

Fungal Wars: Interactions of *Fusarium verticillioides* and Pathogenic *Ustilago maydis* in Maize

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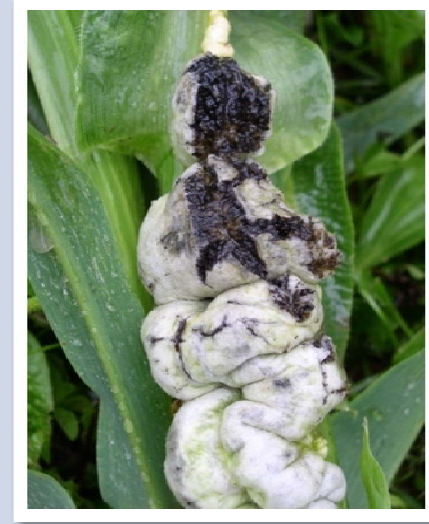
Introduction

Endophytic fungi can increase the fitness of their host plants.

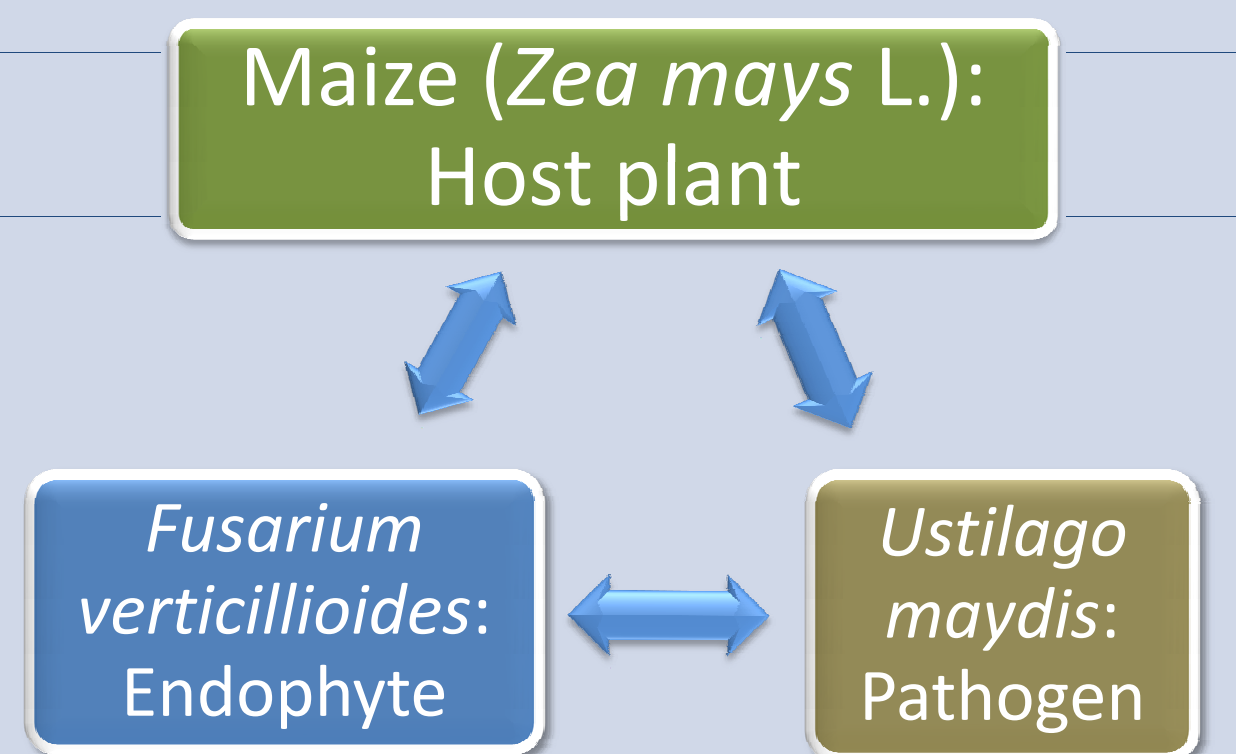
- **Endophytes:** Fungi that colonize interior tissues of plants without causing disease symptoms¹
- Some endophytes help their hosts by:²
 - ↑ Nutrient intake
 - Conferring thermotolerance
 - Protecting against pathogens

Ustilago maydis is an important pathogen of maize.

- Obligate parasite, causes corn smut
- Symptoms:³
 - Plant stunting
 - Chlorotic/necrotic lesions
 - Galls
 - Plant death



Endophytic *Fusarium verticillioides* reduces symptoms of *U. maydis* infection in maize.⁴

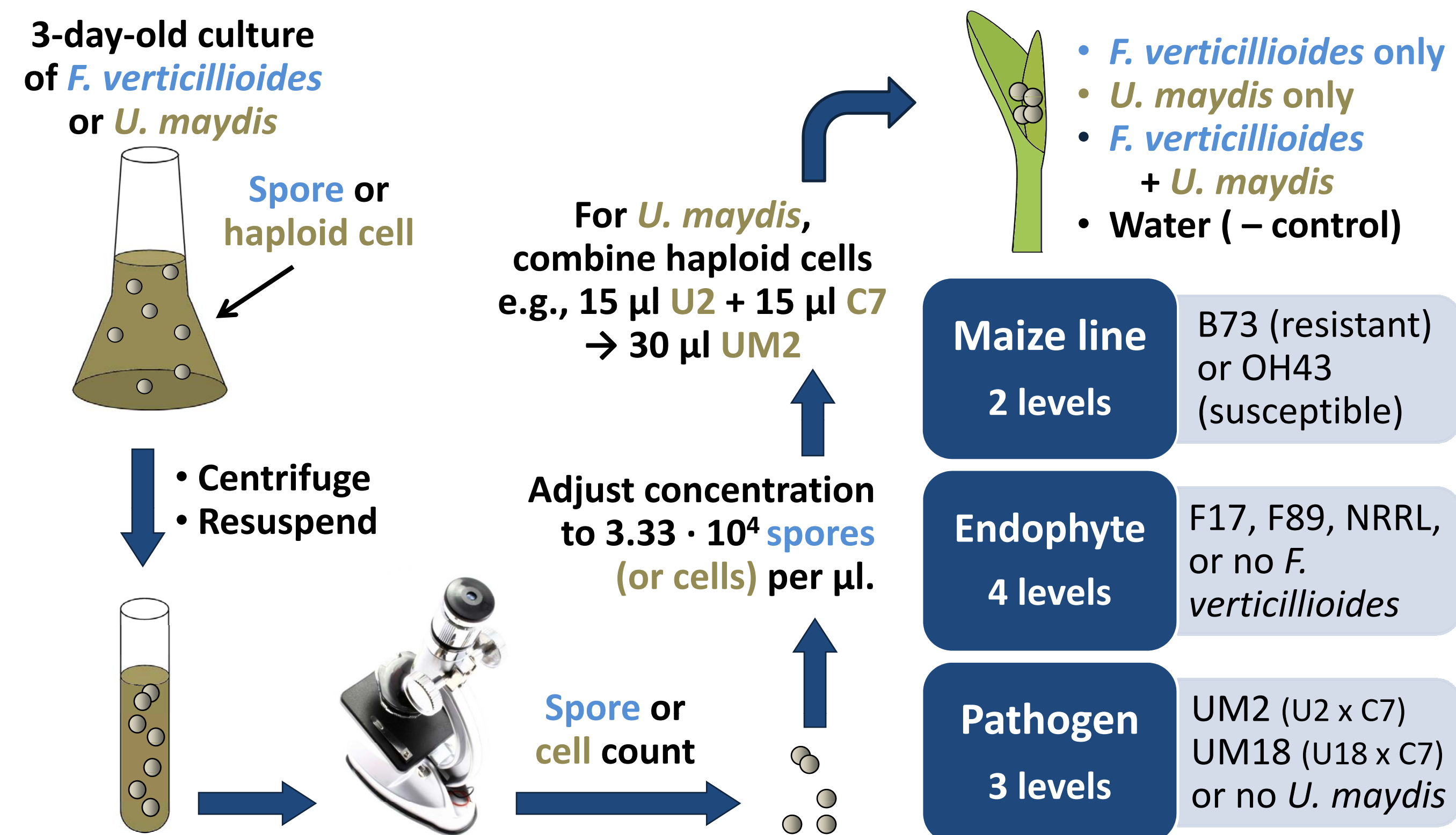


How do different genotypes of maize, *U. maydis*, and *F. verticillioides* interact?

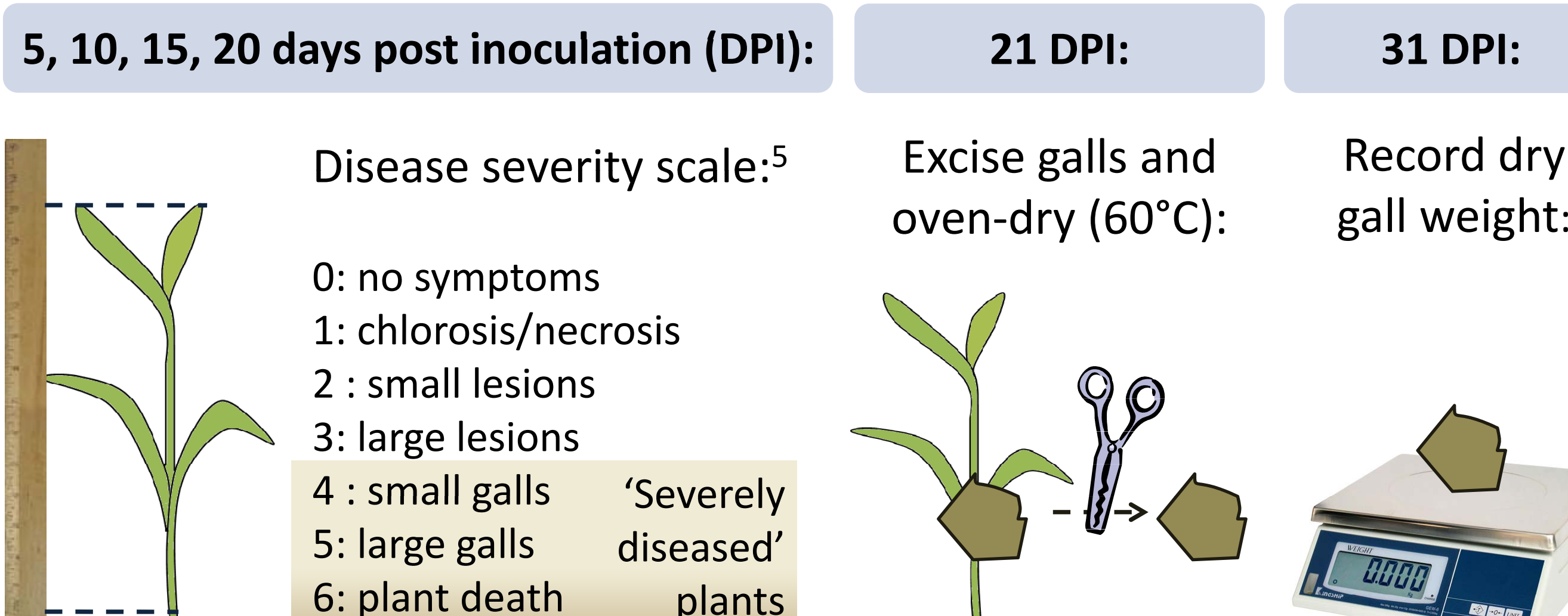
- How do maize lines differ in their susceptibility to *U. maydis*?
- Do *U. maydis* genotypes cause different severities of disease?
- Do *F. verticillioides* strains differ in their ability to reduce *U. maydis* symptoms?

Materials and Methods

Step 1: Inoculum preparation



Step 2: Measurements of plant height, disease severity, and gall weight



OH43 plants were more susceptible to *U. maydis* than B73 plants.

- No B73 plants showed disease symptoms.
- Only OH43 plants died or developed galls.

Ustilago maydis caused plant stunting from 10 – 20 DPI. However, UM2 and UM18 did not cause significantly different levels of stunting.

Fusarium verticillioides significantly reduced plant stunting caused by *U. maydis*.

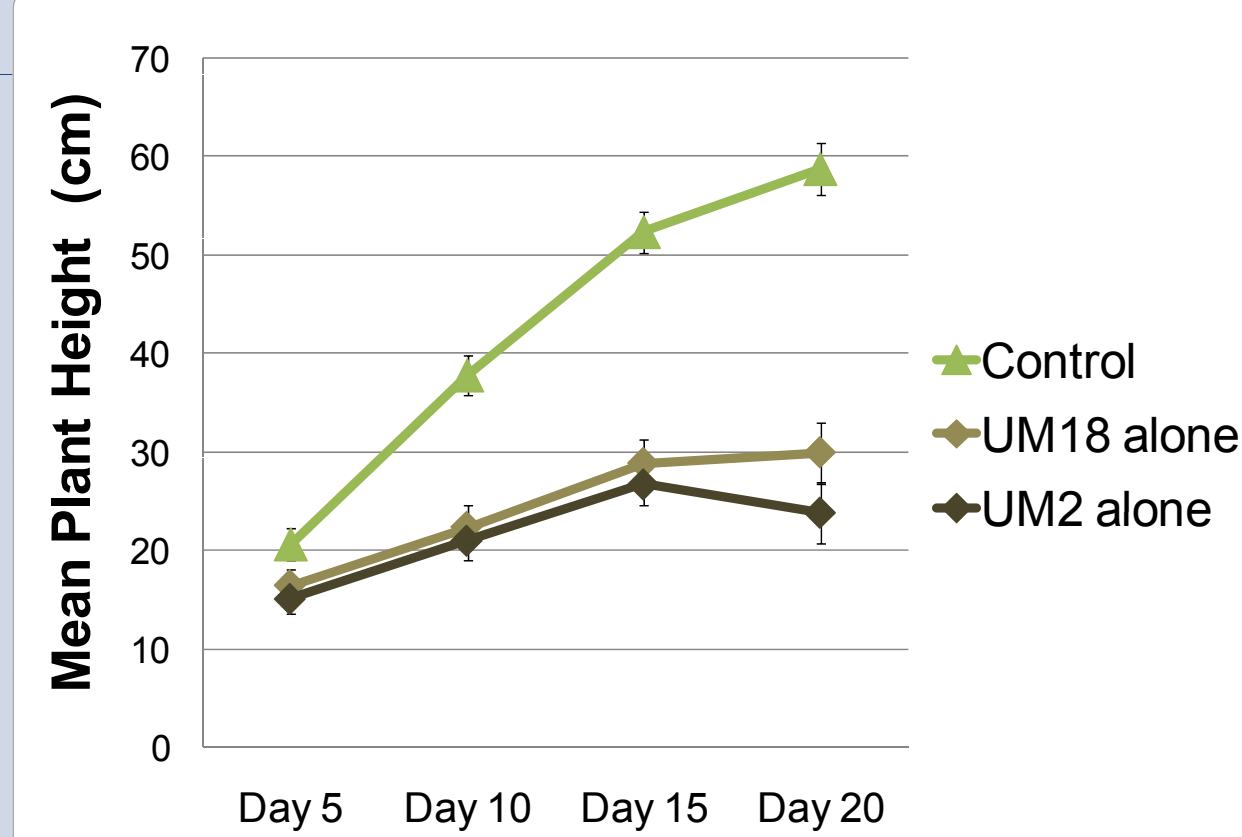


Fig. 1. From 10 – 20 DPI, plants treated with *U. maydis* alone were significantly shorter than control plants ($p < 0.001$). UM2 and UM18 were not significantly different from each other.

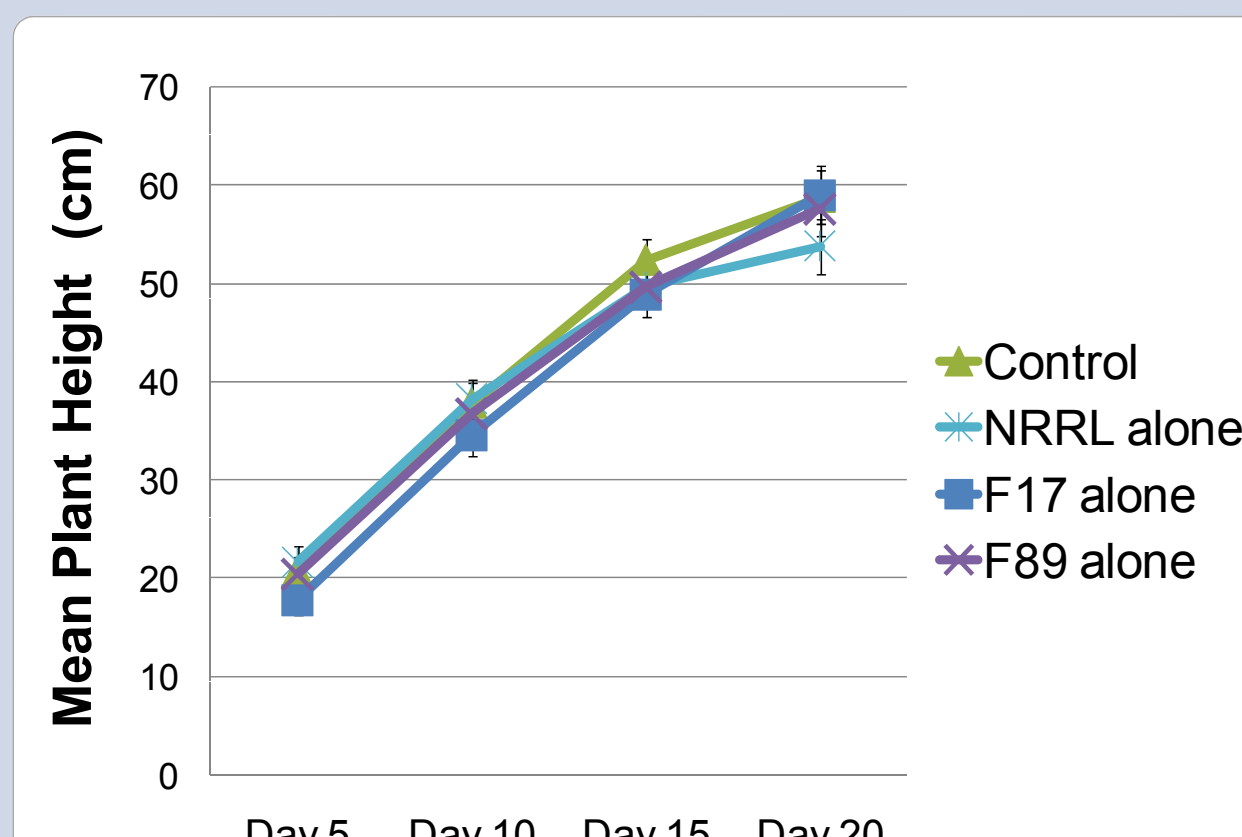


Fig. 2. The presence of *F. verticillioides* alone (i.e. in the absence of *U. maydis*) did not affect plant height, and none of the *F. verticillioides* treatments were significantly different from each other.

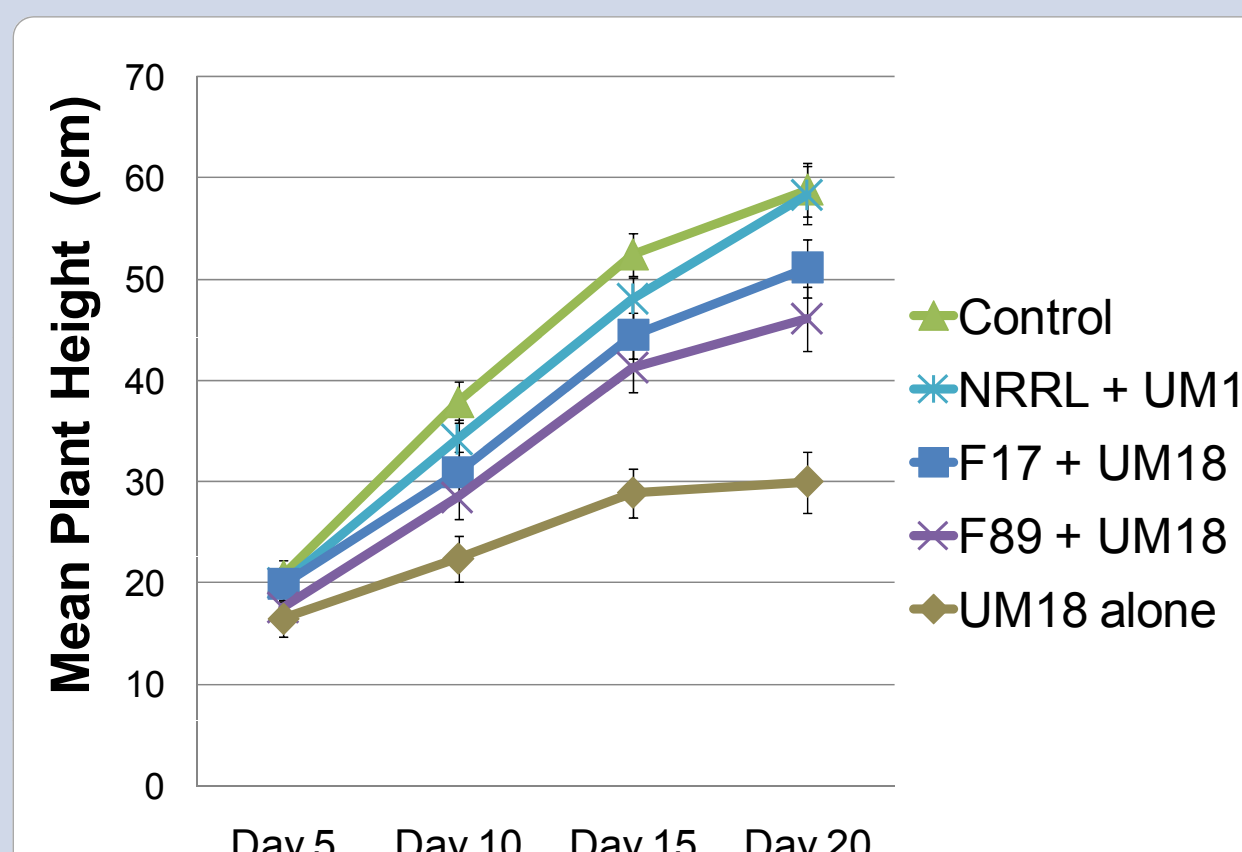


Fig. 3. From 10 – 20 DPI, the presence of *F. verticillioides* significantly reduced plant stunting caused by UM18 ($p < 0.001$). NRRL reduced stunting the most, and F89 reduced stunting the least (not significant).

Although the results were not significant, *F. verticillioides* appeared to reduce plant death.

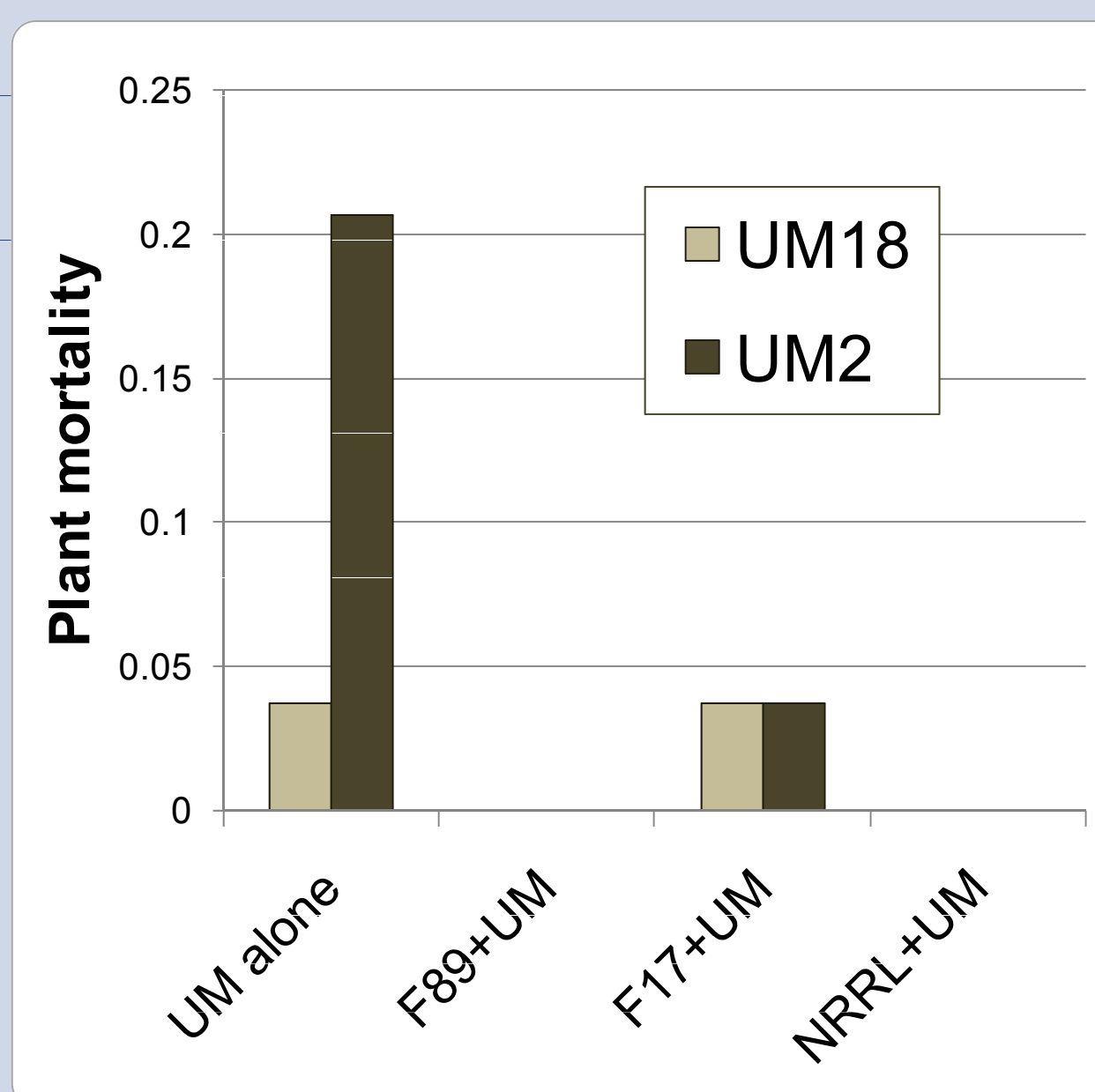


Fig. 4. Plant mortality in *U. maydis*-inoculated OH43 plants. The only co-inoculation treatment that led to plant death was F17 + UM. F89 and NRRL were more successful than F17 at preventing plant death (results not significant).

Results

Fusarium verticillioides significantly reduced disease severity of *U. maydis* infection. Of the three endophyte strains, NRRL seemed to inhibit disease severity the most, and F89 the least.

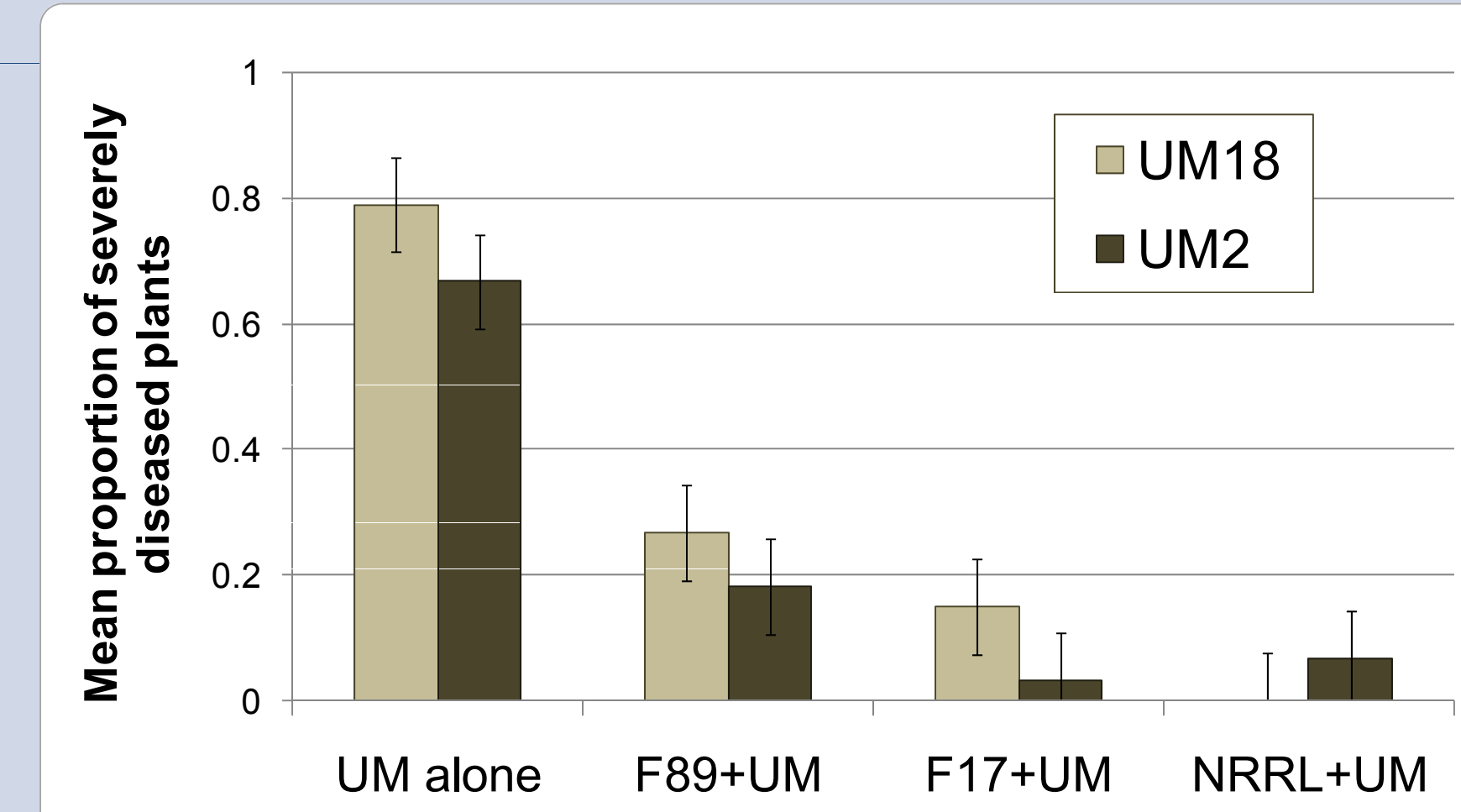


Fig. 5. Disease severity in *U. maydis*-inoculated OH43 plants. In general, UM18 appeared to cause higher disease severity than UM2. Of the *F. verticillioides* strains, NRRL seemed to reduce disease severity the most, and F89 seemed to reduce disease severity the least (not significant).

Fusarium verticillioides inhibited gall formation caused by *U. maydis*. NRRL seemed to inhibit gall formation the most, and F89 the least.

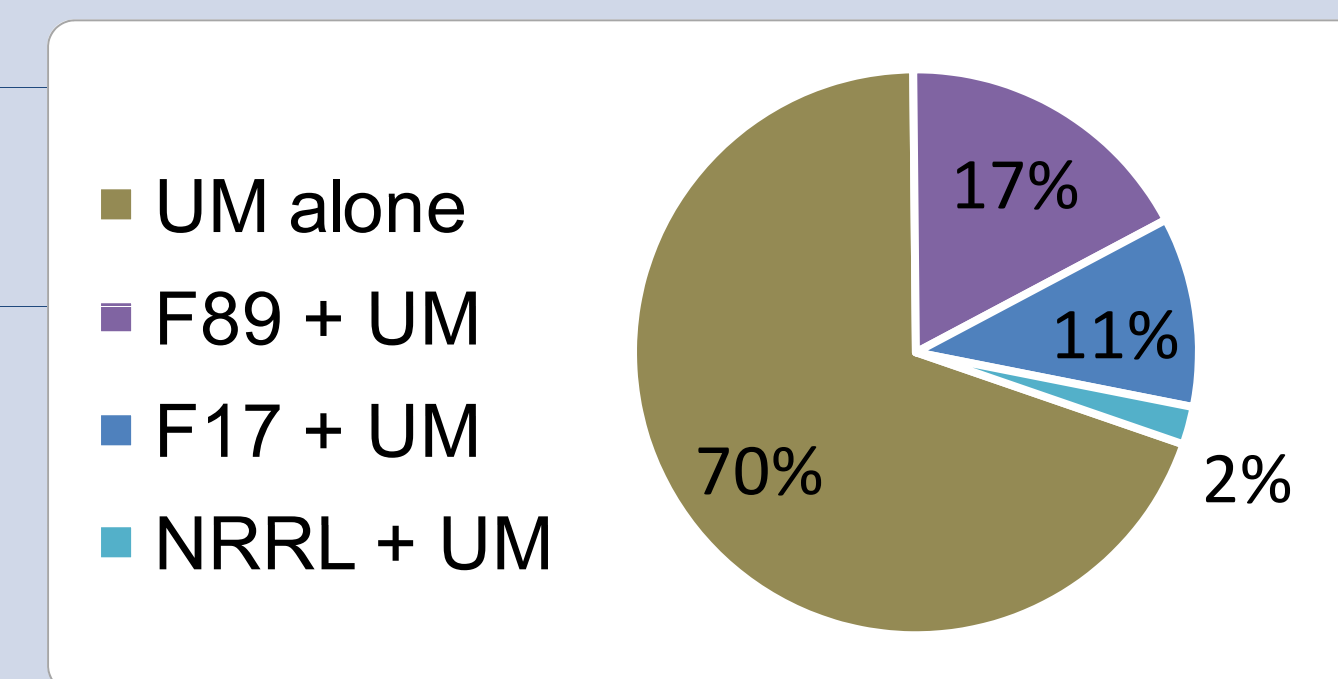


Fig. 6. Proportion of gall-forming plants corresponding to each treatment. Both UM18 and UM2 were included. Of the *F. verticillioides* isolates, NRRL seemed to inhibit galls the most, and F89 the least (not statistically significant).

Conclusions

- Maize genotype was an important influence on plant stunting, plant mortality, disease severity, and gall development.
- As expected, the presence of *F. verticillioides* in maize ameliorated *U. maydis* infection.
- Contrary to my expectations, the host-pathogen-endophyte relationship was not greatly affected by the fungal genotype of either *U. maydis* or *F. verticillioides*.
- Based on plant height and gall development, NRRL appeared to be the most effective *F. verticillioides* strain against *U. maydis*, and F89 appeared to be the least effective strain. However, F17 may actually be the least effective strain in terms of reducing or delaying plant death.

So what's next?

- Studying the mechanisms of interaction between *F. verticillioides* and *U. maydis*.
- Possible applications for biocontrol? Determining the optimal genotypes of maize and *F. verticillioides* to use for controlling *U. maydis* infection.

References

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3. Bolker M. 2001. *Ustilago maydis* – a valuable model system for the study of fungal dimorphism and virulence. *Microbiol.* 147: 1395-1401.
4. Lee K, Pan JJ, and May G. 2009. Endophytic *Fusarium verticillioides* reduces disease severity caused by *Ustilago maydis* on maize. *FEMS Microbiol. Lett.* 299: 31-37.
5. Gold SE, Brogdon SM, Mayorga ME, and Kronstad JW. 1997. The *Ustilago maydis* regulatory subunit of a cAMP-dependent protein kinase is required for gall formation in maize. *Plant Cell* 9: 1585-1594. 10.1105/tpc.9.9.1585.