Grower Summary

Project Number (HL 01107)

Biological, semiochemical and selective chemical management methods for insecticide resistant western flower thrips on protected strawberry

Annual 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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Headline

Headlines

- Adult female western flower thrips overwinter in senescent/dead strawberry flowers and weeds, such as chickweed, groundsel and dandelion.
- Before flowering, WFT can be most effectively monitored using blue sticky traps with a pheromone lure with the bottom of the trap (landscape orientation) about 10cm above the top of the crop (one hand width).
- From flowering, the number of adult thrips per medium age flower (all petals present, anthers brown, pollen shed) from the top of the plant is the best estimate of thrips populations.
- The use of blue sticky roller traps along the tunnel legs (30 cm wide, 100 m long, Optiroll, Russell IPM) can significantly reduce thrips numbers and fruit damage.

Background and expected deliverables

The development and spread of pesticide resistant strains of WFT which cannot be controlled with pesticides seriously threatens the viability of the UK strawberry industry. In 2009 serious outbreaks occurred in several high value crops in southern and central England causing serious loss.

The aim of this project is to develop a comprehensive range of new effective methods for managing insecticide resistant western flower thrips (WFT) on tunnel-grown strawberry in the UK. The methods include improved monitoring methods with attendant damage thresholds, a computer-based population and risk forecasting model, new selective pesticide treatments, new biopesticides, mass trapping and novel, more cost-effective strategies for using existing predators.

These components will be integrated into a comprehensive management strategy for the pest which will be tested on a commercial scale in the later stages of the project.

Summary of project and main conclusions

Progress on each objective of the project is summarised below:

Objective 1 (Monitoring, trapping and damage thresholds)

Information on the distribution of thrips within and between fields was collected to help advise growers on areas of greatest thrips risk. WFT was shown to overwinter as adult females in senescent/dead strawberry flowers and weeds (such as chickweed, groundsel and dandelion) within fields and in field margins. Overwintering in crops resulted in significantly more WFT in second year crops than in first year crops at the beginning of the season. Growing one-year crops or reducing the overwintering thrips population would reduce thrips risk.

Adult thrips moved into strawberry flowers and started to lay eggs at first flower. In first-year crops, the first thrips were observed around the outside of crops, particularly near weedy field margins, demonstrating the need for good weed control to reduce thrips risk. Once thrips populations had established in fields, they were found throughout the crops monitored, but the number of thrips was greater in the warmer, mid to top areas of sloping fields (excluding the exposed tunnel ends and sides). In general there was a mix of species early in the season (mainly WFT, *Thrips major* and *Thrips tabaci*) with increasing proportion of WFT (>90%) from July, especially after insecticide treatments.

Before flowering, the use of blue sticky traps with a pheromone lure, placed on canes (vertical orientation) 10 cm above the crop bed, was the most effective monitoring method. The addition of the pheromone increased trap catches by three fold. From first flowering, a count of adult thrips in medium-aged open flowers was a more accurate monitoring method than using trap counts. Comparison of population estimates by four people demonstrated that farm staff counted adult thrips in flowers accurately following a short training session (5 minutes) on identification from a hand-out. Analysis of the spatial variation in flower counts and thrips density within commercial crops was used to estimate the numbers of flower samples necessary to estimate thrips numbers at levels around a damage threshold of 4 to 8 adult thrips/flower. Counts of thrips in between 10 and 20 flowers may be sufficient to estimate a population in a particular area, but further analysis is needed to recommend a sampling programme. The possibility of reducing sampling time by using binomial (presence/absence) sampling was tested. Thrips occupied all flowers when the mean thrips/flower was approximately 4 thrips/flower in the variety Camarillo, which may be a useful indicator of damage in high risk situations (e.g. in second year crops without predators, in hot/dry conditions). However this method would not be sensitive enough at higher thresholds. Further development of threshold scoring will be done in 2013.

Bronzing damage to strawberry fruit increased with increasing numbers of adult thrips per flower. Significant damage that might result in downgrading of fruit corresponded to an average of about 4 to 8 adult thrips per flower. In 2012, when humidity was exceptionally high and in crops where predators were present, there were occasions where adult thrips numbers exceeded 8/flower yet damage was slight and further work will be done in 2013 to examine damage thresholds further.

The influence of flower flushes was identified as a key factor in the timing of damage. Damage often occurred soon after the end of flower flushes when thrips were concentrated into fewer flowers, so future damage cannot be predicted from thrips per flower alone but has to take account of changes in flower density. To help determine the relationship and timing between thrips per flower and fruit damage, the distribution of thrips on strawberry plants and timing of fruit damage was examined. On flowering and fruiting strawberry plants, 74% of adult thrips were found in the flowers, with the rest spread between fruit of different stages of ripeness. Larvae were mostly on flowers (40%) and young fruit (38%) with the rest on mature fruit. Very few thrips were present on leaves. All stages of flowers and fruit were damaged by both adult and larval WFT, with larvae doing about twice as much damage as adults, possibly because they do more feeding than adults. The greatest amount of damage to fruit occurred at the end of flowering when the flowers were senescent and larval numbers were at their highest, although further damage occurred throughout fruiting.

A number of trap designs were examined in order to identify the most effective trap, including the addition of semiochemicals to increase trap catch. The pheromone neryl (*S*)-2-methylbutanoate and the plant volatile methyl isonicotinate increased trap catches by small amounts (between x1.2 and x1.6) in UK strawberry crops during June and August, but there was no synergistic response. This was consistent with 2011 results. Neither scent increased trap catch in early May, during the first full flower flush, when temperatures were below 20°C, thrips numbers were low (<1 thrips/flower) and flower numbers were high (>16 flowers/plant). There was a similar response to pheromone whether using water or sticky traps.

Trap thickness and cylinder-shaped traps did not affect trap catch. Relatively few thrips were caught in yellow funnel traps, with or without scents. Comparison between white and blue sticky traps was made in protected and outdoor strawberry and bright white traps caught x2 and x1.5 more thrips than blue sticky traps, yet blue water traps caught x10 more thrips than transluscent white water traps. It was concluded that both colour and brightness of the traps is important. The use of LED (Light emitting diode) lights during the night increased trap catch (x1.2). Comparison between different trap types demonstrated that the trap colour is the most important component of the traps, the numbers of thrips caught relating to the area of colour/trap, rather than trap type (water or sticky). Placement of sticky traps about 10 cm above the crop, resulted in the highest trap catch. The cardinal orientation (north/south or east/west) did not affect sticky trap catch but vertical traps caught more than horizontal traps (x2). Traps placed in strawberry beds were vulnerable to damage from tractors. Traps placed in the leg area between tunnels caught fewer thrips in total (x0.9), yet significantly more female thrips (x1.2) than traps in beds. Traps between tunnels were therefore more practical and effective for mass trapping.

Three large-scale, replicated field trials demonstrated that placement of blue roller traps along the legs between tunnels reduced thrips numbers and fruit damage. The use of traps alone (30 cm wide, 100 m long, Optiroll, Russell IPM) reduced thrips numbers by 61% and fruit damage by 55%. The use of roller traps with WFT aggregation pheromone (used for precision monitoring), reduced thrips numbers by 73% and fruit damage by 68%. The addition of roller traps to an IPM programme maintained thrips numbers below economic damage thresholds. The traps remained sticky for at least 2 months but there was a lag between placement and control, so it is recommended that the traps should be in place about 3-4 weeks before damage is expected (e.g. in AprilMay for early flowering second year crops, or early July for everbearers where there is less pest pressure).

Objective 2 (Model)

WFT were reared at a range of constant and fluctuating temperatures to obtain developmental data to incorporate into the model developed in the early years of the project. Time for egg development ranged from 5 days at a constant 20°C to 13 days at a fluctuating 14/10°C. Experiments to determine rates of development for larvae are ongoing.

Objective 3 (Predators)

Experiments were carried out by EMR and ADAS in an attempt to identify the most effective strategy for release of predatory mites in combination with releases of *Orius laevigatus*. In the EMR experiment, on a first year crop, there were 8 treatments replicated 4 times. *O. laevigatus* releases were made to one entire tunnel in an attempt to reduce the potential effects of dispersal of this predator into the no-release *Orius* plots. The treatments were: (1) *N. cucumeris* at one sachet per 2-metre length of row, before flowering in early April and repeated after 6 weeks; (2) as 1 and repeated every 6 weeks; (3) *N. cucumeris* sachets in early April, followed by loose product at 25 per plant every three weeks, starting 6 weeks after the first release of sachets; (4) untreated control; (5) as treatment 1, plus *O. laevigatus* as in 8; (6) as treatment 2, plus *O. laevigatus* as in 8; (7) as treatment 3, plus *O. laevigatus* as in 8; (8) no *A. cucumeris* (as in treatment 4), but treated with four releases of *Orius laevigatus* at 1 per m^2 6 weeks after the first release of *N. cucumeris*.

Thrips larvae and adults were present in similar numbers in all treatments throughout the season, including the no predator release control. Several species were present with 38% of those identified being WFT. No *O. laevigatus* were found in samples taken in the release tunnel. Highest numbers of *N. cucumeris* were found in the plots where sachets had been released every 6 weeks; the peak in predator numbers was also later in this treatment (end of July rather than end of June). However this appears to have had no effect on thrips numbers in the flowers. There was no thrips feeding damage seen in samples taken by EMR at harvest and the grower did not downgrade any of this crop from the experimental tunnel.
In the ADAS experiment the treatments were: (1) Untreated control. (2) *N. cucumeris* at one sachet per 2-metre length of row before flowering on 4 April, repeated at 6-week intervals (on 16 May and 26 June), (3) *N. cucumeris* at one sachet per 2-metre length of row before flowering on 4 April, followed by loose product at 25 per plant after 6 weeks (on 16 May) and thereafter every two weeks (on 31 May, 15 June, 28 June, 12 July and 26 July), (4) untreated with *N. cucumeris* with releases of *Orius laevigatus* adults at 0.5 per m^2 at first flower flush on 10 and 17 May, and again at second flower flush on 26 July, together with nymphs at 3 per m^2 , (5) *N. cucumeris* as in treatment 2, plus *O. laevigatus* as in treatment 4, (6) *N. cucumeris* as in treatment 3, plus *O. laevigatus* as in treatment 4.

Numbers of thrips (all WFT) increased during the experiment in all plots and *O. laevigatus* did not establish well. Very little fruit was downgraded due to thrips damage, but the host grower decided to apply spinosad (Tracer) on 10 August as mean numbers of WFT had reached very high numbers (up to 20 adults per flower on 28 June). Spinosad resistance has not yet developed on this farm.

Objective 4 (Pesticides and biopesticides)

Although there were no significant reductions in WFT populations following treatments with the selected BCAs there were indications of a trend of declining WFT populations over time for the biopesticide Naturalis and the botanical Neem applied as a drench. This method of application is worth investigating further as it could suggest that WFT do not receive a sufficient dose on the crop for lethal fungal infection with foliar applications. Another explanation could be connected with environmental conditions. Entomopathogenic fungi require high humidities and moderate temperatures for activity (the optimum temperature for fungal infection is c. 23°C). In the tunnels the minimum temperatures ranged from 4.5 to 17°C and the maximum temperatures ranged from 23 to 42.5°C. The high temperatures within the tunnels may be detrimental to foliar sprays of fungal biopestcides.

Financial benefits

Strawberry production in the UK is intensive and the crop is of high value, the UK industry being amongst the most effective in Europe. In 2007, 50,739 tonnes of strawberries, worth approximately £212 million were produced from approximately 2,922 ha grown in Britain. A further estimated 41,126 tonnes, worth approximately £174 million, were imported.

The development and spread of pesticide resistant strains of WFT which cannot be controlled with conventional crop protection products seriously threatens the viability of the UK strawberry industry. In 2009 serious outbreaks occurred in several high value crops in southern and central England causing serious loss. The average everbearer crop yields 20,000 kg of class 1 fruit over one season with a current value of £2.70 per kg (£54,000 per ha). On some farms in 2009, WFT damage to everbearer fruit was so severe following failure of spinosad to control the pest, that total crop loss occurred for the latter third of the season (i.e. a loss of £18,000 per ha). Even on farms where spinosad is still effective, WFT damage can lead to at least 20% of the fruit being downgraded to class 2 for half of the picking season. The value of class 2 fruit is less than £1.50 per kg. Thus, WFT currently causes minimum estimated financial losses of approximately £3,000 per ha per season. There is great concern that UK everbearer crop losses will escalate with the further spread of spinosad-resistant strains of WFT. Furthermore, WFT is favoured by hot summer weather conditions. If the 2009 summer weather had been hot it is possible that losses would have been much more extensive.

This project will deliver a new sustainable cost-effective IPM strategy for management of WFT on tunnel-grown everbearer crops which is vital to the survival of the UK strawberry industry. The development of a reliable IPM strategy for successful control of WFT would benefit growers by preventing crop losses and fruit downgrading due to WFT damage. In this project we aim to develop a range of complementary methods for managing WFT. For instance, using WFT predators which may include two releases of *Neoseilus cucumeris* in sachets (costing up to £325 per ha) and two releases of *Orius laevigatus (*costing up to £600 per ha). If this strategy prevented fruit downgrading due to WFT damage for the whole everbearer season, use of the two predators could give a minimum potential 324% return on investment. On farms with spinosad resistance the benefit of investing in a reliable IPM strategy would be much greater as it could prevent entire crop losses.

Action points for growers

- Plan your IPM programme carefully in early spring, in conjunction with an experienced consultant who us up to date in thrips management strategies on everbearers.

- Western flower thrips were shown to overwinter in senescent/dead strawberry flowers and weeds, such as chickweed, groundsel and dandelion. Overwintering in crops resulted in significantly more thrips in second year crops than in first year crops at the beginning of the season. Growing one year crops, avoiding planting new crops in used grow-bags or reducing the overwintering thrips population would reduce thrips risk.

- In first year crops, the first thrips were observed around the outside of the crop, particularly near weedy field margins, demonstrating the need for good weed control to reduce thrips risk.

- Once thrips had established, they were found throughout crops, but numbers were greatest in the mid to top areas of sloping fields (excluding the tunnel ends and sides) where temperatures are higher. This is the area of greatest risk of fruit damage.

- Before the crop is flowering, WFT can be most effectively monitored using blue sticky traps with a pheromone lure. In strawberry the best position for traps is to mount them onto a post (a cheap bamboo cane is sufficient, held in place with a rubber band) with the bottom of the trap (landscape orientation) about 10cm above the top of the crop (one hand width). If any flowering weeds e.g. dandelion or groundsel are present, presence of thrips can be monitored by tapping the flowers over a white card.

- From crop flowering, the number of adult thrips per flower is the best estimate of thrips numbers. When monitoring for thrips the selection of flower age and position affects population estimates. Select flowers of medium age (all petals present, anthers brown, pollen shed) from the top of the plant for monitoring thrips adults, as young (petals fresh, anthers yellow, pollen not shed) or senescent (petals dropping) flowers will result in an underestimation.

- Bronzing damage to strawberry fruit increased with increasing numbers of adult thrips per flower. Significant damage that might result in downgrading of fruit corresponded to an average of about 4 to 8 adult thrips per flower.

- Damage thresholds can only be a guideline as there is much variability. The lower damage threshold may apply in hot/dry conditions in fields without predators. Higher damage thresholds may apply in humid conditions and in fields where predators have established.

- The damage threshold can also vary between everbearer varieties. Further work in the project will aim to gain more information on the relationship between numbers of thrips adults per flower and fruit damage.

- The use of blue roller traps along the tunnel legs (30 cm wide, 100 m long, Optiroll, Russell IPM) reduced thrips numbers by 61% and fruit damage by 55%. The use of blue roller traps with additional WFT aggregation pheromone reduced thrips numbers by 73% and fruit damage by 68%. Roller traps may be a useful addition to an IPM programme, and can maintain thrips damage below economic injury levels (i.e. prevent downgrading of fruit). Note that the aggregation pheromone is a precision monitoring tool and there is no approval for its use as a control agent in commercial crops at this time.

- Roller traps should be put out about 3-4 weeks before damage is predicted (e.g. in April for early flowering second year crops or early July in crops with less pest pressure. They remain sticky for at least 2 months, although sections of glue are washed off in places.

- Monitor thrips numbers in flowers and fruit damage throughout the season. Confirmation of thrips species by an entomologist experienced in thrips identification will provide useful information should it be necessary to consider insecticide treatment.