



Black-grass Bulletin Issue 2

A focus on molecular studies



BLACK-GRASS RESISTANCE INITIATIVE

Toward understanding resistance mechanisms

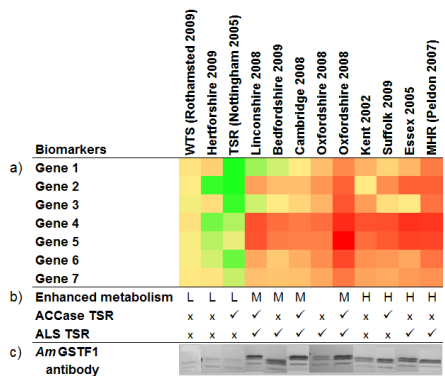
The battle against black-grass - identifying the molecular mechanisms underpinning multiple herbicide resistance for developing future diagnostics and targeted weed therapy

Molecular diagnostics – a decision tool for informed herbicide management

The decision for how to tackle black-grass infestation can be tricky. The rise and spread of herbicide resistance, especially multiple herbicide resistance has turned chemical based management into a lucky dip. This is set to change in the future with our development of a pocket based diagnostic to give power back to growers.

The science behind molecular diagnostics involves several developmental steps. We first compared two black-grass populations – a multiple herbicide resistant and a susceptible population to characterize the genes linked to resistance. This highlighted 7 genes and 1 protein (*AmGSTF1*) that we could use as candidate biomarkers in a resistance screen of several previously uncharacterised black-grass populations, collected across England.

The biomarkers showed selective links to herbicide resistance. Genes 4-7 and *AmGSTF1* were consistently detected in populations with moderate (M) or high (H) levels of herbicide metabolism.



The search for diagnostic biomarkers showing presence (red) and absence (green) of molecular biomarkers linked to mode of herbicide resistance

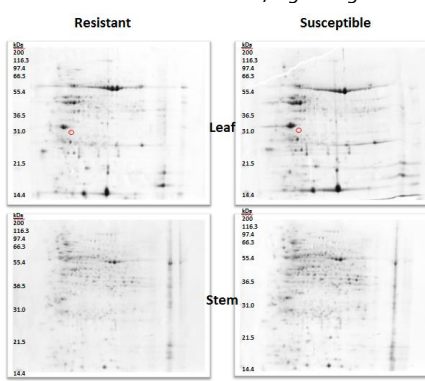
The next steps for us now are to check the specificity of the biomarkers:

- to herbicide resistance rather than resistance against other plant stresses
- in different plant parts, by comparing the leaf and stem tissue

i.e. will the result of the diagnostic depend on the environment, and the section of the plant sampled for the diagnostic test?



Controlled experiments to test herbicide resistance biomarker specificity in different environmental "stresses", e.g. drought.



Identifying protein biomarkers of stress using a technique that extracts proteins from plant tissue and separates them to produce a visual comparison of proteins (black spots) in different plant populations and plant parts.

Targeted weed therapy?

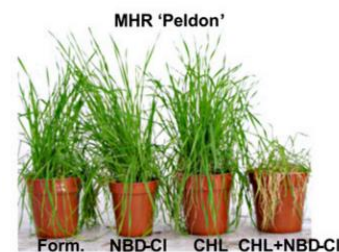
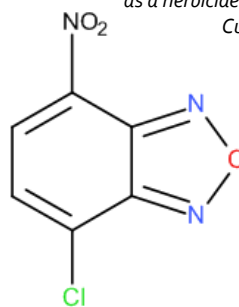
Molecular diagnostics are a common tool in health care, for example in cancer diagnosis. Similar to a doctor taking a sample from a patient to check whether a tumor is cancerous, growers would take a sample of black-grass to diagnose herbicide resistance. Having a negative result (absence of multiple herbicide resistance) would lead to an informed decision about herbicide usage. But what if the diagnostic shows a positive result – presence of multiple herbicide resistance? This is the second focus of our research – exploring the potential to counteract the mechanisms that black-grass use to resist herbicides.

Firstly, we need to understand what these black-grass mechanisms are. In previous research, we characterized several enzymes produced by resistant black-grass that degrade (detoxify) the active ingredients in herbicides. Collectively, we have called these enzymes the plant xenome, which kicks into action as soon as black-grass has taken up the herbicide.

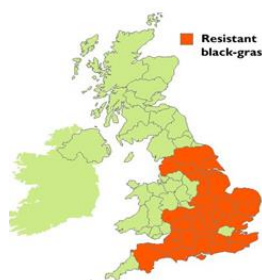
Surprisingly, plant xenome enzymes are similar to the enzymes that cancer cells produce to detoxify anti-cancer drugs, causing multiple drug resistance (MDR). In a recent study, we discovered that treating resistant black-grass with an experimental drug for cancer therapy to combat MDR (NBD-Cl – see insert) can also inhibit the plant xenome, restoring herbicide control.

Sadly, NBD-Cl poses considerable environmental risk and therefore cannot be developed further as a herbicide synergist. However, this research has highlighted that black-grass resistance may have an Achilles heel to be targeted with other therapeutics.

Chemical structure of a xenome inhibitor, 4-chloro-7-nitro-bezoxadiazole (NBD-Cl, left), and its effectiveness as a herbicide synergist with chlorotoluron (CHL, right), published in Cummins et al. 2013, PNAS, 110, 5812-5817.



FAST FACTS



- Herbicide resistance now widespread in black-grass
- 1.2 million Ha affected in UK
- Responsible for major yield losses in wheat

The inaugural stakeholders meeting

Since the last issue of the BGRI bulletin we held the first stakeholders meeting, set up to ensure that information and results from our research feed directly back to farmers and industry. Attendees included our project partners, HGCA and BBSRC, alongside representatives from agricultural organisations and leading UK agronomy companies who met up to discuss our research and the impact that black-grass has on their business. After introductions, we held an afternoon session on 3 topics:

- Maximizing future funding and collaboration for black-grass research via a "BGRI-plus" community
- Ensuring impact of BGRI into practical solutions
- Creating future linked projects

Overall, we had an incredibly productive day of idea sharing and were delighted with the enthusiasm and contribution from all of the stakeholders. Everyone agreed that we should meet regularly throughout the project, with the next Stakeholder Meeting scheduled to coincide with Cereals 2015.

In the meantime, we're hosting our first Farmer Focus Workshop on February 12th. The aim is to develop relationships to facilitate knowledge exchange between BGRI and the farming community.

Upcoming events

Cereals 2015, June 10th-11th www.cerealsevent.co.uk/

Black-grass on the Twitter-sphere

Follow the BGRI on twitter - we tweet about the latest news from ourselves, as well as retweeting news and views about the latest on black-grass research and management from across the UK. This month a lot of people are sharing experiences of black-grass survival over the winter season. See what everyone else is up to and tell us how you are getting on [@BlackGrassRI](https://twitter.com/BlackGrassRI)



Next issue: August 2015

FOR MORE INFORMATION

For more information on any aspect of the project please see our website at bgri.info or contact us by email at bgri@rothamsted.ac.uk