Can allelopathy provide the answer to the black-grass problem?

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Background- Allelopathy

- Interest in finding alternative methods to control black-grass
- Allelopathy, the natural release of biochemicals from the tissues of competing plant species, may hold promise
- Modern cereals-bred in favour of yield over allelopathy
Background- What’s the vision?

❖ Primary goal- a crop mix or breeding recommendation; something that could lead to in-field weed suppression

❖ Alternative- a bioherbicide produced from allelochemicals found in plant exudate material

BLACK-GRASS-B-GONE

• Inhibits black-grass
• Doesn’t inhibit wheat
• Remains effective in microbially active soil
Two Questions

1. Is there innate ability for wheat to produce allelochemicals that could inhibit black-grass at natural concentrations? What are they?

2. Do previously-identified wheat allelochemicals have potential for black-grass control?
Methods- Exudate collection

- Magenta box hydroponic system used to collect exudates
- Hydroponic medium- sterile distilled water; easier to isolate chemical signatures
- Grown for two weeks

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<th>Treatments</th>
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<td>Control- No plants</td>
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<td>Modern wheat</td>
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<td>Ancient wheat</td>
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<td>Black-grass</td>
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<td>Black-grass/ Modern wheat mix</td>
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Methods- Exudate analysis

- Exudate medium from Magenta system concentrated by freeze-drying, then resuspended
- Some exudate retained for chemical analysis
- Remainder used in bioassay of black-grass in Petri-dish system
Results - Exudate analysis

- Black-grass assays with natural concentrations of crude exudate show no difference between pre-treatments.
- With 5x concentrated exudate, a mixed black-grass/wheat exudate inhibitory to black-grass roots.
Summary- Exudate analysis

- Modern wheat root exudates can inhibit black-grass development
- Evidence of signalling interactions in mixed group
- Known allelochemical present in wheat and mixed-group exudates; may be cause of inhibition

So what happens when we synthesise this and test it on black-grass?
Methods- Allelochemical assays

❖ Compound found in chemical analyses, and five related compounds made
❖ Assayed in Petri-dishes on black-grass seed
❖ Dose-response analyses undertaken to determine effects across a range of doses
❖ Promising chemistry tested on multiple black-grass populations and wheat varieties
Four of the six tested allelochemicals excluded from further tests

One of these four had little effect across dose range

The other three required high doses to produce significant inhibitory effects
Results- ‘Allelochemical 1’

- ‘Allelochemical 1’- consistent effects on black-grass roots
- Includes herbicide-resistant populations of black-grass
- Wheat less sensitive to comparative doses
Results- ‘Allelochemical 1’

‘Allelochemical 1’, effects on multiple populations of black-grass
Results - ‘Allelochemical 1’

‘Allelochemical 1’, effects on wheat

Mean root length (cm)

Cultivar

Dose (μM)

- 0
- 250
- 500
- 1000

Cadenza

Gravity
Results- ‘Allelochemical 2’

❖ ‘Allelochemical 2’ inhibitory at lower doses but dose-response effect not yet found

❖ Significant inhibition of black-grass root growth, even at lowest concentration tested

❖ Data of effects on wheat collected but not yet analysed
Summary

❖ Two allelochemicals hold promise for further work
❖ Discriminating doses determined
❖ Next step is to assay promising chemistry in soil and solid media with microbial activity
❖ If they are still effective, wheat/black-grass competition assays

BLACK-GRASS-B-GONE?
✓ Inhibit black-grass
✓ Don’t inhibit wheat
? Remains effective in microbially active soil
Conclusions

- Modern, commercial wheat varieties are likely to exude allelopathic compounds from their roots into the rhizosphere.
- These are unlikely to be at sufficient concentrations in modern wheat to inhibit black-grass growth; ancestors may be more potent producers.
- At above-natural concentrations, these compounds are inhibitory to black-grass, but not wheat root growth; they may therefore have applicability in a planted field.
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