Progress toward understanding *Sclerotinia* pathogenicity and plant resistance to *Sclerotinia* diseases

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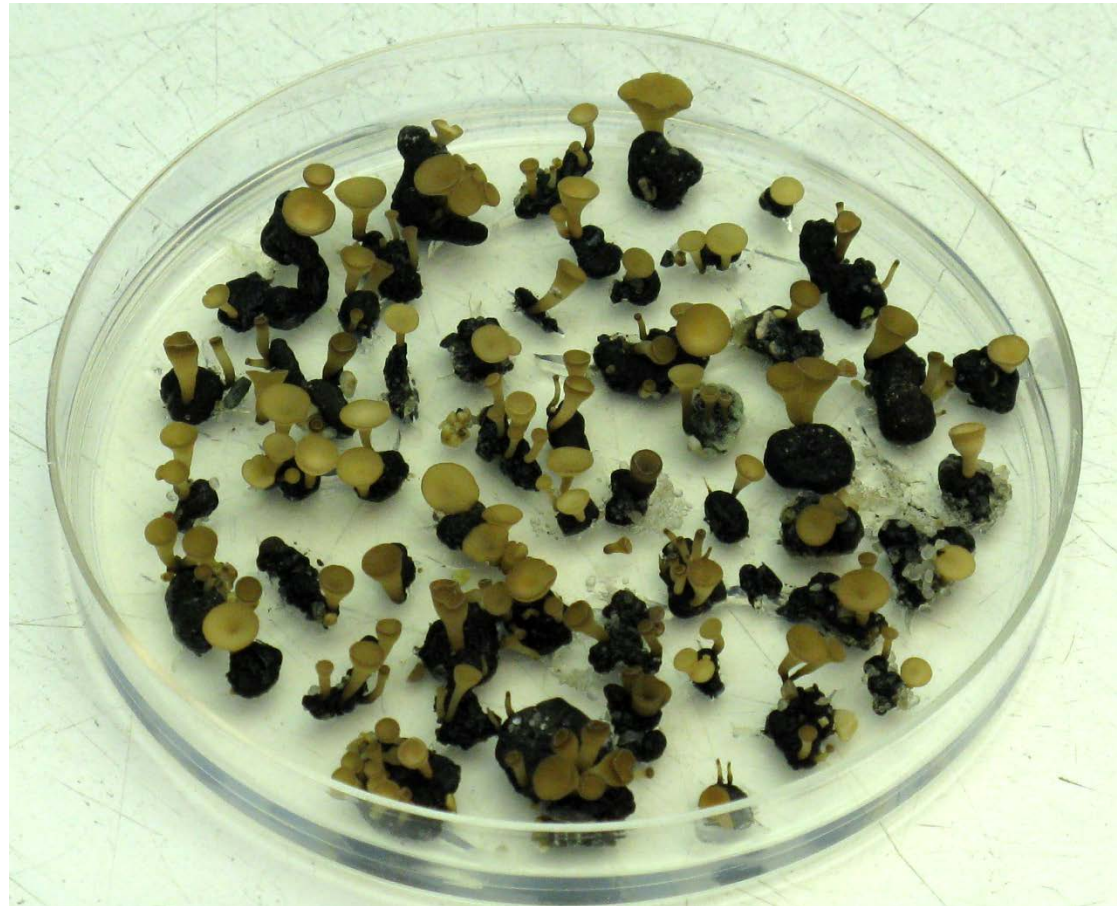# *Sclerotinia* diseases of sunflower
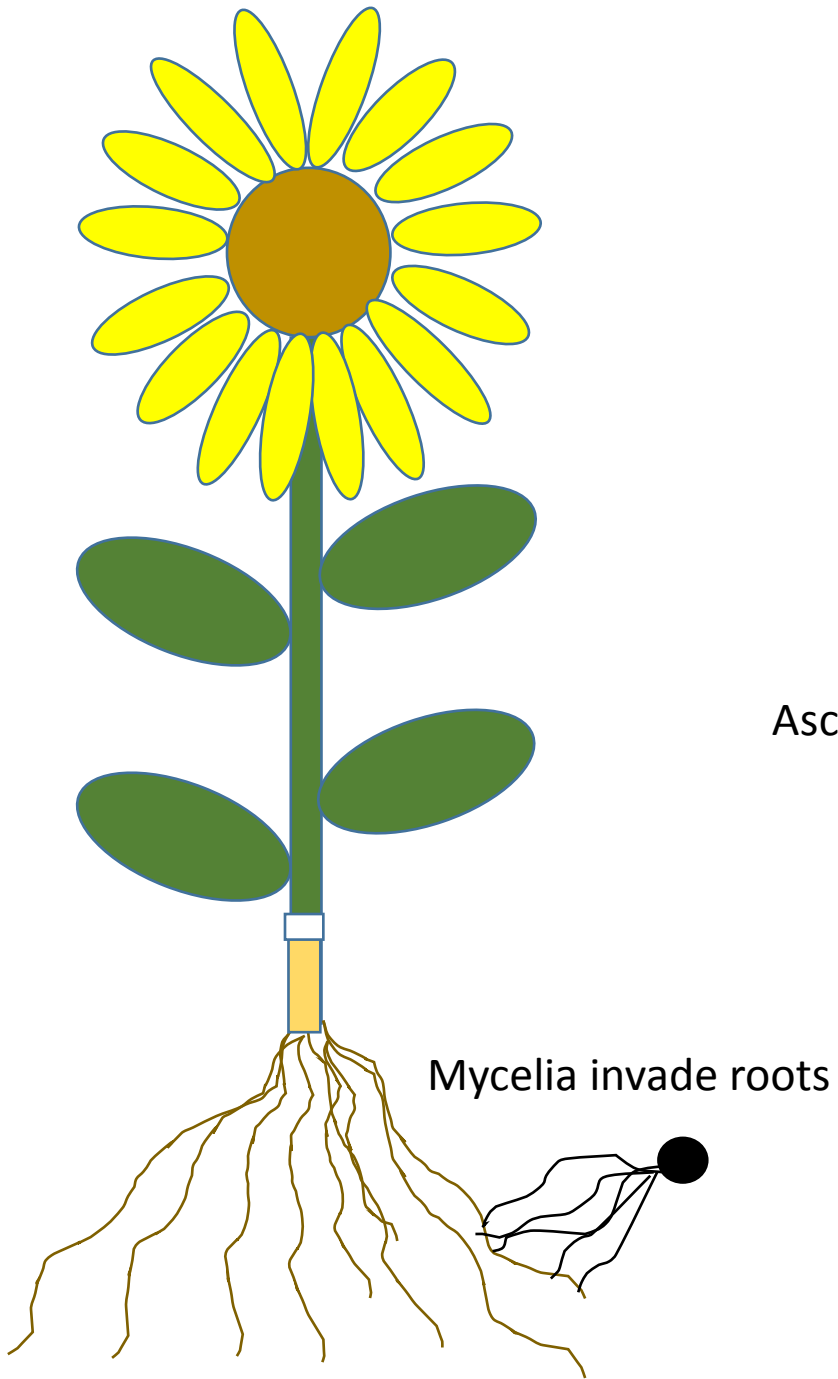

Basal Stalk Rot / Wilt   Mid-stalk Rot   Head Rot

Sclerotia

Mycelia invade roots
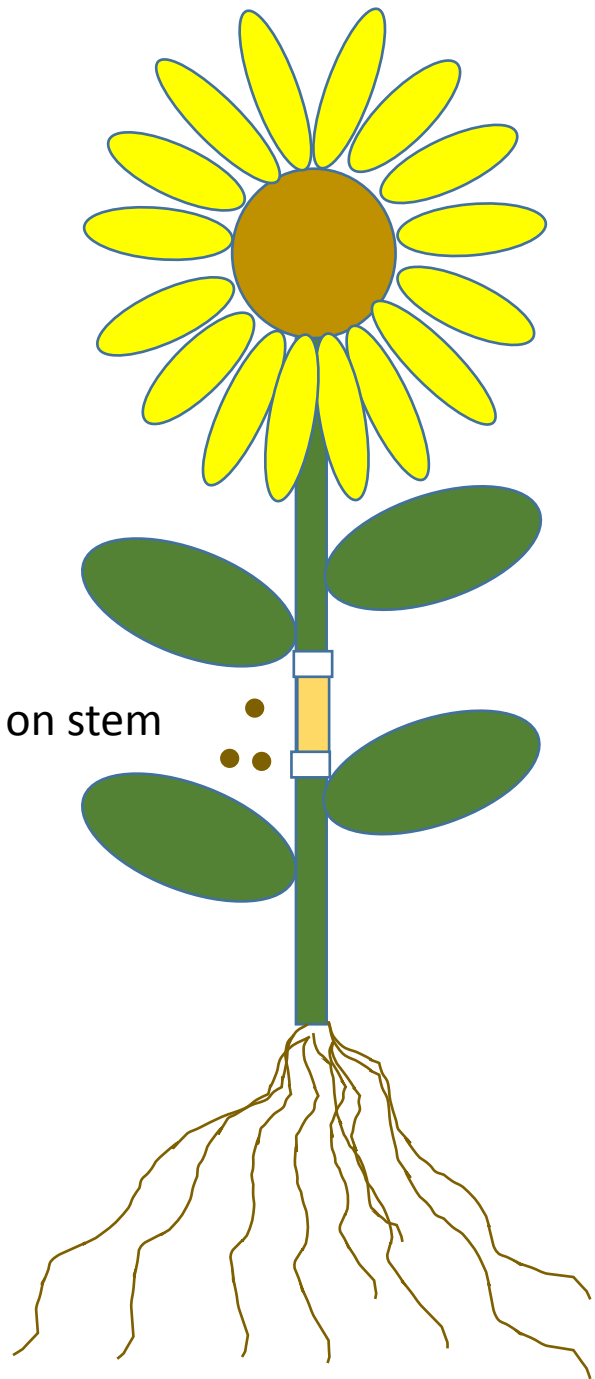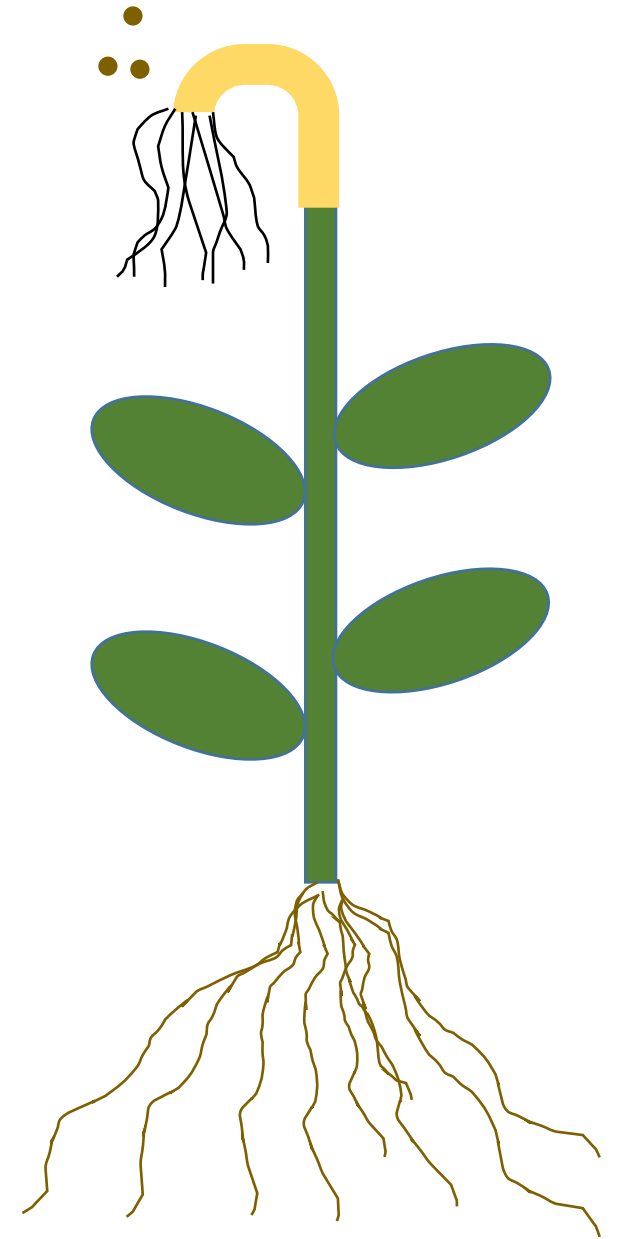
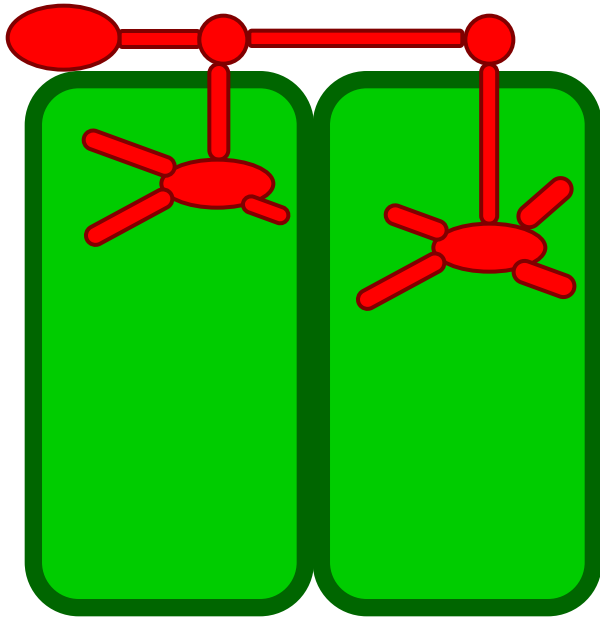Ascospores land on stem

Ascospores land on head

Pathogenesis strategy

Biotrophic

Hemi-biotrophic

Necrotrophic

Qualitative Resistance
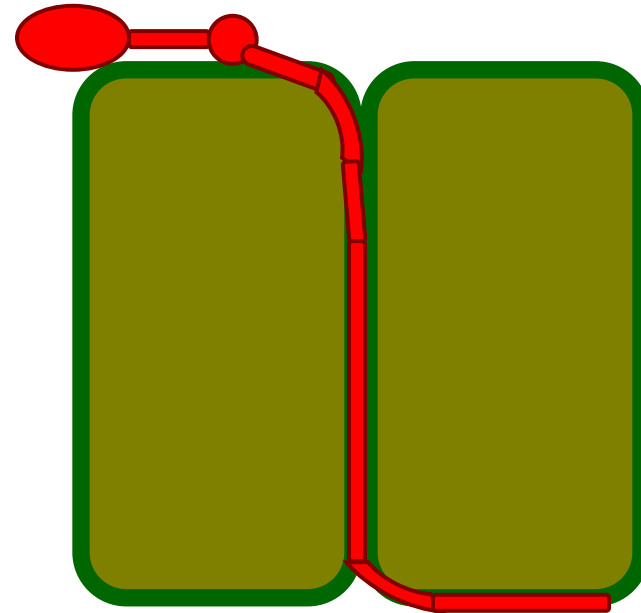
Quantitative Resistance

Pathology program goals for *Sclerotinia*

- Characterize relevant diversity within the pathogen populationand use information on differential aggressiveness to identify virulence determinants.

- Use comparative genomics and functional studies with the plant model plant system *Arabidopsis* to identify genetic factors and defense mechanisms contributing to *Sclerotinia* resistance.

AIM – Unravel complexity to facilitate improvement of sunflower resistance

Topics

- Progress on understanding mechanisms of plant resistance to *Sclerotinia sclerotiorum.*

- Update on identifying genes controlling aggressiveness of *Sclerotinia* isolates.

- *Sclerotinia* field disease nurseries: issues and challenges.

Progress on understanding mechanisms of plant resistance to Sclerotinia sclerotiorum.

- Leveraging *Arabidopsis* genomic and functional resources -

Past year:

- Acquired 360 accession *Arabidopsis* diversity panel.

- Phenotyped 315 accessions for *Sclerotinia* resistance upon spot inoculation of leaves with mycelia of *Sclerotinia* isolate 1980 (sequenced reference isolate).

- Performed genome-wide association mapping to identify candidate genes contributing to resistance.

- Phenotyping with a second, less aggressive *Sclerotinia* isolate is ongoing.

Arabidopsis diversity panel phenotyping

- Leaves spotted with suspension of ground mycelium.

- Resistance scored at 4 dpi and 7 dpi using a 0-9 rating scale.
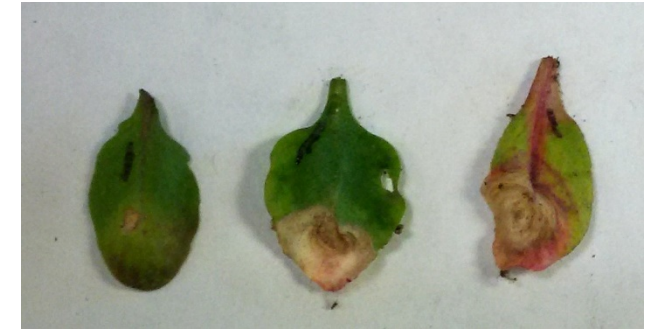
0 – No visible lesion   1 – lesion confined to inoculation site   2 - < 25% leaf area   3 – 25-50% leaf area   4 – 50-75% leaf area

5 – Entire leaf   6 - < 25% plant area   7 – 25-50% plant area   8 – 50-75% plant area   9 – 75-100% plant area

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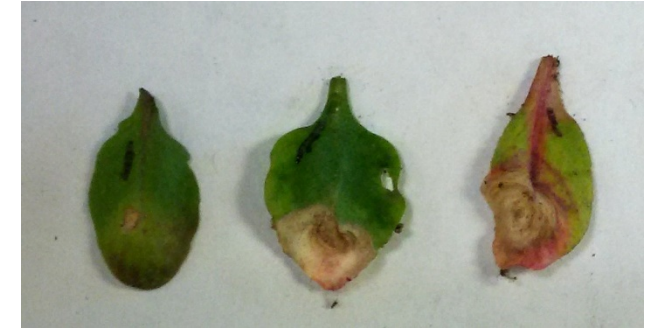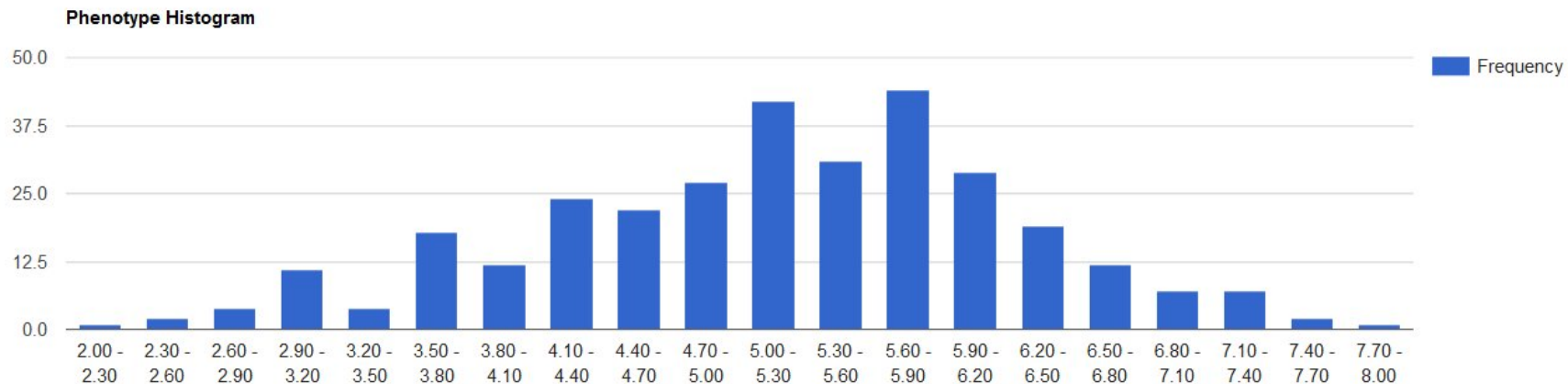
5 – Entire leaf 6 - < 25% plant area 7 – 25-50% plant area 8 – 50-75% plant area 9 – 75-100% plant area

Phenotype Histogram

Genome-wide association

- Mixed model to control for population structure, SNPs with minor allele frequency > 5% considered.
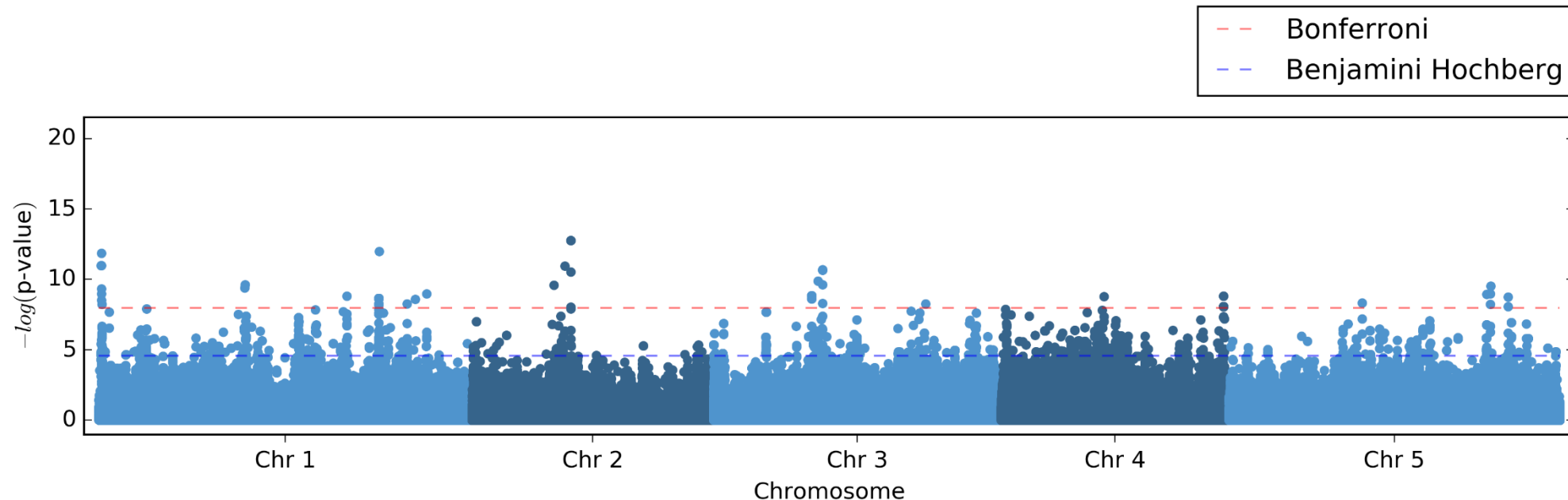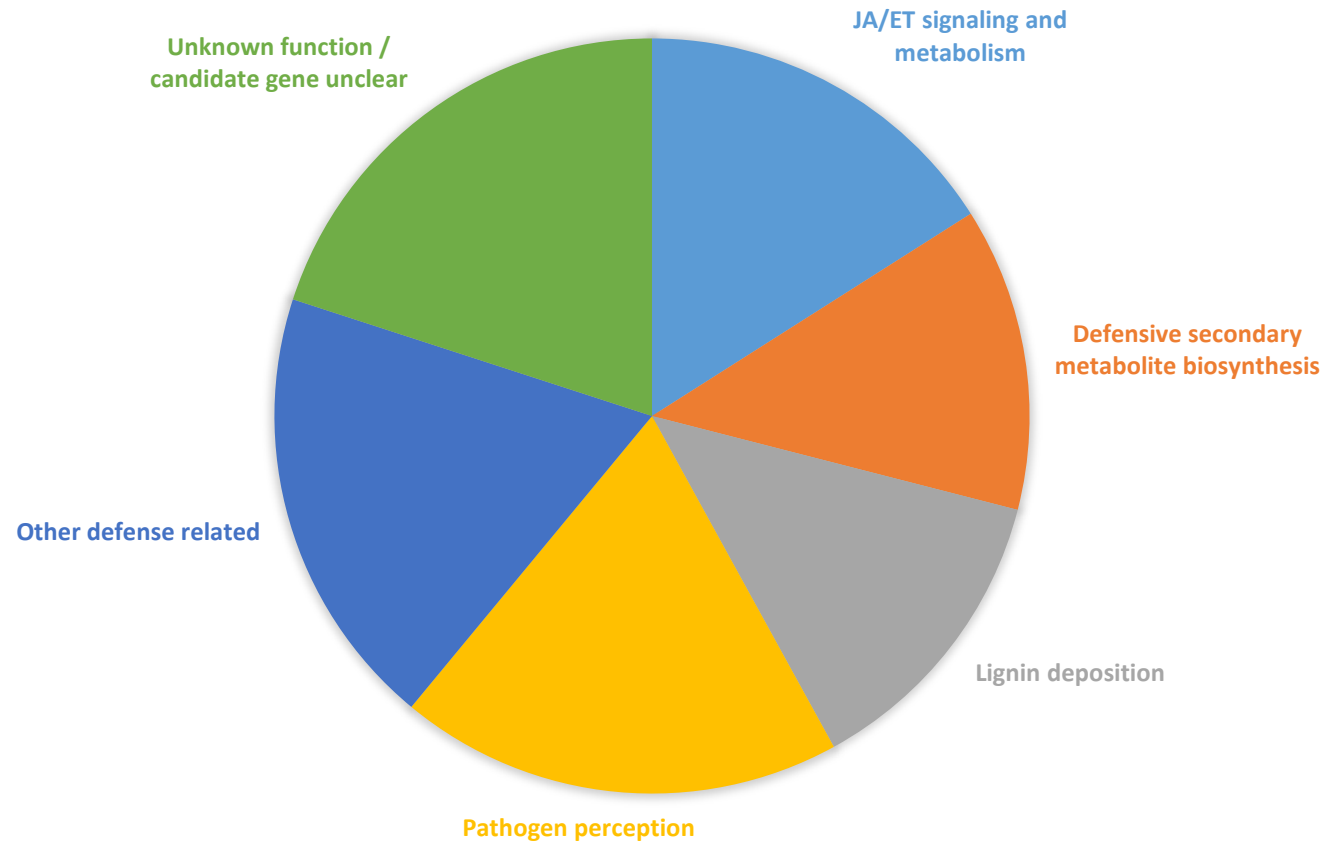

- At Bonferroni cutoff (stringent), over 30 significant associations observed. At more lenient 5% FDR, large number of putative associations.

Genome-wide association

Some common themes of interest:

Ongoing work

- Phenotyping and GWA with a second *Sclerotinia* isolate.

- Functional validation of subset of candidate genes using insertional mutant lines.

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- Functional validation of subset of candidate genes using insertional mutant lines.

Potential Implications for Sunflower

May be worth considering breaking down *Sclerotinia* resistance into potentially easier to phenotype defense physiology components: phytoalexin (scopolin, ayapin) accumulation, JA/ET signaling readout(s), etc.
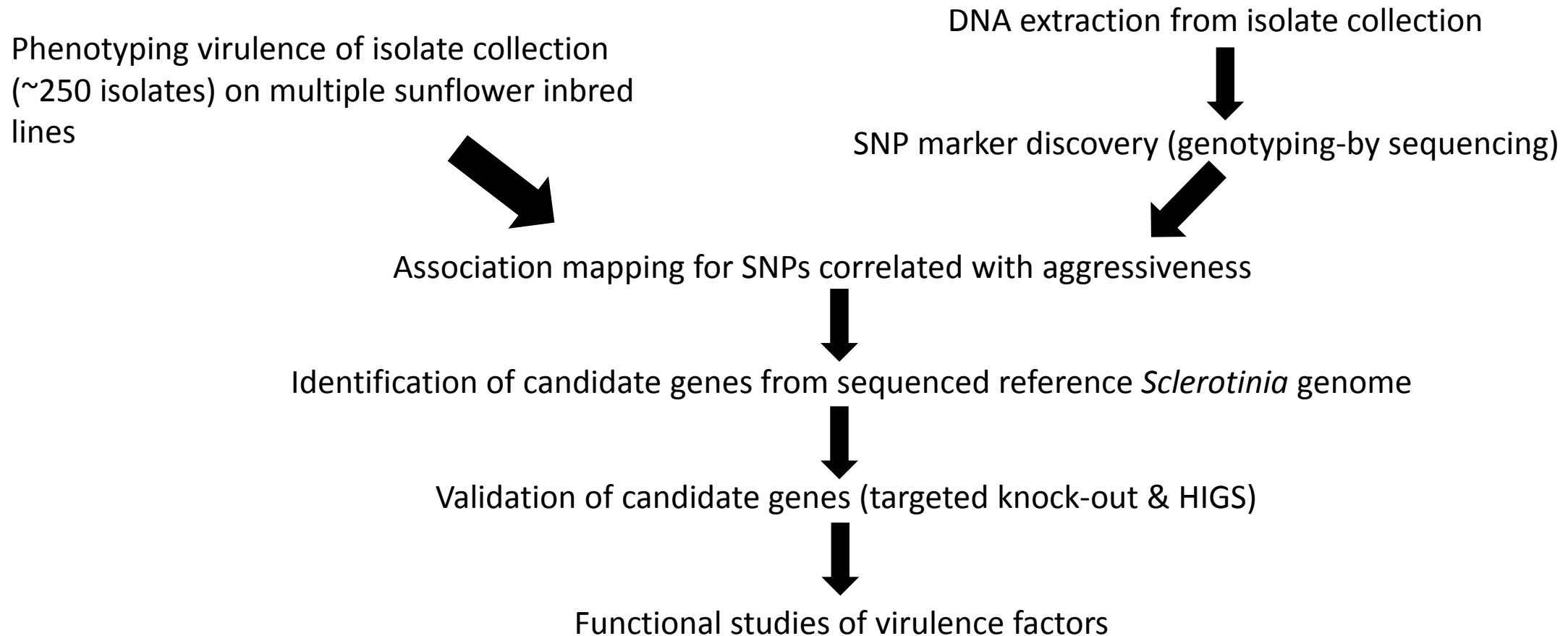
Potential impacts on agronomic traits (yield) should be evaluated.
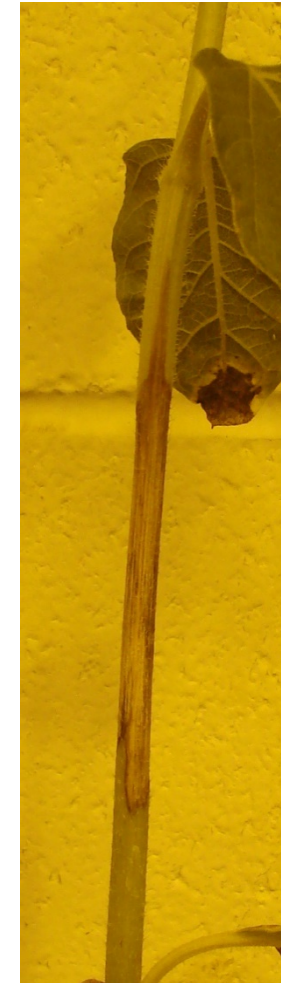
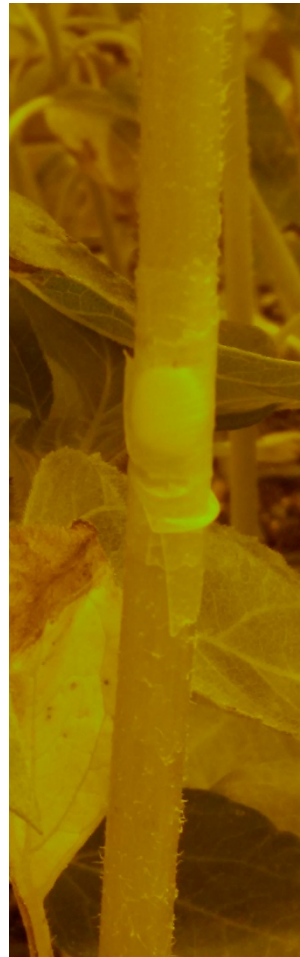# Topics

- Progress on understanding mechanisms of plant resistance to *Sclerotinia sclerotiorum.*

- **Update on identifying genes controlling aggressiveness of *Sclerotinia* isolates.**

- Sclerotinia field disease nurseries: issues and challenges.

Identifying genetic factors contributing to differential aggressiveness of the pathogen (virulence factors)

Phenotyping virulence of isolate collection (~250 isolates) on multiple sunflower inbred lines

DNA extraction from isolate collection

SNP marker discovery (genotyping-by sequencing)

Association mapping for SNPs correlated with aggressiveness

Identification of candidate genes from sequenced reference *Sclerotinia* genome

Validation of candidate genes (targeted knock-out & HIGS)

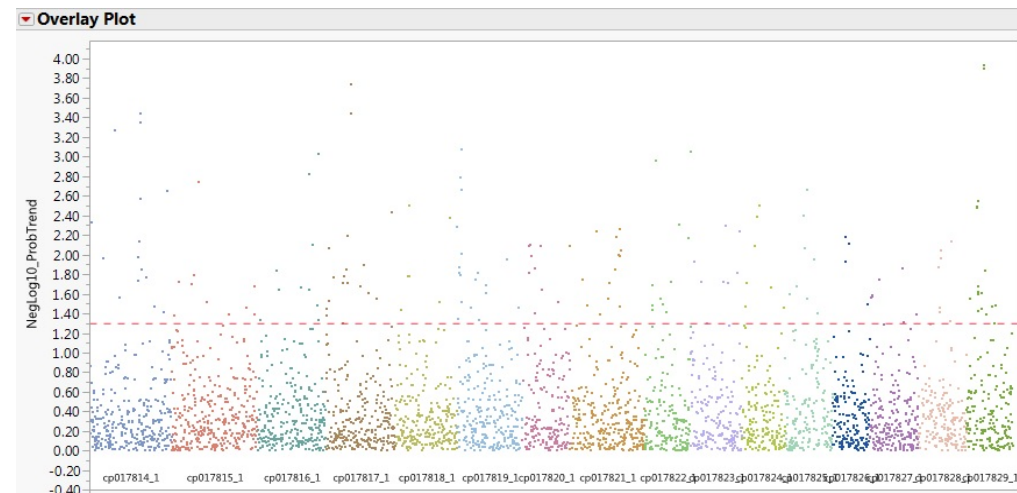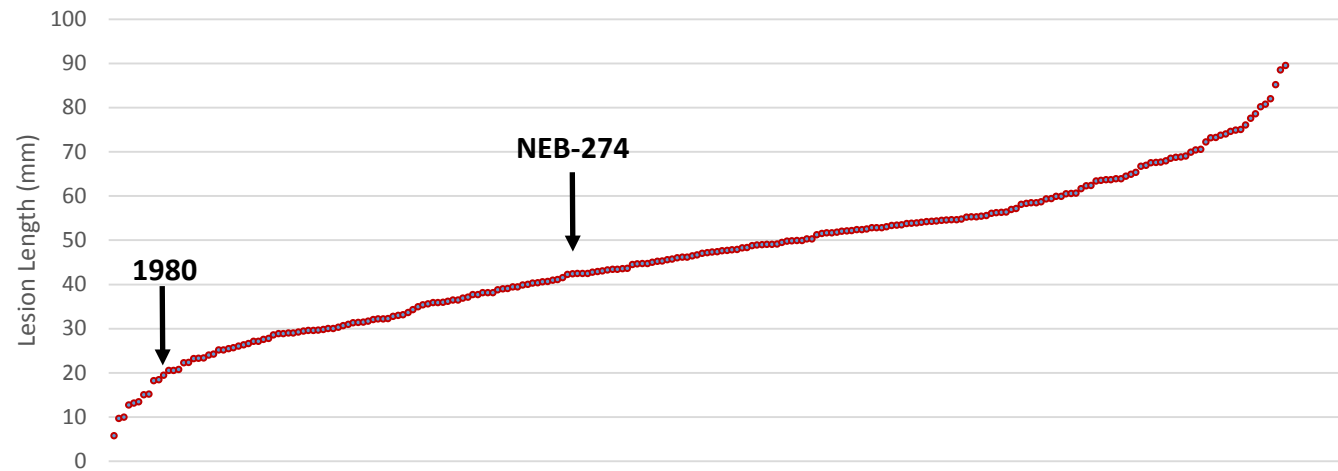Functional studies of virulence factors

Sclerotinia sclerotiorum isolate collection
Aggressiveness on Sunflower inbred line HA 207

Sclerotinia sclerotiorum isolate collection
Aggressiveness on Sunflower inbred line HA 207

Topics

- Progress on understanding mechanisms of plant resistance to *Sclerotinia sclerotiorum.*

- Update on identifying genes controlling aggressiveness of *Sclerotinia* isolates.

- **Sclerotinia field disease nurseries: issues and challenges.**

Improving field screening of sunflower materials

- 2017 Field Nurseries for the Pathology Program:

  - Stalk Rot: ~5500 rows at two sites (NDSU Carrington-REC, Carrington, ND and Central Lakes College Ag & Energy Center, Staples, MN)

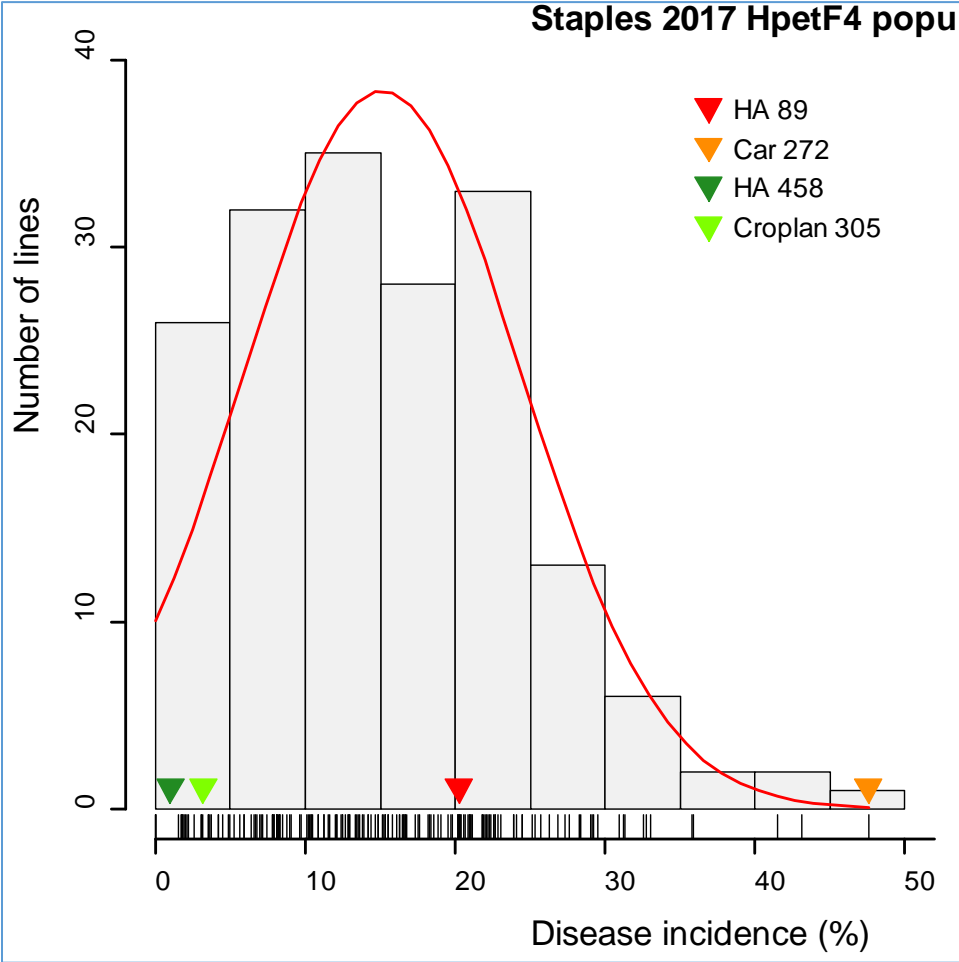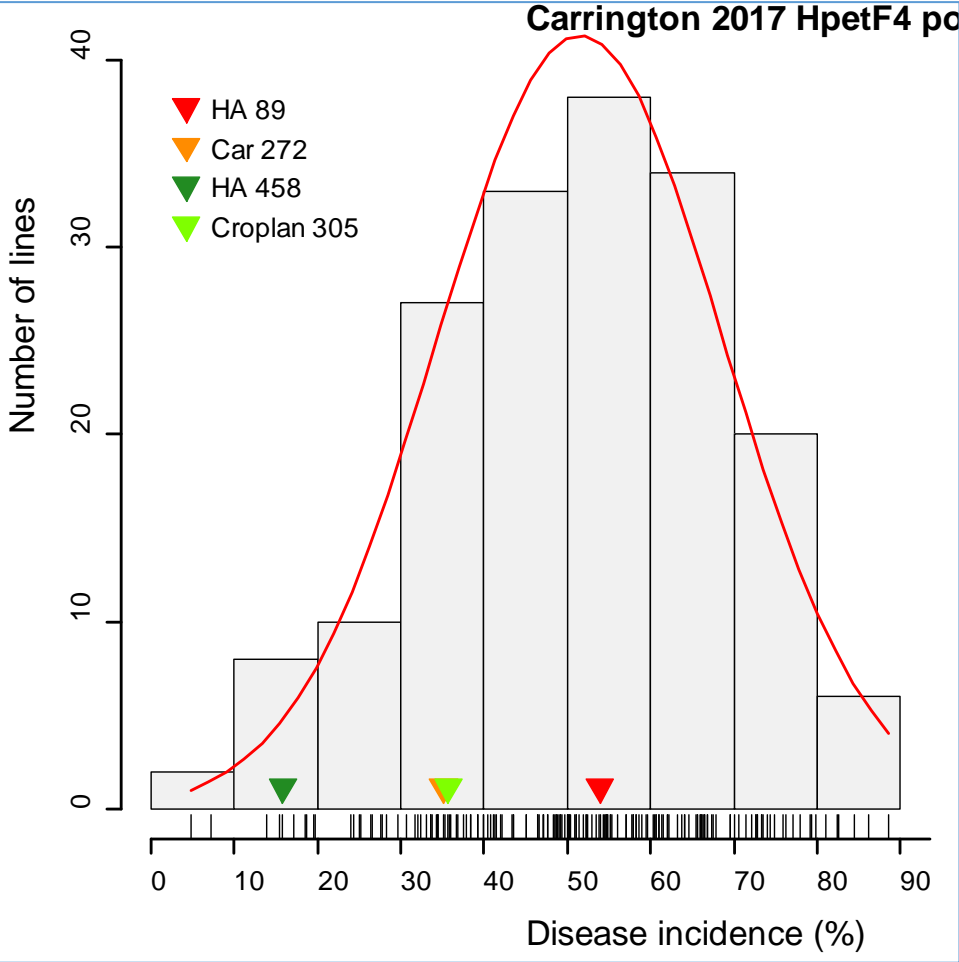 - Head Rot: ~1000 rows in mist nurseries at the same locations

Image from Tom Gulya

Improving field screening of sunflower materials

Staples site very difficult for stalk rot

Ongoing and Future Work

- Complete phenotyping of *Arabidopsis* diversity panel with second *Sclerotinia* isolate.

- Evaluate subset of candidate genes via insertional mutants to verify *Arabidopsis* GWAS results.

- Complete phenotyping of *Sclerotinia* isolates on HA441, complete association mapping, evaluate candidate genes.

- Greenhouse-based stalk rot phenotyping for late-maturing AB populations (w/ Lili).

- Isolate collection for *Phomopsis* genetic and pathogenic diversity project.

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THANK YOU

QUESTIONS?

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