

FUN-CROPS:

Foliar fungal endophytes for crop sustainability and resilience



Corn



Soy



Wheat



Switchgrass



Beneficial fungal endophytes

FUN-CROPS **VISION**

Enhance crop resilience and agricultural security

- 1/3 of global crop yields currently lost to drought, disease, pests
- Yields expected to decline by 10-25% with climate change
- Traditional breeding only expected to rescue production by 7-15% based on 1700 studies

SARAH ZHANG SCIENCE 10.10.16 7:00 AM

FARMERS ARE MANIPULATING MICROBIOMES TO HELP CROPS GROW



FUN-CROPS TARGETS

Fungal endophytes in crop leaves

- All plants have fungi living inside their leaves
- Known to affect plant stress resilience
- Horizontally transmitted
- Many are culturable

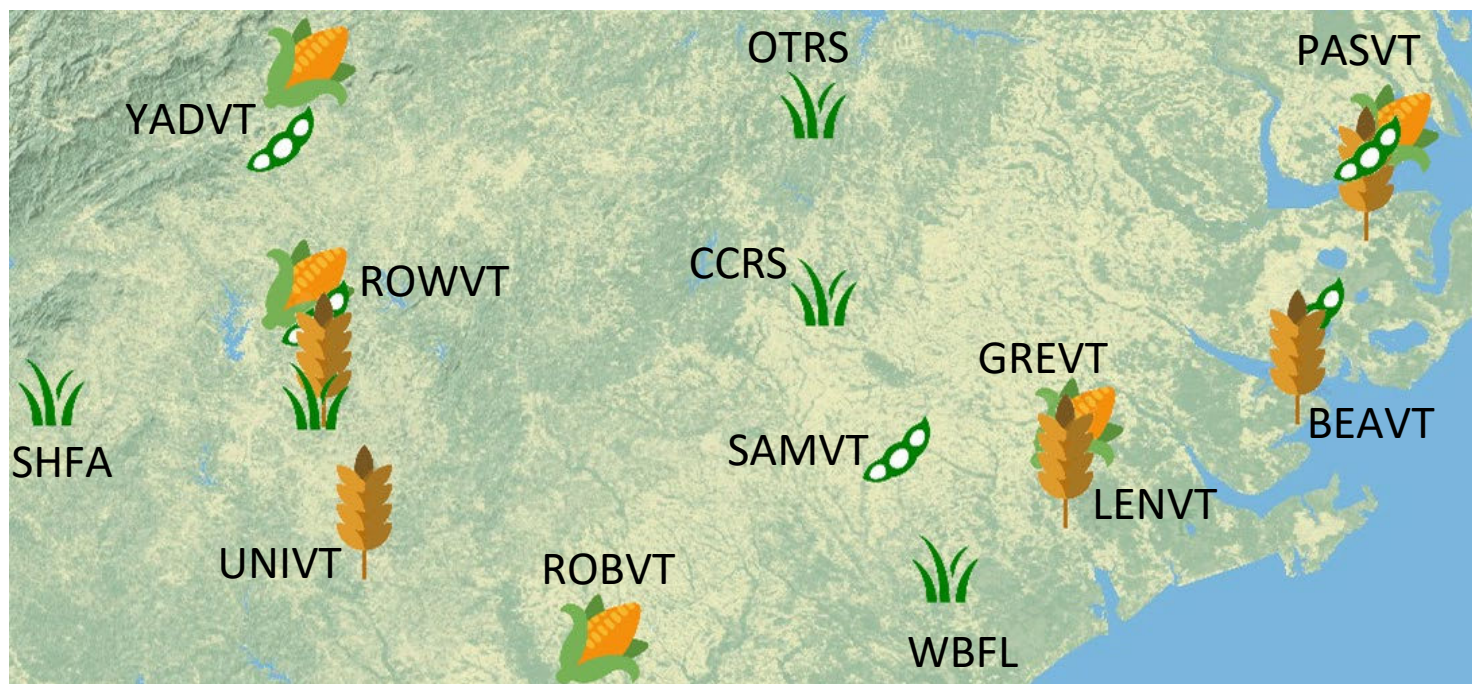
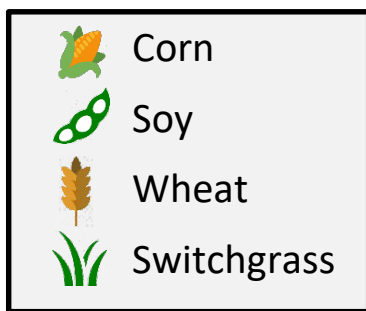


FUN-CROPS OBJECTIVES

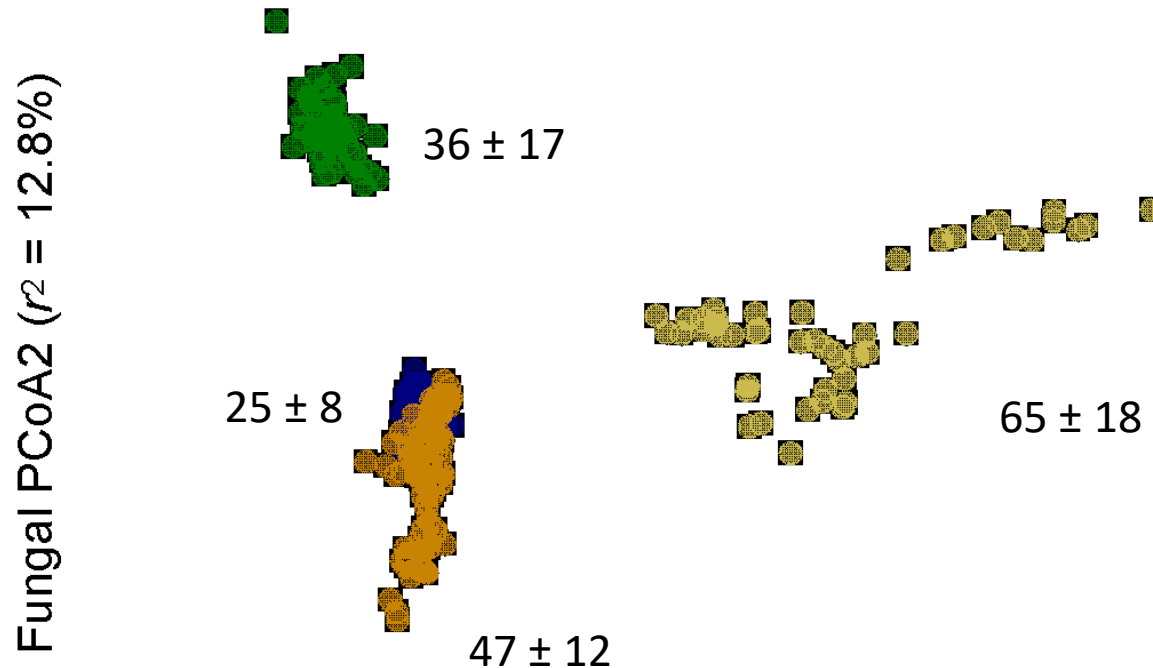
Address challenges to microbiome translation

Obj 1: Identify appropriate scales to manage the plant microbiome

□ Sampled OVT sites in 2019; sequenced foliar fungi

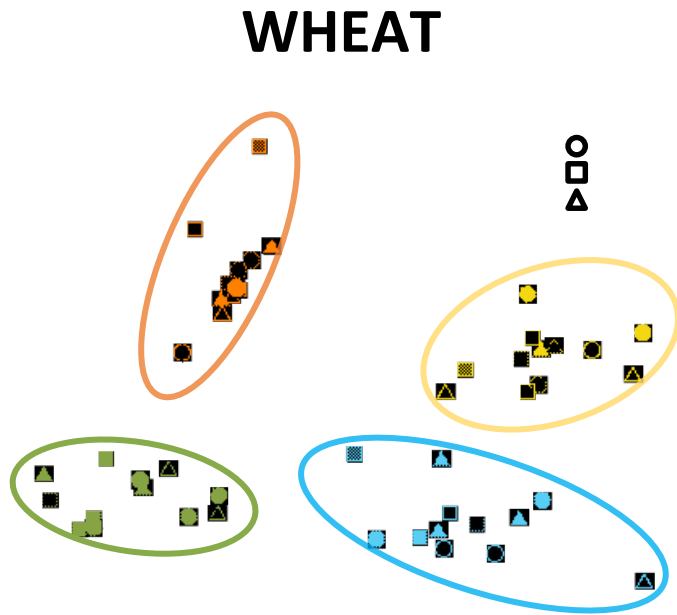


Wheat and switchgrass fungal communities are unique

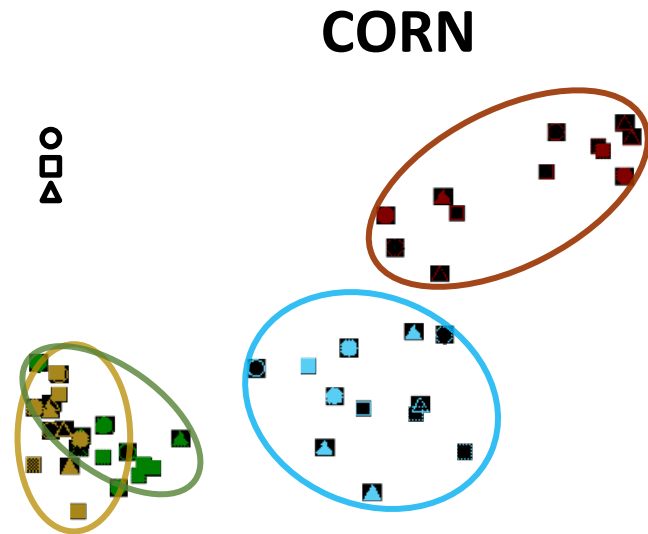


Wheat and corn fungal communities vary by site, not variety

Fungal PCoA2 ($r^2 = 12.8\%$)



Fungal PCoA2 ($r^2 = 11.7\%$)



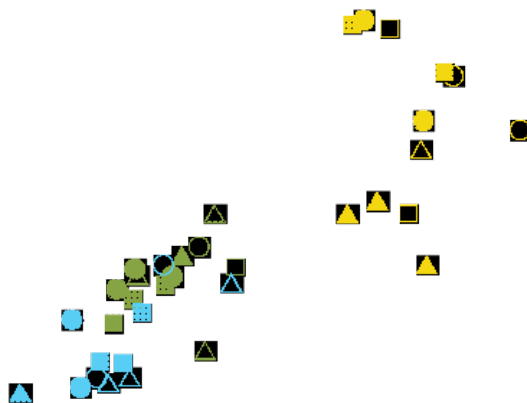
Does observed variation in foliar fungal communities predict yield?

- Wheat, corn
- Potential predictors: PCoA axes for fungi, plant size and physiology, soil properties, rainfall
- Best subsets regression approach with AIC
 - Variables removed for multicollinearity

Foliar fungi predict yield,

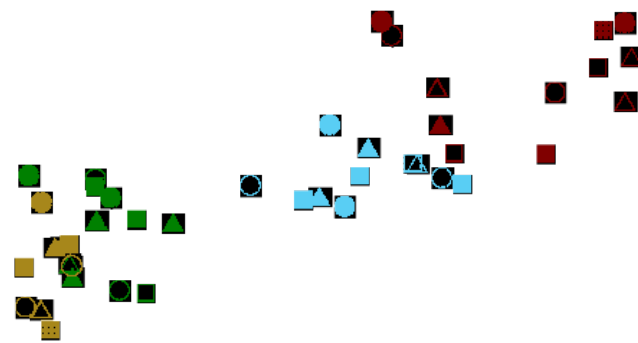
WHEAT

Yield (bushels/acre)



CORN

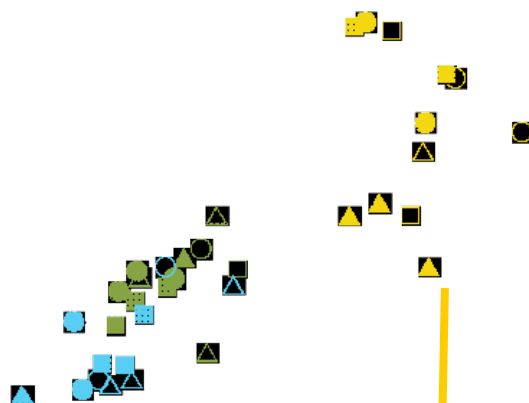
Yield (bushels/acre)



Foliar fungi predict yield, but confounded with site

WHEAT

Yield (bushels/acre)

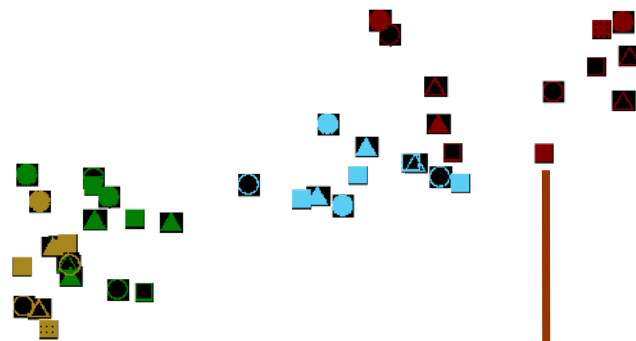


UNIVT site

- Highest fungal diversity
- Dominated by Basidiomycete yeasts (*Sporobolomyces*, Tremellaceae)
- site with highest soil OM, pH

CORN

Yield (bushels/acre)



YADVT site

- Lowest fungal diversity
- Dominated by endophytic Ascomycetes (*Cladosporium*, *Alternaria*)
- site with tallest plants, max photosynthesis

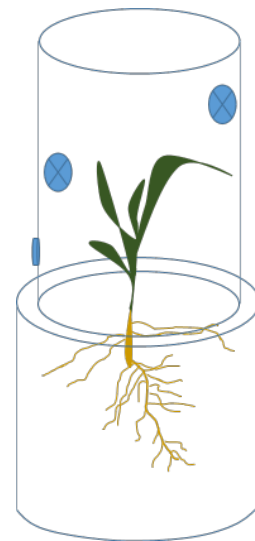
FUN-CROPS OBJECTIVES

Address challenges to microbiome translation

Obj 1: Identify appropriate scales to manage the plant microbiome

Obj 2: Determine how the microbiome affects the plant phenotype, focusing on stress rescue – molecular mechanisms

- a) Quantify endophyte roles in pathogen and drought resistance
 - 736 fungal isolates
- b) Identify candidate fungal genes that control plant responses with predictive modeling
- c) Test candidate gene function via CRISPR/Cas9 engineering
 - currently testing potential transformability of representative isolates



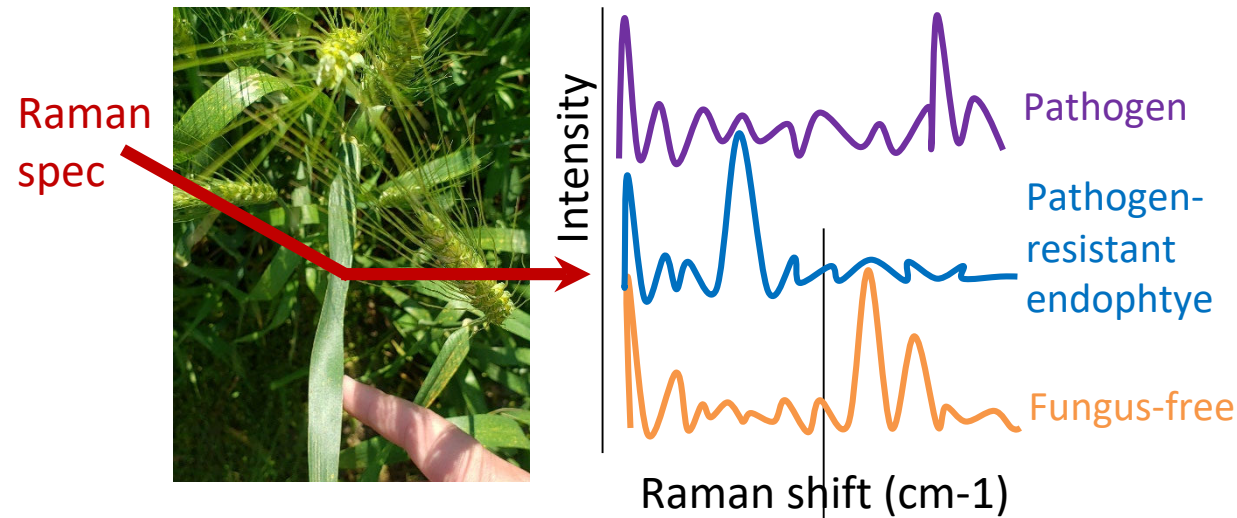
FUN-CROPS OBJECTIVES

Address challenges to microbiome translation

Obj 1: Identify appropriate scales to manage the plant microbiome

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Obj 3: Build tools for rapid field detection of fungal taxa and traits



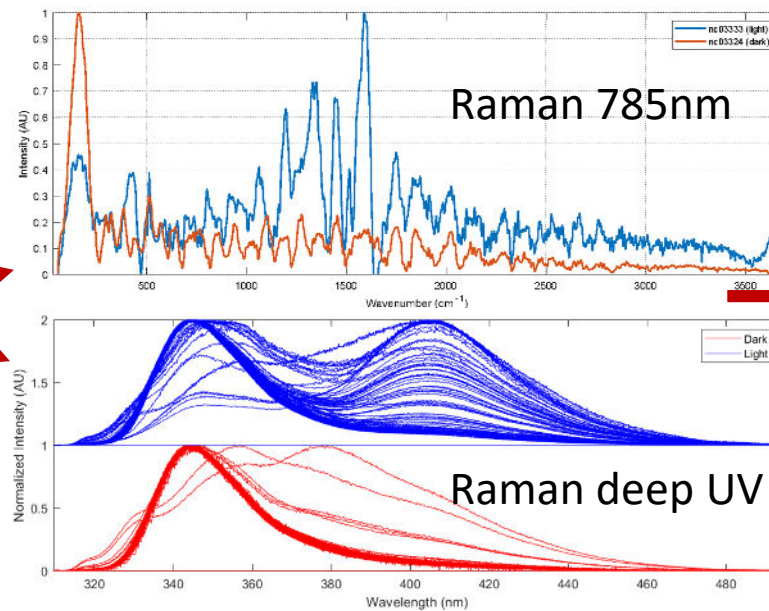
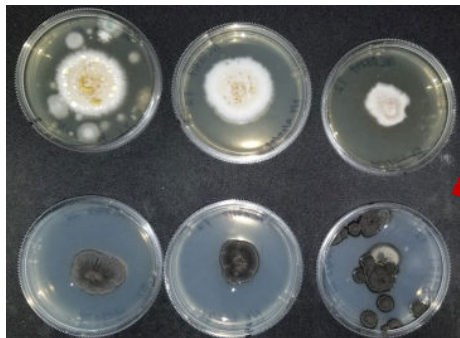
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Next steps:

- More diverse fungi
- Colonized leaves

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Obj 4: Understand regulatory environment and engage stakeholders
☐ currently analyzing policy and state of regulation

Industry



Regulators



Growers, Producers



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Extension and outreach: Make microbiomes a household word for growers ☐ currently planning agent training videos and field days

FUN-CROPS TEAM

Obj 1



Hawkes (PMB)

Obj 2a



Balint-Kurti (DEPP)

Obj 2b



Sozzani (PMB)

Obj 2c



Crook (CBE)

Obj 3



Gray (FER)

Obj 4



Delborne (FER)



Heiniger (CSS)



Brown-Guedira (CSS)



Williams (ECE)



Garcia (CSS)



Kudenov (ECE)



Heiniger (CSS)



Karre
(Postdoc)



Hawkes (PMB)



Nanda Kafle
(Postdoc)



Thiessen (DEPP)



Locke (CSS)



Barnhill-Dilling (Postdoc)

FUN-CROPS - QUESTIONS?

