Grower Summary

FV 441

Celery: Investigation of strategies to control capsid bugs in outdoor crops

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Location of project:	G's, Warwick Crop Centre, Stockbridge Technology Centre
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GROWER SUMMARY

Headline

The capsid bug *Orthops campestris* has been confirmed as the pest insect causing damage to celery crops in eastern England. This species appears to feed mainly, or possibly entirely, on wild and cultivated members of the carrot family (Apiaceae).

Background

Capsid bugs damage fruit and protected crops in the UK and are also pests of certain species of ornamental plant. Though considered sporadic pests of vegetable and salad crops grown outdoors, recent high incidences of capsid damage in celery suggest that the status of capsids as pests of this crop is increasing, particularly in organic crops. Three species of capsid have been seen in the vicinity of infested celery crops: common green capsid (*Lygus pabulinus*), European tarnished plant bug (*Lygus rugulipennis*) and what appeared to be *Orthops campestris* (and has now been confirmed in this project as the main pest in celery crops), which does not have a common name. Crop invasion by capsids is unpredictable and relatively little is known about their biology, particularly the biology of *O. campestris*, which would inform the development of an integrated control strategy for celery, although if the main pest species are common green capsid and European tarnished plant bug then information and techniques developed for strawberry crops might be used.

Current control of capsids in celery relies on the use of a small number of generally broad-spectrum synthetic insecticides. In organic crops, control is reliant on the use of mesh covers, which work well if applied at the right time and they are well-sealed. However, the presence of the covers may exacerbate infection by pathogens such as celery late blight, *Septoria apiicola,* and reduce crop quality. The use of crop covers also presents challenges for effective weed control, is expensive and labour intensive.

The aim of this project is to improve current understanding of the complex of capsid bugs that can infest celery crops, identify the key pest species and identify and evaluate approaches to control.

Summary

The specific objectives of this project are to:

1. Develop a clearer understanding of the identity and life cycles of the key species of capsid bug which infest celery crops in the UK.
2. Once the key species have been identified, determine the feasibility of rearing them in the laboratory or under semi-field conditions, so that more detailed studies can be undertaken on their life-cycle and on methods of control.
3. Using the information from Objective 1, review possible strategies (including the use of insecticides or crop covers) for managing populations of capsid bugs in the vicinity of celery crops.
4. Evaluate products approved currently for application to celery and novel insecticides and bio-insecticides that might be used to capsid bugs in small-scale field trials and undertake a small scale study of potential biocontrol agents (predators).
5. Determine the potential and significance of improved monitoring and forecasting of infestations by capsid populations.
6. Identify promising approaches that could be investigated in a subsequent project.

Only objectives 1, 2 and 4 will be covered in this report on the first year of the project.

Objective 1: Develop a clearer understanding of the identity and life cycles of the key species of capsid bug which infest celery crops in the UK.

Sampling celery crops and field margins

Sampling of field margins was carried out at 4 sites where celery was grown starting 1 April 2015 until 28 September and thereafter at fortnightly intervals until 7 December. The margins of an additional site where celery was not grown were also sampled. At each site 4 lengths of 5m along the margin were marked out and one section was swept each week using 5 sweeps of the net. If anything resembling a capsid was caught it was placed in a pot with alcohol and labelled with location and date. Further samples were collected from field margins surrounding organic crops by Ela Witkowska from G's (Figure 1). Sampling started in April 2014 and has been effectively continuous since then. All of the samples were from fields where organic crops of celery were grown.

Crop sampling was also carried out regularly in the organic celery crops once activity started, for around 4-6 weeks per site, whilst the crop was at the right growth stage to be attractive to capsids. Five plants per week from an uncovered area were carefully pulled up and shaken

into an insect proof bag and capsids were collected. The occasional capsid found in conventional crop walking was also captured and saved in pots with alcohol.

The most abundant species of capsid was identified as *Orthops campestris* and this identification was verified by Joseph Botting an expert on plant feeding bugs. Once the identity of *O. campestris* had been confirmed, the samples collected in alcohol were identified. Only *O. campestris* adults were found in the crop samples between July and September. Damage was seen particularly in the crops of organic celery between early July and the end of August. Adult *O. campestris*, common green capsid (*Lygus pabulinus*) and European tarnished plant bug (*Lygus rugulipennis*) were found in samples from the field margins. A large proportion of the capsids from the samples from the field margins were nymphs (70%). Some of these at least (from their size) appeared to be common green capsid nymphs. Figure 1 compares the abundance of adults and nymphs in samples from field margins in 2014 and 2015. The data suggest that there may have been three 'peaks' in the numbers of nymphs in 2014 and two in 2015. Estimation of accumulated day-degrees above a base of 6°C from 1 January each year indicated that 2014 was warmer overall than 2015 and the 'difference' was about 2 weeks.

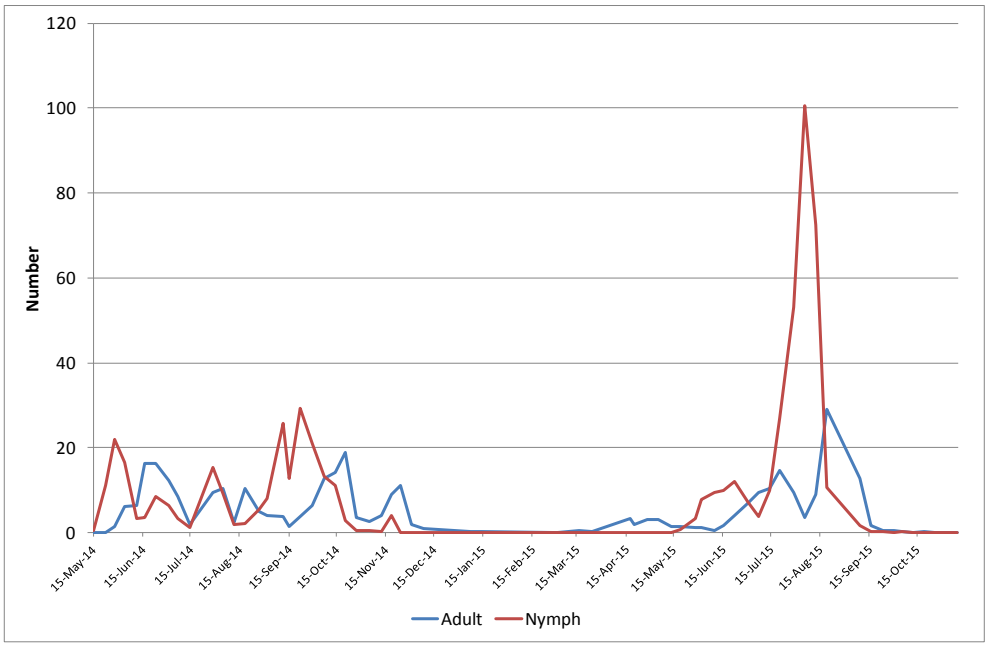

Figure 1. Numbers of adults (*O. campestris)* and nymphs (identification not verified) sampled from the vegetation surrounding organic crops of celery at G's in 2014-2015 (data provided by E. Witkowska).

Objective 2: Once the key species have been identified, determine the feasibility of rearing them in the laboratory or under semi-field conditions, so that more detailed studies can be undertaken on their life-cycle and on methods of control.

Large numbers of capsids were collected at G's in early August 2015 by shaking the flower heads of wild apiaceous host plants into Bugdorm® cages (30 x 30 x 30 cm). Further samples were collected in late August. The cages and their contents were taken back to the Insect Rearing Unit at Warwick Crop Centre and placed in a controlled environment room at 15°C. As the insects had been collected in a non-selective way, the cages contained many species of invertebrate including spiders and ladybirds. As many as possible of the non-target species were removed from the cages initially. Potential food plants for the target species (*O. campestris*) were then placed into each cage and these included organic celery heads purchased in a supermarket, potted celery plants grown at Warwick Crop Centre and the foliage and flowers of wild Apiaceae. This was initially wild carrot (*Daucus carota)* followed by hogweed (*Heracleum sphondylium*) in late winter – early spring, followed by the foliage of cow parsley (*Anthriscus sylvestris*). Seeds of wild carrot and wild parsnip (*Pastinaca sativa*) were also sown in pots. The wild carrot germinated and these pots were placed in some of the cages. The food material was replaced as necessary. Over time the *O. campestris* were moved to new cages by selectively removing them with a pooter.

The caged *O. campestris* were observed and the adults were seen feeding in particular on the flowerheads of the apiaceous weeds. Initially there were a large number of nymphs in the samples collected from G's. However, these appeared to die quite rapidly. The adult population seemed relatively constant until late December 2015 but after this it declined. The behaviour of the caged *O. campestris* was observed. At any moment a proportion of the adult *O. campestris* were on the roof of the cage, suggesting that they were displaying dispersal behaviour. The opportunity was taken to observe the diurnal periodicity of this behaviour i.e. whether a greater proportion were on the roof of the cage at any particular time during the day. It was impossible to count all the *O. campestris* in any cage so this was a relative estimate. The photoperiod in the controlled environment room was 12L:12D initially (lights on at 5 am) and observations were made under these conditions (records made 3-17 December), it was then altered to 16L:8D (lights on at 5 am) to see how this affected the periodicity of activity (records made 18-28 January). There was a clear pattern in their activity. Under a 12L:12D photoperiod the adults were most numerous on the cage roofs at 12 noon and they were most numerous at 2 pm under a 16L:8D photoperiod.

Objective 4. Evaluate products approved currently for application to celery and novel

insecticides and bio-insecticides that might be used to capsid bugs in small-scale field trials and undertake a small scale study of potential biocontrol agents (predators).

Preparations were made to undertake a small field trial at G's in one of the conventional celery crops in 2015. This was to evaluate insecticides approved currently on celery as well as additional active ingredients, as there is no information about the efficacy of any of these treatments. Unfortunately an infestation of sufficient size to collect robust data did not occur. Approved insecticides are lambda-cyhalothrin, pymetrozine and Majestik. Pirimicarb was approved but will no longer be available. The same approach will be taken in 2016. However, it seems that it will be more productive to undertake small scale laboratory tests with *O. campestris* collected from the field. It is certainly possible to maintain adults in good condition for a long period of time which means that these are suitable candidates for efficacy trials with both insecticides and bioinsecticides (at Warwick Crop Centre) and predators (Stockbridge Technology Centre).

Stockbridge Technology Centre has drawn up a protocol for small-scale tests of biocontrol agents. The only product specifically for control of capsids is Tigranem (Koppert - unspecified *Steinernema* nematode sp.). Generalist predators, such as ladybirds and lacewings, are likely to be effective. Other natural enemies may not be effective against adults, but may be useful against nymphs and eggs. Potential test organisms that are available commercially are *Tigranem* (Koppert)*, Macrolophus pygmaeus, Coccinella septempunctata, Adalia bipunctata* and *Chrysoperla rufilabris.*

Discussion

Orthops campestris appears to be a very common bug on apiaceous weeds throughout the UK, although there is very little recent information on its biology. However, there are a number of older publications on *Lygus campestris* and it appears that this is the same species and that it has been re-named as *O. campestris*. In the publications on *L. campestris* it is described as a pest of carrot crops grown for seed production, celery and fennel and it appeared to have one generation per year in Nova Scotia and two in the Netherlands. Identification of adult capsids found in celery crops in 2015 showed that *O. campestris* was the only species of capsid found in the crop, although common green capsid and European tarnished plant bug were found in the field margins.

The data obtained to date in the present study confirm that *O. campestris* overwinters as an adult (sampling in 2014 began too late to detect the first period of adult activity). In 2015, where monitoring started in January, adults became more active in mid-April and the first nymphs were found in mid-May. It seems unlikely that this species completes a single

generation in the UK and the data from 2015 suggest that there are two generations – as suggested for populations in the Netherlands. The data from 2014 indicate that there might possibly be 3 generations.

All of the host plants mentioned in the literature are members of the Apiaceae. If this is the case then there are opportunities to manage *O. campestris* through managing apiaceous weeds in the vicinity of the crop. This is in contrast to common green capsid and European tarnished plant bug which have a wide range of hosts from a number of plant families.

Large numbers of capsids were captured in August and kept in a controlled environment room at 15°C at Warwick Crop Centre. The nymphs appeared to die very quickly but the adults survived until early January. There was no evidence that they produced young during this period. The simplest explanation is that these adults were in reproductive diapause and that they did not receive the environmental cues to complete diapause and begin to reproduce. The fact that the adults survived so long means that they will be good candidates for efficacy trials in 2016. However it will be important also to test the immature stages although it is likely that the eggs will be inaccessible to control with either insecticides or biocontrol agents.

Work plan for 2016

Further work will focus on the biology and control of *O. campestris*. Key activities will be to:

- Sample the spatial distribution of *O. campestris* on field margins to determine their association with host plants, especially Apiaceae.
- Monitor the phenology of *O. campestris* in crops of celery and in field margins.
- Collect *O. campestris* adults and nymphs as soon as they appear and culture them at high temperatures/long daylengths with apiaceous umbels as one source of food. Determine generation times under these conditions.
- Collect *O. campestris* adults and nymphs to undertake laboratory tests on insecticides, bioinsecticides and biocontrol agents.

Financial Benefits

It is expected that the project will identify the key pest species, provide further information about their biology, and identify ways of improving capsid control. The results will be most applicable to celery producers, but will have cross-sector relevance, particularly for soft fruit producers. Results may also have relevance for the control of other pests sharing a similar biology.

Action Points

There are currently no action points from the first year of this two-year project.