Grower Summary

FV 407

Spinach: Preliminary studies on forecasting migrations of Aphis fabae into crops

Final 2012

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Project Number:	FV 407
Project Title:	Spinach: Preliminary studies on forecasting migrations of Aphis fabae into crops
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Headline

There are some very strong relationships between the timing of the spring and summer migrations by *Aphis fabae* and weather (temperature) data and these could be developed into a day-degree forecast to predict the timing of migration and also to predict the abundance of aphids in conjunction with real-time suction trap outputs.

Background

The black bean aphid (*Aphis fabae*) has a very large range of summer hosts, of which spinach is one. *Aphis fabae* overwinters mainly as eggs on spindle bushes, and a few other shrub species, and occasionally, in warmer locations, as mobile stages on members of the pea/bean family (wild hosts or winter beans). The eggs hatch from late February to early April and colonies develop on young leaves and shoots of the winter host. Winged forms are produced in May/June and these migrate to summer hosts. Reproduction continues throughout the summer, further winged forms are produced in response to crowding and these spread within crops and invade new crops. Populations usually peak in July/August. In autumn *A. fabae* migrates back to spindle and winter eggs are laid.

Winged forms of *Aphis fabae* are captured in the suction traps operated by the Rothamsted Insect Survey and information on numbers captured is presented on their web site. Several researchers have developed forecasting systems for infestations of *A. fabae* on beans or sugar beet. Some of these have relied on counting aphid eggs on overwintering hosts. However, a paper by Way *et al.* (1981) considered an approach using both egg counts and suction trap samples to forecast infestations in field beans. The forecasting system they developed was used in the UK for a number of years.

Previous studies on other pest species have indicated relationships between pest activity/abundance and weather data (either day-degree forecasts or statistical relationships). Rothamsted suction trap data and weather data could be summarised and analysed to determine whether there are any relationships that could be developed for *A. fabae*. The aim of this project is to gain a better understanding of *A. fabae* and its life cycle with a view to developing a prediction method to provide advance warning of possible sudden influxes onto spinach crops.

Summary

The project consisted of four objectives:

Objective 1. Produce a short review of relevant information on the life cycle and biology of Aphis fabae and summarise previous approaches to forecast development.

A relatively small number of papers have been published on this topic and these were summarised. Researchers have divided captures by suction traps into three phases representing the spring migration from spindle to herbaceous hosts, the summer migration to other hosts and then the autumn migration back to spindle. Whilst the second and third phases are well-separated in time, the first phase can be hard to separate from the second when inspecting the data. The studies have indicated that:

1. Populations fluctuate from year to year and two studies indicated that there may be a ‘pattern’ to this e.g. regular alternation of small and large populations.
2. There may be correlations between the abundance of *A. fabae* and certain weather conditions (temperature or rainfall).
3. The distribution of winter and summer host plants determines the distribution of *A. fabae* and its relative abundance to a great extent. The distribution of the winter host, spindle, is not uniform and it is more abundant in the south and west than the east (it grows on calcareous soils) and this affects the distribution of eggs and thus the occurrence of spring migrants (few in Norfolk, Lincolnshire and northern Britain). The summer host crops are more abundant in other areas (such as East Anglia). However, since summer migrants occur in moderate numbers throughout the UK, even where the key crops are scarce or absent, it is apparent that wild hosts are also colonised.
4. It is possible to sample spindle trees during the winter to record the numbers of overwintering eggs. A paper by Way *et al.* (1981) described the use of egg counts and suction trap data to forecast the infestation of field beans by *A. fabae*. They found that:
    - Autumn trap catches (the autumn migration back to spindle) were useful as early forecasts of likely very large or very small populations of aphids on field beans (about 8 months later), but that otherwise they lacked precision.
    - Egg sampling in winter provided a more accurate forecast approximately 5 months before infestation of the bean crop.
    - In May, aphid counts on spindle were most useful for predicting the time of migration and provided approximately 2 weeks warning for insecticide application if needed.
    - Captures in the suction traps in spring provided the latest estimate of both the sizes of crop infestations and the best timing for insecticide treatment.

- In terms of forecasting infestation levels, Way *et al.* used criteria as shown in the Table below.

Forecasting criteria for catches in suction traps (from Way *et al.*, 1981).

Forecast damage to spring-sown beans	Total aphids/trap (mid September – early November)	Total aphids/trap (May – mid June)
Unlikely	0-15	0-4
Possible/probable	>15	>4

Objective 2 Summarise Rothamsted suction trap records on captures of Aphis fabae over at least 10 years to indicate the pattern of aphid migration.

Rothamsted Research provided suction trap data for *Aphis fabae* captures at Broom's Barn in Suffolk and Wye in Kent. This was because the suction traps at these sites captured relatively large numbers of *A. fabae*. EXCEL was used to summarise the data in terms of aphid abundance and the timing of key events in the pattern of aphid migration. Linear regressions were fitted to some of the data and correlation coefficients were estimated using the facility in EXCEL. The total numbers of aphids captured up to 31 August (spring and summer migrations) in each year are shown in Figure A.

Generally, more spring migrants were caught at Wye than at Broom's Barn, whilst summer and autumn migrants were more abundant at Broom's Barn. Annual captures (up to 31 August) at Wye and at Broom's Barn were highly correlated, indicating a general effect of 'year' on abundance. There was a statistically significant correlation for the data from Broom's Barn between numbers of aphids trapped in spring (up to 15 June) and those trapped in the previous autumn, but no correlation for the data from Wye. There were no correlations between numbers of aphids trapped in summer (15 June – 31 August) and those trapped in the previous spring (up to 15 June).

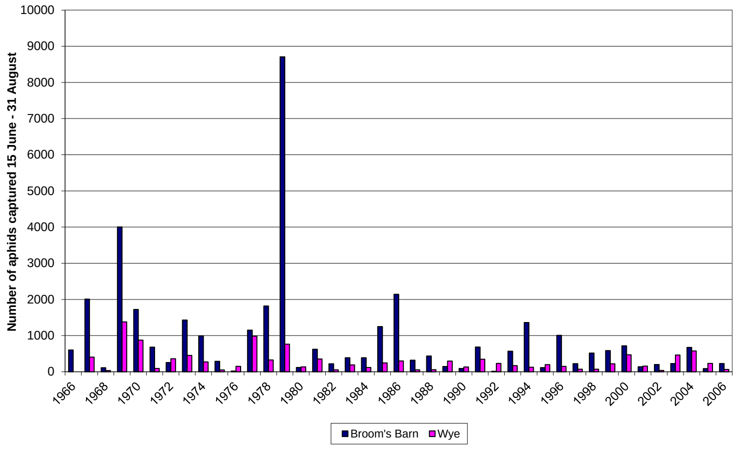

Figure A. Total numbers of female *A. fabae* captured per year at Broom's Barn and Wye over 40 years.

Both the times of first capture and 50% capture have become earlier during the 40 years of observations. The date of 50% capture was consistently earlier at Wye than at Broom's Barn, but the relationship was less consistent for the date of first capture.

Objective 3. Look for relationships between aphid flight times/abundance and weather data using information from the literature as available.

The information on key events and abundance from Objective 2 was used to look for relationships between key events, abundance and weather records (temperature and rainfall). Weather data for Suffolk and Kent were obtained from the Met Office web site and consisted of monthly averages for the maximum and minimum daily temperature and the total monthly rainfall for Lowestoft and Manston respectively. The mean temperature for defined periods in the spring was calculated and was used to determine the relationship between the date of first capture and 50% capture (up to 31 August) and mean temperature. The date of first capture was highly negatively correlated with all of the measures of mean temperature; the warmer the spring, the earlier the first aphid was captured (e.g. Figure B). The relationship for the two sites was also very similar, the fitted lines having similar slopes and intercepts.

The date of 50% capture was also highly negatively correlated with all of the measures of mean temperature and, as with the date of first capture, the warmer the spring, the earlier the date when 50% of aphids were captured. The fitted lines for the two sites were also very similar. Relationships between temperature or rainfall and aphid abundance were also investigated but there were no significant correlations.

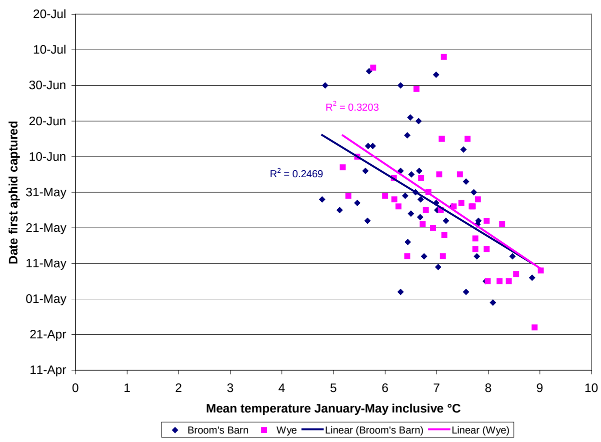

Figure B. Relationship between the date the first aphid was captured and the mean temperature in January-May inclusive.

Objective 4. Propose a way forward

This analysis was obviously limited, firstly because only data from two suction trap sites were used and secondly because the weather data sets were not from sites that were particularly close to the suction traps, nor were daily records available. Thus the data can be used only to indicate trends that can be used to suggest a way forward.

The analysis has not detected any obvious strong relationships with either temperature or rainfall, unlike previous studies. This may be because the temperature and rainfall parameters used in this project are too crude (because no daily records were available), the weather records were from sites too remote from the suction traps, or because the statistically significant relationships in the other studies occurred by ‘chance’, being based on smaller sets of data where the specific weather patterns favoured particular correlations (e.g. two studies observed cycling in population size and this is not obvious from the larger data sets used in this study (Figure A)).

The timing of migration of winged aphids also varies from year to year and site to site, but in this case there is a very strong correlation with the mean temperature summarised over different periods leading up to the spring and summer migrations. The high correlation coefficients and the similarity of the fitted lines for the two sites (slope and intercept) indicate that there is a robust relationship with temperature and that the timing of key events should be highly predictable using accumulated temperatures (day-degrees). Such day-degree forecasts have been used successfully for other pest aphids that overwinter as eggs on woody hosts (e.g. willow-carrot aphid, lettuce root aphid – used on the HDC Pest Bulletin).

Based on the findings of Objective 2 and Objective 3, a way forward is proposed:

1. Obtain data for all suction trap sites at which reasonable numbers of *A. fabae* have been captured.
2. Obtain comparable daily weather data from appropriate Met Office stations.
3. Use the suction trap data and weather data to develop a day-degree forecast for *A. fabae* to predict the start of the spring migration and the timing of different stages of the summer migration (i.e. when 1% caught, 10% caught, 50% caught, 90% caught etc).
4. Analyse these data for relationships that might help to predict abundance.
5. Develop a method of predicting abundance in the summer as early as possible from real-time suction trap data. This is probably feasible by using day-degrees to predict, for example, the date of 10% capture and then checking the real-time suction trap data to see how many aphids 10% capture equates to. This can then be used to predict abundance going forwards.
6. Determine whether relationships developed by Way *et al.* (1981), based on the numbers of aphids captured in suction traps, are likely to be of any practical use to spinach growers.
7. Incorporate the forecast into the HDC Pest Bulletin

Financial Benefits

This proposal is in direct response to a request from industry and the intention is to provide information that will inform an improved control strategy for *Aphis fabae* on spinach.

Action Points

- Even without the development of a forecast, growers could regularly update themselves on the numbers of *A. fabae* captured by Rothamsted suction traps in the current season http://www.rothamsted.ac.uk/insect-survey/STAphidBulletin.php.

- To reinforce this, information on suction trap catches could be added to the HDC Pest Bulletin updates.