Grower Summary

CP 091

Biology of the cabbage whitefly, Aleyrodes proletella.

Final 2015

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.

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Before using all pesticides check the approval status and conditions of use.
Read the label before use: use pesticides safely.

Further information

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Project title:	Biology of the cabbage whitefly, *Aleyrodes proletella.*
Project number:	CP 091
Project leader:	Dr Rosemary Collier
Report:	Final report, December 2015
Previous report:	Annual reports 2013, 2014
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Location of project:	Warwick Crop Centre School of Life Sciences University of Warwick Wellesbourne CV35 9EF
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Date project commenced:	1st October 2012
Date project completed **(or expected completion date):**	31st December 2015

GROWER SUMMARY

Headline

In the field, the generations of cabbage whitefly were clearly distinguishable. The first generation of adults emerged after approximately 455D° above a base temperature of 6°C had elapsed, confirming laboratory studies. The fit was not so close for subsequent generations. During the early summer, adults make short flights within and around their host plants so that crops close to heavy infestations are most at risk. Longer range flights occur in the autumn. An entomopathogenic fungus appeared to be the biotic factor causing the highest levels of natural mortality during the study period.

Background

The cabbage whitefly, *Aleyrodes proletella,* has become an increasing problem for the Brassica industry in recent years, especially on Brussels sprout and kale. The reason for this is unknown, but it is believed to be due to a combination of climate change, removal of certain active ingredients from use and later harvest times of crops. Little research has focused on this species as, historically; it has been regarded as a minor pest. Knowledge about the biology of the cabbage whitefly is limited and most of what is currently understood about its ecology has been inferred from minimal anecdotal evidence.

The overall aim of this project was to understand population trends of *Aleyrodes proletella* in the most vulnerable crops, Brussels sprout and kale. This includes understanding the key times of population/generation increase and colonisation of a new crop. This information can then be used to inform the development of an integrated control strategy using insecticides and other tools, which might include biological control agents and methods of cultural or physical control. Information from this project is being used to inform experimental control programmes in AHDB Horticulture project FV 406a.

Summary

Host crops of cabbage whitefly

- Potential wild hosts were surveyed at the start of the project but no cabbage whiteflies were found. Whiteflies were found subsequently on *Sonchus*, *Taraxacum* and *Euphorbia spp.,* all known to be wild hosts.
- An oilseed rape crop sampled in July 2013 was infested with an average of 0.1 adults $0.5m^{-2.}$ Taking this as an estimate for the entire field, there was potential for the 10ha field to support approximately 40,000 adult whiteflies.

- Adult cabbage whiteflies were counted on individual plants within a commercial crop of kale in Lincolnshire. Average numbers of cabbage whitefly on plants at the edge were approximately 4 times greater than those at a distance of 115 plants into the field. There was as much as a five-fold difference in numbers of adult whitefly between the four edges of the crop.

Headline: infested crop plants are likely to be the main sources of cabbage whitefly.

Monitoring dispersal of cabbage whitefly

- It is believed that yellow sticky traps are attractive to adult cabbage whiteflies making short flights within and around their host plants and that blue traps are attractive to female cabbage whiteflies undertaking longer-range dispersal flights. In preliminary field tests, yellow sticky traps caught more whiteflies than blue traps and traps on the ground caught more whitefly than those positioned 1m above the ground.
- Yellow and blue sticky traps were used to determine the vertical distribution of flight. Early in the year (April – August), yellow sticky traps caught significantly more whitefly than blue traps, but this trend was only evident for heights up to 120cm above the ground; above these heights captures on blue and yellow traps were very low and did not differ. Yellow sticky traps at ground level caught more adult whitefly than any other trap colour/height combination. Relatively more whiteflies were caught on blue sticky traps in September – November than in the earlier part of the year. At this point, female whiteflies had entered ovarian diapause (the overwintering stage).
- Yellow sticky traps and cauliflower trap plants were deployed in transects at a range of distances from plots infested with whitefly. There was a statistically-significant decrease in the number of adult whiteflies found on trap plants between 0 and 5 m from infested plots, but the numbers found on plants placed at distances of 5 and 15 m did not differ. At 25 m, the number of whitely was nearly 5 times less than that at 5 m. The numbers of whitefly caught on yellow sticky traps at distances of 0 and 5 m from the population source differed significantly from each other and from all other traps within the transect. The numbers captured on traps located at the remaining distances of 10m, 20m and 30m caught very similar numbers of whitefly and did not catch significantly different numbers from each other.
- In a further experiment, yellow sticky traps were placed horizontally and 1cm above the ground on the north, south, east and west side of infested plots. 'Activity indices' were calculated using the log (number of whitefly caught/mean number of adult whitefly per plant) in the plot. The indices varied during a year (August 2013 – July

2014). A slight, but statistically-significant peak in activity occurred in October 2013. Another peak in November was followed by a period where the activity was at its lowest (January), increasing in February-March. Activity indices during the period April 2014 – July 2014 were significantly higher than at all other times, with a large, statistically-significant peak occurring in late May – June.

- Samples from Rothamsted Insect Survey suction traps at Wellesbourne and Kirton (12.2 m high) were assessed for the presence of cabbage whitefly. With the exception of 2010 at Kirton, the median date of capture of adult whiteflies by the suction traps was between 11th October and 12th November. Whiteflies were caught about a month earlier at Kirton in 2010.

Headline: the results together suggest that cabbage whitefly undertake short low-level flights, within and around their host plants, during the first part of the summer (yellow sticky traps) and that female cabbage whiteflies undertake longer-range dispersal flights at higher altitudes in the autumn once they enter ovarian diapause (captures in suction traps and on blue sticky traps).

Development of cabbage whitefly

- The time required for cabbage whiteflies to complete development from egg to adult was monitored under controlled conditions for six ‘constant’ temperatures. The duration of development ranged from 79 days at 11.9°C to 23 days at 25.5°C.
- A straight line was fitted to the relationship between the rate of development and rearing temperature. The extrapolated lower development threshold was 6.3°C and it was estimated that 455 day-degrees (D°) above this threshold were required to complete development. The model was shown to predict accurately the emergence of the first generation of the season; however subsequent generations were predicted with less accuracy. Development of generations within a new crop was predicted accurately.

Development of field populations

- Plots of Brussels sprout and kale were planted on 2nd May 2013 to investigate the natural pattern of colonisation and increase in cabbage whitefly numbers over a season. Five replicate plots were planted in different locations on the Wellesbourne site. Numbers of whitefly remained very low, but were similar in all plots, for the first few weeks after transplanting. It was not until June that egg numbers increased, and soon after that all other life stages increased dramatically in numbers. This trend continued until September when numbers ceased to increase. All populations decreased from November until January 2014 when a large increase in egg numbers was observed. However, a corresponding increase in numbers of nymphs did not occur until March, followed by pupae in mid-May and adults in early June, after which numbers declined, coinciding with the senescence of the plants after flowering. Statistically-significant differences between plots in the numbers of whitefly were for a short duration only and most of the differences occurred over the winter months.

- Immigration rates of whitefly onto kale and Brussels sprouts were not significantly different nor were the rates of initial population increase, suggesting that they do not differ in 'attractiveness' to immigrant whitefly or their quality as a host plant. Differences in populations did occur later in the season, particularly during the winter, suggesting that kale may have provided more shelter from poor weather conditions.
- In 2014, plots of kale were planted in 5 locations at Wellesbourne. Each plot consisted of 5 sub-plots separated by ~18m. A single sub-plot was planted at each location on 19th May, 17th June, 19th July, 15th August and 16th September. In contrast to 2013, the numbers of adult whitefly differed between locations from as early as 2 weeks after the first plots were transplanted and there was a statistically significant relationship between the adult population on each new plot and the distance of the plot from the nearest highly-infested plot planted in 2013. Doubling the distance from 50m to 100m led to an approximate reduction in the adult population of 75%. There was also a strong relationship between the mean population size after one generation and the initial immigration rate into each plot (number of adults 2 weeks after planting). Generally, although the size of the infestation varied, the pattern of population increase did not differ between locations. The size of the infestation at the end of the season was related to planting date and was greatest in plots planted in May. The whitefly counts were also plotted on a day-degree scale (threshold 6.3^{o}C) and this indicated that whitefly numbers increased considerably once one generation (455D^{o}) had been completed following planting. This pattern occurred in all plots for all of the planting dates, except the plots planted in September, where ovarian diapause occurred and, over time, temperatures decreased below the lower development threshold of 6.3^{o}C, preventing further development.
- Egg laying began a month earlier in 2014 than in 2013. Mean January maximum daily temperatures were 2°C warmer in 2014 than 2013 and this may have been the reason for the earlier egg laying.

Headline: in 2013 there were no highly infested plants near to the newly-planted plots and initial infestation rates were low and similar between plots. The similarity between plots in the *size of the whitefly infestation persisted throughout the year. In 2014, some of the new plots were closer to infestations of whitefly (in the overwintered 2013 plots) than others and the immigration rate was related to the distance from an overwintering site. This, together with the results of the experiments on dispersal, suggests that colonisers of new crops in spring are likely to be from the immediate vicinity. The development of cabbage whitefly infestations could be clearly separated into 'generations'. In the field, the duration of the first generation in particular could be predicted using the day-degree sum estimated from laboratory experiments.*

Natural control of cabbage whitefly

Relatively few potential natural enemies (predators or parasitoids) of cabbage whitefly were seen in commercial crops or in field plots. However, dead adult whiteflies were observed in some of the field plots from October 2014. These dead adults were attached to the foliage and had outspread wings. A fungal growth could be seen on the thorax and abdomen of some individuals indicating that a fungal epizootic had occurred in some (but not all) of the plots. No relationship was found between the proportion of dead whiteflies and the total number of whiteflies present on a plant. Observations of the fungus in the laboratory confirmed that it is a member of the genus Zoophthora. Confirmation that the fungus was *Zoophthora radicans* could not be made as subsequent magnification of the specific primers for *Zoophthora radicans* was not successful.

Conclusions

- The rate of colonisation of new crops by whitefly is highly influenced by the distance of the new crop from sources of overwintering females. An increase in distance from 50m to 100m led to a 75% reduction in immigration rate.
- Kale and Brussels sprout plants appear to have the same level of 'attractiveness' to colonising cabbage whitefly.
- Field edges supported, on average, 4 times as many whitefly as areas towards the centre of the field. Populations of whitefly at each field edge also differed significantly from each other.
- Whiteflies are caught most effectively on yellow sticky traps at ground level, suggesting they are dispersing near to the ground. Increasing the height to 60cm led to, on average, a ten-fold reduction in catch rate.
- Activity of overwintering female whitefly increased during February-March showing potential for these females to move into new crops. Peak activity of adult whitefly was

in May-June when first generation of adults were emerging. It is likely to be the time of greatest colonisation of new crops.

- Female cabbage whiteflies undertake longer-range dispersal flights at higher altitudes in the autumn once they enter ovarian diapause (captures in suction traps and on blue sticky traps).
- It was estimated that 455 day-degrees above a threshold of 6.3°C are required to complete development from egg to adult. This was shown to be accurate in predicting the emergence of the first generation in 2013 and 2014; subsequent generations in 2014 were predicted with less accuracy.
- No parasitoids and very few natural predators were seen feeding on cabbage whitefly in the field. An entomopathogenic fungus was seen to cause an epizootic often killing >90% of the adult whiteflies.

Financial Benefits

Contamination of fresh produce by cabbage whitefly and associated damage can lead to rejections by retailers. Improved control of whitefly will have considerable financial benefits for growers through an improvement in crop quality.

Action Points

- Growers should be aware that new crops planted close to crops already infested by cabbage whitefly are likely to be most at risk of infestation.
- When planning their strategy for crop walking, growers should be aware that field edges are likely to support higher numbers of cabbage whitefly than areas towards the centre of the field. Whitefly numbers may also vary from edge to edge.
- A sum of 455 day-degrees above a threshold of 6.3°C are required for cabbage whiteflies to complete development from egg to adult. This information can be used to predict emergence of the first generation.
- Action points presented in the Final Report for Project FV 406a will be based on biological observations made in this project.