Project title:	Development of a Pheromone Trap for Monitoring Blackcurrant Sawfly
Project number:	SF 162
Project leader:	Dr Michelle Fountain NIAB EMR
Report:	Final Report (Year 3) 2017
Previous report:	Year 2 Report
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Location of project:	NIAB EMR, NRI, Grower sites
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Date project commenced:	April 2015
Date project completed (or expected completion date):	March 2018

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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GROWER SUMMARY

Headline

- In trials to test the efficacy of a blackcurrant sawfly sex pheromone, the diversity of natural enemies appeared to reduce populations of sawfly to uneconomically damaging levels.

Background and expected deliverables

Blackcurrant sawfly (*Nematus olfaciens*) is a common and frequently damaging pest of blackcurrant, present to varying degrees in most UK blackcurrant plantations. Larvae feed on foliage in May-June (1st generation) and July-August (2nd generation) making irregular holes in leaves and causing defoliation which weakens the bushes and causes substantial losses in yield. Larvae may also contaminate harvested fruit so good control prior to harvest is important.

Infestation is sporadic and localised and damage can occur rapidly. Frequent crop inspection is needed for first signs of eggs, larvae and damage. Current grower practice is to spray for control as soon as eggs, larvae or damage is detected by crop scouting. No practical systematic sampling methods or attendant crop damage thresholds have been developed and it is believed that there is widespread prophylactic treatment. Adequate crop scouting is time-consuming and expensive, so a more sensitive and rapid monitoring method is needed. Pheromone traps could offer a solution.

Non-UV reflective white sticky traps are used for monitoring various other Tenthredinid sawfly pests of fruit trees including apple sawfly (*Hoplocampa testudinea*). Female gooseberry sawfly (*Nematus* ribesii), have been shown to produce a sex pheromone that attracts conspecific males, but, until recently, nothing was known about the chemical ecology of blackcurrant sawfly.

Development of a pheromone trap for blackcurrant sawfly was one of the objectives of the Defra Horticulture LINK project HL01105 ‘Developing Biocontrol Methods and their Integration in Sustainable Pest and Disease Management in Blackcurrant Production’ which ended in 2015. In this project, it was shown that male blackcurrant sawfly were attracted to virgin females, confirming the existence of a sex pheromone. Four potential pheromone components were detected, identified and synthesised. Three of these were produced only by females. They had structures unrelated to those of compounds reported as pheromone components in other sawfly species, but they caused very strong electroantennogram (EAG) responses from blackcurrant sawfly males. The fourth compound was produced in large quantities by both females and males and did not elicit an EAG response.

Trapping tests were carried out with blends of these compounds on several growers' farms during 2013 and 2014. A blend of two of the three EAG-active compounds was shown to be highly attractive to male blackcurrant sawfly, whilst the addition of the fourth component seemed to increase attractiveness even further. The trapping experiments also confirmed the sporadic nature of this pest in that few or no sawfly were caught on several of the farms.

Blackcurrant growers differ in their approach to sawfly control. Some spray prophylactically, and others apply no sprays for the pest. In trials in the previous Defra Horticulture LINK project it was noted that one of the latter growers had sawfly adults in the crop, detected using pheromone traps. Eggs and young larvae were found in the bushes, but no older larvae were observed and no significant damage occurred. This may be because growers using fewer broad spectrum control products have a higher diversity of natural enemies, particularly earwigs which are known to feed on a range of pest species in tree fruits – see AHDB project TF 220 'Further development of earwig-safe spray programmes for apple and pear orchards'. However, this was not explored in the Defra Horticulture LINK project. In addition, *Drosophila suzukii* (SWD) could become an increasing pest of blackcurrant meaning that control sprays used against this pest may disrupt natural enemy numbers in the crop near to harvest. These factors have obvious implications for spray programmes and targeting of spray applications for sawfly control.

Summary of the project and main conclusions

In 2015, field trials of pheromone trapping of blackcurrant sawfly were carried out in growers' blackcurrant fields. A replicated trial confirmed previous results that a three-component blend of two isopropyl esters, isopropyl (*Z*)-7-tetradecenoate (Z714iPr) and isopropyl (*Z*)-7-hexadecenoate (Z7-16iPr), and the unsaturated hydrocarbon, (*Z*)-9-tricosene (Z9-23H), is attractive to male blackcurrant sawfly. New results found that reducing the pheromone loading from 1 mg Z7-14iPr to 0.1 mg reduced catches. In addition, more sawfly were caught in red delta traps than green, at least for the most attractive blend. In a further trial to optimise the relative amount of Z7-16iPr in the blend, few blackcurrant sawfly were caught and no conclusions could be drawn. The different blends and traps were also tested in three other growers' fields but catches were low and overall the results illustrated the sporadic and localised nature of this pest.

In 2016 and 2017 we aimed to relate catches of blackcurrant sawfly with this optimised pheromone blend and trap to infestations by blackcurrant sawfly. The influence of natural enemies on this relationship was investigated.

Thirty eight red delta traps with the optimised three component blend released from a polythene vial were hung from the bushes throughout a plantation in Kent in 2016 and in East Anglia in 2017.

In 2016 natural enemies, sawfly adults, eggs, larvae and damage levels were assessed for 20 weeks from 13 May – 22 September. Low adult sawfly catches (18 in total) were found. In this crop the first presence of eggs and larvae in the plantation coincided with a mean trap catch of 4.28 per trap. There were only 15 sawfly eggs, 12 larvae and very low levels of foliar damage detected. Low damage was found after observations of eggs and early stage larvae were made, and this potentially suggested that predation could be occurring before significant damage could take place. The adult blackcurrant sawfly catch was not significantly affected by the row in which the trap was deployed. A survey of earwig abundance in blackcurrant plantations in five regions across the UK in 2016 (SF 168) showed earwig numbers varied significantly between plantations and farms.

In 2017, the study was repeated in East Anglia and demonstrated much higher numbers of male sawfly in the pheromone traps (75, 789). However, no significant foliage damage was observed from larval feeding. In addition the numbers of adult sawfly in each trap location in the field did not correlate with the numbers of sawfly eggs or larvae in the same location. In this crop the first presence of eggs and larvae in the plantation coincided with a mean trap catch of 8.6 and 612 per trap, respectively.

There were numerous and diverse natural enemies in the studied plantations and it is likely that these are keeping the sawfly egg and larvae numbers in check. Earwigs contained with sawfly eggs and larvae in Petri dishes were observed to feed on the immature stages of the pest.

Hence, currently the pheromone trap, whilst useful to detect sawfly in blackcurrant crops has not been calibrated to provide a spray threshold.

Financial benefits

Blackcurrant sawfly is a common and frequently damaging pest of blackcurrant, present to varying degrees in all UK blackcurrant plantations. Larvae feed on foliage causing defoliation which weakens the bushes and causes substantial losses in yield. Larvae may also contaminate harvested fruit so good control prior to harvest is important.

Adequate crop scouting is time-consuming and expensive, and a more sensitive and rapid monitoring method is needed. More effective monitoring would help to make more cost-effective use of insecticides currently available with a likely reduction in their use. Monitoring will be vital for effective use of any more benign, biological approaches developed in the future.

Pheromone traps could provide such a tool. Growers are generally familiar with this technology providing it is made readily available through commercial suppliers with adequate supporting information and protocols.

An improved understanding of the interaction between natural enemies and pests within blackcurrant plantations may allow for a reduction in the use of plant protection products.

Action points for growers

- Look for adults flying in April and May and target with approved products to prevent egg laying.
- Check for eggs on the underside of leaves in the centre of the bush.
- Check for larval damage low down in the centre of the bush.
- Monitor predator populations (earwigs) in plantations by tap sampling using a white tray and beating stick.
- Purchase traps for monitoring from Agralan.

SCIENCE SECTION

Introduction

Blackcurrant sawfly is a common and frequently damaging pest of blackcurrant, present to varying degrees in all UK blackcurrant plantations. After overwintering, adults will emerge in late April or May. They are most active on warm sunny days laying their eggs on the underside of the leaves. Feeding occurs at the base of the bushes, during May and June. Hatched larvae (1st generation) develop through four or five larval instars (Mitchell et al., 2011). After spinning a cocoon, the pre-pupal stage falls to the ground and pupates in the soil. In July - August, second generation adults emerge. Developing larvae make irregular holes in leaves (Figure 1), causing defoliation which weakens the bushes and causes substantial losses in yield (Mitchell et al., 2011). Larvae may also contaminate harvested fruit so good control prior to harvest is important.

Figure 1. Blackcurrant sawfly damage on blackcurrant bush

Monitoring the pest relies on the detection of the eggs on the underside of leaves in the centre of the bushes and this egg laying may be aggregated within a plantation. Hence, crop scouting is not always reliable because doing an adequate search is time-consuming. It is not uncommon for early infestations to be missed if the plantation is not well covered during an inspection.

In a previous Hort LINK project (Developing biocontrol methods and their integration in sustainable pest and disease management in blackcurrant production: HL01105), four potential components of the female sex pheromone of blackcurrant sawfly were identified and synthesised. Field tests suggested that three of these compounds were necessary for attraction of males. High catches of males were obtained in some fields and very low in others, confirming the sporadic nature of the pest.

Intensive monitoring at a site in the South East was carried out in 2016 in the second year of the project. Low adult sawfly trap catches, eggs, larvae and sawfly damage was observed throughout the season at this site. When sawfly were recorded in the plantation they were often found sporadically and no correlations between trap catch, trap positioning, sawfly eggs, larvae or damage were found. However, a wide range of natural enemies was found in the plantation (spiders, earwigs, anthocorids, ladybirds, soldier beetles, Heterotoma) with overlapping population peaks at different periods throughout the season, possibly responding to prey populations (aphids, midges, sawfly).

In 2017 the study was repeated in a plantation in East Anglia found to have high numbers of adult sawfly in 2016.

Aims

The overall project aims to optimise the pheromone blend, dispenser and trap and then calibrate catches in the traps with field populations of blackcurrant sawfly. Factors affecting this relationship, such as the presence of natural enemies and the use of pesticides, will be investigated and thresholds for the two generations estimated.

The objectives of the final year of the project were to:

- Correlate trap catches with populations of sawfly adults, eggs, larvae and damage levels associated with sawfly.
- Continue work to correlate predator numbers with numbers of sawfly adults, eggs, larvae and damage levels to establish the sawfly population threshold that can be reached before predator control is no longer effective and pesticide application is required.
- Continue work to establish optimal trap positioning within a plantation for effective monitoring of blackcurrant sawfly.

Materials and Methods

Field Monitoring

In 2016, 38 red delta traps (10 x 20 x 28 cm; Sentomol) (Figure 2) were deployed in a blackcurrant plantation in Horsmonden, Kent, spaced 43 m apart. In rows containing 6 traps, the first trap in the row was 21.5 m from the edge and in rows containing 7 traps the first trap was placed at the end of the row (Figure 3A). Lures were sealed polyethylene vials (20 mm x 8 mm x 1.5 mm) impregnated with a blend of 1 mg isopropyl (*Z*)-7-tetradecenoate + 0.5 mg isopropyl (*Z*)-7-hexadecenoate + 5 mg (*Z*)-9-tricosene, prepared at NRI. These were renewed monthly and the sticky bases of traps were replaced weekly or when they became saturated with by-catch.

A similar experiment was carried out in 2017 with 40 red delta traps deployed in a blackcurrant plantation in Bradenham, Norfolk. Traps were placed 50 m apart. In rows containing 5 traps the first trap in the row was 25 m from the edge and the following row the trap was placed at the end of the row (Figure 3B). Sticky bases of traps were replaced fortnightly.

Figure 2. Trap deployed in plantation

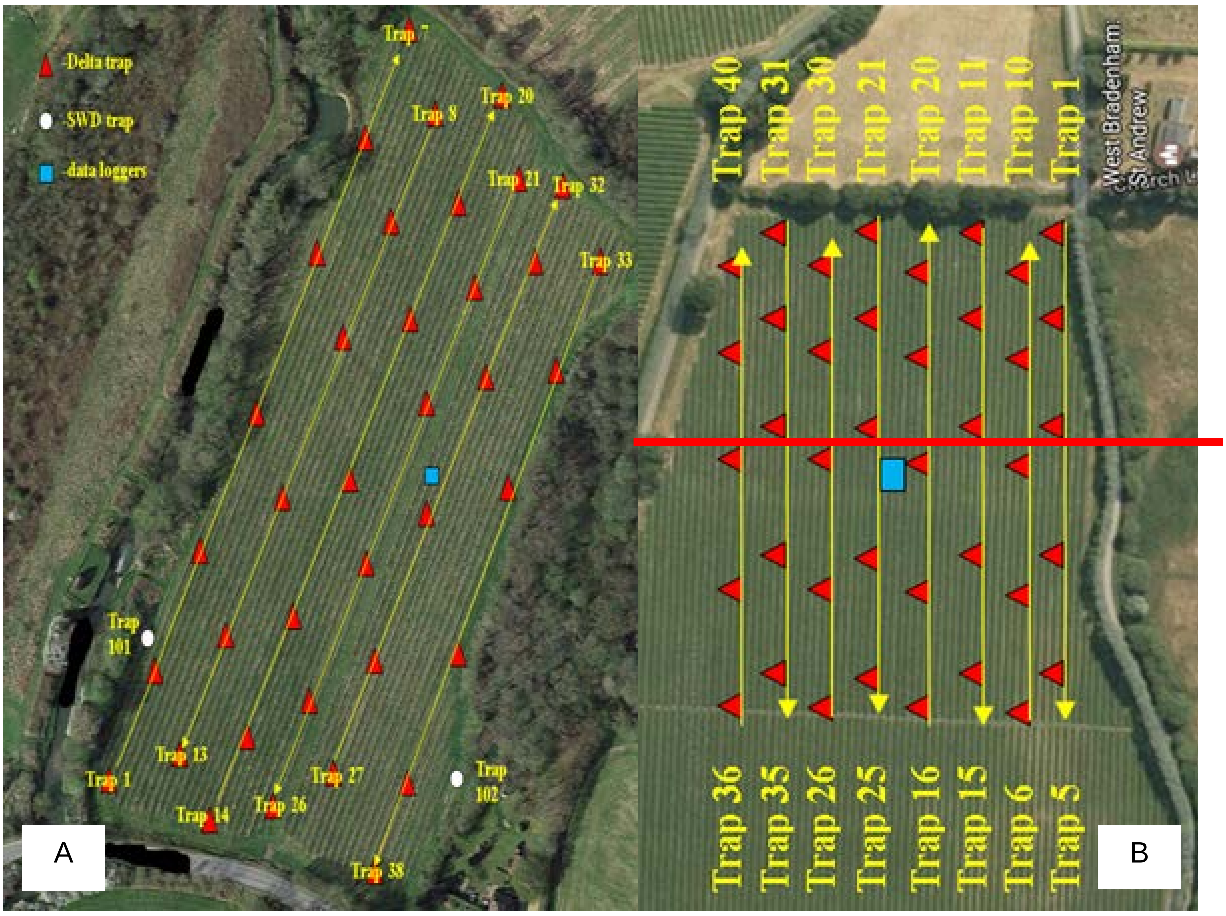


Figure 3. (A) Sawfly (red triangles) and *Drosophila suzukii* (white circles) trap locations in 2016 trial. (**B)** Sawfly (red triangle) trap locations in 2017 trial, red line indicates the division of the field, top half of field is to the right of the line and bottom half of field is to the left of the line.

Assessments

In 2016 assessments were done weekly or fortnightly from 13 May – 22 September 2016. In 2017 assessments were carried out fortnightly from 21 April – 13 October 2017. Adult blackcurrant sawflies were identified in the field on the sticky bases of traps (Figure 4). Sticky bases with sawfly were wrapped in cling film and brought back to the laboratory where the sex was determined.

At each trap location four blackcurrant bushes were examined for sawfly eggs (Figure 5A), larvae (Figure 5B) and damage (Figure 5C). In 2017 other soft bodied pests (aphids and caterpillars) were also recorded. Ten leaves in the centre at the base of each bush were assessed. The total numbers of pests on the forty leaves were recorded and sawfly damage was recorded by counting the number of leaves out of the 40 that had characteristic sawfly damage, i.e. feeding between and along veins, sporadic holes, stripping of leaf but not the veins (Figure 1).

At each of the trap locations four bushes were sampled for natural enemies. A white tray was held at the base of the bush and the bush was given three sharp shakes over the tray. The numbers of natural enemies (earwig nymphs/males/females, ladybird larvae/adults, anthocorids, soldier beetles, lacewing larvae, hoverfly larvae, Heterotoma, spiders and parasitic wasps) were then recorded.

An assessment of the crop growth stage was made each week using the EPPO (1984) crop growth stage key for blackcurrants. The spray programme was requested from the grower to determine when insecticides that may impact insect phenology were applied.

To determine whether the mean adult blackcurrant sawfly trap catch per trap, sawfly eggs and larvae per 4 bushes or earwig numbers per 4 bushes were related to the row in which the trap was deployed all 4 bushes were assessed, an ANOVA was carried out on SQRT transformed data testing for row differences. In 2017 the plantation was divided (Figure 3B). to determine whether there was a significant difference between the mean number of earwigs per 4 bushes in the top half of the plantation and in the bottom half of the plantation An ANOVA was carried out on SQRT transformed data testing for difference between the top and bottom half of the plantation.

Figure 4. Adult sawfly on white sticky bases collected from pheromone traps. Red arrow and circle indicate examples of sawflies on sticky base

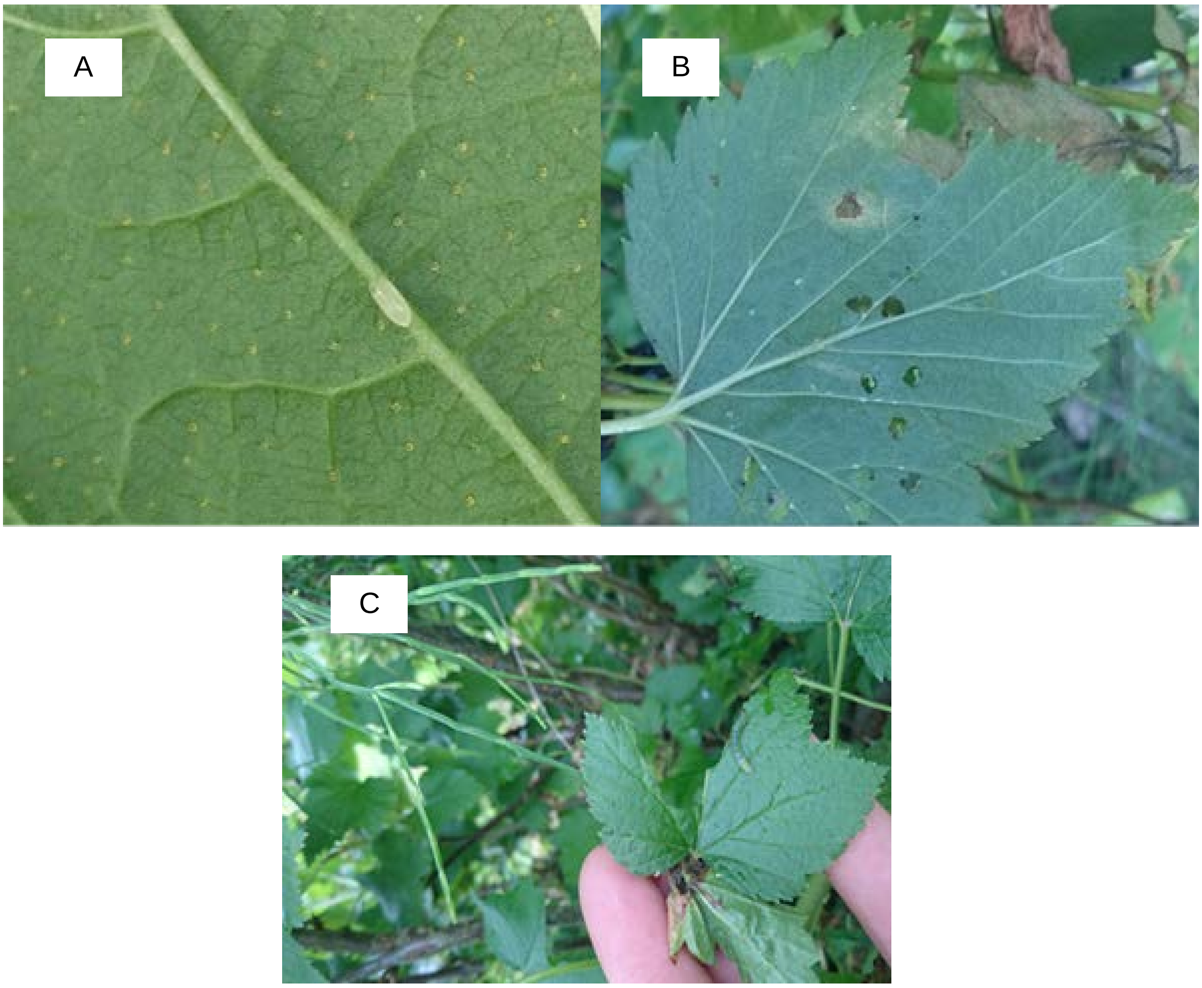


Figure 5. (A) Sawfly egg; (B) sawfly young instar larvae and damage; (C) sawfly damage and late instar larvae

Results

Blackcurrant sawfly adult trap catch, eggs, larvae and damage were low in the plantation monitored in 2016 (Table 1). This was consistent with industry reports of low numbers of blackcurrant sawfly in the South East in 2016 (H. Roberts, pers. comm). Numbers were much higher In 2017 (Table 1).

All types of natural enemies (earwigs, spiders, soldier beetles, heterotoma, ladybirds, anthocorids, hoverfly larvae) recorded in the plantation in Kent were recorded in the plantation in Norfolk (Table 1). Numbers of earwigs recorded in 2017 were approximately double the number recorded in 2016 (Table 1). Conversely, higher numbers of Heterotoma, soldier beetles, ladybirds and spiders were recorded in 2016 than in 2017 (Table 1).

Table 1. Summary of the total number of sawfly and natural enemies recorded at plantations in Kent during 2016 and Norfolk in 2017

	Kent 2016	Norfolk 2017
Trap catch male sawfly adults	18	75,789
Number of leaves assessed	25,840	19,200
Sawfly eggs	15	341
Sawfly larvae	12	440
Sawfly damaged leaves	3	4,008
Number of bushes assessed	2,584	1,920
Male earwigs	18	131
Female earwigs	25	166
Nymph earwigs	43	73
Heterotoma	154	69
Soldier beetles	72	48
Ladybirds	40	32
Anthocorids	52	46
Hoverfly larvae	6	21
Spiders	4,119	256

Phenology of blackcurrant sawfly

Low numbers of sawfly adults, larvae, eggs and damage were observed throughout the season in 2016 (Figure 6A). In 2017 a mean trap catch of 8.6 per trap was recorded in the traps when the first eggs were recorded (0.025 per 40 leaves) on 5 May 2017. Adult male trap catch and eggs increased through flowering and fruit set. They reached a peak of an average of 622 males per trap and 2.3 eggs per 40 leaves on 15 June. The numbers then decreased to an average of 94 adults per trap and 0.18 eggs per 40 leaves on 28 July and then increased on 11 August with a mean of 179 adults per trap and 3.03 eggs per 40 leaves. After 11 August the mean number of sawfly adults and eggs decreased until zero sawfly eggs or adults were recorded on the 13 October (Figure 6B).

No larvae were found until 30 May 2017 when an average of 1.98 larvae per 40 leaves was recorded. This coincided with a mean adult trap catch of 612 sawfly per trap. The mean number of larvae then decreased to 0.5 on the 15 June 2017 before increasing to 3.15 on the 30 June. The numbers then continually decreased until no larvae were recorded on the 13 October 2017. No damage was observed until the 30 May 2017 (adult trap catch of 612 sawfly per trap) when an average 2.68 leaves per 40 leaves assessed had damage. The number of leaves with damage then continued to increase to 21 leaves per 40 (30 June 2017). The mean number of damaged leaves then decreased until it reached 5.48 on the 13 October (Figure 6B).

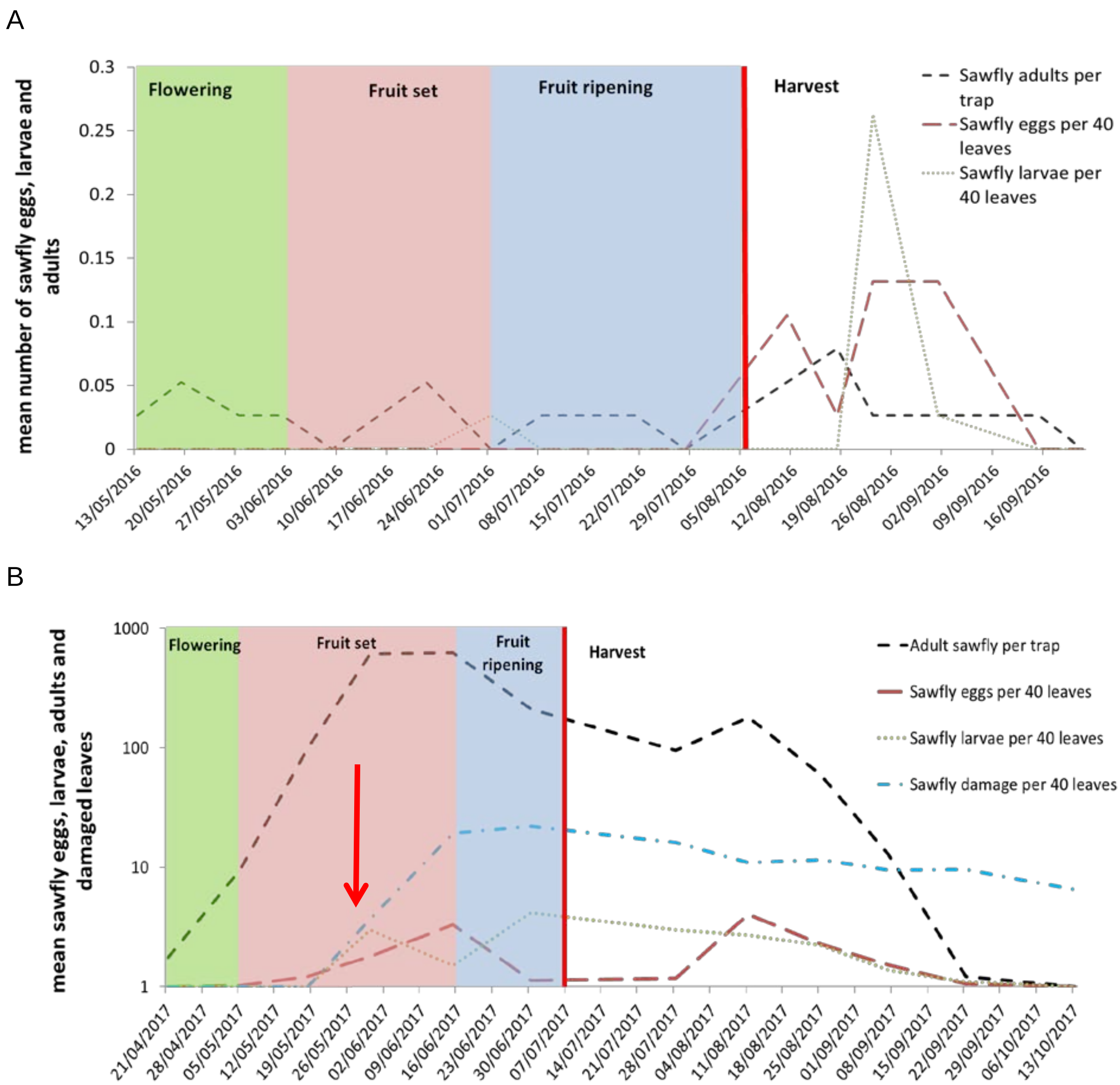


Figure 6. (A) Mean weekly counts of blackcurrant sawfly eggs, larvae and adult trap catches from the 13 May – 22 September 2016; (**B)** mean fortnightly counts of blackcurrant sawfly eggs, larvae, damage and adult trap catches from the 21 April – 13 October 2017 (Data for 2017 plotted on a $\log_{10}$ (n+1) scale).

Phenology of natural enemies and other pests

Low natural enemy counts were observed throughout flowering in 2016 and 2017 (<0.2 natural enemies per 4 bushes).

In 2016, the number of soldier beetles (Cantharidae) increased throughout fruit set and reached a peak of 0.61 per 4 bushes on the 22 June 2016 then decreased as the fruit began to ripen (Figure 7A). In 2017, the number of soldier beetles reached a peak of 0.5 per 4 bushes on the 30 May 2017, and then peaked again on the 30 June with 0.43 soldier beetles during fruit ripening after which the numbers decreased (Figure 7B).

Zero Heterotoma's were recorded in the early part of 2016 and then increased to an average of 1.61 per 4 bushes on the 15 July 2016 and remained high throughout fruit ripening then decreased to zero after harvest (Figure 7A). In 2017, the average Heterotoma numbers reached a peak of 1 every 4 bushes sampled on the 30 June 2017 and then decreased to zero after harvest.

Low levels of ladybirds (Coccinellidae) and anthocorids were observed throughout the 2016 season. In 2017, low numbers of anthocorids, seven spotted ladybirds and harlequin beetles were observed in the plantation throughout the season. Anthocorids numbers peaked twice, on the 30 May 2017 (0.35 per 4 bushes) and the 30 June 2017 (0.33 per 4 bushes) (Figure 7B).

Earwig numbers remained low throughout flowering, consistent with populations of other natural enemies in 2016 and 2017 (Figure 8A, 8B). Nymphs and adult females were first observed during fruit set on the 2 June 2016 and 18 May 2017 (Figures 8A, 8B). From fruit set until fruit ripening earwig nymphs were present and earwig male and female adults remained low (< 1 recorded) or were not present during this period (Figures 8A, 8B). In 2016, after harvest (5 August) the number of nymphs decreased and the number of male and female earwigs increased until no nymphs were found in the canopy (16 September) (Figure 8A). In 2017, the number of male, female and nymph earwigs increased from zero on the 15 June 2017 to 1.1, 1.38 and 1.03 per 4 bushes assessed on the 30 June 2017, respectively (Figure 8B). The mean number of nymph earwigs decreased after the 15 June 2017 until zero nymph earwigs were observed from the 22 September onwards (Figure 8B). The number of earwig males and females decreased with earwig nymphs to a mean of 0.33 and 0.25 per 4 bushes, respectively, on the 11 August, and then increased and remained higher than nymph numbers until the end of the trial (Figure 8B).

A

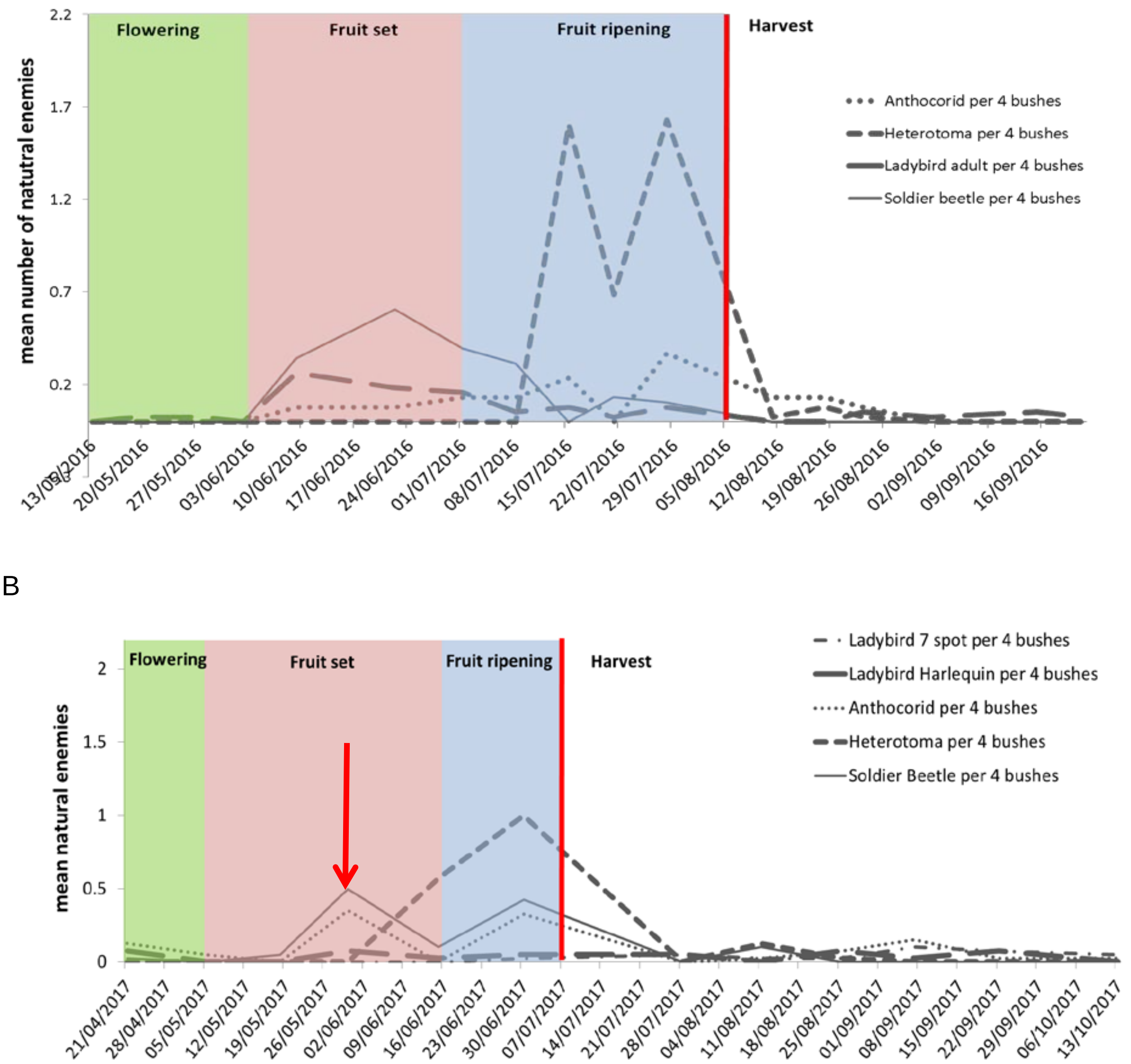
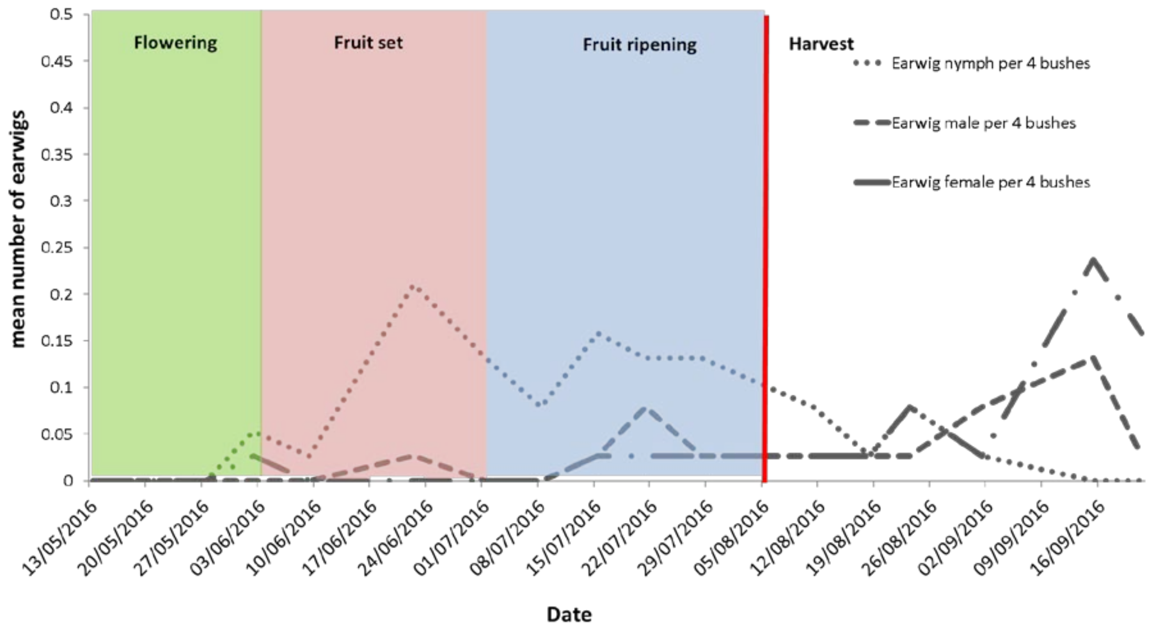


Figure 7. (A) Mean counts of natural enemies per week from the 13 May - 22 September 2016; (**B)** mean counts of natural enemies per fortnight from the 21 April – 13 October 2017

A



B

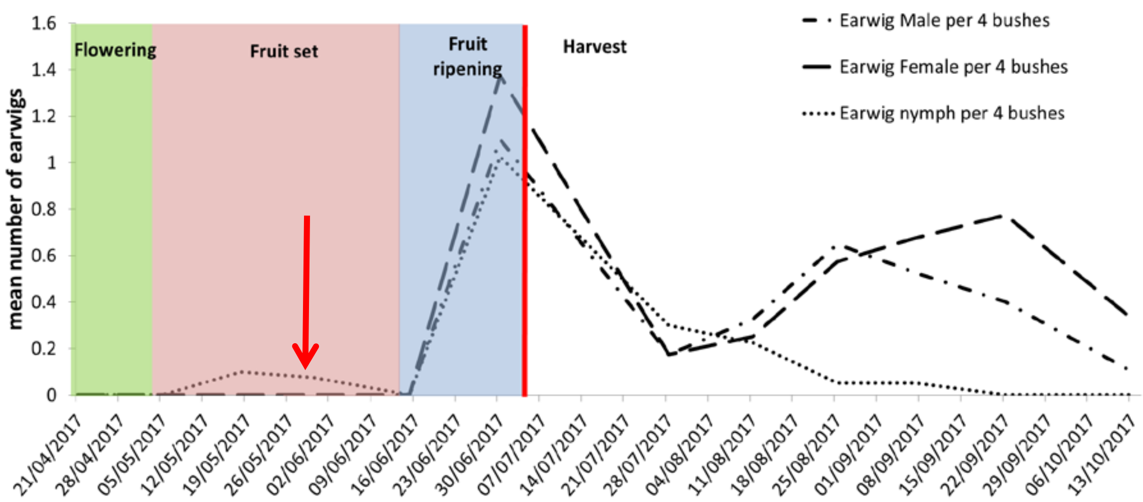


Figure 8. (A) Mean weekly counts of earwig males, females and nymphs from the 13 May – 22 September 2016; (**B)** mean fortnightly counts of earwig males, females and nymphs from the 21 April – 13 October 2017.

During 2017, aphids (mean of 17.35 per 40 leaves) and parasitic wasps (mean of 0.63 per 4 bushes) were present at high numbers from the first assessment (21 April 2017), and numbers reached a peak on the 30 May 2017 of 146.1 per 40 leaves and 8.63 per 4 bushes, respectively. Aphid and parasitic wasp numbers then decreased to 1.9 per 40 leaves and 0.53 per 4 bushes on the 15 June 2017. Aphid numbers plateaued for the rest of the trial whilst parasitic wasps steadily decreased for the rest of the trial (Figure 9). Spiders were present throughout the trial, zero spiders were found on the 28 July 2017. Caterpillars were observed at low levels in the plantation (Figure 9).

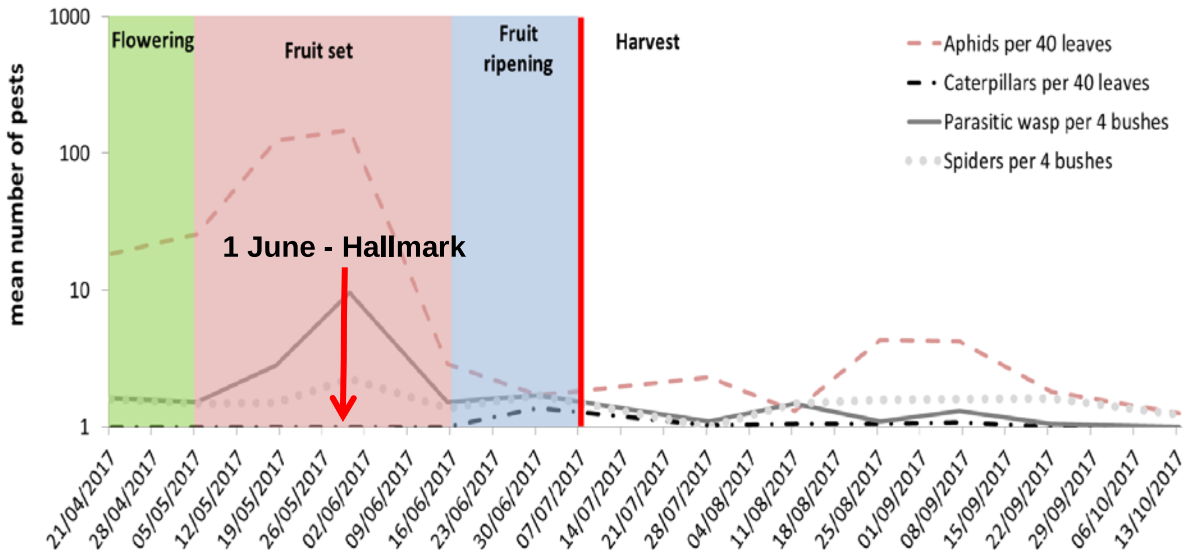


Figure 9. Mean fortnightly counts of aphids, caterpillars, parasitic wasps and spiders from 21 April – 13 October 2017 (Data plotted on a log_{10} (n+1) scale).

Distributions of sawfly and natural enemies

The distribution of adult sawfly in the traps across the plantation was sporadic in 2016 and distributed throughout the plantation in 2017. There was no significant relationship in 2016 (P = 0.088) or 2017 (P = 0.495) between the row in which the trap was deployed and the mean number of adult blackcurrant sawfly caught per trap (Figure 10). The highest numbers of male adults were found at trap 1 in 2017 (3,421) (Figure 10).

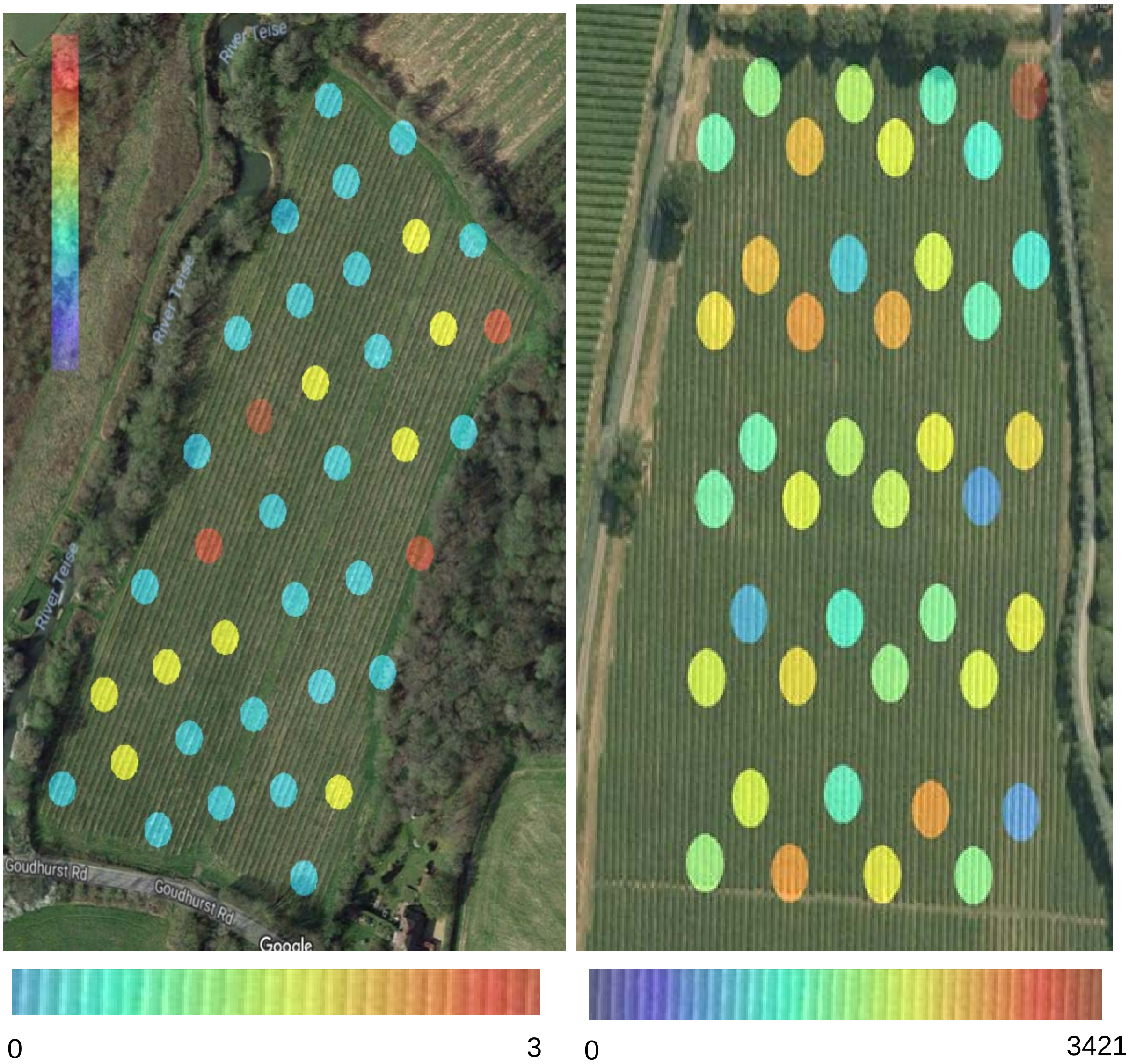


Figure 10. Distribution map of the total cumulative number of adult blackcurrant sawfly caught in pheromone traps in Kent 2016 (left) and Norfolk 2017 (right).

The total cumulative distribution of eggs and larvae showed no clear pattern through the plantation in 2016 or 2017 (Figure 11). There was no significant relationship in 2016 or 2017 between the row in which the leaves were assessed for eggs (P = 0.304 and P = 0.894, respectively) or larvae (P = 0.509 and P = 0.754, respectively) and the mean number of eggs or larvae per 40 leaves. High numbers of eggs were found at trap 1 in 2017 (82 eggs).

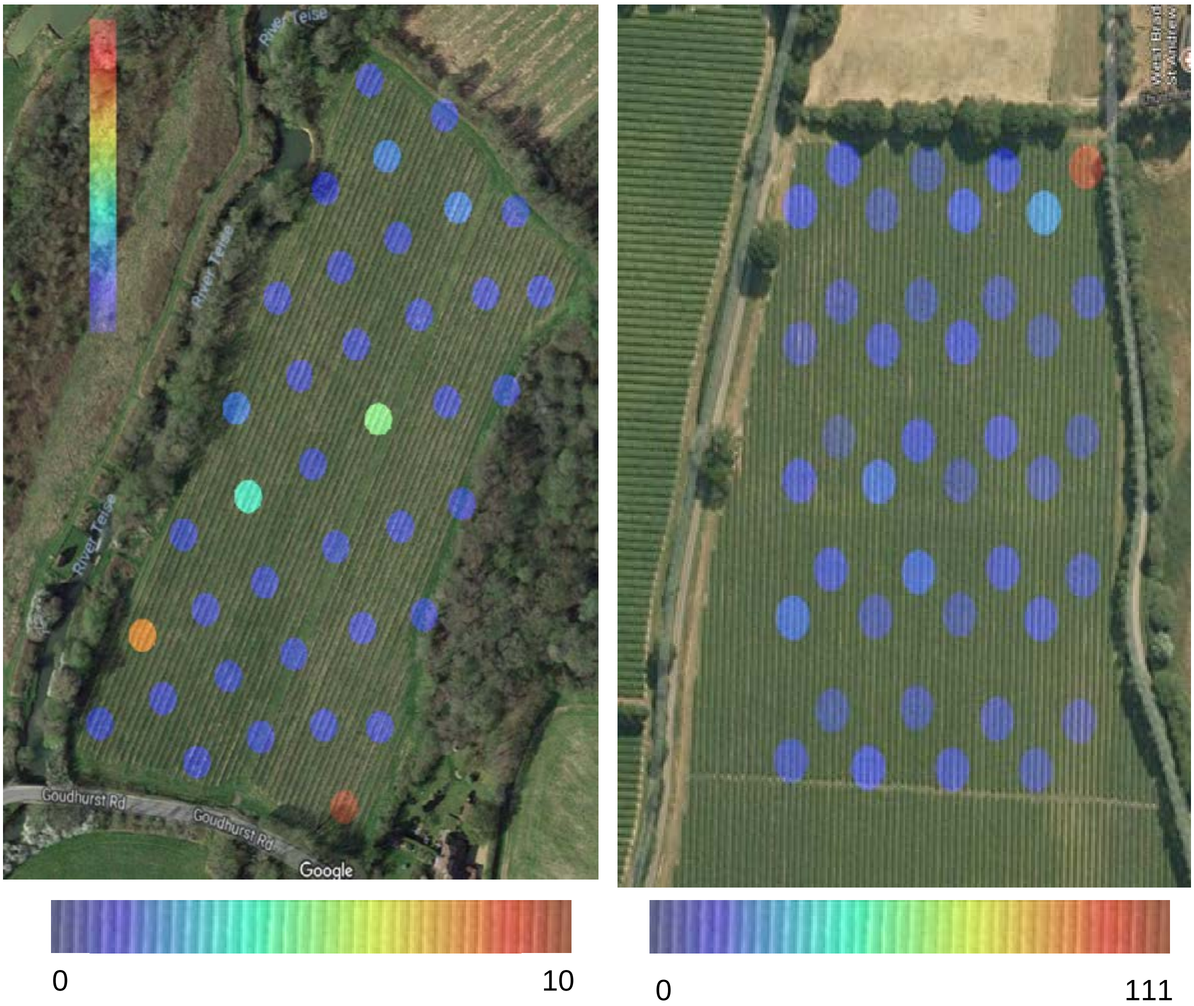


Figure 11. Distribution map of the total cumulative blackcurrant sawfly eggs and larvae at blackcurrant plantations in Kent 2016 (left) and Norfolk 2017 (right).

The total cumulative distribution of earwigs showed a clear pattern through the plantation, in 2016 and 2017 (Figure 12). In 2016 there was a significant difference in the mean number of earwigs recorded per 4 bushes between rows (P < 0.001, l.s.d. 0.0894, s.e.d. 0.455) (Figure 12). Row 1 (traps 1-7) and row 2 (Traps 8-13) to the left in Figure 12 had a significantly higher mean number of earwigs per 4 bushes, 0.303 and 0.216, respectively, than rows 3-6. In 2017, there was not a significant difference in the mean number of earwigs per 4 bushes between rows (P = 0.75). However, there was a significant difference in the mean number of earwigs per 4 bushes monitored around traps in the bottom half (1.95) of the plantation than the top half (0.83) (P <0.01, l.s.d. 0.1779, s.e.d. 0.0905) as shown in Figure 12.

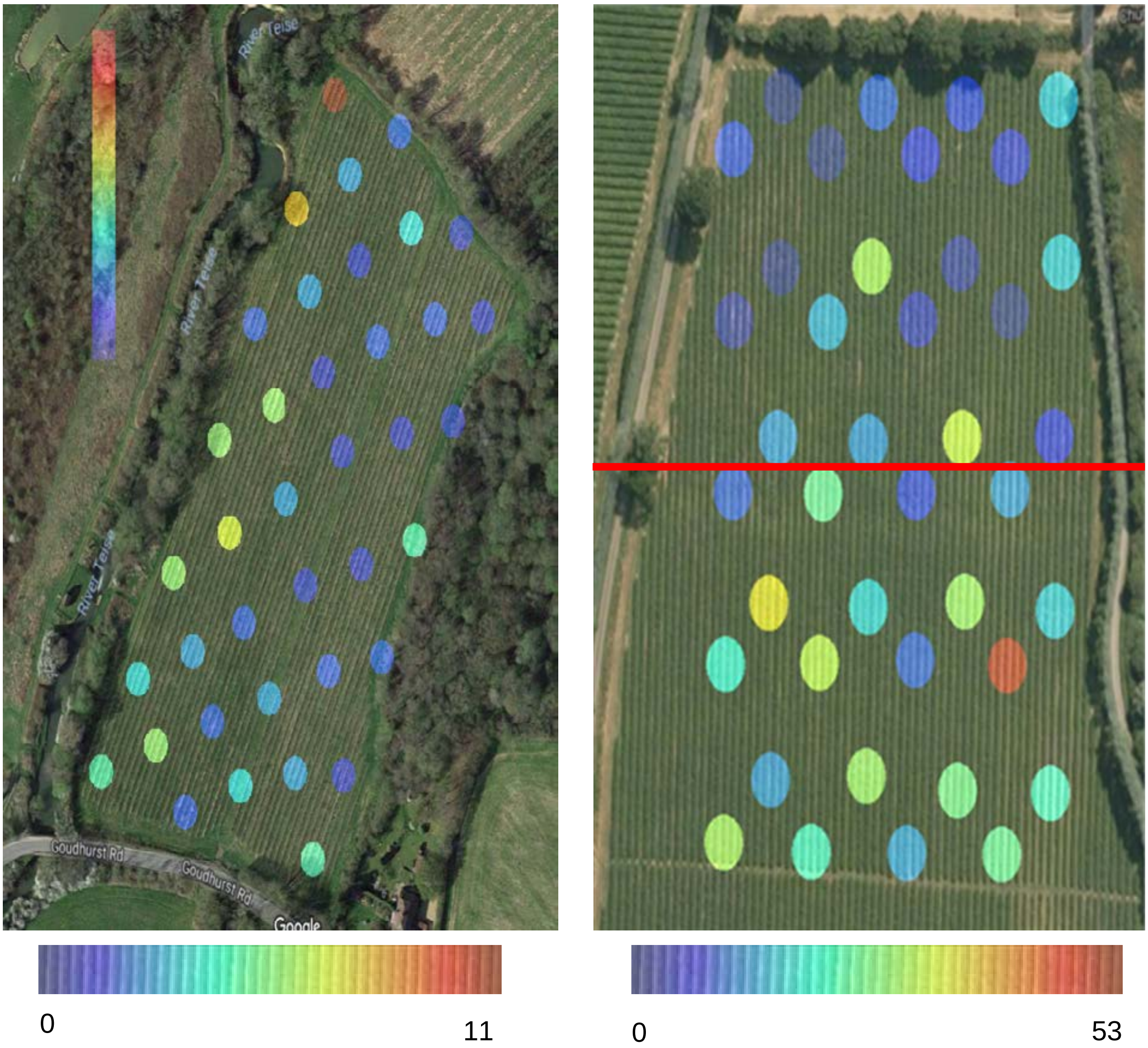


Figure 12. Distribution map of the total cumulative number of earwig males, females and nymphs in Kent 2016 (left) and Norfolk 2017 (right).

Spray programmes

No insecticides were applied to the Kent plantation in 2016. However, Calypso (Thiacloprid) was applied at early - late flowering (20 May) in 2015. In 2017 Hallmark (lambda cyhalothrin) was applied to the plantation on the 1 June.

Observations

Earwigs collected from a tree fruit orchard were placed in a petri dish with sawfly eggs and larvae. The earwigs were then observed feeding on the larvae and eggs.

Discussion

- Adult sawfly trap catch was low in Kent and high in Norfolk yet sawfly eggs, larvae and damage was not significant in either year.
- The first presence of eggs and larvae in the plantation coincided with a mean trap catch of 4.275 and 306 male adults per trap, respectively, after 7 days at which point natural enemy numbers in the plantation were low.
- The row positioning of the trap had no significant effect on trap catch.
- There were numerous and diverse natural enemies in the studied plantation throughout the blackcurrant growing season in 2016 and 2017.
- The same natural enemies were recorded in both plantations monitored in 2016 and 2017.
- The phenology of the predators was similar in both plantations.
- Relationships between natural enemies and sawflies and other soft bodied pests was difficult to quantify within the parameters of this study.
- Earwigs collected from a tree fruit orchard were observed feeding on sawfly eggs and larvae when given no choice.
- There was a significant effect of position in the plantation on earwig numbers, in Kent the position of the row and in Norfolk there was a difference between the top of the monitored area and the bottom.
- Further analysis into the data would help to determine whether the position of the earwigs in the plantations changes overtime and whether there is a difference between nymphs, females and males.
- The following insecticides have been found to be effective against blackcurrant sawfly larvae in and are approved for use on blackcurrants; Tracer (spinosad), Calypso (thiacloprid) and Hallmark (lambda cyhalothrin)
- An application of Hallmark (lambda cyhalothrin) on the 1 June had no obvious effect on the population of blackcurrant sawfly in the plantation.

Additional Work

Further work will look to;

- Create an economic threshold for the pheromone trap
- Better understand the roles of natural enemies in blackcurrant plantations
- Establish whether you have to spray for a pest (aphids, leaf curling midge and blackcurrant sawfly) if you have a certain number of natural enemies (earwigs, soldier beetles, heterotoma, ladybirds) per bush
- Determine if blackcurrant plantations could be optimised to encourage natural enemies (e.g. earwig refuges, seed mixes)

Knowledge and Technology Transfer

The role of earwigs and other predators for pest control in blackcurrants. Madeleine Cannon, ADHB Soft Fruit Day, NIAB EMR, 23 November 2016.

Sex Pheromones of the Blackcurrant Sawfly, Nematus olfaciens*, and the Gooseberry Sawfly,* N. ribesii *(Hymenoptera: Tenthredinae)*. David Hall, ADHB Soft Fruit Information Day, Winter Meeting, February 2016.

Development of Sex Pheromone Monitoring Traps for Blackcurrant and Gooseberry Sawfly. Michelle Fountain, ADHB Soft Fruit Information Day, Winter Meeting, 16 Feb 2017.

Blackcurrant sawfly pheromone and natural enemies Michelle Fountain, AHDB Soft Fruit Information Day, November 2017

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