



Evaluating Fungicide Efficacy Against *Claviceps purpurea*: Implications for Ergot Control

Daisy Garratt
First Year PhD Student

Supervisors: Dr Lesley Boyd¹, Prof. Nik Cunniffe², Dr Aoife O'Driscoll¹, Dr David Clarke¹
Niab¹, Department of Plant Sciences, University of Cambridge²

Background



- *Claviceps purpurea*, the causal agent of ergot
 - Causes ergot in >400 grasses (Poaceae), inc. wheat, barley, rye etc.
- **Sclerotium** formation
 - Contains ergot alkaloids (EAs)
 - Often harvested with grain
 - Fragment and transfer EAs to clean grain
- Many UK millers have zero-tolerance policy on sclerotia presence
 - Costly grain rejections

Problems:

- Current **on-farm** management methods are **limited**
 - Lack of seed treatments
 - No foliar fungicides



Fungicide Efficacy Assays *in vitro*

- **High throughput** testing using microtiter plates
- Investigated **16 fungicides across 3 groups**

Fungicide Groups and Actives

DMIs

DeMethylation Inhibitors



**Target Site: C14-demethylase
(*erg11/cyp51*)**

Disrupts: Sterol biosynthesis

8 Actives Tested:

Difenoconazole

Imazalil

Mefentrifluconazole

Metconazole

Propiconazole

Prothioconazole

Prothio-desthio

Tebuconazole

SDHIs

Succinate DeHydrogenase Inhibitors



**Target Site: (complex II)
succinate dehydrogenase**

Disrupts: Respiration

5 Actives Tested:

Benzovindiflupyr

Fluopyram

Fluxapyroxad

Penthiopyrad

Pydiflumetofen

Qols

Quinone outside Inhibitors



**Target Site: (complex III)
cytochrome bc1 (ubiquinol oxidase)**

Disrupts: Respiration

3 Actives Tested:

Azoxystrobin

Picoxystrobin

Pyraclostrobin

Thank you for Listening

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Figure 1. Ergot infected wheat spike

1) Background

a) *Claviceps purpurea*, the causal agent of Ergot

- *Cp* infects all grasses (Poaceae)¹, including important many cereal crops (i.e., wheat, barley, rye)
- Spores infect unfertilised ovaries, mycelia grows to fill this space, later hardening to form a **sclerotium**
- Sclerotia are often harvested with grain – fragment and release EAs, contaminating clean grain via physical transfer
- Many UK millers have a zero-tolerance policy on sclerotia presence, causing costly grain rejections for farmers

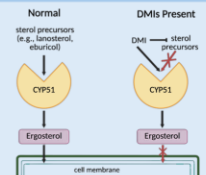
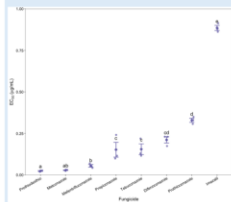
b) Problem

- Current management strategies are **limited & target post-harvest** (contamination occurred)
- **No foliar fungicides or seed treatments** authorised in UK to combat ergot
- Project addresses this issue, investigating fungicide groups & actives which **inhibit**:
 - Mycelial growth
 - Spore germination

1) Demethylation Inhibitors (DMI)

Target Site: C14-demethylase (*erg11/cyp51*) in sterol biosynthesis

- DMIs inhibit growth within a narrow concentration range (0.02-0.89 µg/mL)
- Differences observed may be due to:
 - Biological subgroup (imidazoles vs triazoles) & binding affinity
 - Metabolic conversion (prothio-deshio vs prothioconazole)

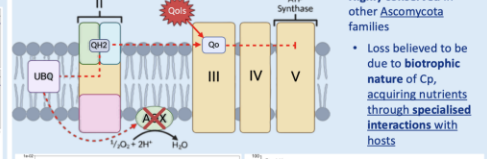
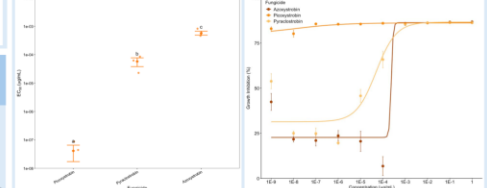
3) Quinone outside Inhibitors (QoI)

Target Site: (complex III) cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene) in respiration

- QoIs exhibit high efficacy (>6x10⁻⁵ µg/mL)
- Possibly inhibiting spore germination
- Highly effective as **preventative fungicides** in other fungal plant pathogens

Why?

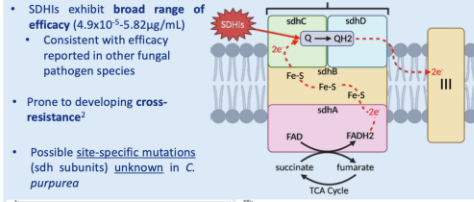
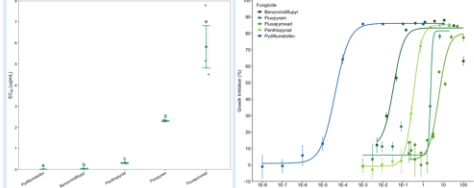
- *C. purpurea* lacks alternative oxidase (AOX) enzyme³
- AOX capable of providing up to **40% of energy** produced from the main respiration route
- Highly conserved in other Ascomycota families
- Loss believed to be due to **biotrophic nature** of *Cp*, acquiring nutrients through specialised interactions with hosts

2) Succinate Dehydrogenase Inhibitors (SDHI)

Target Site: (complex II) succinate-dehydrogenase in respiration

- SDHIs exhibit **broad range of efficacy** (4.9x10⁻⁵-5.82 µg/mL)
- Consistent with efficacy reported in other fungal pathogen species
- Prone to developing cross-resistance²
- Possible **site-specific mutations** (sdh subunits) **unknown** in *C. purpurea*

4) Future Work

4.1) Inhibition of Spore Germination vs Pre-Germinated Spores

- Investigate effects of QoI activity on spore germination
- *Cp* spores germinate within 24 hours of landing on stigma hair
- Testing by applying fungicide treatment at 0hpi compared to 24hpi

4.2) Investigating Fungicide Efficacy Across Multiple *C. purpurea* Isolates

- Explore whether observed efficacy in 04-97.1 is isolate specific or applicable to a variety of isolates
- Detect trends in resistance (i.e., historical vs modern isolates etc.)

4.3) Spring Wheat Field Trial (2027)

- Investigate efficacy *in planta* in SW variety Mulika

Test:

- Application timing
- Spray rate
- Nozzle aperture
- Fungicide concentration



References
[1] Haarmann, T., Reilein, A., Gieseler, S., and Tschaplinski, H. (2009) Ergot from wheat to biosecurity. Molecular Plant Pathology, 10(6), 563-571.
[2] Scazzafam, M., & Scazzafam, G. (2013) A Review of Current Knowledge of Resistance Against the Next-Generation Succinate Dehydrogenase Inhibitor Fungicides.
[3] Haverkamp, M., Poth, S., C. Keller, N., Smith, D. L., and Kollmann, M. (2002) A broadly conserved fungal alcohol oxidase (AOX) facilitates fungal invasion of plants. Molecular Plant Pathology, 3(1), 39-46.
Figures: 1. National Fungicide Trials (NFT) (2022) 'Ergot - spot the ergot', Nottingham, 29 July. Photo made in R&G graphics made in Blender by D. Garratt (2026).