Final Project Summary

Project title	Determining the routes of transmission of ergot alkaloids in cereal grains		
Project number	21130053	**Final Project Report**	603
Start date	02/01/2018	**End date**	02/01/2019
AHDB funding	£49,792	**Total cost**	£49,792

What was the challenge/demand for the work?

The fungus *Claviceps purpurea* infects cereals and grasses at anthesis, producing an ergot sclerotia in place of a grain. Ergot sclerotia contain a cocktail of ergot alkaloids (EAs) that are highly toxic to humans and animals.

The main source of EA contamination of grain comes from ergot being present in grain loads. However, evidence shows that even with grain that has had the visible ergot sclerotia removed, some grain is still substantially contaminated with EAs. This project tested three hypotheses to find out the route of EA contamination in cereal grain: via the rachis in developing grain, via honeydew coating the ear pre-harvest or via contact with ergot sclerotia post-harvest.

Previous NIAB research found that the fungal genes that control the biosynthetic pathway for the alkaloids are active at a very early point in the life cycle (within a week of infecting the plant) and, therefore, there is the potential for EAs to be present and, possibly, circulating in the plant a lot earlier than when an ergot gets harvested along with the grain.

The European Commission (EC) has been considering recommendation of maximum levels for sclerotia and EAs in unprocessed cereals and milling products, respectively. An introduction of maximum levels for EAs would pose a major challenge to the industry, as the understanding of transmission of EAs in cereal grains and its management is currently quite limited.

How did the project address this?

This project had four objectives:

Objective 1*: To determine whether ergot alkaloids are transferred from C. purpurea infected flowers to healthy grain within the same ear.*

Objective 2: *To determine whether the potential transfer of ergot alkaloids from C. purpurea infected flowers to healthy grain differs between cereal species, comparing wheat, barley and rye.*

Objective 3: *To determine whether C. purpurea produces differing levels of ergot alkaloids in different fungal structures, comparing honeydew, sclerotia and sphacelia.*

Objective 4: *To determine to what extent ergot alkaloids are transferred to healthy grain during direct, physical contact with whole, partial and sclerotia dust.*

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What outputs has the project delivered?
1. Main findings from Objectives 1 & 2: A single isolate of *C. purpurea* was used to infect wheat, barley and rye ears. The grain that developed on the ear alongside an ergot was collected and tested. Grains were positive for EAs and contained a more diverse range of EAs, compared to the mature ergot from the same isolate. There were differences in the subset of EAs found between grain that developed above vs grain that developed below the ergot. The variation in total EAs present between replicates of grain was very high. This indicates that there is a strong environmental effect and no conclusions could be made of effects between hosts as the within-host variation was so high. The grain contained anywhere between 15 ppb to 77,589 ppb, meaning that this could significantly contaminate grain.
2. Main findings from Objective 3: A single isolate of *C. purpurea* was used to infect wheat, barley and rye. A further six isolates were tested just on wheat. There were significant differences in the average size and weight of the sclerotia from the different hosts, with wheat producing the heaviest and rye the lightest. The EA levels in sclerotia were highest in the ergots from rye, followed by wheat then barley. The levels of EAs in honeydew and sphacelia were only tested for barley and wheat, in both cases the levels of EAs in fungal tissues on wheat were higher than those on barley. There appeared to be little host-effect on spectra of EAs detected with all three hosts producing sclerotia with very similar EA profiles. Of the seven isolates of *C. purpurea* tested on wheat, honeydew has relatively low levels of EAs present (<500 ppb), sphacelia at 15 days after inoculation contained 53,000–265,000 ppb and ergots 1.14–3.03 million ppb. There were a diverse set of EA profiles between the isolates tested.
3. Main finding from Objective 4: If whole ergots were present at the current EU maximum levels (0.5g/kg or 0.05%), then there were low levels of transfer (3–15 ppb). However, if ergots were broken and damaged, it led to much higher contamination (66–229 ppb). A 'worst-case scenario' was also carried out. This used 10 times the EU maximum levels, where whole ergots transferred 66–187 ppb and broken ergots transferred 318–1467 ppb. This means that if there is heavy contamination at harvest before cleaning, or lengthy transportation before cleaning, transfer of EAs could pose a credible risk.

Who will benefit from this project and why?	
The results of this project will be fed into the EC consultation currently underway to decide maximum levels of EAs in processed grain. It may also be used to inform and update advice to farmers, agronomists and food processors.	
Lead partner	NIAB
Scientific partners	Campden BRI