Grower Summary

CP 067

Biology and Control of Currant-Lettuce Aphid (*Nasonovia ribisnigri*)

Final 2013

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:	CP 067
Project Title:	Biology and Control of Currant-Lettuce Aphid (*Nasonovia ribisnigri*)
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Contractor:	University of Warwick
Industry Representative:	David Norman, Precision Agronomy Ltd
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Headline

- More accurate prediction of population development of currant-lettuce aphid can now be made for use in forecasting models
- Active currant-lettuce aphids (adults and nymphs) can overwinter in the Midlands, on 'alternative' host-plants to lettuce, particularly speedwell

Background

The currant-lettuce aphid (*Nasonovia ribisnigri*) is one of four significant species of pest aphid infesting lettuce, and is the most important due to its preference to feed in the centre of lettuce heads where the infestation is often difficult to control with foliar insecticides, resulting in unmarketable produce and therefore financial losses for growers. Rapid population development of *N. ribisnigri* can also lead to stunted plant growth and affect the palatability of harvested lettuce.

Historically, aphids have been controlled by farmers and growers through the application of pesticides. However, due to recent concerns about potential chemical residues and the imposition of high selective pressures for insecticide resistance, there have been increased demands for farmers and growers to adopt Integrated Pest Management (IPM) practices. For *N. ribisnigri,* resistant lettuce cultivars are also available but now that these are grown widely, the increased selection pressure appears to have resulted in a new resistance-breaking biotype of *N. ribisnigri* which has overcome the resistance provided by these cultivars.

Recent research on *N. ribisnigri* has focused on its development, insecticide resistance and its response to resistant cultivars. Therefore, there is little information available on its basic biology which is vital for creating new and informed control strategies.

The overall aim of this PhD project was to quantify aspects of the life-cycle of both wild type (WT) and host-plant-resistance-breaking (Rb) *N. ribisnigri* to inform the development of a more effective and targeted control strategy. The specific objectives were to:

1) Investigate the effects of photoperiod and temperature on the development of parthenogenetic summer aphids.
2) Investigate the conditions required to stimulate development of sexual morphs, egg production, termination of egg diapause and egg hatching.
3) Investigate alternative host plants (to lettuce) and confirm whether *N. ribisnigri* can use them as overwintering hosts.
4) Investigate the population dynamics of *N. ribisnigri* in response to natural enemies and entomopathogenic fungi.

Summary

One clone and one population of wild type (WT) and two clones and one population of host-plant-resistance-breaking (Rb) *N. ribisnigri* biotypes were used in this research.

1. Investigate the effects of photoperiod and temperature on the development of parthenogenetic summer aphids.

The effects of temperature and daylength on the developmental parameters of WT *N. ribisnigri* have been established. This has included establishing optimum temperatures and lower and upper developmental thresholds (agreeing with those determined in a similar study). The study confirmed that temperature is a significant factor affecting development time, development rate, the intrinsic rate of increase, fecundity and the propensity to become winged, of both WT and Rb *N. ribisnigri*.

The data collected in this study described a linear relationship between development rate and temperature, allowing for the estimation of the day-degree requirements for development from nymph to the final adult moult (which was again similar to other work). Daylength did not influence development, and estimates were similar between WT and Rb *N. ribisnigri,* meaning that aphid 'type' does not need to be considered in the development of the forecast.

Prior to this study, the method used for predicting the population development of *N. ribisnigri* in the UK was based on a day-degree model, using an Estimated Lower Developmental Threshold temperature. This forecast can now be refined, using the values determined specifically for *N. ribisnigri*, to provide a more accurate forecast of its activity.

This study raised questions about the effectiveness of aphid-resistant cultivars at lower temperatures, where the control provided in resistant cultivars by the Nr-gene appeared to fail. However, as the ambient temperature fluctuates in the field, and is likely to be above 15ºC for at least some of the period during which lettuce crops are grown, resistance will still be provided against WT *N. ribisnigri*. As a breakdown in resistance was not observed in the field prior to the 'arrival' of the new resistance-breaking biotype, it seems likely that the temperature sensitivity of the Nr-gene is unlikely to threaten the control of WT *N. ribisnigri*. Despite this, the effects of temperature, particularly fluctuating temperatures, on the performance of new resistant cultivars should be analysed to clarify this.

2. Investigate the conditions required to stimulate development of sexual morphs, egg production, termination of egg diapause and egg hatching

Nasonovia ribisnigri reproduces throughout the summer months, without mating, on lettuce and other broad leaved hosts. As temperature and daylength decrease in autumn, winged males are produced initially, followed by winged females, which migrate around mid-October to the winter host (currant species). The winged females then produce another type of female, which lays eggs after mating with males found on the winter host. Once the eggs have been deposited, usually in the angle between a stem and a bud, they enter a state of diapause. Experiments showed that rearing conditions of 12°C 13 hours light: 11 hours darkness can induce production of the winged males and females, which leads to the production of diapausing eggs after approximately 49 days.

In the field, diapause ended during mid-late January, but temperatures below the Lower Developmental Threshold (4.6°C) prolonged post-diapause development and hatching until early February. It was estimated that post-diapause development takes just under 50 day-degrees, using a Lower Developmental Threshold of 4.6°C. The eggs hatch to produce female aphids, which develop and begin reproduction, feeding from the nutrient-rich buds of the currant plant. Once winged progeny are produced, migration to lettuce crops occurs. At this stage, currant is no longer accepted as a suitable host for colonisation (no nymphs are produced).

3. Investigate alternative host-plants (to lettuce) and confirm whether N. ribisnigri can use them as overwintering hosts.

The data collected in this study confirmed that WT and Rb *N. ribisnigri* can utilise several alternative hosts in the summer. Eight species of plant (mainly wild species) were confirmed as suitable hosts, including *Cichorium intybus, Crepis capillaris, Lapsana communis, Hieracium aurantiacum, Hieracium pilosella, Veronica arvensis, Veronica spicata* and *Veronica officinalis*. Development of WT and Rb *N. ribisnigri* biotypes was similar regardless of the host-plant. A selection of these host-plants also supported overwintering, active stages of *N. ribisnigri* between November and March, confirming that *N. ribisnigri* may overwinter as nymphs/adults, an attribute which could have implications for the timing of their spring migration, as aphids overwintering in the active stages continue development as soon as temperatures exceed the Lower Developmental Threshold. It is likely that such aphids would migrate to lettuce crops 'sooner' and develop larger summer populations than those overwintering as eggs. Removal of potential winter host-plants would remove possible refuges for *N. ribisnigri* but consideration must be given to their 'other' roles, for example, as a nectar source for natural enemies during the summer.

Finally, this study confirmed that temperature and host-plant location were the key factors determining aphid survival during the winter, with a combination of sheltered plants and mild winters resulting in enhanced survival and potentially larger spring populations.

4. Investigate the population dynamics of N. ribisnigri in response to natural enemies and entomopathogenic fungi

The monitoring of *N. ribisnigri* populations in field trials during 2010 and 2011 recorded the occurrence of the mid-summer crash, which has been described for various aphid species. In this study, in both years, high natural enemy numbers were observed prior to the decline, suggesting that this was one of the most important regulating factors for *N. ribisnigri* populations. Entomopathogenic fungi, hover fly larvae and parasitoids were present in the highest numbers during these trials and future work should focus on determining the effects of individual predator species.

Emigration was also determined to be an important factor regulating aphid populations as the percentage of winged aphids was observed to increase prior to the mid-summer crash in both field trial years. As this study only analysed the potential for emigration to occur, future work should implement methods to monitor ‘real time’ emigration to confirm its role in the mid-summer crash.

Like various other studies, this study has failed to identify a single factor which resulted in the mid-summer crash, but it has identified significant factors involved. Due to its complex nature it is uncertain whether the mid-summer crash will ever be understood fully, but achieving this would allow researchers to predict when aphids will decline naturally, therefore avoiding unnecessary insecticide applications. Idealistically, identifying the factors responsible could facilitate the re-creation of these conditions in the field to induce an aphid decline when required.

Life cycle

Using the information collected in this study a more detailed life-cycle of *N. ribisnigri* can be provided:

- Female *N. ribisnigri* reproduce without mating throughout the summer months, feeding on lettuce and several species of broad-leaved weed. Development occurs at temperatures above 4.6°C, where development from nymph to the final adult moult takes approximately 121 day-degrees. Temperatures exceeding 26°C are deleterious to development.

- As temperature and daylength decrease in autumn, winged males are produced initially, followed by winged females and these migrate around mid-October to the winter host (currant species). The females then produce another form of female, which lays eggs after mating with males found on the winter host.

- Once the eggs have been deposited, usually in the angle between a stem and a bud, they enter a state of diapause, which terminates naturally in the field between late-January and early-February. However, the preponderance of temperatures below the Lower Developmental Threshold for egg development delays hatching until late February.

- Female aphids hatch from the eggs, develop and begin reproduction, feeding from the buds of the primary host-plant. Once winged females are produced, migration to lettuce (and weed hosts) occurs. At this stage, currant is no longer accepted as a suitable host for colonisation.

- It has also been confirmed that *N. ribisnigri* can overwinter as active aphids (adults and nymphs) in the Midlands, on 'alternative' host-plants to lettuce, particularly *Veronica arvensis* (speedwell).

Financial Benefits

As this is a PhD project, there are no direct immediate financial benefits, but in the longer term this work will support the improved accuracy of pest forecasting and hence grower management programmes.

Action Points

- There are no action points for growers.