Final Project Summary

Project title	Investigating the effect of natural enemies and environmental conditions on soil populations of saddle gall midge (*Haplodiplosis marginata*)		
Project number	214-0002	**Final Project Report**	SR42
Start date	01/01/13	**End date**	31/12/16
AHDB Cereals & Oilseeds funding		**Total cost**	

What was the challenge/demand for the work?

Haplodiplosis marginata is a sporadic pest of cereals across Europe. Due to the occasional and unpredictable nature of outbreaks, research into this pest has been similarly sporadic and lacking in comparison to more common cereal pests. This resulted in an absence of suitable control options when outbreaks of this pest were reported in the UK in 2010 onwards. This project aimed to address the gaps in knowledge that have prevented the development of integrated pest management tactics for this species. In particular, the environmental conditions affecting the development of larvae in the soil stage were to be investigated to provide a means of predicting the emergence of adults on a yearly basis. Additionally, the potential for natural enemies to effect soil populations was to be investigated.

How did the project address this?

Populations of *H. marginata* at a number of field sites across the UK were studied over three years. Soil samples were taken and traps deployed to track the development of larvae in the soil and the start of adult emergence each year. Meteorological data was collected from a national network of weather stations to investigate the effect of soil temperature and rainfall events in the timing of adult emergence and degree day calculations were used as the basis of a forecasting model. Assessments of potential yield loss in relation to galling were made at heavily infested sites. The sex pheromone of female *H. marginata* was further investigated as a means of improving monitoring methods for this pest, including the optimisation of a pheromone lure and pheromone trap placement. A PCR-based assay was developed to identify natural enemies of *H. marginata* from the guts of field-caught specimens.

What outputs has the project delivered?

- Development of a degree-day based model for predicting peaks in *H. marginata* adult emergence, based on soil temperature accumulations above 0°C of 512DD (±9.11DD) following a rainfall event.
- Development of a degree-day based bimodal model for predicting the cumulative emergence of *H. marginata* over the entire flight period. The start of emergence could be predicted to within 3 days using this model.

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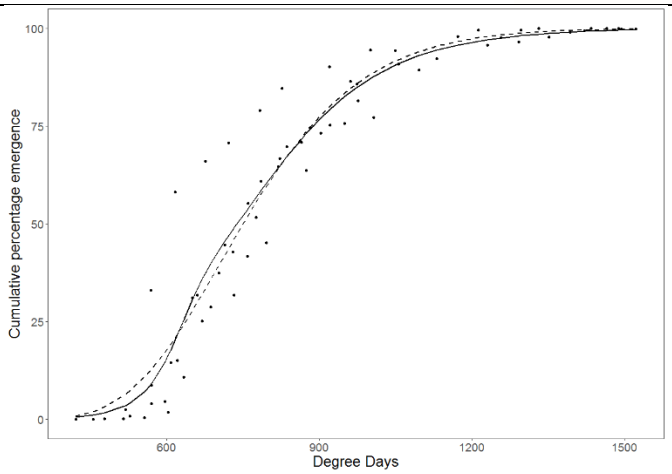

Figure 3. Percentage cumulative emergence of *Haplodiplosis marginata* as a function of accumulated degree days for all sites and years studied. Predicted emergence based on the probit model (dashed line) and bimodal model (solid line) shown.

- Determination of the effect of galling on plant characteristics. Galled stems had shorter stems, shorter ears, and fewer grains per ear but grain weight per ear was not affected.

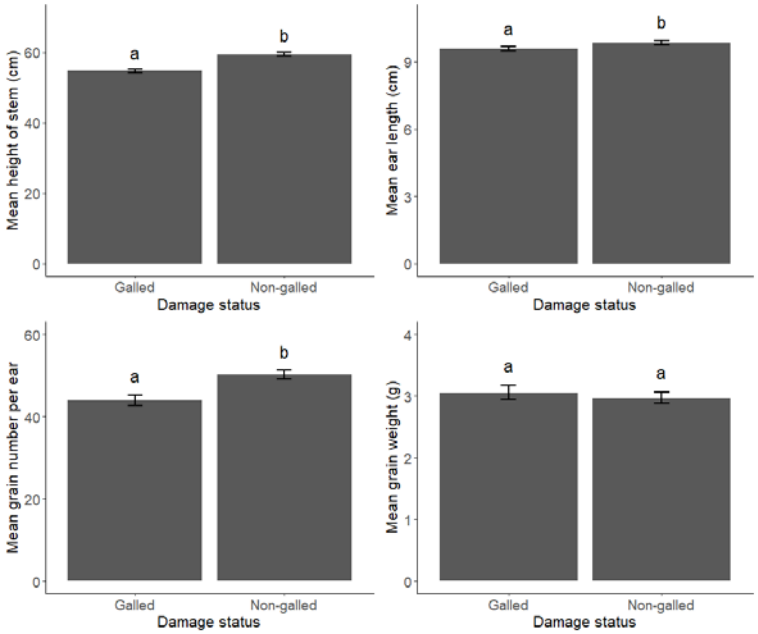

Figure 2. Crop damage assessment of stems sampled 2014 – 2016. Mean values (± SEM) show differences between galled and non-galled stems in **A.** height **B.** ear length **C.** grain number per ear **D.** grain weight per ear. Lowercase letters represent where these differences are statistically significant at the P = 0.05 level.

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- Optimisation of a pheromone lure for *H. marginata* through field trials investigating different dispensers, formulations and loadings. Polyethylene vials containing 0.5 mg of (*R*)-2-nonyl butyrate were determined to be the best performing lures for monitoring purposes.
- Maximising catch of pheromone trap based on field trials to determine optimal trap height, distance into the crop and inter-trap distance minimising lure interference. Lures were still attractive after 9 weeks in the field. Traps should be positioned at the height of the ear of the crop at least 20m away from the field margin with a minimum of 20m between traps.

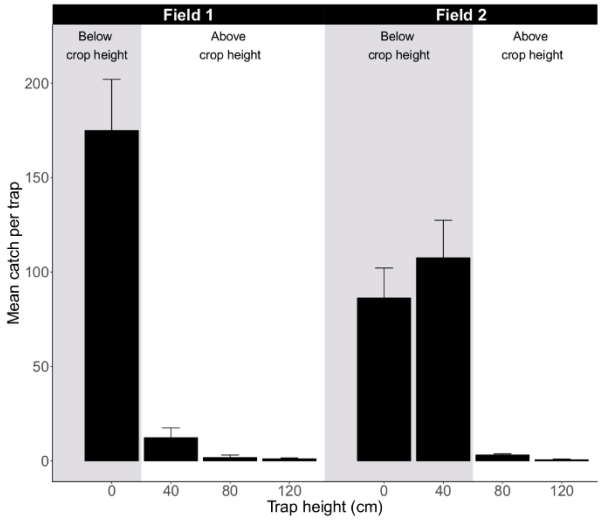

Figure 4. Mean catches (+SEM) of *Haplodiplosis marginata* males in traps positioned at different heights in fields of spring wheat (Field 1) and winter wheat (Field 2) at the Oxford field site (13-19 May 2016; *N* = 4 at each site and height; shaded areas represent traps at or below the height of the crop).

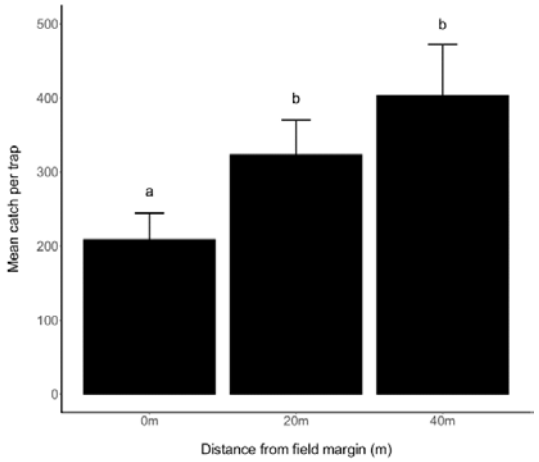

Figure 5. Mean catches (+SEM) of *Haplodiplosis marginata* males in traps positioned at increasing distance from the field margin (19 May – 1 June 2016; three sites, N = 4 at each site). Lowercase letters indicate significant differences between distances.

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- Development of a PCR-based assay to identify *H. marginata* in the guts of predatory arthropods. Identification of 7 species of beetle that predate on *H. marginata* from a field survey demonstrating the potential of the assay.

Publications:

- Rowley, C., Cherrill, A., Leather, S., Nicholls, C., Ellis, S. & Pope, T. (2016) A review of the biology, ecology and control of saddle gall midge, *Haplodiplosis marginata* (Diptera: Cecidomyiidae) with a focus on phenological forecasting. *Annals of Applied Biology*,**169**,167–179.
- Rowley, C., Pope, T.W., Cherrill, A., Leather, S.R., Fernández-Grandon, G.M. & Hall, D.R. (2017) Development and optimisation of a sex pheromone lure for monitoring populations of saddle gall midge, *Haplodiplosis marginata*. *Entomologia Experimentalis et Applicata*, **163**, 82–92.

Who will benefit from this project and why?

Growers and agronomists will benefit from improved monitoring of *H. marginata* as a result of this project. Forecasting models and pheromone traps can be used to determine the start of emergence of this insect and predict further peaks later in the season. Growers can then use this information to make crop inspections to check for the start of egg-laying. This information is also necessary for the correct timing of any chemical controls to reduce the number of unnecessary and ineffective applications. Pheromone traps are effective even with low numbers of individuals and could provide early warning of infestations and encourage greater crop rotation in certain areas. Confirmation of predation on *H. marginata* by predatory arthropods may encourage growers to adopt agricultural practices that are beneficial to these species. These practices will in turn have beneficial consequences for the wider environment.

If the challenge has not been specifically met, state why and how this could be overcome

The impact of population size and consequent galling on crop yield is still unresolved. Assessments of crop damage in this study were not conclusive due to the relatively low levels of infestation in the study years. Further research over several outbreak years in different crops may overcome this, with the added benefit of using standardised pheromone traps to relate trap catch to eventual damage.

How have you benefited from this studentship?

I have acquired many skills needed to be an independent researcher and am confident in my ability to produce high quality research. I have learned a great deal about the agricultural sector and how the study of entomology can have benefits for both the industry and the wider agri-environment.

Lead partner	
Scientific partners	Natural Resources Institute, University of Greenwich
Industry partners	ADAS
Government sponsor	

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