



Recent investigations into Fusarium bulb rot diseases of garlic



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Sold as bulbs and seed



Infected seed = primary inoculum source

When in growing season do infections occur?
What environmental factors influence infection?
Unknown



Infested soil = primary inoculum source



What are inoculum sources?
Do secondary infections occur?

Is there opportunity to modify current storage conditions to suppress post harvest rot?



Bulbs harvested and stored

Is the dry down period influencing fungal infection?

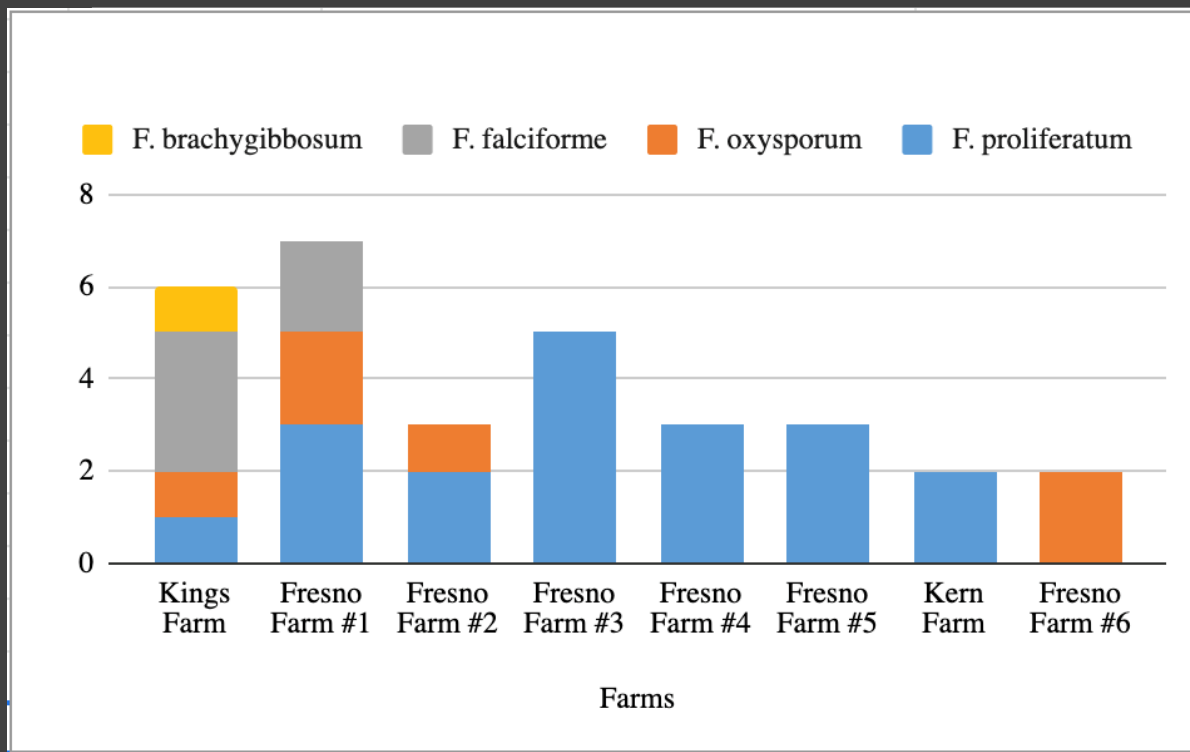


Bulb curing in field



Inoculum remains in soil and residues

At least four Fusarium species associated with bulb rot



F. proliferatum: most common, all but one farm, commonly sole species

F. oxysporum: second most common, 50% of farms, rarely sole species

F. falciforme: 25% of farms, never alone

F. brachygibbosum: rare

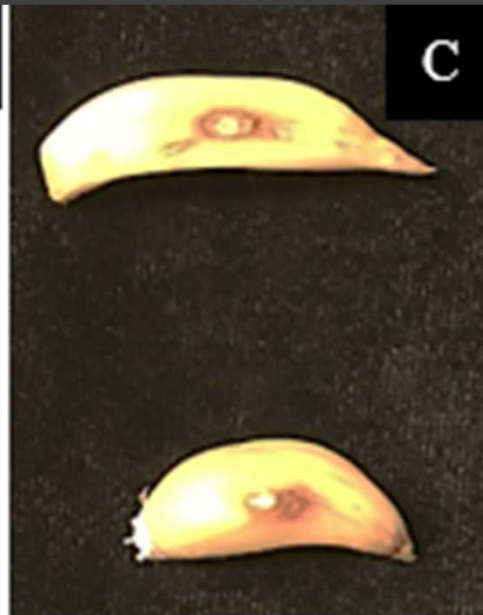
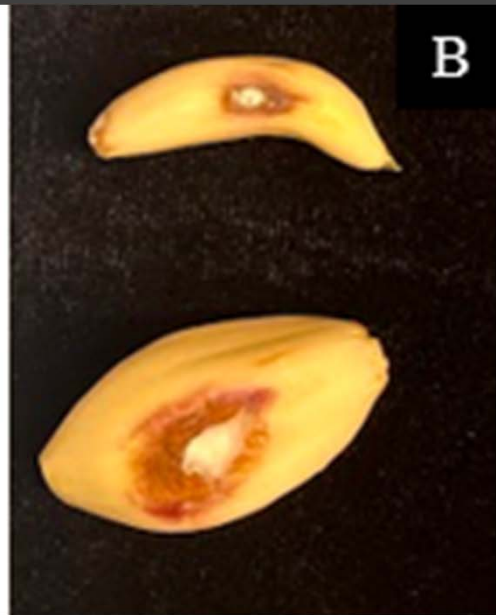
Fusarium proliferatum, F. oxysporum and F. falciforme can cause rot

F. proliferatum

F. oxysporum

F. falciforme

Mock



F. proliferatum

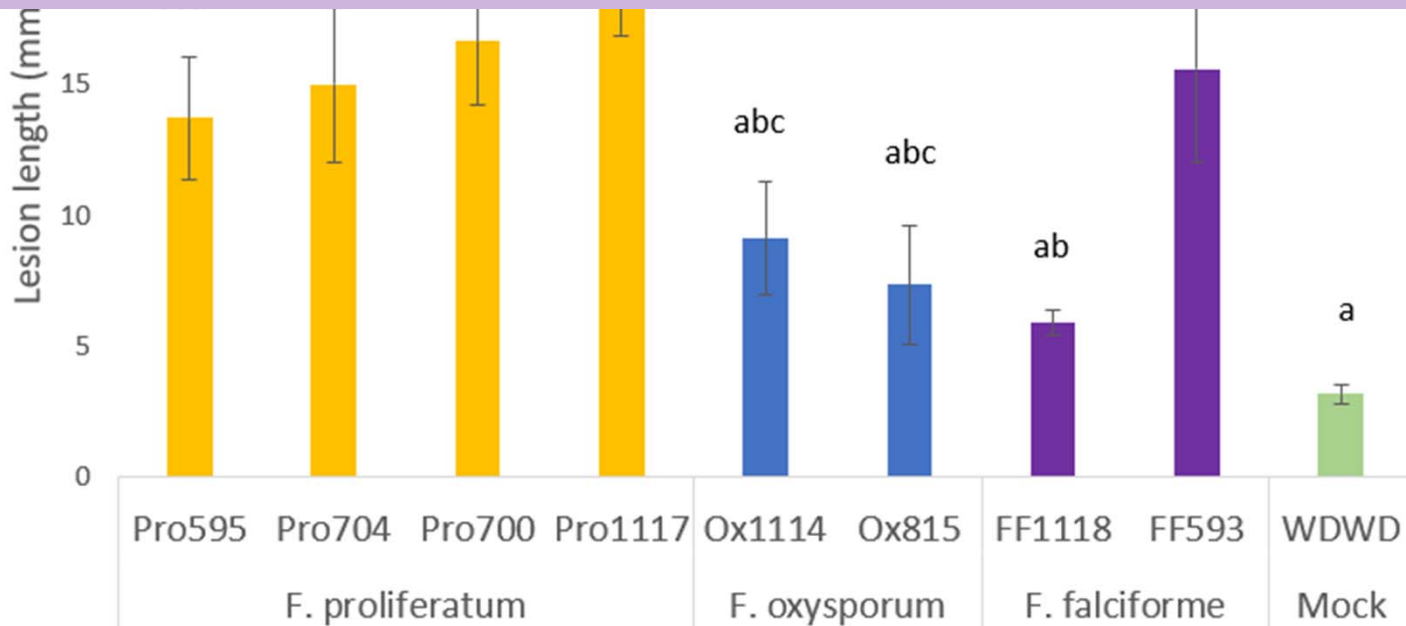
F. oxysporum

F. falciforme

Mock

In CA F. proliferatum is likely the primary driver of rot
May facilitate other species

And other species may cause less severe losses alone or more severe losses under certain conditions



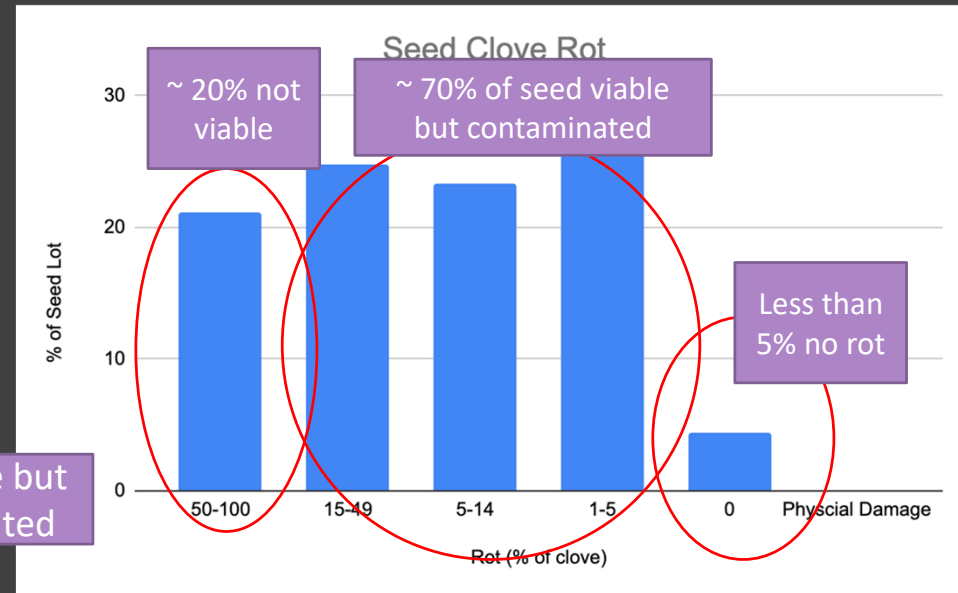
is the most virulent

F. oxysporum the least

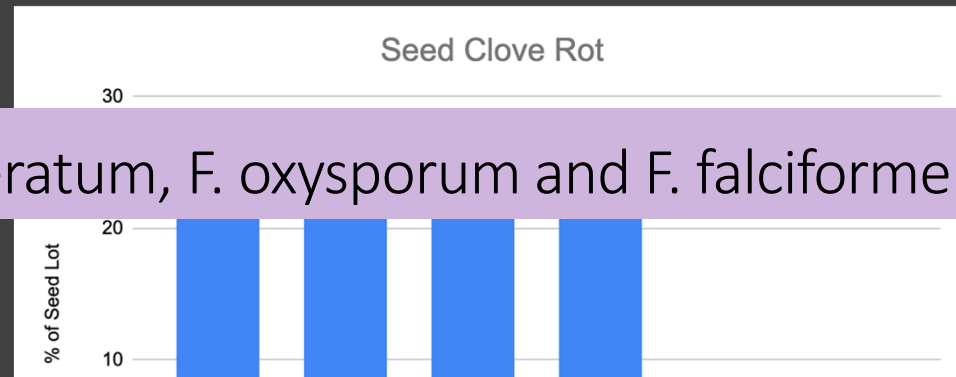
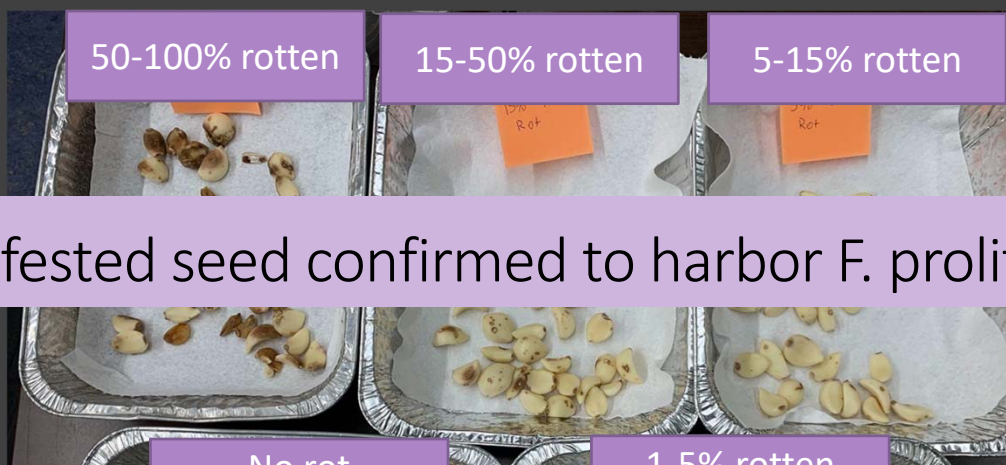
F. falciforme variable

Contaminated seed is a major management challenge

Over 90% of seeds have some rot and over 20% are at least half rotten



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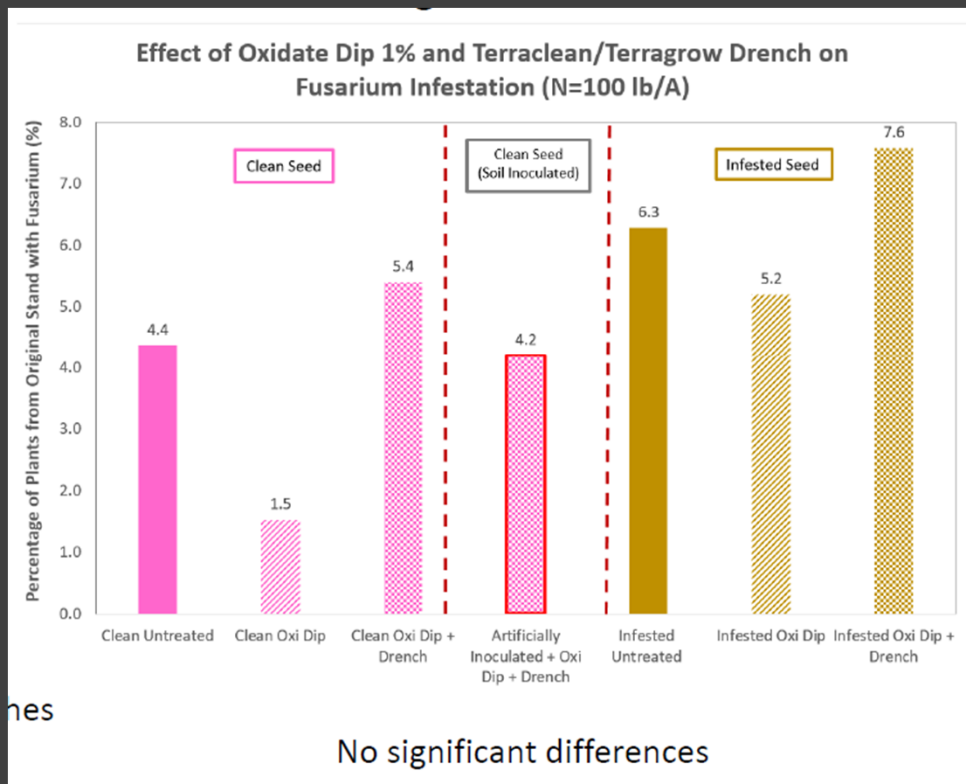


Infested seed confirmed to harbor *F. proliferatum*, *F. oxysporum* and *F. falciforme*

Need methods to manage seed infection and rot



Reducing primary inoculum from seed: Sanitizing seed does not appear to reduce rot development



New York study (Fusarium spp. unclear)

1% Oxidate dip

Hydrogen peroxide + peracetic acid drench (TerraClean)

Baccillus spp. + Trichoderma (TerraGrow)

Other options for reducing primary inoculum and bulb rot losses

Other seed treatment strategies

- ❖ Heat treatment?
- ❖ Other chemical seed treatments?

Field management methods to reduce infections and rot in seed and bulb production fields?
Chemical, cultural, other

- ❖ Reduce infection in garlic seed to lower primary inoculum in bulb fields and rot

Post harvest management in seed and bulb production?

- ❖ Management methods to reduce rot and potential spread in storage



In-season and post-harvest options for garlic rot management in seed and bulb production



Agriculture / Onion and Garlic / Fusarium Basal Rot

Agriculture: Onion and Garlic Pest Management Guidelines

Fusarium Basal Rot

Fusarium oxysporum f. sp. *cepae*

UC IPM

Management options target onion, where there is cultivar resistance

Soil insect management recommended, but what insects, when and why are unknown

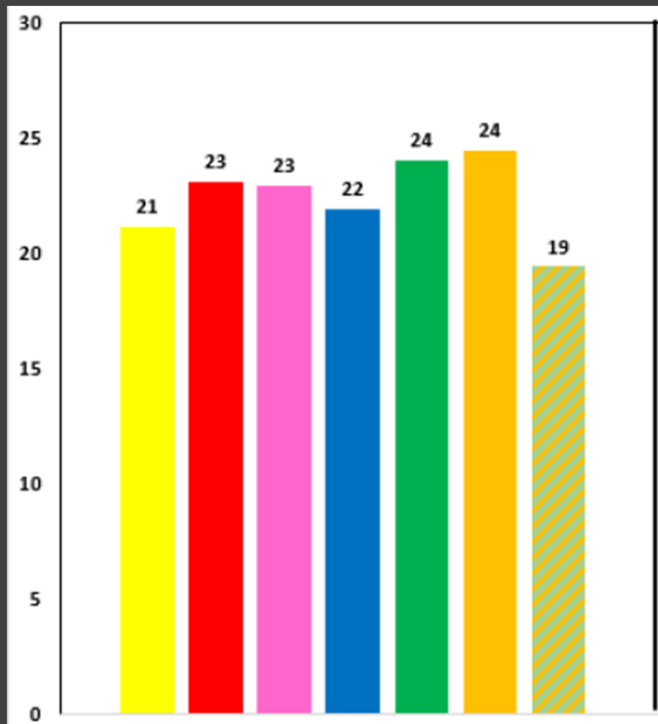
Proper curing recommended but no BMPs have been developed

Management

Cultural Control

Plant resistant onion cultivars. Avoid fields with a history of Fusarium basal rot problems, and rotate 3 to 4 years out of onion, garlic, leek, and other crops that favor growth of the fungus, such as corn, tomato, and sunflower. Manage soil insects and foliar diseases, and cure bulbs properly before storage. To avoid favorable conditions for infection, store bulbs at temperatures no warmer than 39°F and at low relative humidity (about 70%).

Improving management options: Chemical management?



Many studies of chemical management-all indicate no control

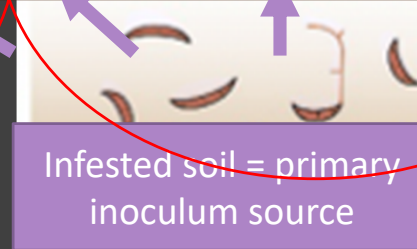
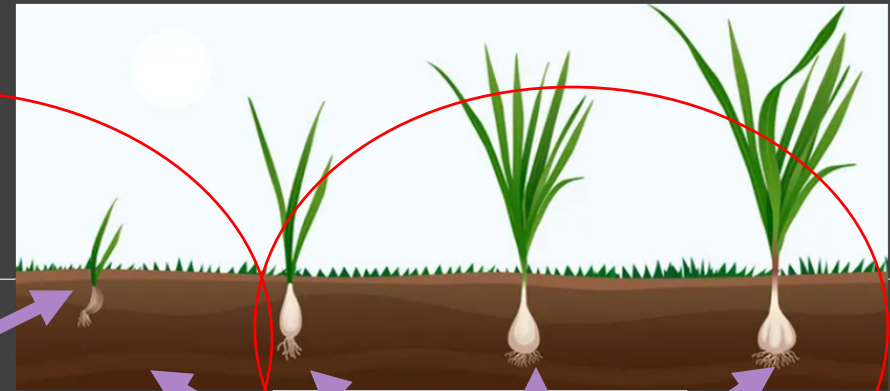
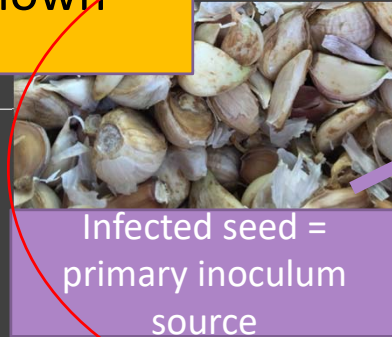
All fungicides trials focus on treating seed pre or at planting

Trials include few synthetics, many biologicals

■ Untreated ■ Maxim ■ Vibrance ■ Serifel ■ Rootshield Plus ■ Terradean dip ■ Terradean/Terragrow

Christy Hoepting, CCE Cornell Vegetable Program
Sandy Menasha, CCE – Suffolk County

When in growing season do infections occur? Unknown



Seed treatments prevent early season infections

Unlikely to prevent later infections

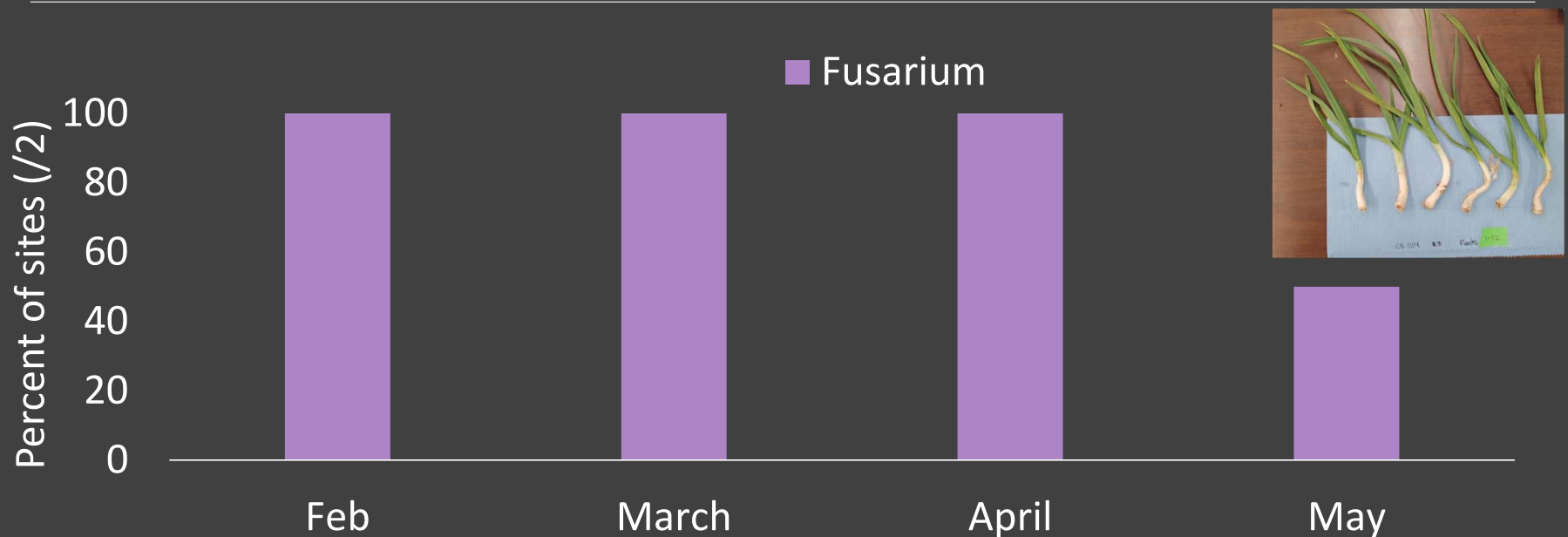
Understanding when infections are occurring can help identify target periods for chemical control

Identifying target control periods: determining when infections are occurring in the field (pre-symptomatic)

Sample #	Date Rec
006-2021	March 8
007-2021	March 8
008-2021	March 8
009-2021	March 8
016-2021	April 9
017-2021	April 9
022-2021	May 6
026-2021	May 6

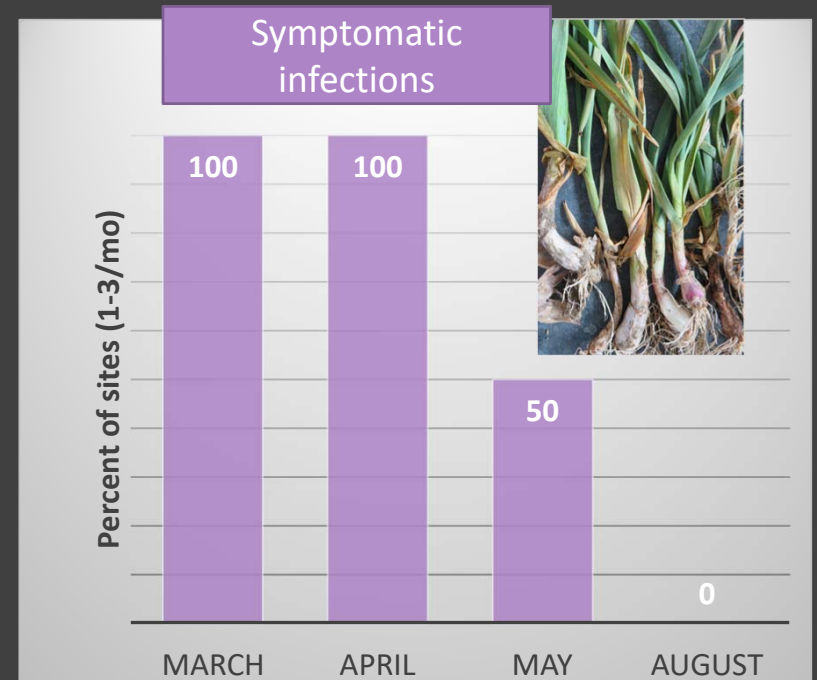
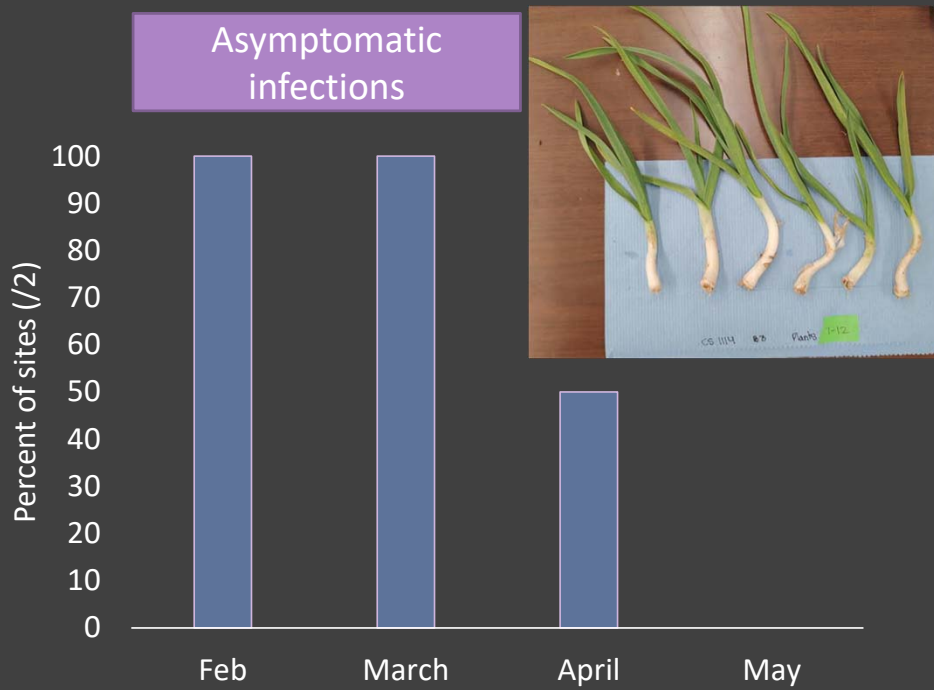


Identifying target control periods: determining when infections are occurring in the field in healthy-looking bulbs



Fusarium detected in asymptomatic bulbs starting in first sample month (Feb)
Declining in May

F. oxysporum appears more active in cooler months

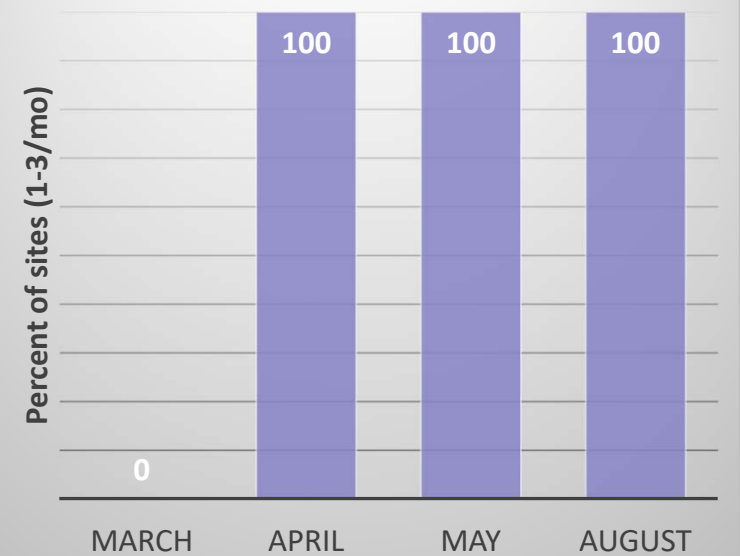


While *F. proliferatum*, the primary pathogen (potentially) is more active in later months

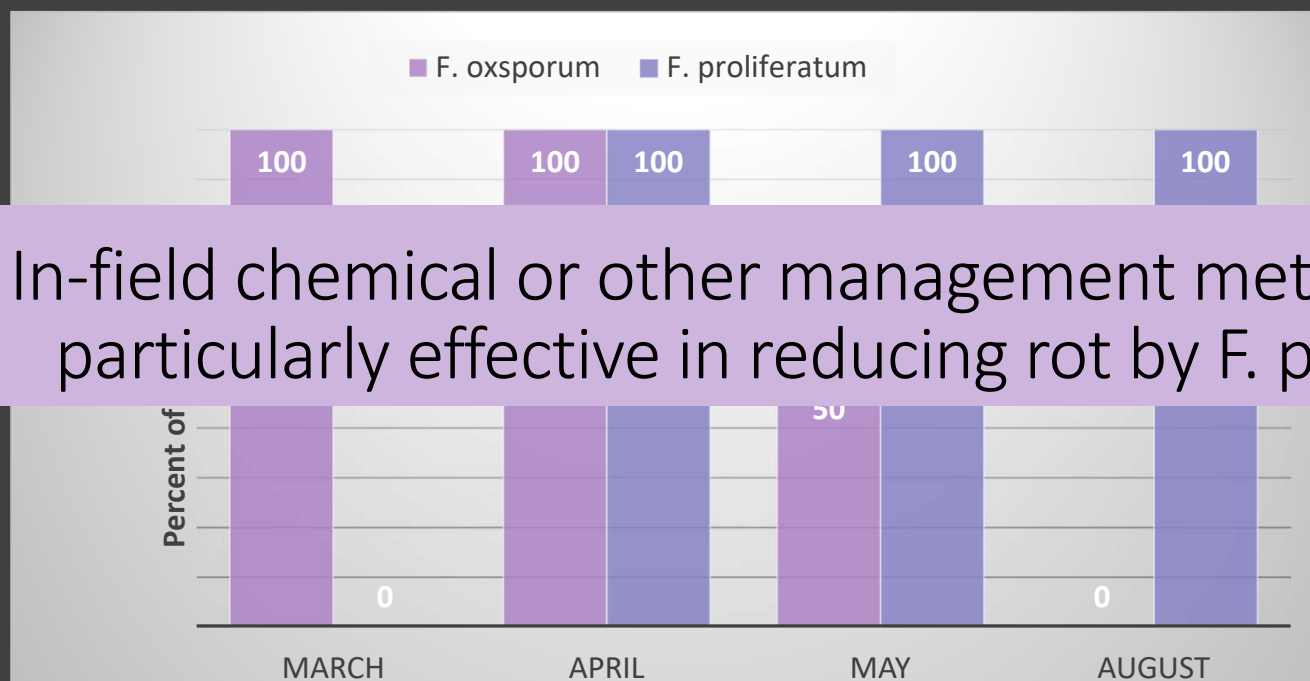
Asymptomatic infections



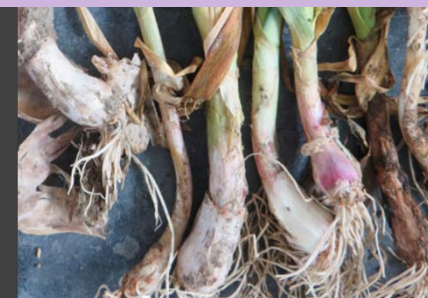
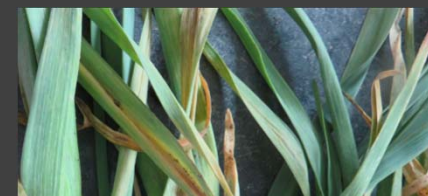
Symptomatic infections



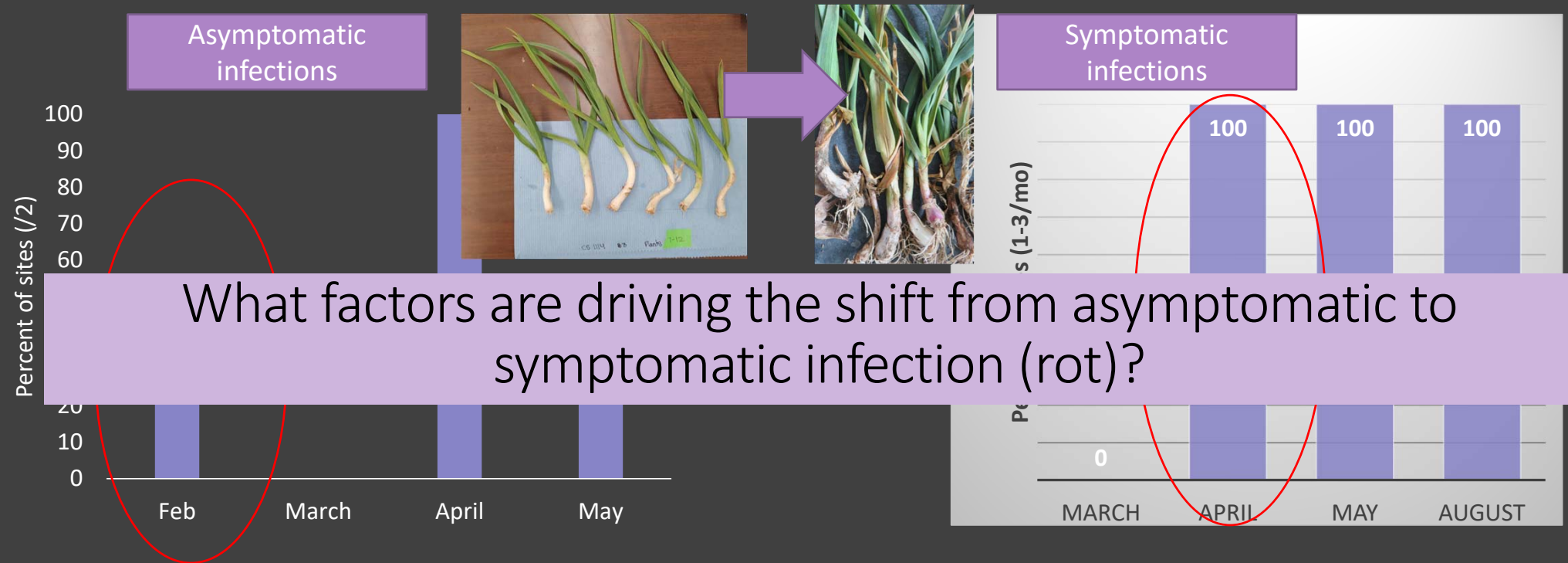
Rot primarily caused by *F. oxysporum* early season and (solely?) *F. proliferatum* later season



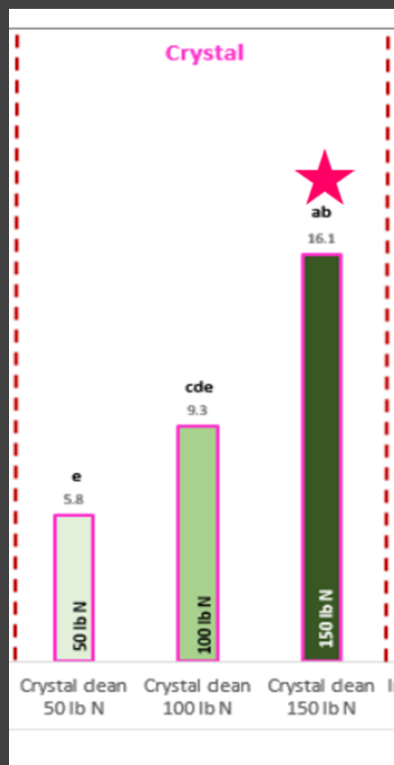
In-field chemical or other management methods may be particularly effective in reducing rot by *F. proliferatum*



While bulbs become infected as early as February, rot is rarely detected before April



Improving management options



Higher nitrogen rate in some cases increased the severity of bulb rot (percent of the clove rotten) in a New York study

50 and 100 lbs N were similarly low

Increase occurred at 150 lbs N, which is a CA industry standard

QUESTION: Is the high N rate used in the CA garlic industry increasing infection and/or rot development

In-season management options for garlic rot management-seed and bulb production



[Agriculture / Onion and Garlic / Fusarium Basal Rot](#)

[Agriculture: Onion and Garlic Pest Management Guidelines](#)

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Evaluating co-factors associated with infection and rot of *F. proliferatum* and *F. oxysporum*: controlled trial

Correlations with changes in:

- Soil nutrient levels
- Soil moisture and temperature
- Plant developmental stage
- Possible pesticide interactions (eg. phytotoxicity)
- Arthropods associated with asymptomatic and symptomatic infection windows (and bulbs)
- Agronomic practices (eg. dry down)



Conclusion: More research needed!
Many potential opportunities to improve
Fusarium bulb rot management



Questions, comments?

