Grower Summary

SF 145

Understanding and developing methods for managing spotted wing drosophila (SWD) in the UK: Vital research to maintain the viability of the UK fruit industry

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Date project completed (or expected completion date):	31 March 2017

GROWER SUMMARY

Headline

- A greater understanding of the biology and control of SWD in the UK has been achieved with findings directly relevant to UK soft and stone fruit growers.

Background and expected deliverables

Spotted wing drosophila (*Drosophila suzukii*, SWD) is a new invasive pest to the UK, but has caused considerable losses in fruit crops in Europe and the USA. The overall aim of the project is to monitor the spread of *D. suzukii* within the UK and to develop measures for its control. To this end five objectives have been set for the project:

1. To determine the distribution and seasonal population dynamics of all life stages of *D. suzukii* in different cropping situations and especially polytunnel crops on fruit farms in the UK.
2. To develop economically and environmentally sustainable treatment and disposal strategies for soft and stone fruit waste to eliminate it as a source of *D. suzukii* infestation and attraction on fruit farms.
3. To develop and evaluate sampling and extraction methods for quantifying *D. suzukii* infestations in different soft and stone fruits.
4. To develop a synthetic lure and attract and kill technology for *D. suzukii* for incorporation into IPM programmes.
5. To obtain evidence for the effectiveness of different plant protection products including biopesticides to aid developing an insecticide resistance management strategy for SWD.

Summary of the project and main conclusions

Objective 1: To determine the distribution and seasonal population dynamics of all life stages of Drosophila suzukii in different cropping situations and especially polytunnel crops on fruit farms in the UK and investigate its wide wild hosts and overwintering.

National monitoring

In 2015, the national monitoring of adult *D. suzukii* numbers was continued at a network of 15 sites across the UK using modified Biobest traps with Cha-Landolt bait: 5 in Kent, including NIAB EMR, 1 in Surrey, 3 in the West Midlands, 2 in East England and 4 in Scotland, including the James Hutton Institute.

Numbers of *D. suzukii* caught were considerably higher in 2015 than in previous years. The largest catches were in the south east of England, but *D. suzukii* were found at all sites in 2014. In a similar pattern to previous years the numbers caught in crops peaked in August before declining and then rose again in late October, with adults migrating to woodlands and hedgerows where numbers remained high throughout November and December, reaching a peak of over 20,000 per trap per week at one site. It is estimated that numbers in the winter of 2015 are at least 3 times higher than at the same time in 2014, although the winter has been quite mild, probably resulting in a higher activity and trapping efficacy.

Habitat survey

The distribution of *D. suzukii* on two farms, including NIAB EMR was studied throughout the year. Over 50 traps were deployed on each farm in a range of crops and in neighbouring wild areas and woodlands. *D. suzukii* were recorded in the traps every week in 2015, in contrast to 2014 when for 5 weeks in the spring none were recorded.

The trap catch throughout 2015 showed a similar pattern to previous years. Activity increased in early spring from 14 April to 8 June, with more pronounced activity towards the end of the summer from 27 July until the winter. Numbers peaked in late autumn and winter with considerably higher catches than in 2014. Higher numbers of *D. suzukii* were caught in cherry orchards than in other crops surveyed. The number of *D. suzukii* decreased in the cherry orchards once all the leaves had fallen.

All reproductive stages were seen during the fruit growing season on both farms in 2015. *D. suzukii* from Farm 2 appeared to have a longer period of fertility than Farm 1 (April through to

November), a trend that was found in the previous year. This may be related to the later removal of polytunnels and/or the removal of raspberry waste at Farm 1.

Population modelling

A computer model was constructed using fertility studies, climatic data and biological parameters derived from this project and from published literature, to predict *D. suzukii* population changes. This model is being validated against population data collected during the course of this project and gives a good estimate of the time of first egg laying and the start of population growth. Future research should continue to optimise the programme, especially for population prediction later in the year.

Monitoring SWD larval infestations in early, mid and late season cherry varieties

In the first trial, seven commercial varieties of cherries were assessed covering early to late cropping. Brix (sugar content), hardness and *D. suzukii* emergence were monitored for each crop. In general there was a positive relationship between Brix and the softening of the cherry fruits, especially Sweetheart, Korvic and Merchant.

D. suzukii larvae were not found in the early variety Simone (picked first week of July) and although they emerged from the other early variety, Merchant, this was only after the optimal time for harvest had passed and the fruits were very soft. If no plant protection products were applied eggs could be laid in Sweetheart and Penny very early.

In a second survey of *D. suzukii* occurrence in four commercial orchards in Southern England, no *D. suzukii* emerged from fruits harvested between 14 May and 8 June, however small numbers were recorded after this time.

UK host plants for D. suzukii and overwintering sites.

Black Bryony and Yew berries were shown to be potential oviposition sites towards the end of the year. However, Cotoneaster, Snowberry, Guelder Rose, Dogwood, Hawthorn, Red Bryony and Rose do not appear to support *D. suzukii* development. All of these fruits are rather dry and fibrous. Raspberry cuttings and leaf litter did not appear to be significant sheltering sites for *D. suzukii* in the late autumn and winter in this limited study.

Objective 2. To develop economically and environmentally sustainable treatment and disposal strategies for soft and stone fruit waste to eliminate it as a source of D. suzukii infestation and attraction on fruit farms.

Treatment in anaerobically sealed Dolav bins was shown to kill all *D. suzukii* in soft fruit waste, as long as the ambient temperature was over 18^{o}C. However, if the ambient temperature was lower, such as might be found at the end of the season, then three days would be necessary to kill eggs and larvae.

Stone fruit was shown to take a longer period of storage to remove all *D. suzukii*, so that four days of storage are required, or five days if temperatures are below 16^{o}C ambient temperature. Oxygen depletion was very rapid for each fruit type. It was non-detectable after 6 hours and it is possible that this is the crucial factor in killing eggs and larvae. There was a rapid increase of CO_2 levels in soft fruit waste, but this was much slower in stone fruit waste, possibly because of the firmer nature of the fruit and the presence of air pockets.

Mixing treated waste with at least 90% (w/w) organic matter such as manure or slurry was shown to prevent re-inoculation, as was rotavation to a depth of 20 cm. The rate of application of treated waste to land should not exceed 125 tonnes/ha to prevent exceeding EU directives on nitrate addition.

Disposal of fruit waste via digestion plants was not considered to be financially attractive due to the high moisture content and low calorific value of fruit wastes, along with transport and gate fee costs.

Objective 3. To develop and evaluate sampling and extraction methods for quantifying D. suzukii infestations in different soft and stone fruits.

Low cost methods were trialled to detect *D. suzukii* larvae (both early and late stage) in samples of blueberries, cherries, raspberries and strawberries. The methods included immersion of crushed fruit in strong sugar or salt solutions, in a weak detergent solution or freezing whole fruit overnight. These methods were compared to emergence testing (keeping fruits in boxes at room temperature for 3 weeks and counting adult emergence) and dissecting the fruits open to count the numbers of larvae directly by hand. Sugar and salt immersion were the most successful in detecting *D. suzukii* larvae, whether late or early stage, with sugar solution slightly more effective. No method gave 100% recovery of the larvae.

Flotation with a strong sugar solution was the most practical way to determine the infestation levels of fruits and a standard protocol has been prepared in conjunction with AHDB Horticulture for growers. Training videos and training posters on how to undertake a flotation test using sugar solution have been published by AHDB Horticulture and are available on the dedicated SWD site of the AHDB Horticulture website.

Evaluating intra species competition for egg laying sites

D. suzukii appear to prefer to oviposit into media that has not been exposed to *D. melanogaster.* The latter do not seem affected by previous exposure to *D. suzukii* egg laying. This may be related to the niche that *D. suzukii* occupies; they do not need to compete with other *Drosophila* species for egg laying sites, whereas *D. melanogaster* need to compete for egg laying sites with other UK species. The absence of competition may also explain the relatively long development time of *D. suzukii*.

Objective 4. To develop a synthetic lure and attract and kill technology for D. suzukii for incorporation into IPM programmes

Testing commercially available and experimental baits

A comparison of various commercially available *D. suzukii* lures and traps was made, comparing *D. suzukii* catch, bycatch and ease of use. A detailed breakdown of the results is provided in the Science Section of this report. It was also found that topping up precision monitoring traps with DrosAttract rather than replacing the whole unit was as effective and cheaper, whilst producing less bycatch and waste. Chemical analysis of the successful commercial baits suggested that ethanol might not be as necessary as previously believed. In contrast, 3-Methylbutanol was released from all baits tested and might be a useful component of future lures.

Develop target device and identify suitable insecticide(s) for attract and kill formulation

An ‘attract and kill’ device is being developed in conjunction with the NRI. Miniature, dry versions of the Cha Landolt lures have been shown to be effective in attracting *D. suzukii* and deltamethrin (Decis) appears to be a good candidate choice for an insecticide. This work will be continued in 2016.

The evaluation of components of Cha-Landolt baits for the efficiency of trapping

Delivery systems for the components of the Cha Landolt trap system, ethanol, acetic acid, acetoin and methionol were assessed. Sachets for acetoin and methionol developed by NRI were found to be as effective as the vials previously used and much easier to use. However, ethanol and acetic acid were more effective in the drowning solution than in sachets or vials. This is being investigated further.

Objective 5. To obtain evidence for the effectiveness of different plant protection products including biopesticides and for developing an insecticide resistance management strategy for D. suzukii.

Evaluate the efficacy of approved and emerging products against adults and other life stages in crops

In a replicated field experiment, with a population of *D. suzukii*, crop protection products were assessed for effectiveness of *D. suzukii* control on cherries. The efficacy of *D. suzukii* control varied with the plant protection product applied and time post spraying. Spinosad, lambda cyhalothrin, cyantraniliprole and a coded product gave good control over the duration of the study, whilst deltamethrin, acetamiprid and another coded product gave good initial protection, but by day 14 were beginning to lose effectiveness. In contrast, one application of lime and a pyrethrins mixture gave relatively poor control.

Evaluate the use of sugar as an adjuvant for enhancement of insecticide treatments in the control of D. suzukii

Sugar was investigated as a way of enhancing the effectiveness of plant protection products against *D. suzukii*. A literature review found sugar to be effective in a number of cases. In our trials, sugar significantly enhanced adult mortality from chlorantraniprole. However, no significant effect of sugar on adult mortality or subsequent emergence was found with spinosad, lambda cyhalothrin or deltamethrin.

Additional research

Efficacy of Jet 5 or Lime for the control of egg laying of Drosophila suzukii

Jet 5 and lime were assessed for usefulness in *D. suzukii* control. Blueberries were dipped in the treatments and adult flies were added. Direct mortality, egg laying and subsequent emergence of adults from the fruit were measured. Jet 5 caused mortality to flies added to

the fruit, but this may be due to vapour action within the experimental arena. Lime reduced the number of flies emerging from treated fruit indicating a repellent effect on egg laying

Population dynamics of Drosophila suzukii in relation to other Drosophila species in the UK 2014-17

Six *Drosophila* species and the species group *Drosophila obscura* were regularly found in the national monitoring traps. These species may interact with *D. suzukii* via competition, the transmission of pathogens or spread of parasitoids. The commonest bycatch was the *D. obscura* group. These were found in all sites and all time periods. In terms of monitoring, bycatch of other *Drosophila* can slow assessment considerably and several species can look like *D. suzukii* to an inexperienced observer.

Financial benefits

D. suzukii poses a clear threat to the fruit industry and has had a commercial impact on UK grown fruit since 2014. Growers have reported significant financial losses in cherry and some soft fruit crops.

Action points for growers

- Monitor adults in susceptible crops and wild areas around crops from February onwards to predict the onset of egg laying by *D. suzukii*. Use a recommended trap and bait.

- Consider winter trapping and deploy perimeter trapping around vulnerable crops before fruit begins to ripen, potentially delaying movement of *D. suzukii* into the crop.

- Monitor for the presence of larvae in the crop. The flotation technique using sugar solution is recommended for rapid detection of larvae, but growers should consider emergence testing (boxes of fruit at room temperature) for early season detection.

- Crop hygiene is one of the best methods of population control. All waste fruit should be removed from the crop during and after harvest and be treated in sealed vessels and then disposed of responsibly by incorporating into the surface of field soils or mixed with organic matter such as manure or slurry.

- Consult BASIS trained advisers for the latest approvals for effective plant protection products and use the comprehensive information on SWD in the dedicated SWD site of the AHDB Horticulture website http://horticulture.ahdb.org.uk/.