Final Project Summary

Project title	Competitive crop cultivars: optimising yield and sustainable weed suppression		
Project number	RD-2011-3757	**Final Project Report**	SR38
Start date	01/10/2011	**End date**	30/09/2015
AHDB Cereals & Oilseeds funding	BBSRC & AHDB £37,500	**Total cost**	£37,500

What was the challenge/demand for the work?

Herbicide-resistant black-grass (*Alopecurus myosuroides*) is increasingly a challenge for growers, and there are no new actives. Growers are needing to optimize their integrated weed management strategies through the use of cultural control. One such tool is the use of different cultivars (varieties) to suppress the growth and seed production of black-grass. A better understanding of what makes cultivars competitive, and how to best use them, is needed.

How did the project address this?

This project had three specific aims:

1. Can competitive traits be identified in wheat?
2. Can these traits be used to screen cultivars for suppressive ability?
3. How does cultivar choice contribute to other weed control strategies, most specifically increased sowing rate and delayed sowing.

The project examined ten winter wheat cultivars, as well as one barley (Volume) and one oat (Gerald) over three years of study, to identify what traits made some cultivars better at reducing the growth and seed production of black-grass. This was done in outdoor containers and in field experiments, with the cultivars growing alongside black-grass. Multivariate analysis and linear mixed modelling was employed to identify traits that may predict the suppressive ability of cultivars and to determine if these traits co-occur. Two mathematical models (the Relative Weed Green Area model and INTERCOM) were used to see how predictions of weed control would differ between cultivars possessing different weed control traits. How cultivar choice contributes to increasing sowing rate or delaying drilling was investigated through field experiments and mathematical models.

What outputs has the project delivered?

The competitive ability of cultivars was similar across the three years of container-based experiments, except in the 2012-13 experiment (Figure 1). Seed produced by black-grass in competition with Duxford (one of the most competitive) was lower than KWS Santiago (one of the least competitive) by 35.5% in 2011-12 and 52.2% in 2013-14, but only 20.6% in 2012-13. The 2012-13 growing season had a colder autumn and winter period than 2011-12 and 2013-14, leaving cultivars less developed. In the colder year, early traits did not differ greatly between the cultivars, which we suggest explains the

similarity in each cultivars ability to suppress black-grass. No consistent competitive ranking was seen in the field-based experiment. It is difficult to judge if this would be the case in a longer study, as one of the two years was the notably colder season (2012-13).
Various plant traits were related to black-grass seed production. Cultivars that were better at covering the ground during autumn and winter were often better competitors (greater leaf area, greater seedling height), but not in all experiments. A reduced green area was better for reducing black-grass seed return in one of the years, which may suggest that root competition was more important that year. Cultivars that produced fewer tillers and subsequently lost fewer tillers also seemed to be better competitors, but this requires further investigation.

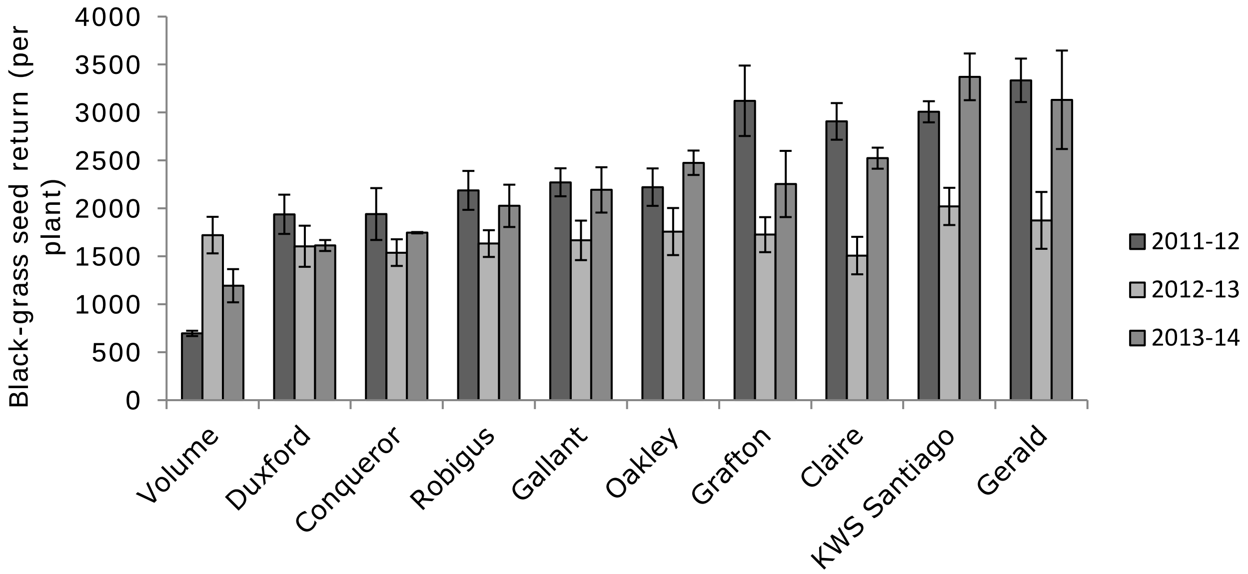

Figure 1 – The seed return of black-grass when grown with different cultivars in the container-based experiment. All cultivars are wheat except Volume (barley) and Gerald (oat). Bars indicate standard error.

Generally, cultivar choice is quite compatible with the use of higher sowing rates and delayed drilling. Early light-blocking traits are less important when sowing is delayed, but it remains an effective means of reducing black-grass populations.
The Relative Weed Green Area model suggests that differences in cultivar growth rate is important to consider when predicting yield losses. The INTERCOM model showed that increased green area growth rate, earlier spring booting, thinner leaves and greater root mass gives a cultivar a competitive advantage. This model also predicted that the use of a strongly competitive cultivar with delayed sowing or increased sowing rate further reduces seed production of black-grass.

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Who will benefit from this project and why?
Information on important traits may be useful to predict the competitive ability of new cultivars as they come to market, allowing growers to consider competitive cultivars in IWM strategy. If cultivars can be screened for competitive ability early, growers can chose to incorporate competitive cultivars into their IWM. Breeders may also be able to use these findings to target competitive traits, in order to boost the competitive ability of new cultivars.

If the challenge has not been specifically met, state why and how this could be overcome
Although this project has identified useful traits, there is still uncertainty surrounding their interaction with the environment. An understanding of the role of belowground traits may help us understand why greater green area was beneficial to decrease black-grass seed production in some years, but not in others. However, belowground traits are difficult to study. Hopefully this area can be examined more thoroughly as technology to examine crop roots develops.

How have you benefited from this studentship?
I have developed skills in plant growth form analysis and modelling techniques required to interpret plant growth. My understanding of arable agriculture has increased, and I am well versed in the principles of plant community ecology. I have developed various practical, development and management skills necessary to conduct experiments in the field, in containers, and in controlled environments. AHDB-Cereals &~~and~~ Oilseeds also gave me the opportunity to develop grant-writing and leadership skills by funding a 3-month student who worked under my supervision. My time based at Rothamsted Research has given me valuable insight into scientific research, and my contact with industry and farmers has heightened my awareness of the needs of the agricultural sector.

Lead partner	Jonathan Storkey [1] and Debbie Sparkes [2]. (1. Rothamsted Research; 2. University of Nottingham)
Scientific partners	
Industry partners	Agrii, who offered ‘in kind’ support in the form of access to trial sites and training. Syngenta UK, who assisted in the purchase of materials for the project.
Government sponsor	BBSRC, who funded half of this studentship.