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

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ROTHAMSTED RESEARCH

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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

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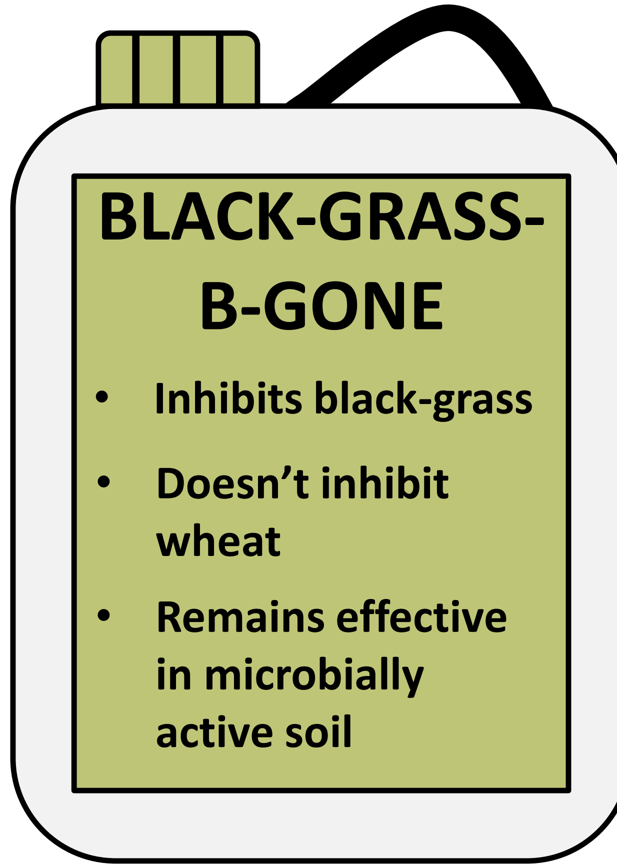
Background- What's the vision?

- 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



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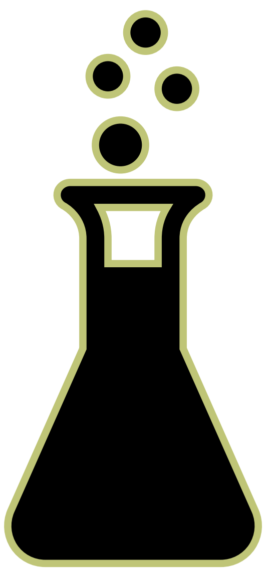
Two Questions

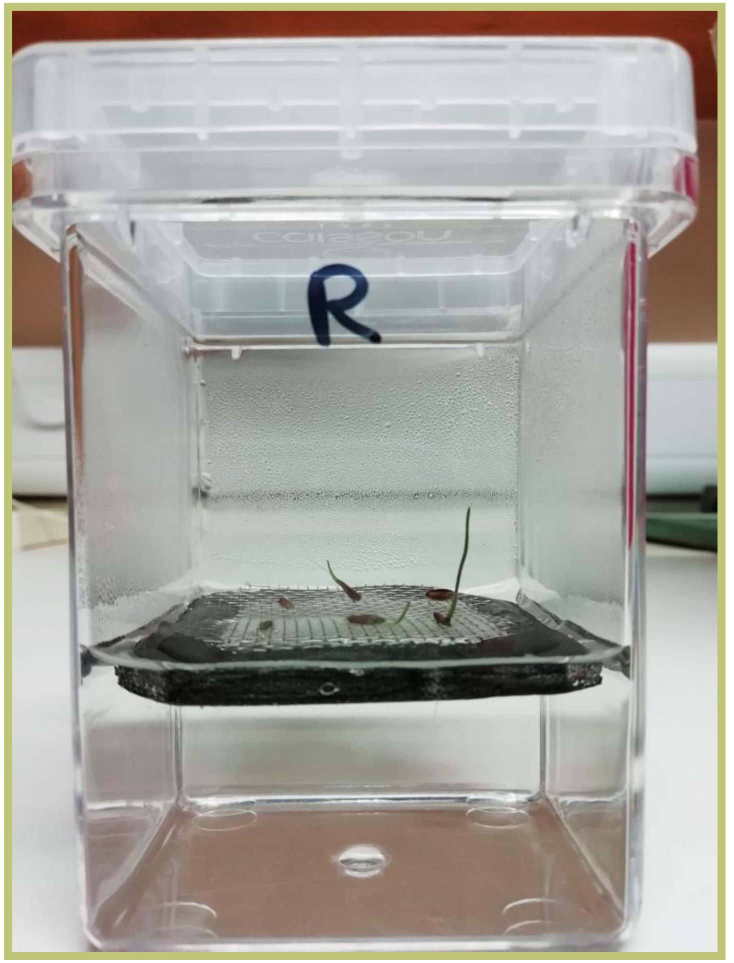
1. *Is there innate ability for wheat to produce allelochemicals that could inhibit black-grass at natural concentrations? What are they?*
2. *Do previously-identified wheat allelochemicals have potential for black-grass control?*



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

Treatments
Control- No plants
Modern wheat
Ancient wheat
Black-grass
Black-grass/ Modern wheat mix



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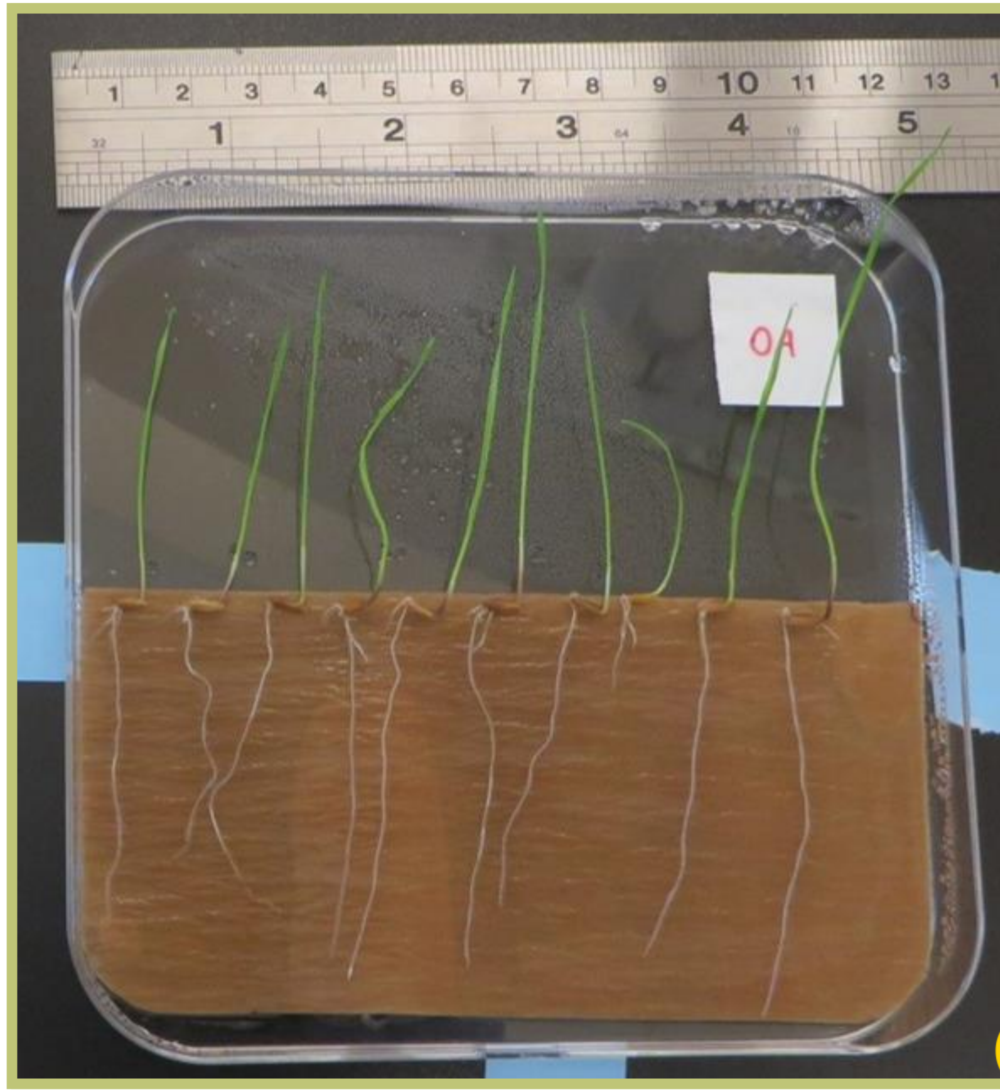
Methods- Exudate analysis

- 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



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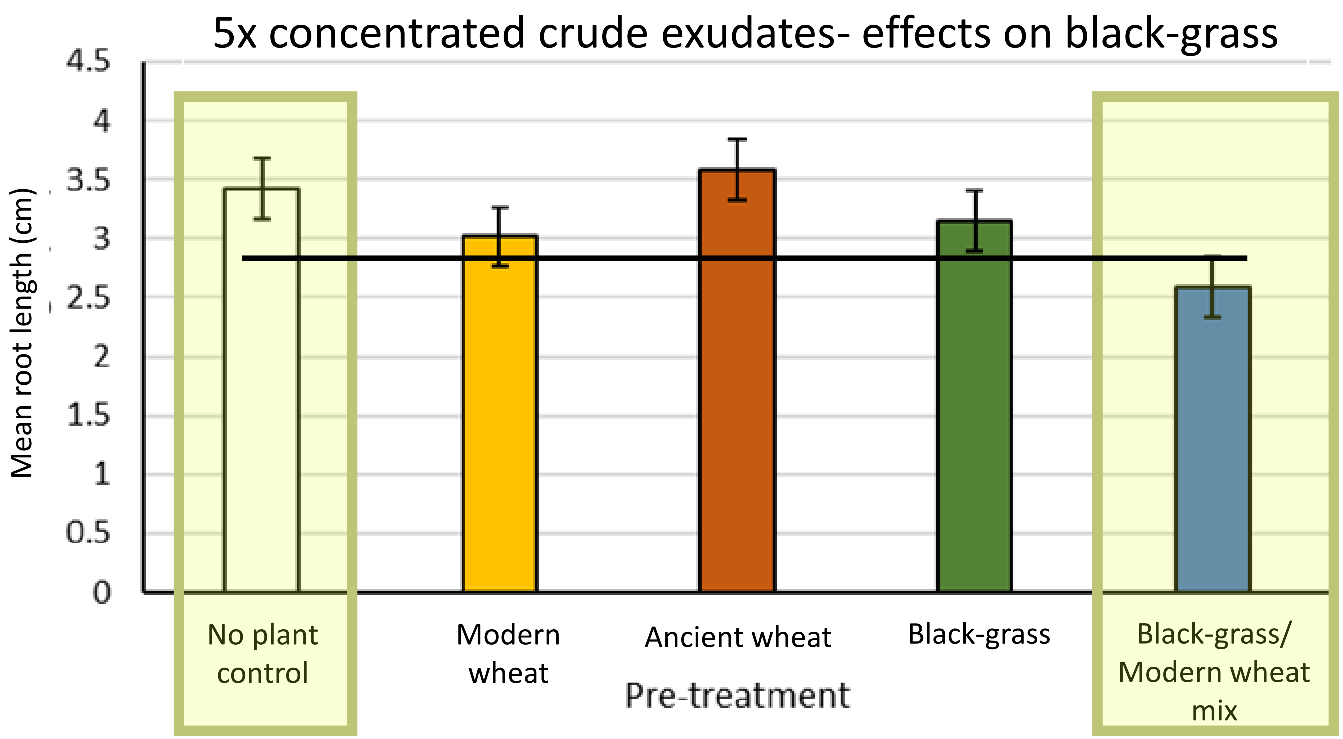
Results- Exudate analysis

- 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



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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?

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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

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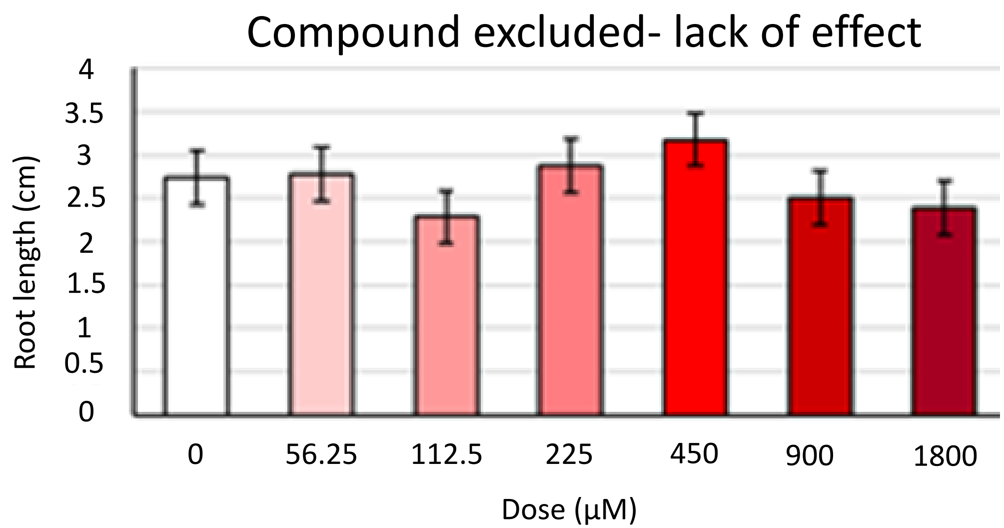
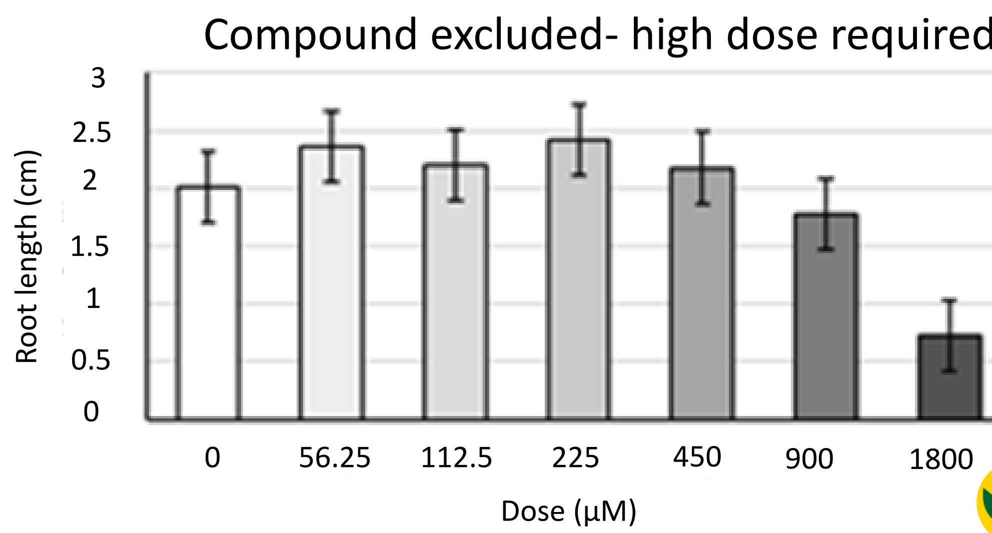
Results- Excluded allelochemicals

- 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





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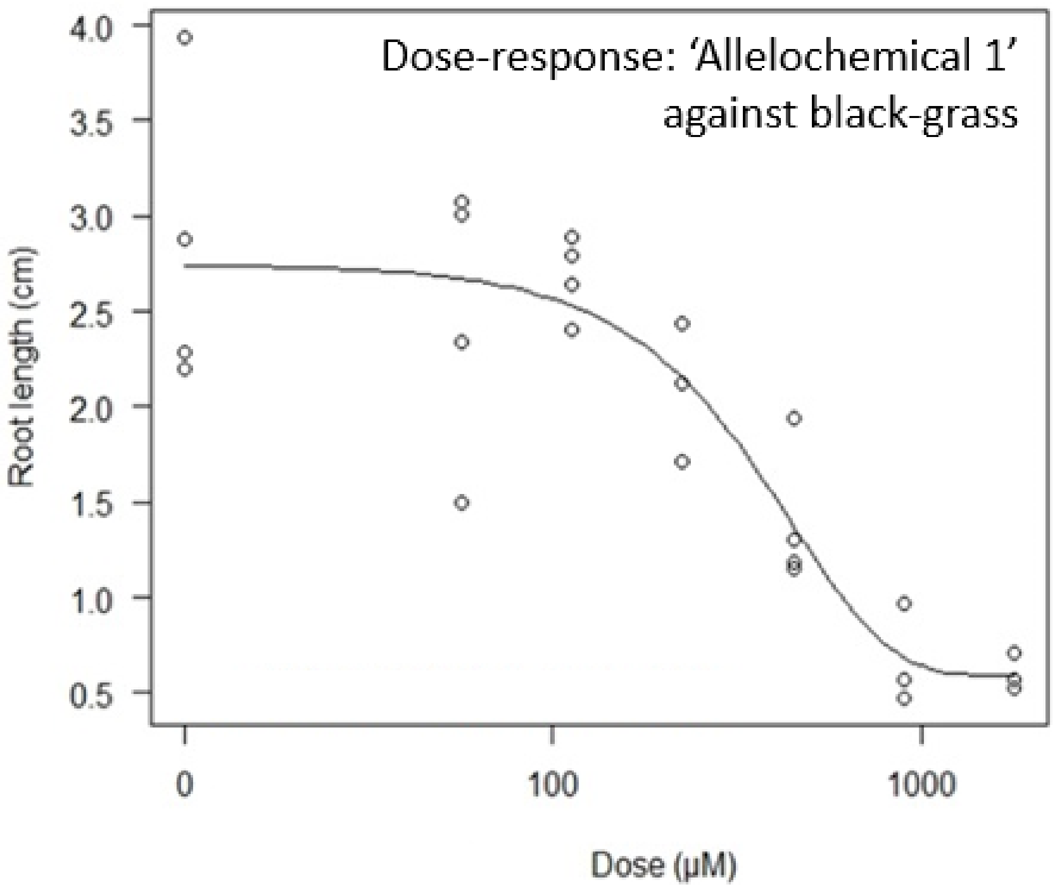
Results- ‘Allelochemical 1’

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



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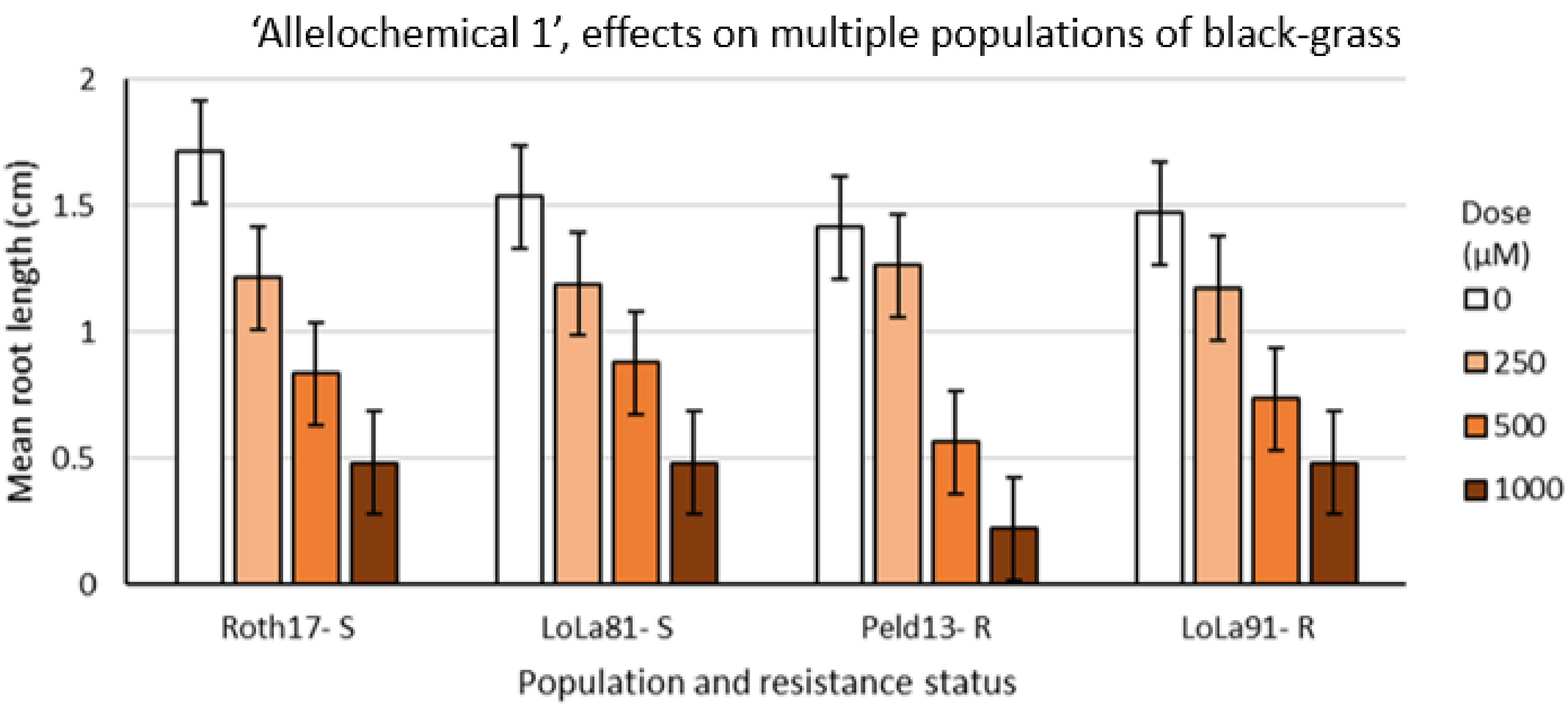
Results- ‘Allelochemical 1’



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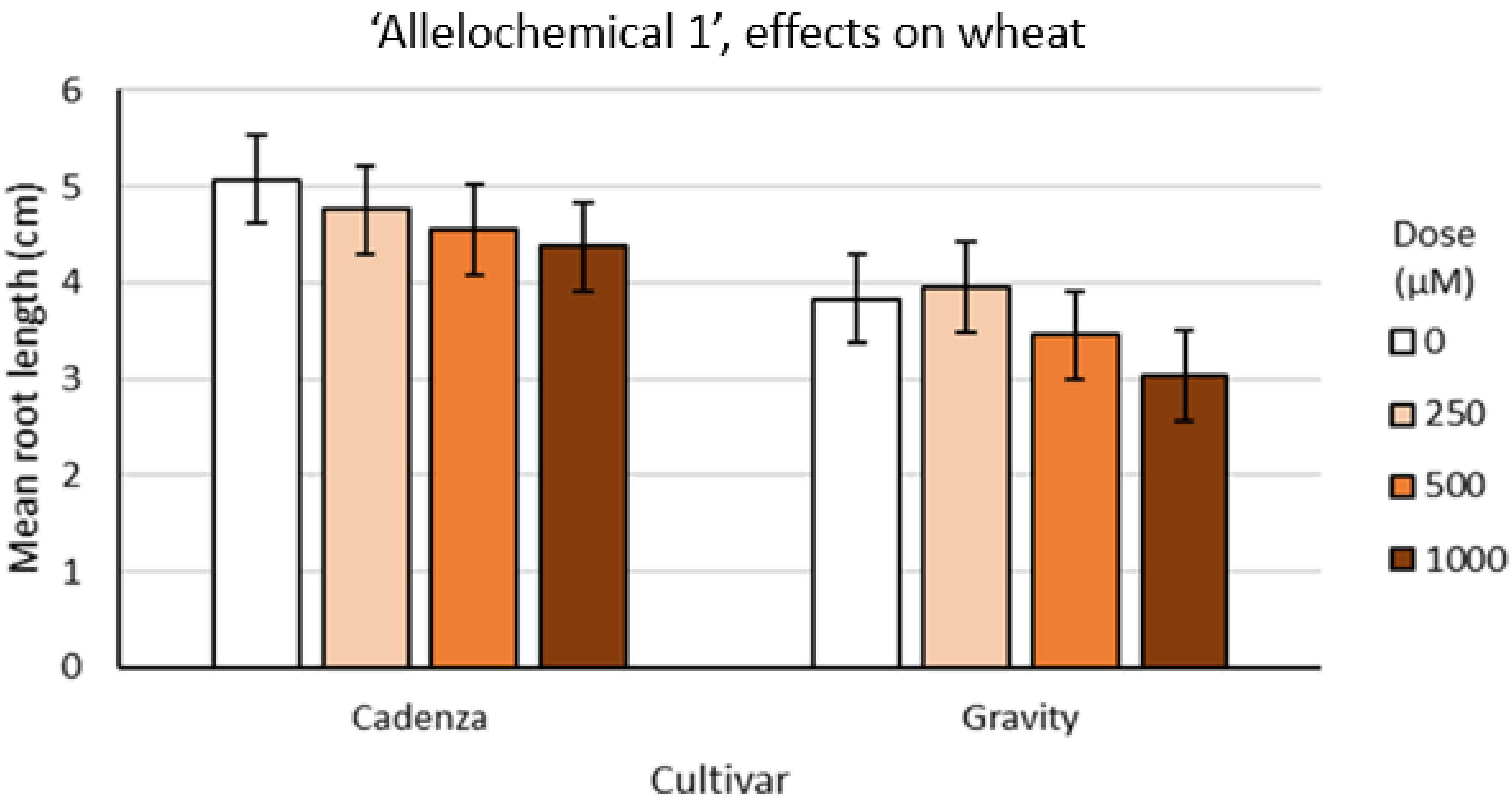
Results- ‘Allelochemical 1’



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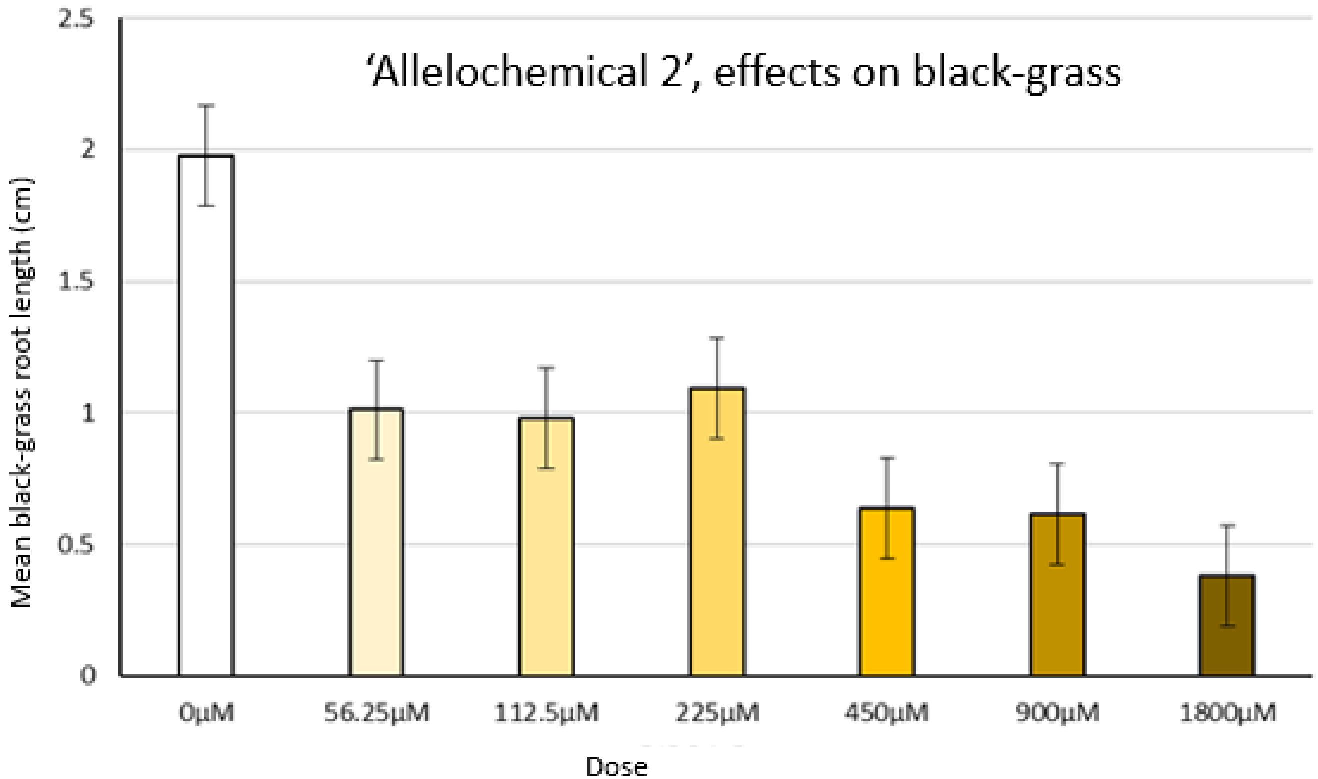
Results- 'Allelochemical 2'

- '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



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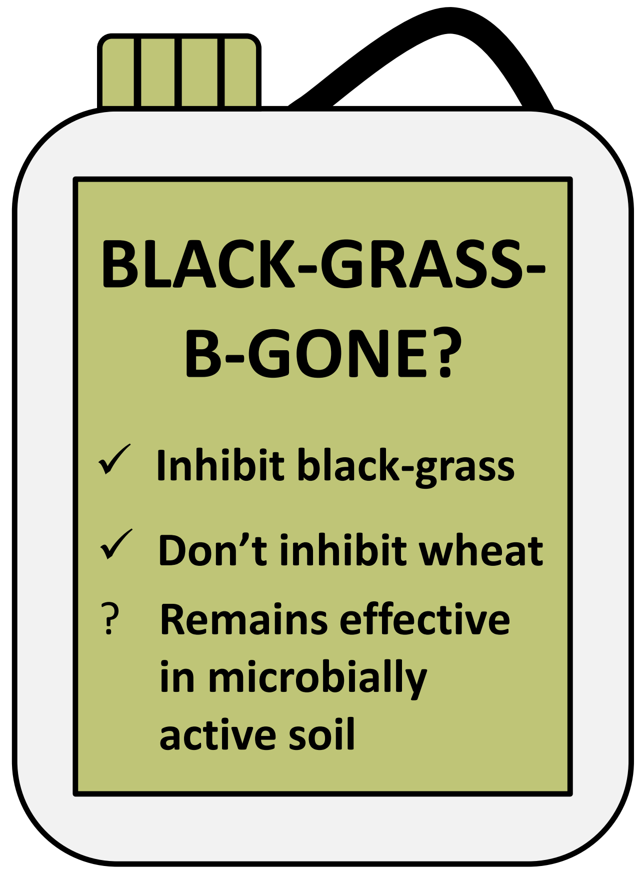
Summary

- 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



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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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Acknowledgements

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Thank you for listening