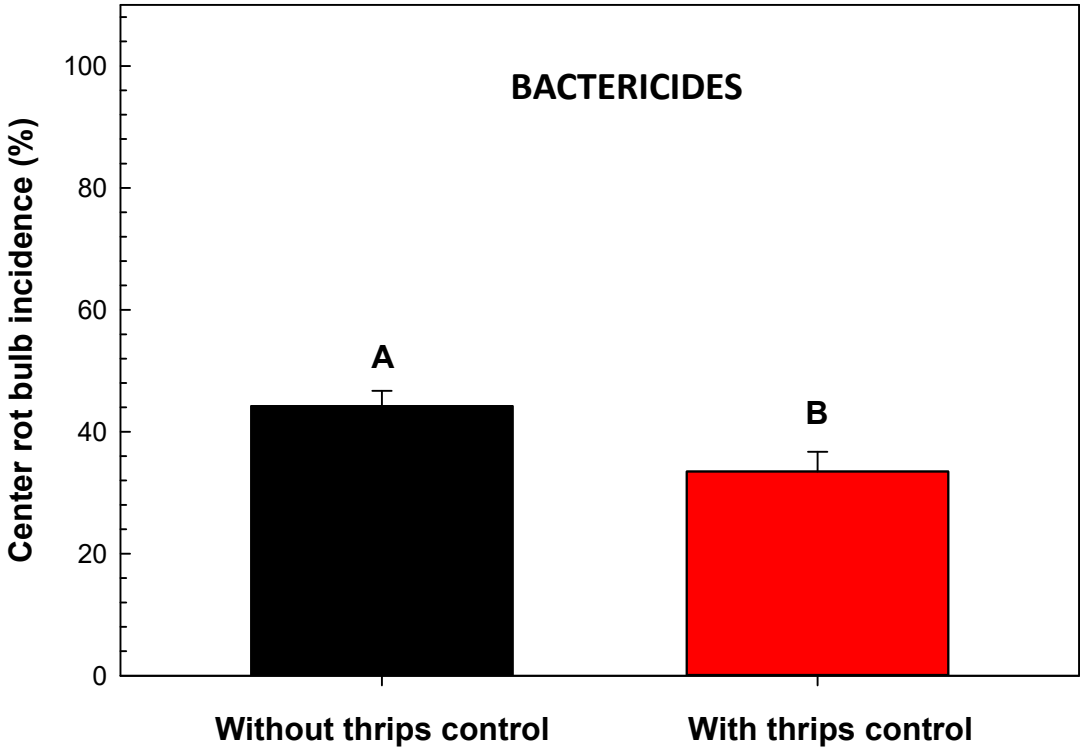
Insect transmitted bacterial pathogens by-pass surface chemical protection in plants

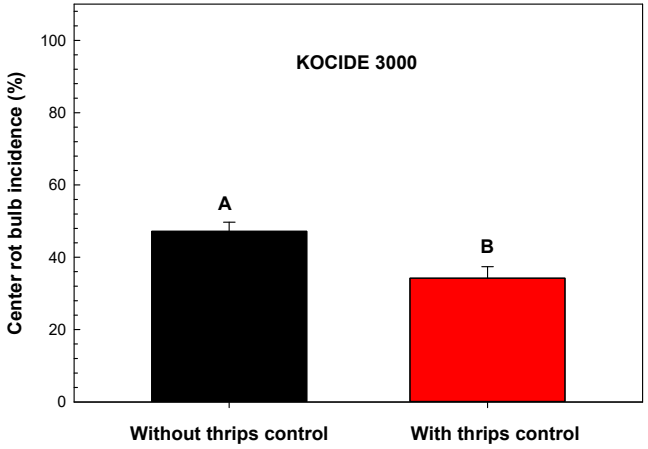
Bactericides work efficiently under thrips control program (greenhouse study)

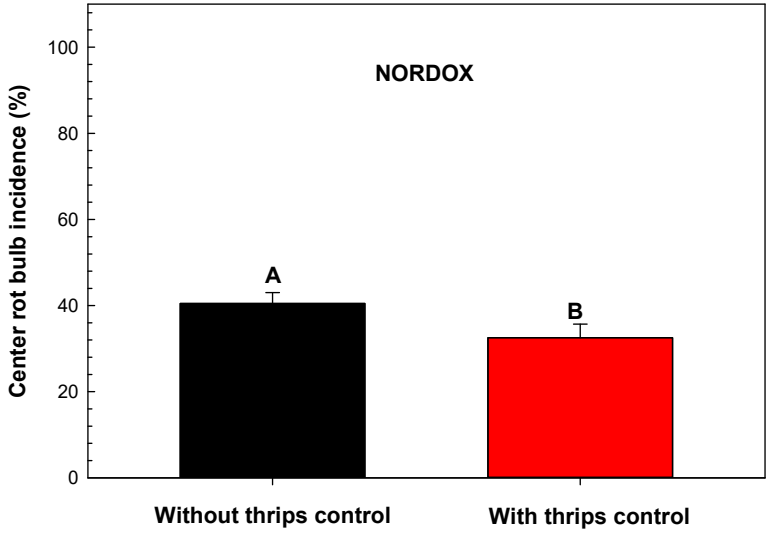




Bactericides work efficiently under good thrips control program (field conditions)



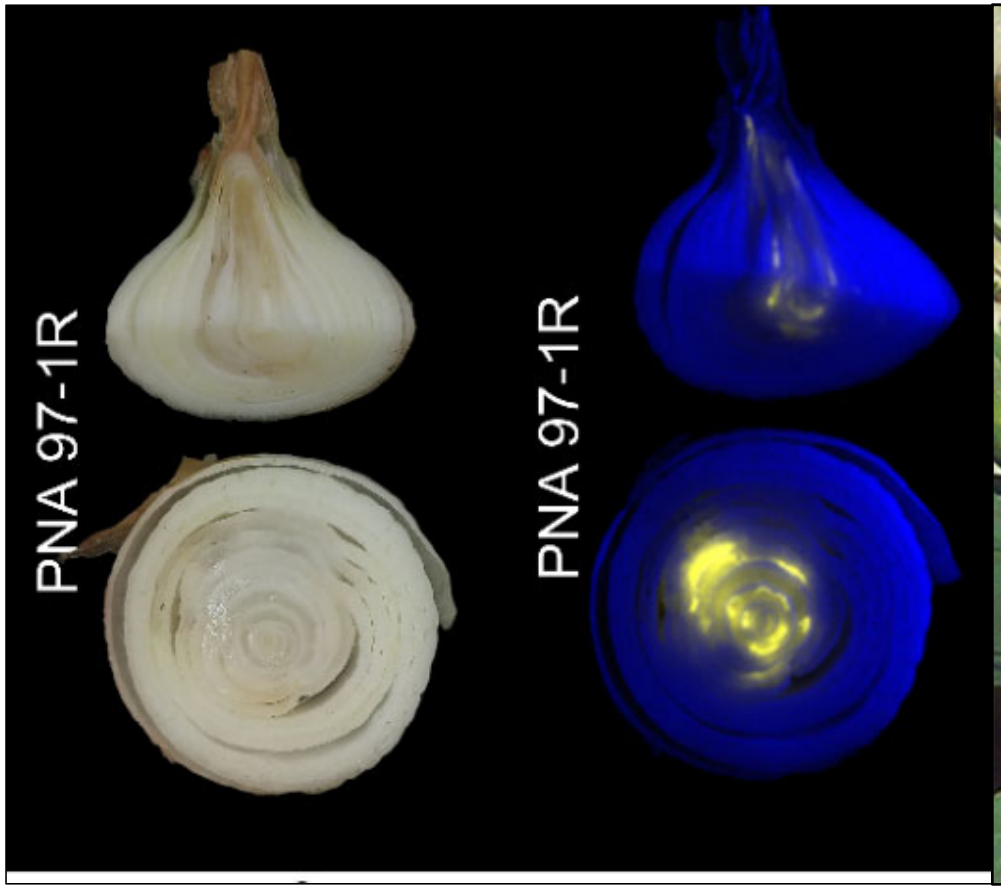


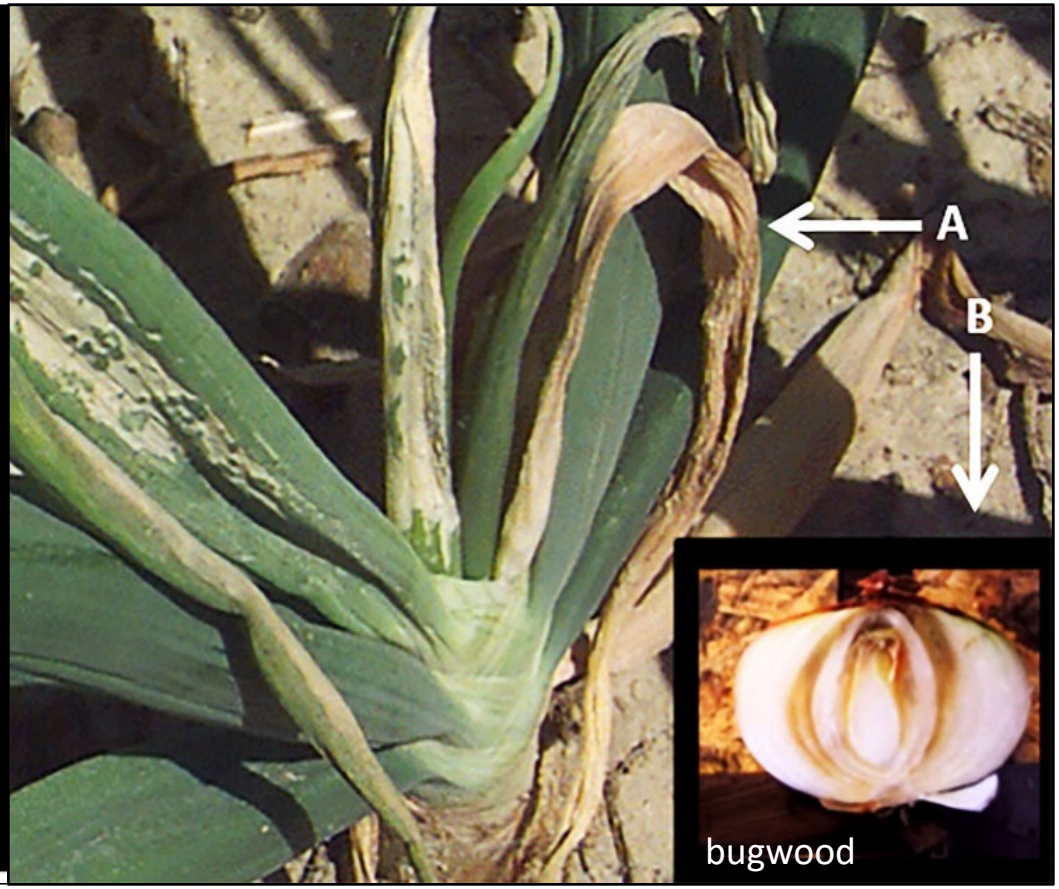


Host: Bacterial Disease Development within Onion Plant/Bulb

Infection through neck or shoulder or outer dead and decaying foliage

Host: Infection of foliage at the center or nearby leaves





Host factor: Which growth stage of onion is highly susceptible to bulb infection?

- Seedling stage
- True leaf stage (4-6)

Vegetative phase

- First leaf senescence
- Bulb initiation
- Bulb swelling

Vegetative phase****

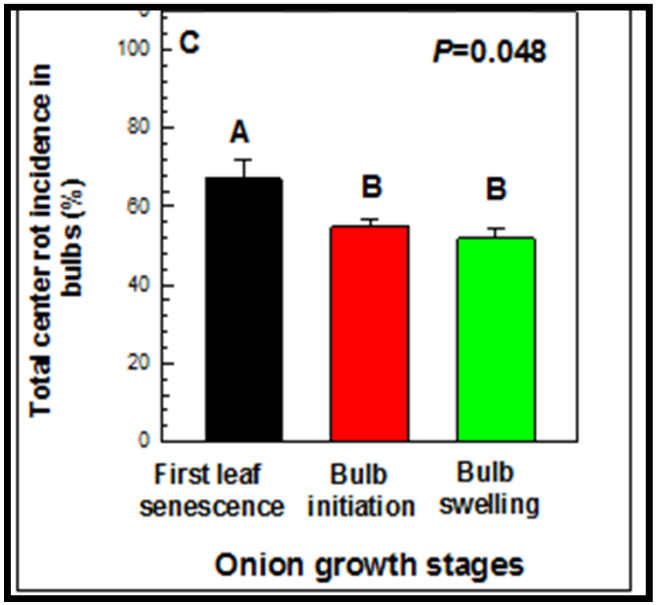
- Pseudostem hardening
- Flowering

Reproductive phase

Results

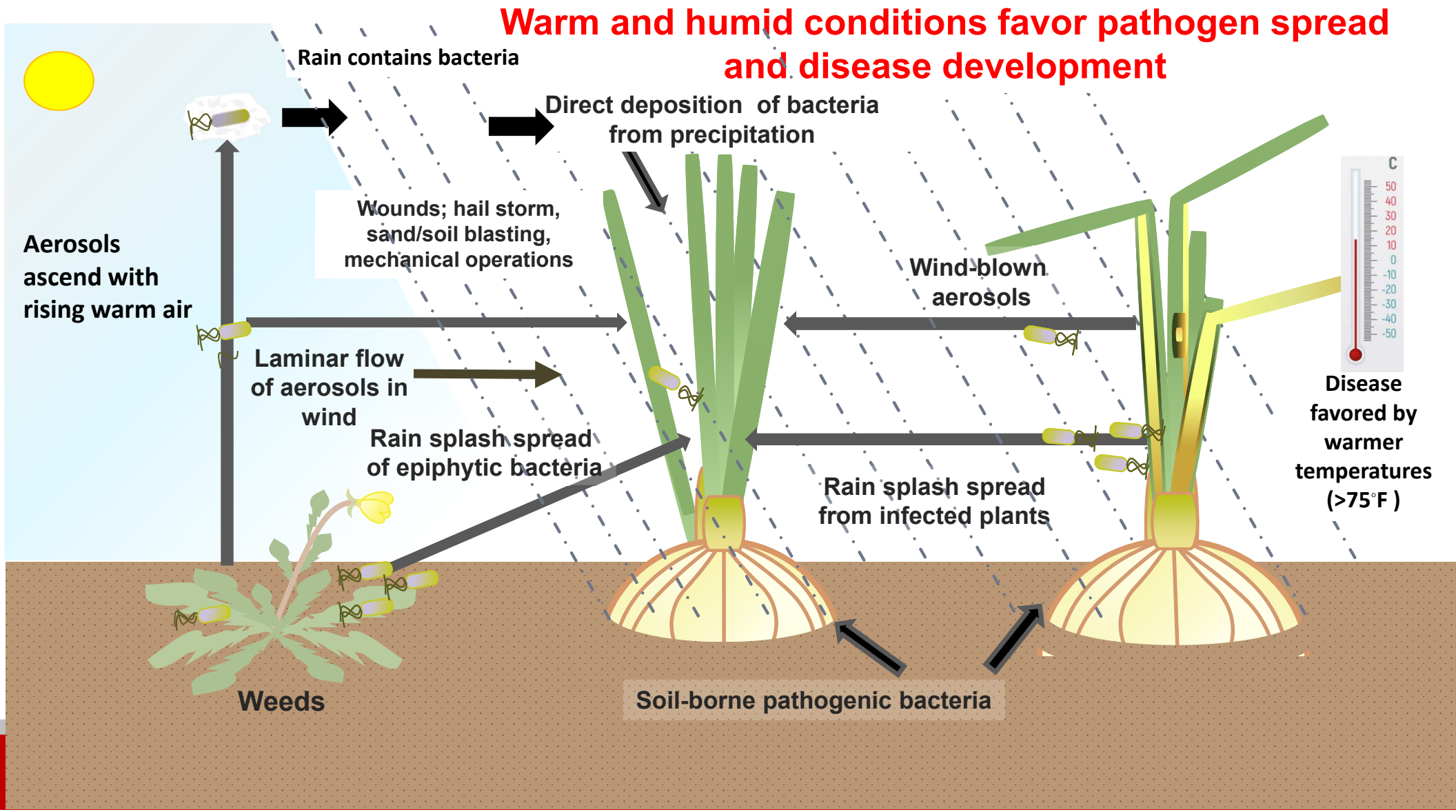
Growth stages, variety	df[a]	*F*-value	*P* > F
Experiment[b]	1	3.17	0.248
Growth stages of onion[c]	2	24.2	0.037
Variety[d]	4	29.2	<0.001
Growth stages of onion× variety	8	48.3	0.923

[a] Degrees of freedom.
[b] Number of experiments.
[c] Inoculation was done at first leaf senescence, bulb initiation, and bulb swelling growth stages.
[d] Five Vidalia onion variety (1518, 1407, Granex YPRR, Pirate, and Sweet harvest) were used



- Onion growth stages can influence incidence of *P. ananatis* in bulbs (Stumpf *et al.*, 2017)

Environment: Favorable Conditions for Bacterial Disease


Warm and humid conditions favor pathogen spread and disease development
Rain contains bacteria
Direct deposition of bacteria from precipitation
Wounds; hail storm, sand/soil blasting, mechanical operations
Aerosols ascend with rising warm air
Wind-blown aerosols
Laminar flow of aerosols in wind
Rain splash spread of epiphytic bacteria
Rain splash spread from infected plants
Disease favored by warmer temperatures (>75°F)
Weeds
Soil-borne pathogenic bacteria

Host: Antimicrobial Properties of Onion and How that Relates to Infection and Disease Development

Damaged onions and garlic produce aromatic **sulfur compounds**

https://www.marthastewart.com/1114368/how-crush-garlic

C. Hoepting

Some of these sulfur compounds make you **cry**

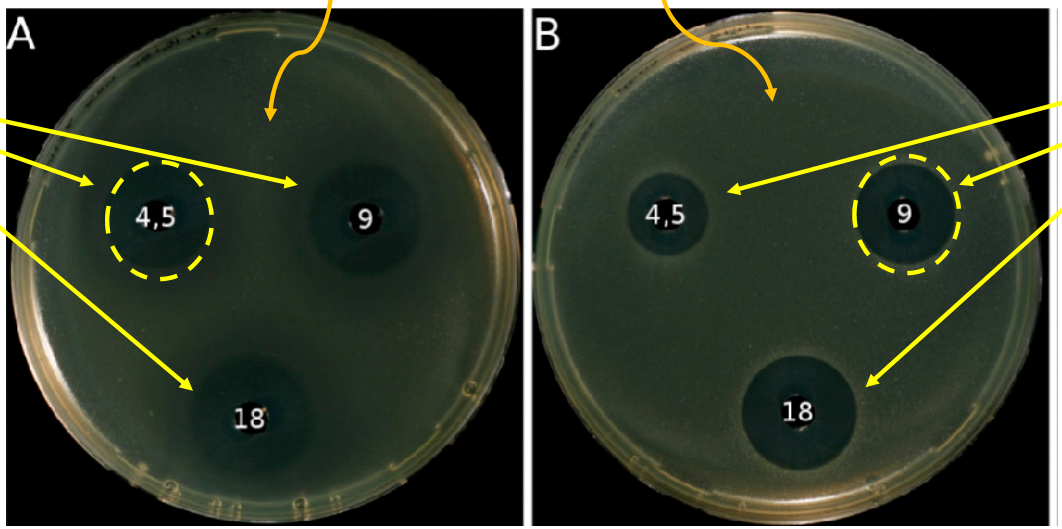
Host: Antimicrobial Properties of Onion and How that Relates to Infection and Disease Development

Some of these sulfur compounds are **antimicrobial (kill bacteria)**

Bacteria growing on petri plates

A. Treated with **Kanamycin** (common human antibiotic)

*Bacteria does not grow in presence of **kanamycin***



Borlinghaus, 2014

B. Treated with **Allicin** from garlic (aromatic sulfur compound)

*Bacteria does not grow in presence of **allicin***

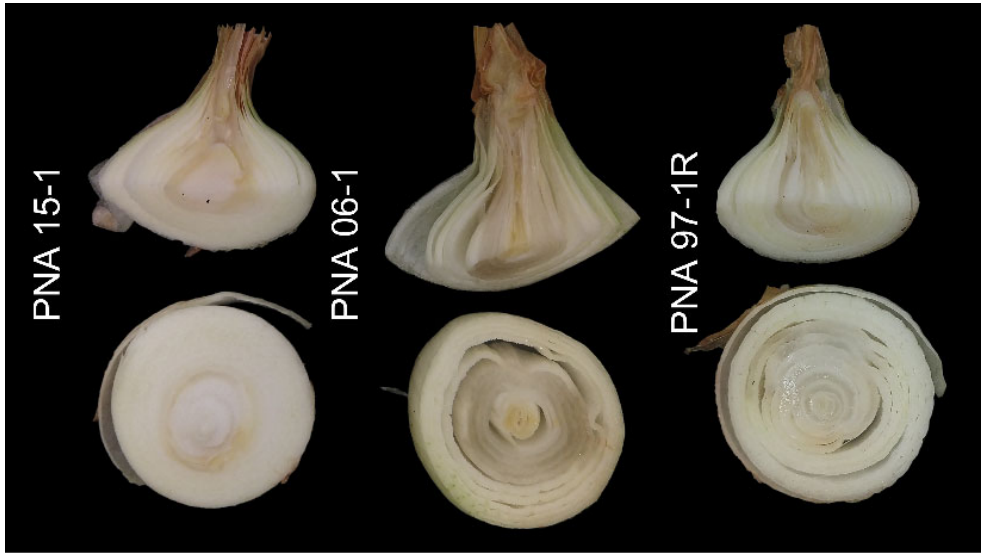
Host: Antimicrobial Properties of Onion and How that Relates to Infection and Disease Development

If onions have antimicrobial properties, why do they get infected with bacterial at all?

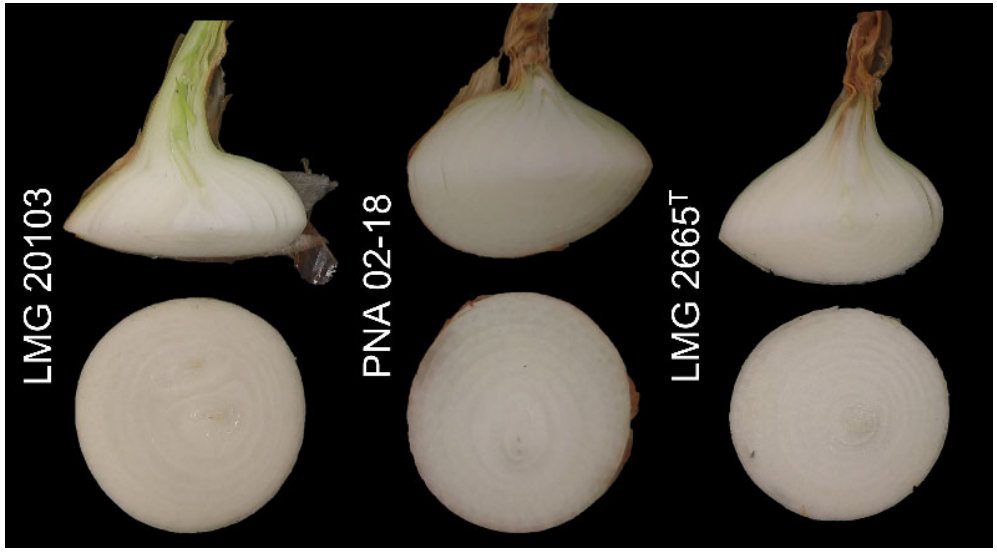
Because some *Pantoea* onion pathogens have **genetic resistance to onion sulfur antimicrobials**

Onions inoculated with bacteria:

Onion sulfur compound resistant *Pantoea* strains



Onion sulfur compound sensitive *Pantoea* strains



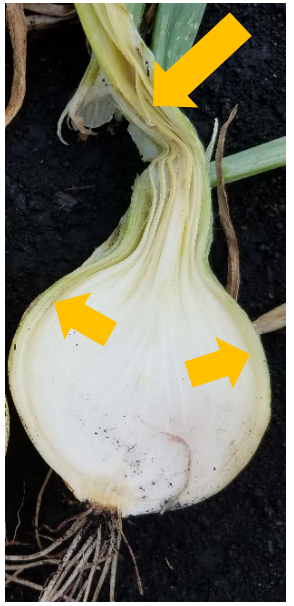
Host: Antimicrobial Properties of Onion and How that Relates to Infection and Disease Development

Antimicrobial properties of onion may (in-part) explain differences in incidence of foliar bacterial symptoms and incidence of bulb rot

Foliar symptoms of bacterial disease

Bacterial disease in leaf & neck, not in bulb

Bacterial bulb rot



*Bacterial disease in **leaf** tissue*

*Bacterial disease in **bulb** tissue*

Host: Effect of plant architecture (floppy leaves) on bulb rot

upright ⟷ floppy

More upright plant architecture is not as prone to rot as plants with “floppy leaves”.

Host: Effect of plant architecture (floppy leaves) on bulb rot

Due to more areas for water to pool in leaf axils that would increase risk of bacterial infection.

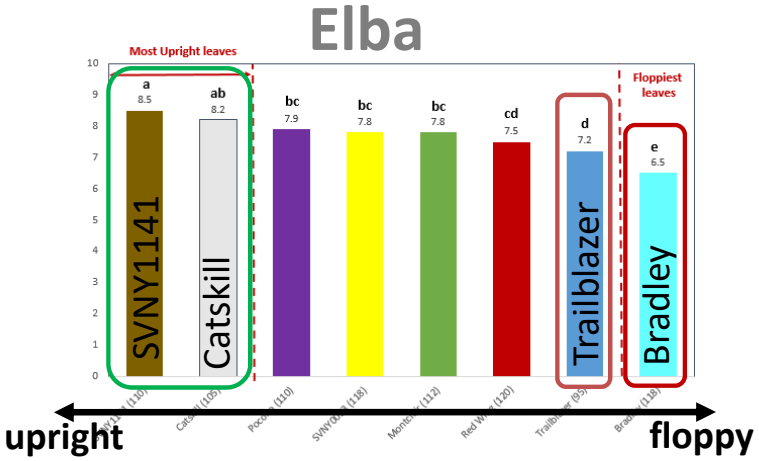
Host: Effect of plant architecture (floppy leaves) on bulb rot

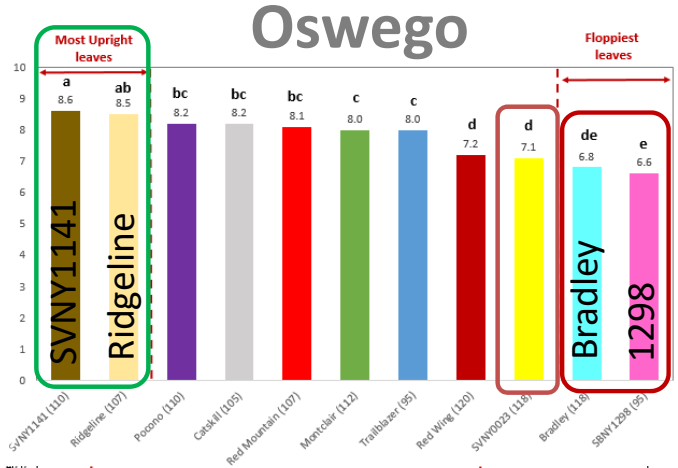
Onion Variety Rot Project, New York: 2019 (*Hoepting*)

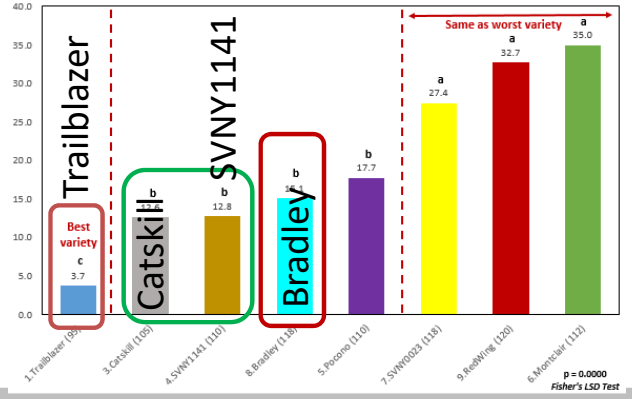
Floppy Leaves
Scale 1-10
Floppy to upright

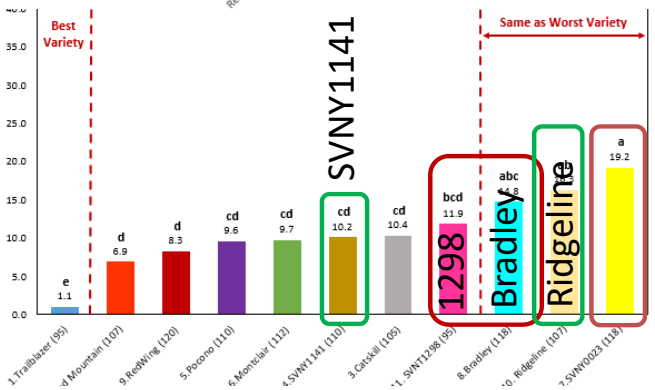
Natural Bulb Rot (%)

Inconsistent relationship between growth habit and bulb rot.





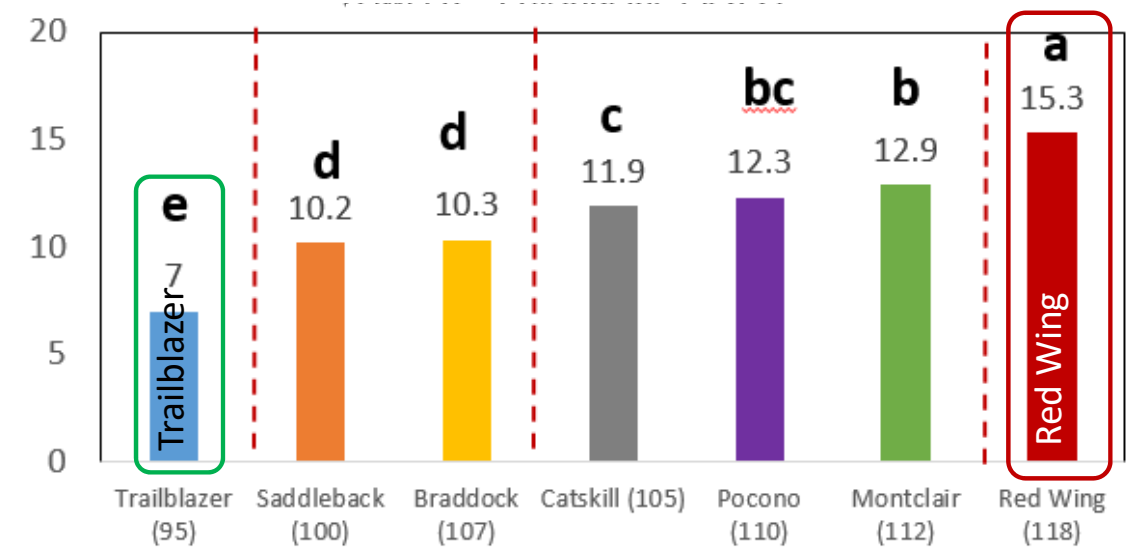




Host: Effect of plant architecture (neck thickness) on rot

Onion Variety Rot Project, New York: Elba 2018 (*Hoepting*)

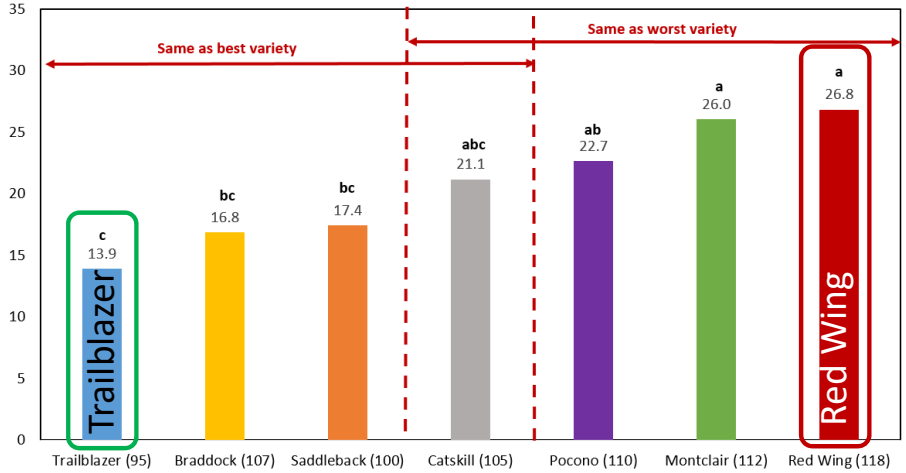
Neck Diameter (at 95% lodging)



Thin/early ⟷ Thick/late

As neck diameter increased, bulb rot increased.

Natural Bulb Rot (%)

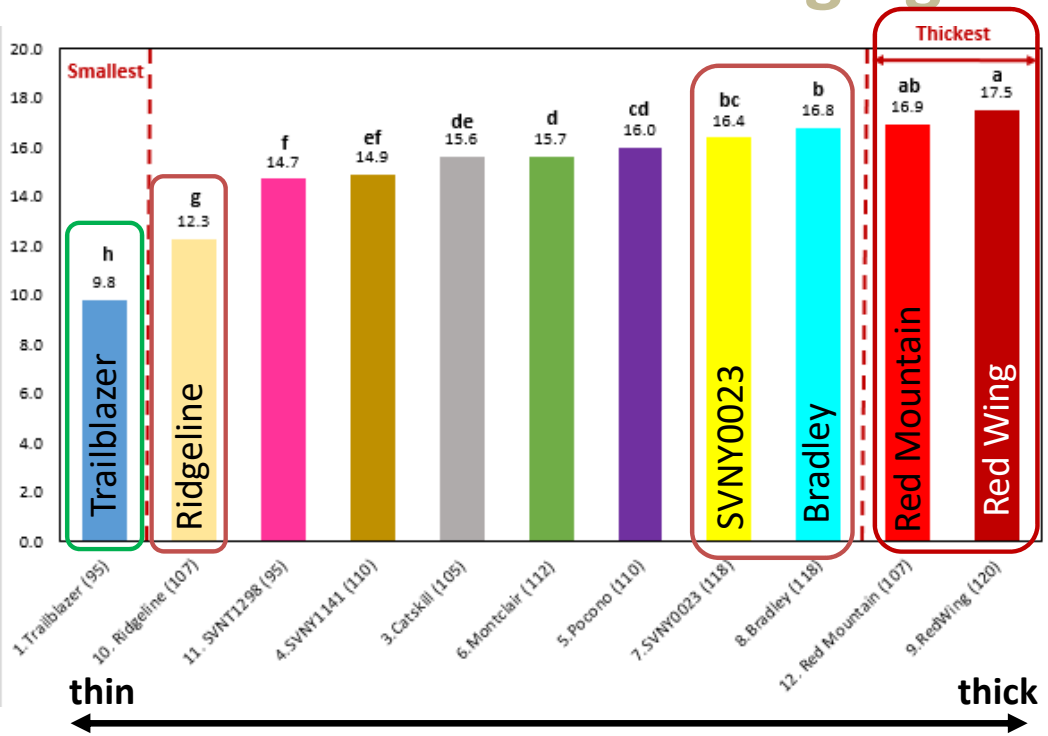


As days to maturity increased, neck diameter increased.

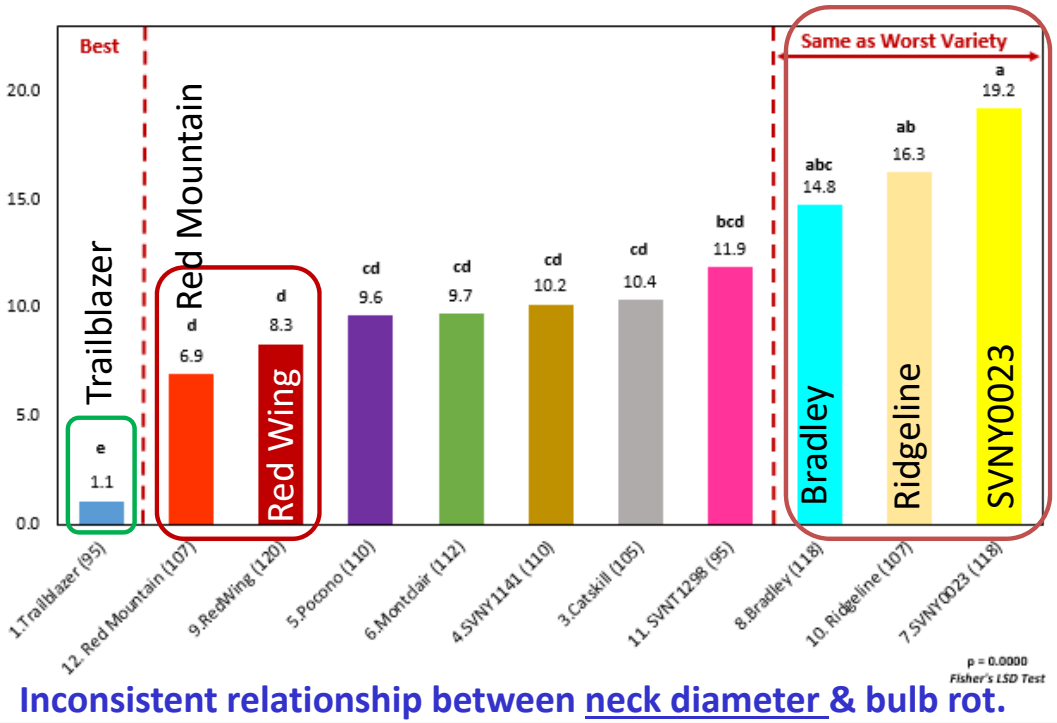
Host: Effect of plant architecture (neck thickness) on rot

Onion Variety Rot Project, New York: Oswego 2019 (*Hoepting*)

Neck Diameter at Lodging



Natural % Bulb Rot

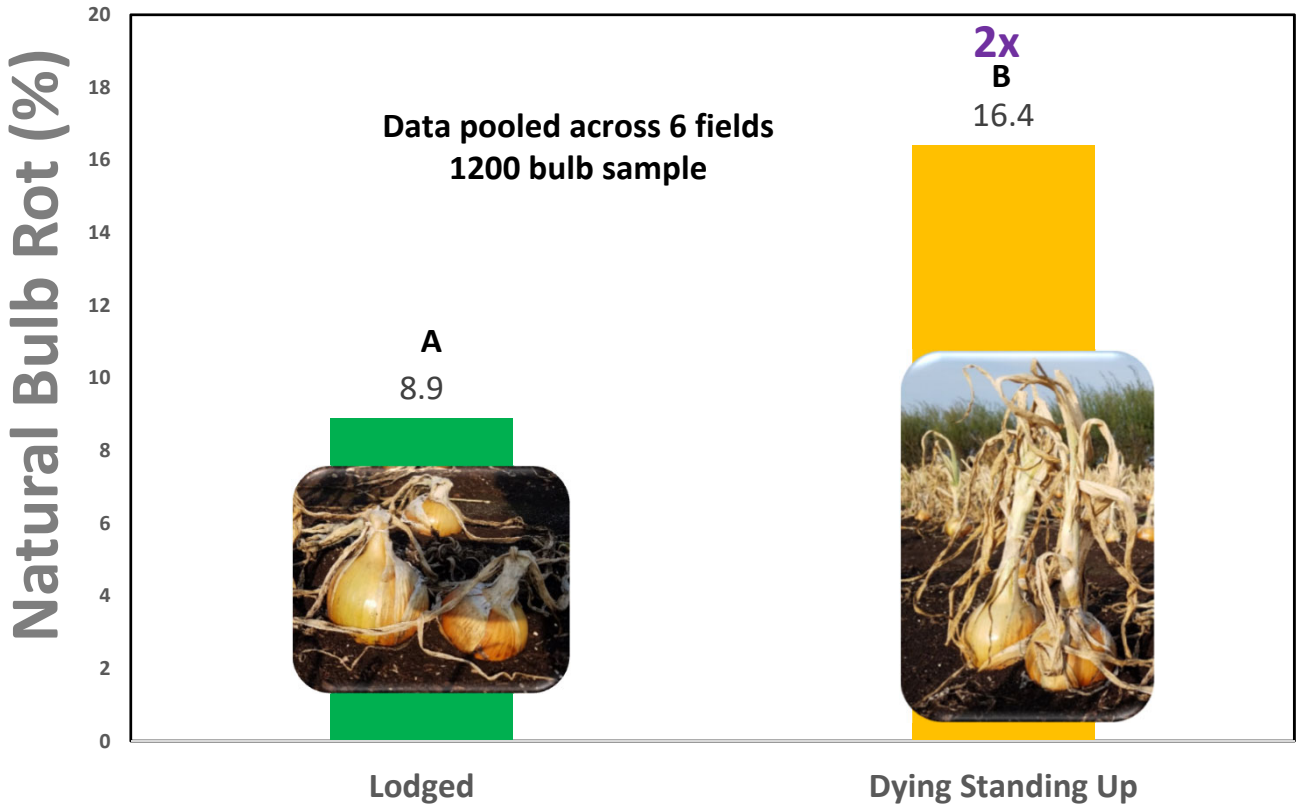


Inconsistent relationship between neck diameter & bulb rot.

Host: Effect of dying standing up on bulb rot

Field Survey, New York: 2015 (*Hoepting*)

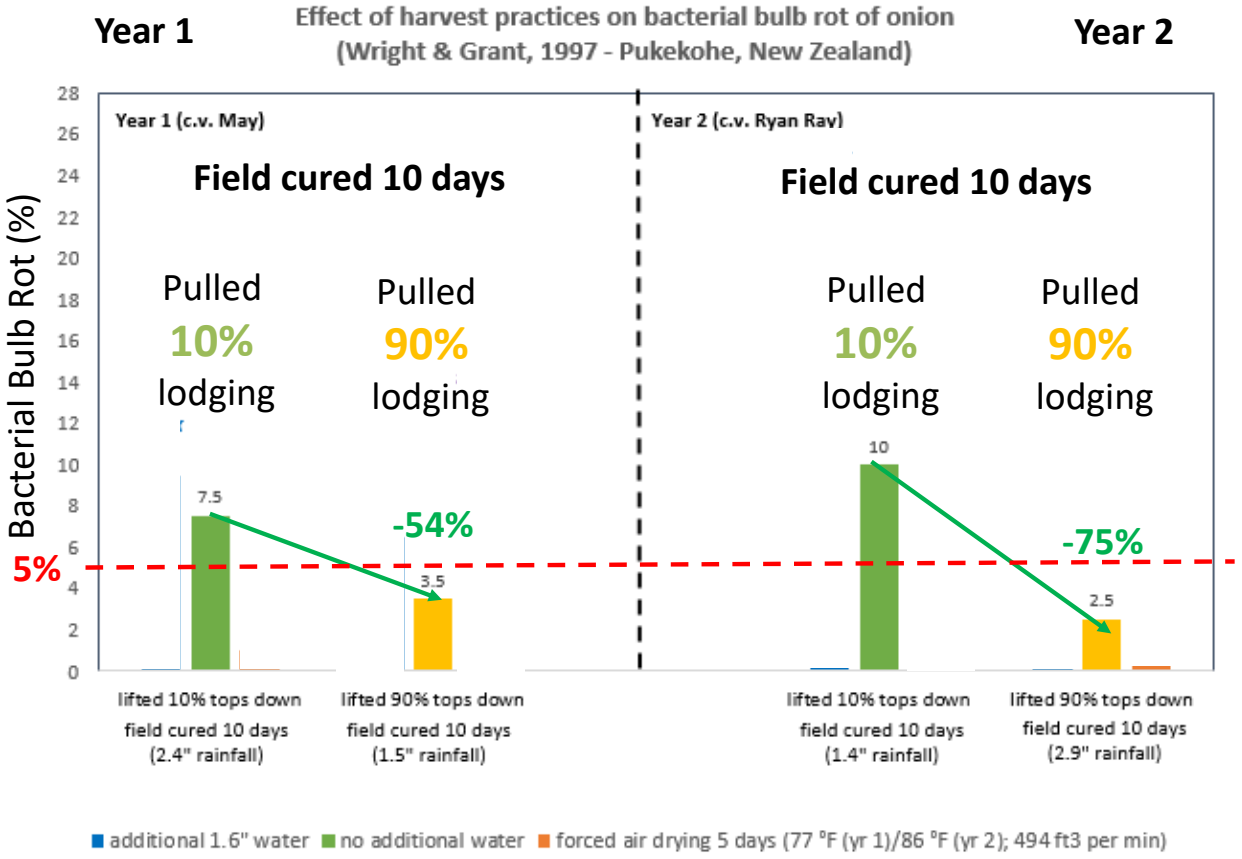
Plants that died prematurely standing up had **2-times** as much bulb rot at harvest.



Hoepting 2015

Environment: Implications of Harvest & Post-Harvest Practices on Onion Bulb Rot – Effect of Lodging

As lodging increases,



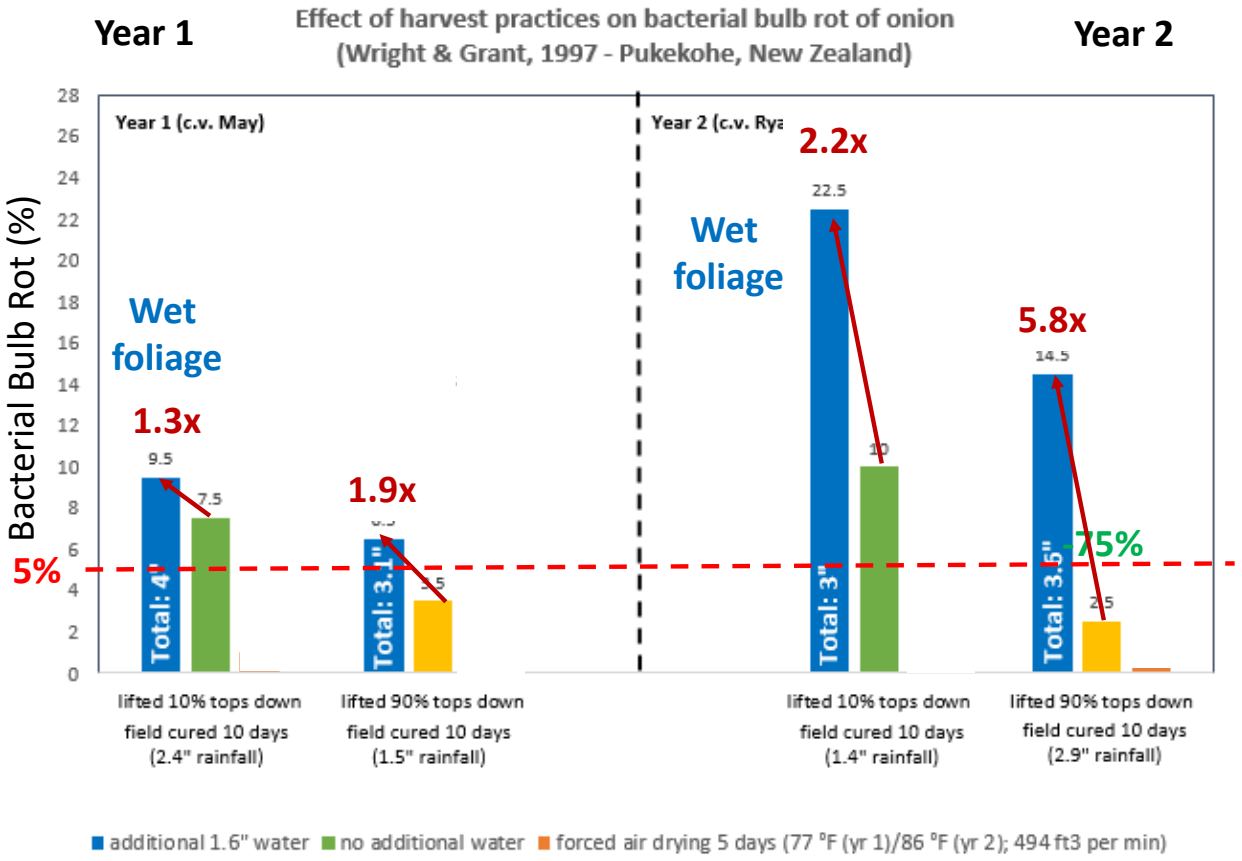
Bulb rot decreases.

Environment: Implications of Harvest & Post-Harvest Practices on Onion Bulb Rot – Effect of Wet Foliage During Curing

Field cured 10 days

Pulled	Pulled
10%	90%
lodging	lodging

Leaf wetness during field curing



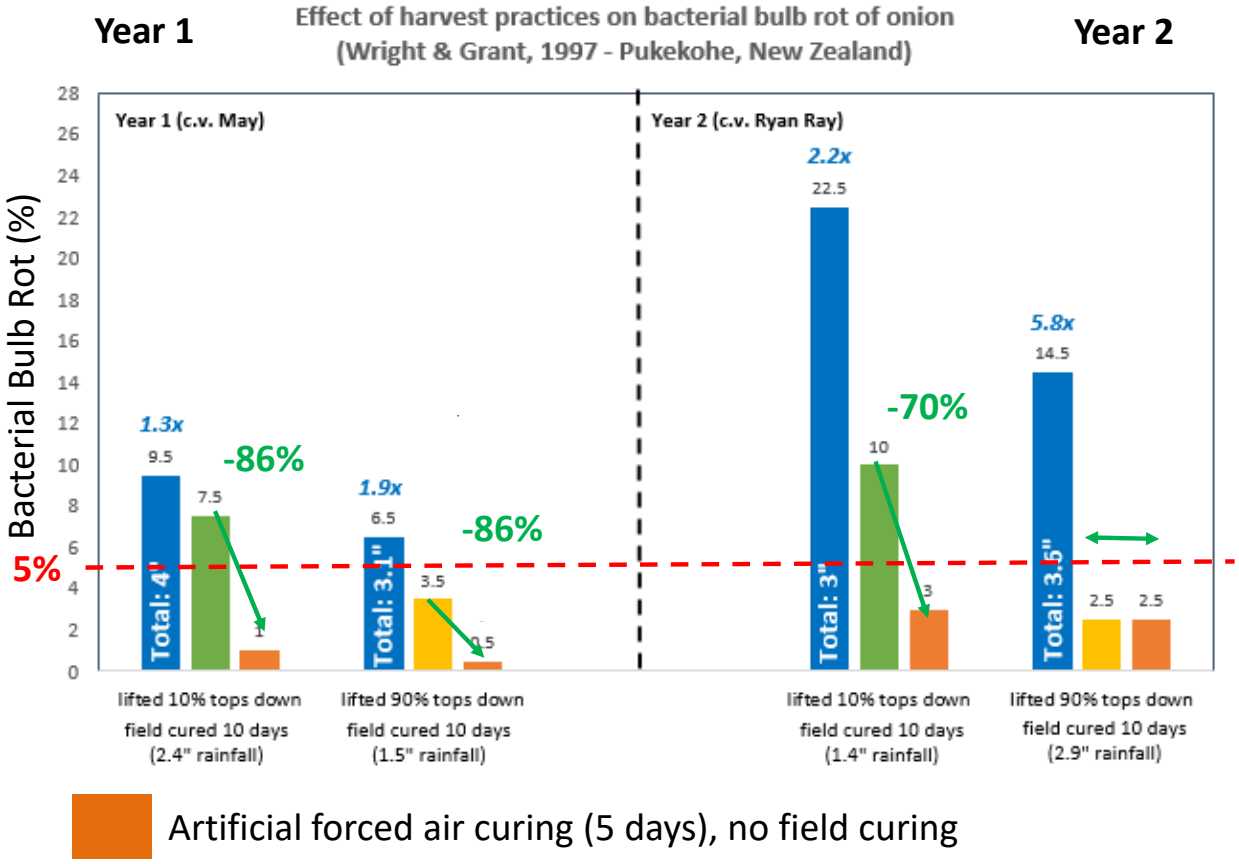
increased Bulb rot.

Environment: Implications of Harvest/Post-Harvest Practices on Onion Bulb Rot – Effect of Artificial Forced Air Curing

Field cured 10 days

Pulled	Pulled
10%	90%
lodging	lodging

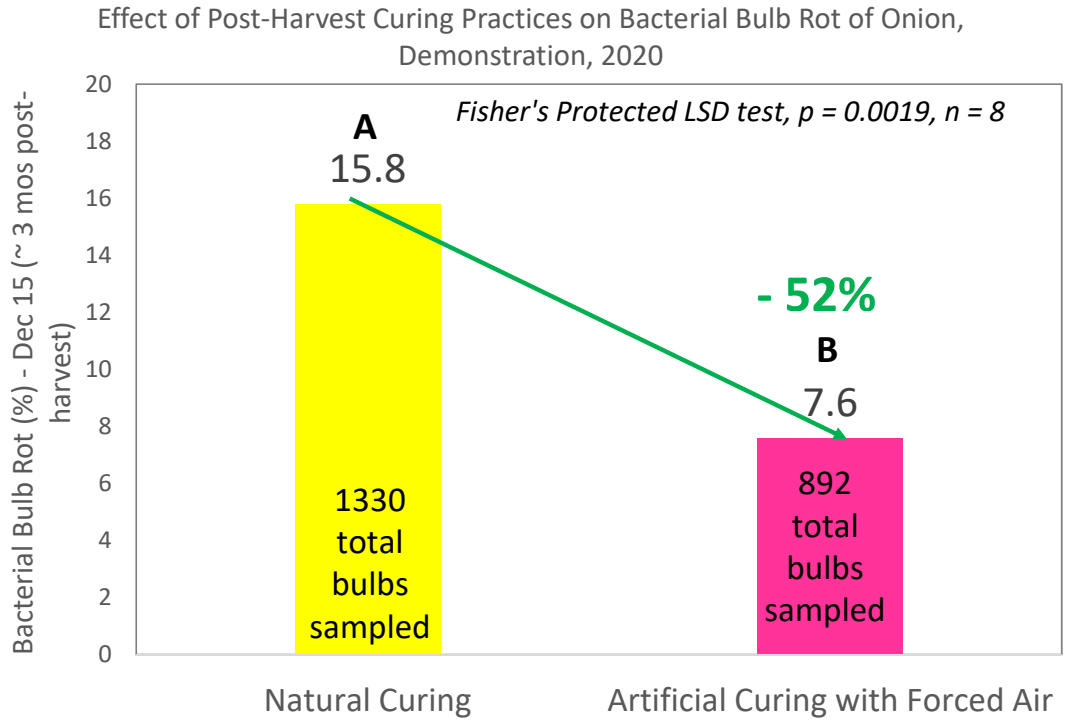
Artificial forced air curing (drying wall)



decreased Bulb rot.

Environment: Implications of Post-Harvest Practices on Onion Bulb Rot – Effect of Artificial Forced Air Curing – Elba 2020 (Hoepting)

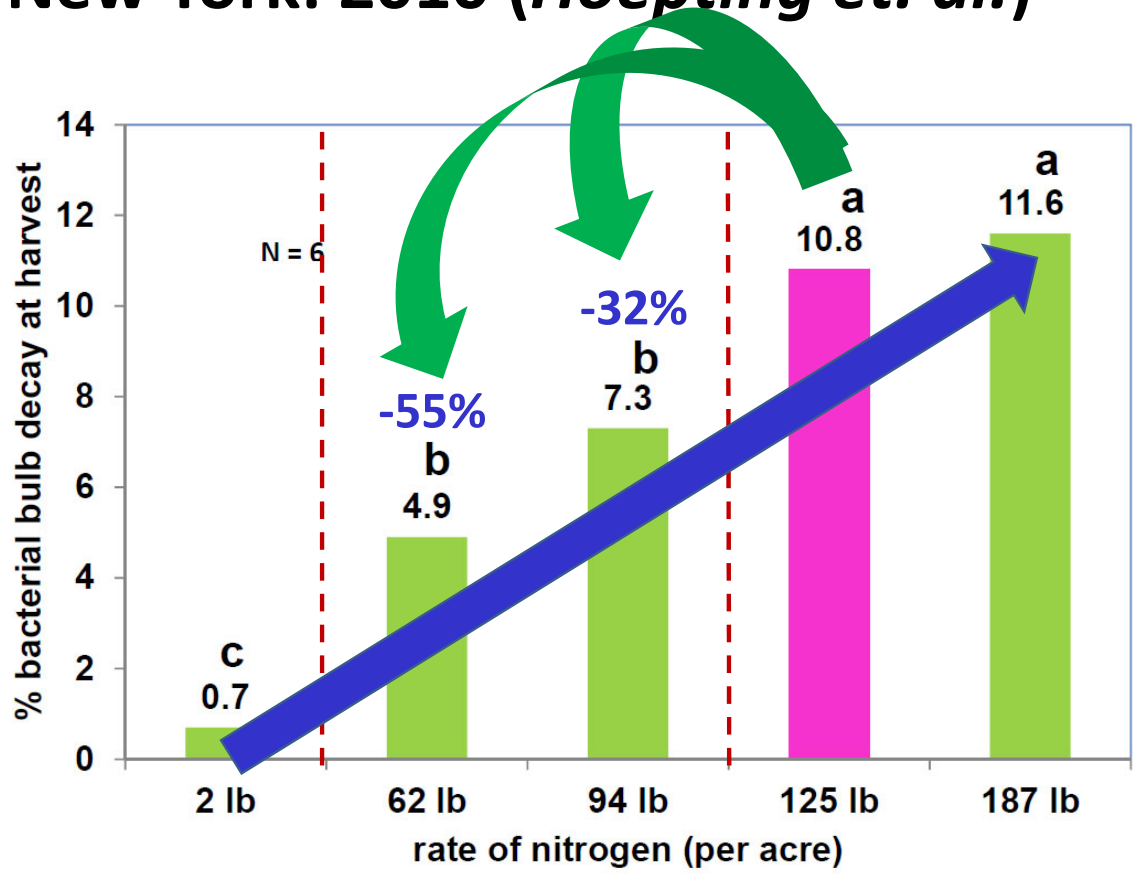
Compared to natural curing, **artificial curing reduced incidence of bacterial bulb rot by 52%.**



Environment: Effect of nitrogen on bulb rot

Onion Variety Project, New York: 2010 (*Hoepting et. al.*)

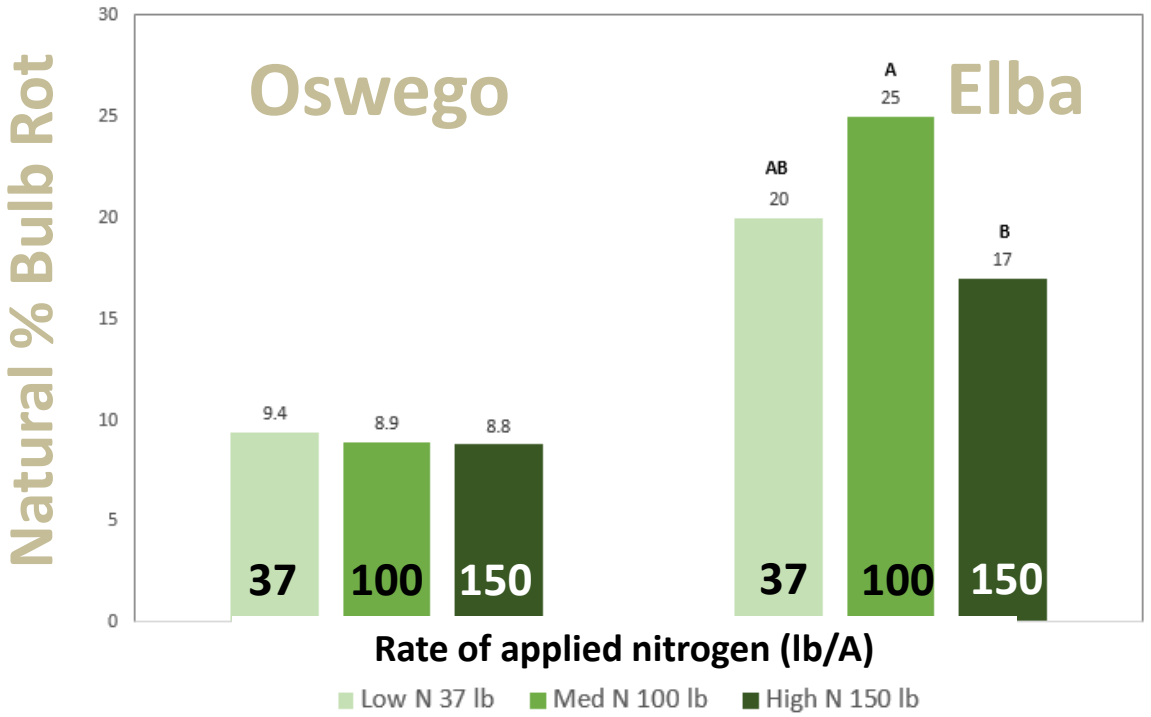
As rate of applied total nitrogen (**2, 62, 94, 125, 187 lb/A**) increases, bacterial bulb rot increases.



Environment: Effect of nitrogen on bulb rot

Onion Variety Rot Project, New York: 2018 (*Hoepting*)

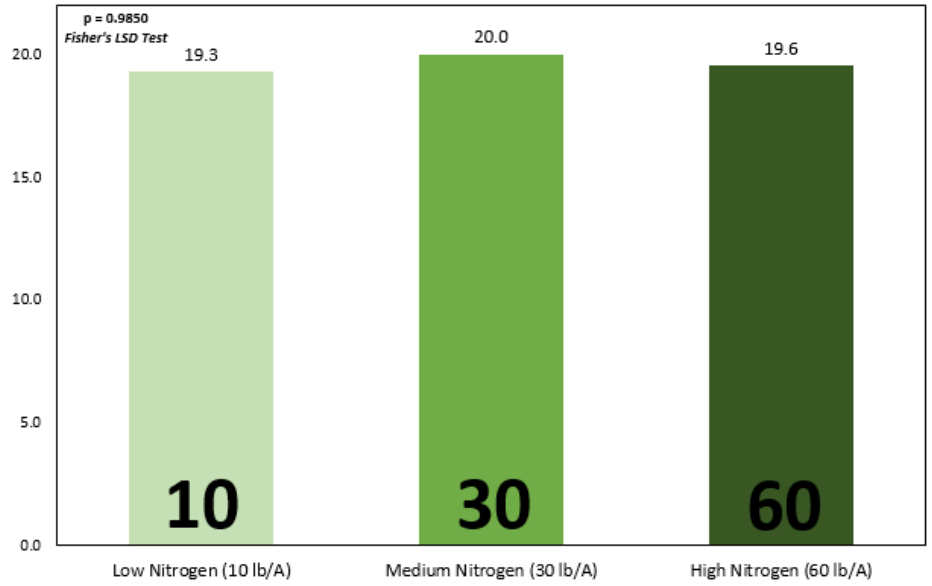
No relationship between **37**, **100** & **150** lb/A nitrogen and bulb rot



Environment: Effect of nitrogen on bulb rot
Onion Variety Rot Project, New York: Elba, 2019 (*Hoepting*)

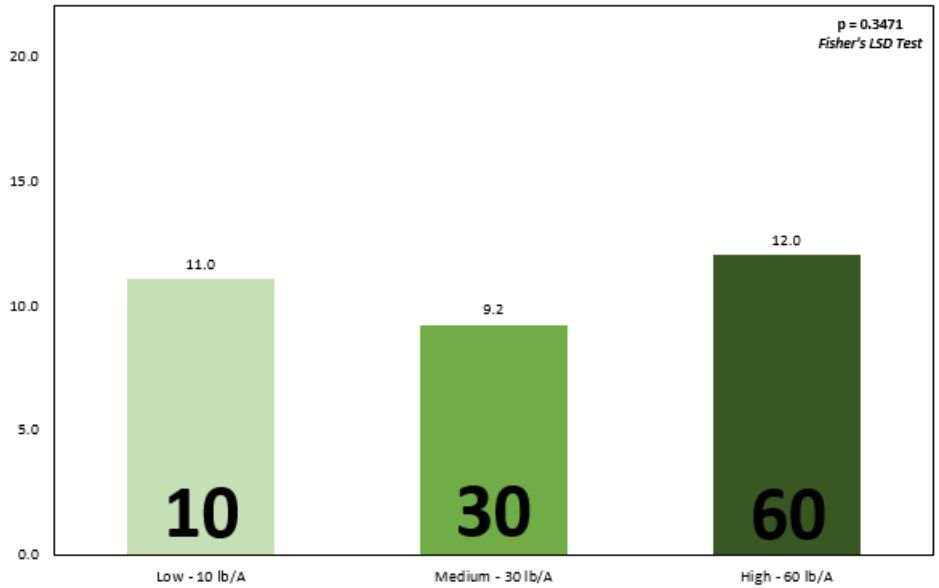
No relationship between **10**, **30** & **60** lb/A nitrogen and bulb rot

Natural % Bulb Rot
Elba



Rate of applied nitrogen (lb/A)

Natural % Bulb Rot
Oswego



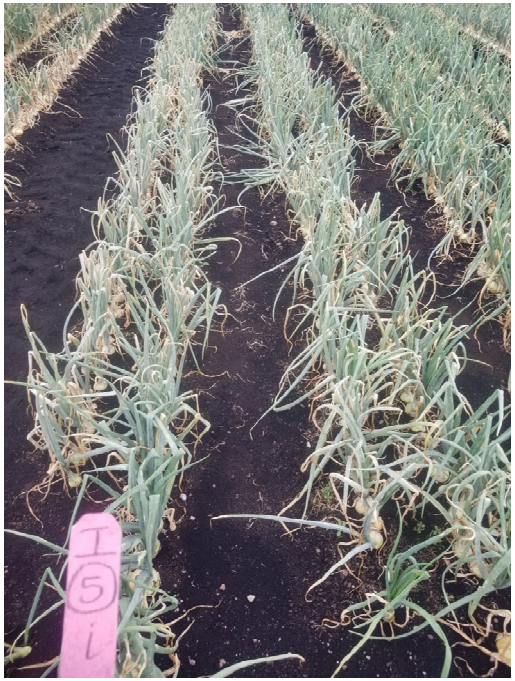
Rate of applied nitrogen (lb/A)

Environment: Effect of onion thrips feeding on bulb rot

Onion Variety Rot Project, New York: Elba, 2019 (*Hoepting*)

Thrips feeding damage (white foliage)

low ← → **high**

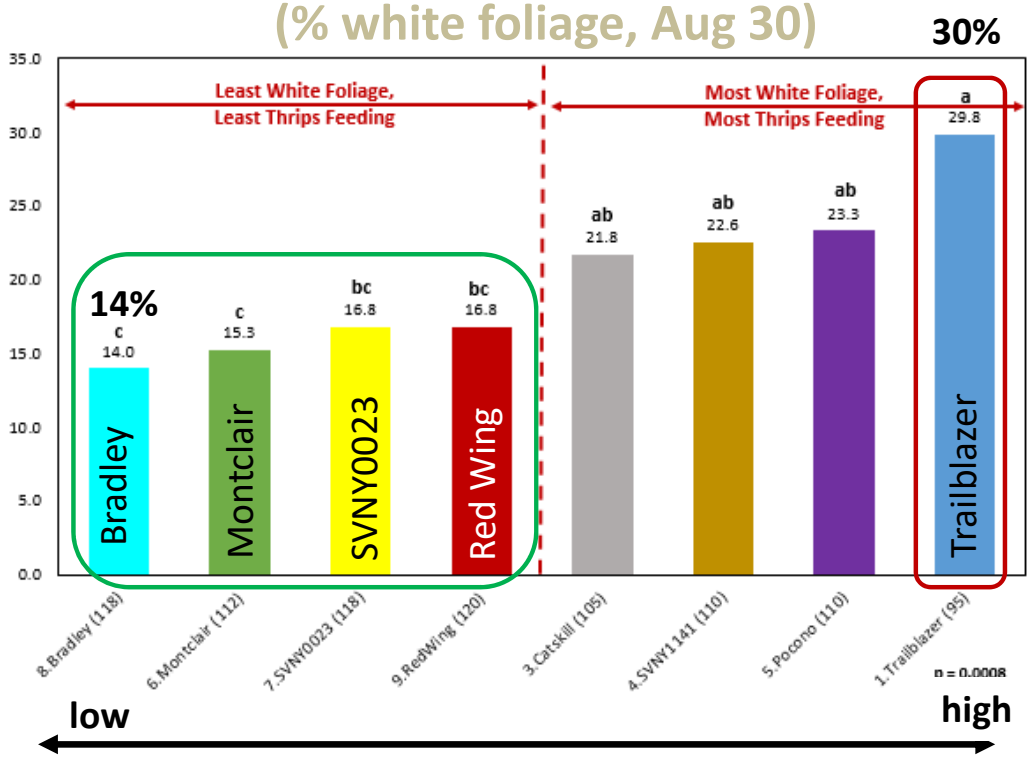


Onion thrips spread bacterial pathogens and cause wounding that may increase risk of bacterial infection.

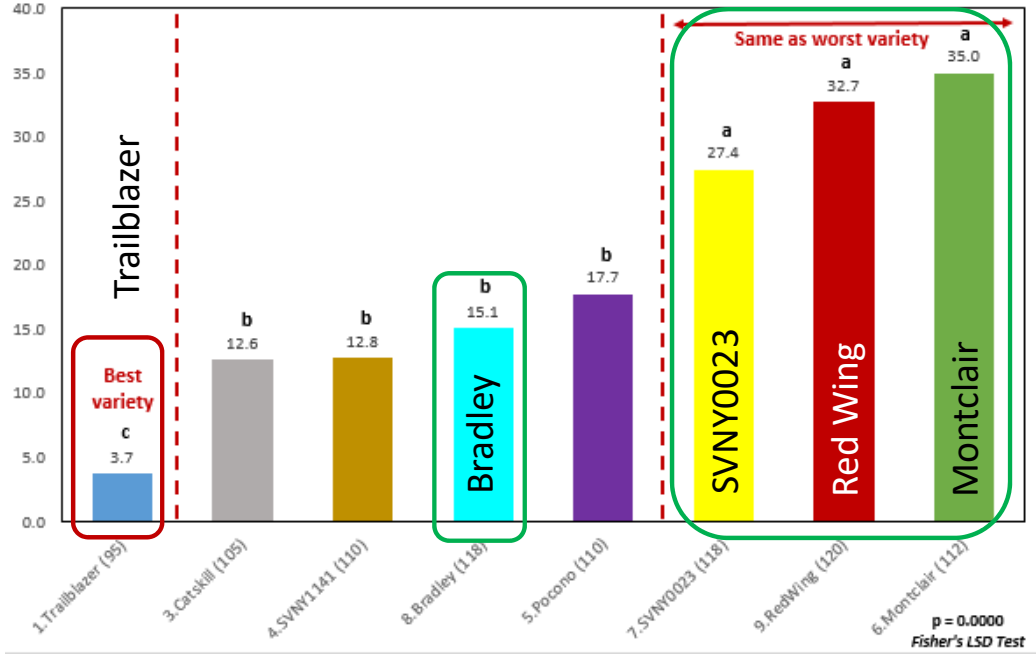
Environment: Effect of onion thrips feeding on bulb rot

Onion Variety Rot Project, New York: Elba, 2019 (*Hoepting*)

Onion Thrips Feeding
(% white foliage, Aug 30)



Natural % Bulb Rot



No relationship between thrips feeding and bulb rot.

Stop the Rot

Combating onion bacterial diseases with pathogenomic tools and enhanced management strategies

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