# Grower Summary

Development and implementation of season long control strategies for *Drosophila suzukii* in soft and tree fruit

SF145a

Annual report 2018

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| **Project title:** | Development and implementation of season long control strategies for *Drosophila suzukii* in soft and tree fruit |
| **Project number:** | SF145a |
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| **Previous report:** | N/A |
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| **Location of project:** | NIAB EMR |
| **Industry Representative:** | Marion Regan, Hugh Lowe Farms |
| **Date project commenced:** | 01 April 2017 |
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*[The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.]*

## 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

Development and implementation of season long control strategies for *Drosophila suzukii* in soft and tree fruit

## Headlines

- Trap catches of SWD continued to increase in traps in most regions of the UK
- The components of a ‘Push-Pull’ system have shown promise and will be tested in 2018
- Advances have been made with a feeding bait which increases mortality and reduces egg laying when combined with a low dose of crop protection product.
- A fortnightly spray programme was as effective at controlling SWD in cherry as weekly sprays when combined with insect mesh.
- The potential for SWD to feed on the extra-floral nectaries of cherry leaves lasts until the leaves senesce in late summer.

## Background and expected deliverables

The Asiatic vinegar fly *Drosophila suzukii* (spotted wing drosophila, SWD) invaded the UK in 2012. It has increased in numbers from year to year and has become a key pest of stone and soft fruits. It has the potential to cause significant fruit damage and growers incur significant increases in production costs in gaining control. The spread of *D. suzukii* across Europe has strongly disrupted existing and developing IPM control strategies in all countries. Growers currently control the pest with sprays of plant protection products (PPPs), some of which are broad spectrum. This causes a reduction in beneficial arthropod populations, disrupting their ecological contribution in keeping pests below economic threshold values. Repeated use of a limited number of active ingredients to control SWD could accelerate resistance development.

In Europe and North America, initial research projects on *D. suzukii* are coming to an end (projects IPMDROS, DROSKII and DROPSA). The aim of these projects was to create new knowledge and understanding of the damage and losses on fruit crops resulting from *D. suzukii* activity, studying its biology and evaluating control methods. This AHDB project builds on international progress and on AHDB funded work in project SF145. It focuses on practical development and elaboration of new control technologies that can be used by UK farmers within the short to medium term.

To this end, six project objectives have been set up and this Grower Summary will report on these objectives worked upon in Year 1.

1. Continue to monitor populations of *D. suzukii* in England and Scotland with additional habitat evaluation in Scotland

2. Develop and optimise a push/pull system using repellents and attract and kill strategies

3. Further develop, optimise and test bait sprays

4. Investigate prolonging spray intervals for maximum effect using minimal applications

5. Integrate exclusion netting with other successful controls

6. Integrate approaches for season long control

This work is being led by Michelle Fountain and her entomology team at NIAB EMR in Kent in collaboration with Alison Dolan at the James Hutton Institute who is working with growers in the East of Scotland.

## Summary of the project and main conclusions in Year 1

### **Objective 1.** *Continued National Monitoring of the populations of D. suzukii in Scotland and England*

Since the first detection of *D. suzukii* in the UK in 2012, populations of *D. suzukii* have continued to rise in most regions of England and there are more frequent reports of the pest being detected nationally and also in Ireland. In contrast to the general UK trend, populations in Scotland have been low since the pest was first detected in 2014.

In collaboration with Berry Gardens, in 2017, we continued to monitor in the main fruit growing regions with 57 traps across nine farms in England (Kent, Surrey, Herefordshire, Staffordshire, Northamptonshire, Yorkshire and Norfolk) and 40 traps on four farms in Scotland.

Monitoring traps were deployed in pairs, one in the centre and one at the edge of each crop. Pairs of traps were also deployed in a wooded area on each farm. The modified Biobest trap design and Cha-Landolt bait was used.

Activity-density of adult *D. suzukii* in the monitoring traps was higher in the spring (Mar-May) and late summer (Jul-Aug) of 2017 than in previous years. This correlated with increases in reported damage to early forced June bearer strawberry and cane fruits respectively, by the industry. The first peak autumn catch was almost a month earlier with catches in Nov-Dec almost double the trap catch (>800) from the previous highest recording in 2015/16. Peaks in Nov-Dec in 2015 corresponded with mild weather and a similar pattern was observed in Oct 2017. These autumn – winter peaks in activity are when the flies are in reproductive diapause in their winter-form. At this time, *D. suzukii* can be detected at 50 m height in suction traps (Rothamsted Research). This period coincides with depletion in egg laying resources and defoliation of trees. Decrease in trap catches during the summer months can be attributed to several causes. Traps tend to be less attractive than ripening crops. Numbers can be reduced by crop protection products and warmer weather can influence catches.

Additional study sites, in Scotland, in 2017, caught very few *D. suzukii* although 'hotspots' were identified. Data showed similar trends suggesting that the national monitoring data set is representative of the *D. suzukii* density in Scotland. Very few *D. suzukii* emerged from unsprayed wild hosts suggesting that populations are still very low. Indeed no *D. suzukii* were detected until 9 August, with fecund females present through until November.

Data has been collated throughout the reporting period and regularly sent to the AHDB.

**Objective 2.** *Develop and optimise a push/pull system using repellents and attract and kill strategies*

Potential repellents to deter *D. suzukii* laying eggs in fruits or discouraging adults from entering the cropping area were investigated in the previous project (SF 145). These were further investigated in 2017 alone or as a blend. Repellent methods are likely to be more effective in combination with other methods, such as Attract and Kill (A&K) technology to form a Push-Pull strategy; pushing away from the crop and pulling towards an attractant which would contain a distracting or fatal component. Therefore, further optimised the NIAB EMR / NRI prototype Falcon tube device including the design and the attractant formulation and compared this to a commercial trap currently undergoing approval. The control component in the prototype is enclosed within the inner surface of the device to minimise human exposure and environmental contamination including adverse effects on beneficial insects. Unlike 'mass traps', the A&K device is open ended and does not become saturated with dead flies which reduces high labour costs.

Two repellent experiments were done in an unsprayed cherry orchard at NIAB EMR. All six treatments were synthetic semio-chemical compounds and were coded. Repellents were dispensed from polyethylene sachets or rubber septa. Twenty sachets/septa were suspended evenly throughout each cherry tree (a plot) on 12 May and again on 13 July. Sentinel fruits were then deployed within the tree canopy and incubated for two weeks in a laboratory to test for the presence of *D. suzukii*. There were five replicates of each treatment in a randomised block design. Sentinel fruit were deployed on 15 and 22 May for the first experiment and 14 and 21 July for the second experiment. Only one *D. suzukii* emerged from sentinel strawberries in the blend treatment in the first experiment suggesting that a blend may be more effective than single components. However, *D. suzukii* was aggregated in only two blocks in the first experiment, removing the possibility of detecting a significant effect. *D. suzukii* was present throughout the cherry orchard in July but numbers were too high and plots probably too small to detect repellent effects.

In work to improve the A&K Falcon tube device (Figure A) we compared the NIAB / NRI device and attractant to a commercial standard. In a series of experiments set up in semi-field cages, 10 male and 10 female (3 – 12 days old), mated *D. suzukii*, from a laboratory culture, were introduced with the prototypes and mortality assessed 24 hours later. The lures used in the prototype were separate half size sachets containing ethanol/ acetoin, acetic acid and methionol (provided by NRI) and referred to as mini Cha-Landolt. Experimental prototypes, with the exception of the untreated controls, were coated on the inside with a formulation of Decis (deltamethrin) or a field formulation of spinosad (Tracer). All experiments had seven replicates and manipulated the number or positioning of the entry holes and/or red colouration on the prototype devices.

**Figure A.** Prototype Falcon tube devices compared to a commercial standard

The prototype Falcon tube devices, with Decis as killing agent, were as effective as the commercial trap in controlling *D. suzukii*. The devices give up to 30% kill of *D. suzukii* within 24 hours in these semi-field cage trials. The devices with eight holes on the red sections were more effective than devices with four holes on the clear part of the trap. However, increasing the number of holes on the device from eight to sixteen did not increase the efficacy.

In a third piece of work we aimed to improve and miniaturise the standard Cha-Landolt bait which is composed of the fermenting volatiles: ethanol, acetic acid, acetoin and methionol into a dry formulation removing the need for a liquid killing agent.

All tested formulations were compared to the standard Cha-Landolt lure; ethanol and acetic acid were dispensed from the drowning solution (300 ml) and/or the commercial Biobest "Dros'Attract" solution (300 ml). Dry formulations were dispensed in polyethylene sachets. Release of the four components of the Cha-Landolt blend from polyethylene sachets provides a practical "dry" alternative to the conventional liquid bait, as required for development of devices for control of *D. suzukii* by attract-and-kill and, particularly, lure-and-infect approaches. The standard sachet lure developed originally released ethanol and acetic acid at 1% and 10%, respectively, of the rates from the liquid Cha-Landolt lure and require changing every six weeks rather than weekly.

The attractiveness of the standard sachet lure was not affected by increasing the release rates of ethanol or acetic acid, or by reducing the release rate of ethanol to one quarter. However, the attractiveness of the standard sachet lure can be increased by increasing the release rate of acetoin by four times to approximately 32 mg/d. Further increase in release rate of acetoin did not increase catches significantly.

In most experiments, removing the methionol did not affect catches of *D. suzukii*, but in other experiments  catches were reduced. The requirement for methionol needs further investigation.

In some experiments catches with the optimised sachet lure were at least as great as those with the liquid Cha-Landolt and Dros'Attract lures, but in others they were significantly lower. The reason for this is not fully understood.

A MiniLure has been developed for use in the Falcon tube attract-and-kill devices and shown to be effective under semi-field conditions. This should have a lifetime of at least 6 weeks and probably longer in the confines of the Falcon tube. Although release rates of ethanol, acetic acid and methionol are probably adequate, there is scope to increase attractiveness by increasing the release rate of acetoin from the MiniLure nearer to the optimum level. Longevity can be increased by increasing the loading of the compounds once the release rates have been optimised.

### **Objective 3.** *Develop bait sprays for control of D. suzukii in vitro*

*D. suzukii* phago-stimulatory baits could improve the efficacy of insecticides or minimise the dose of insecticide required. The use of baits is expected to improve *D. suzukii* control efficacy of insecticides with the potential to reduce application rates and improved efficacy of a wider range of insecticide types, leading to reduced risk of fruit residues and resistance. In a series of laboratory assays, we tested commercially available and novel baits for attractiveness to *D. suzukii*, toxicity when combined with a low dose of insecticide and, finally, ability to prevent egg laying.

Results from a jar microcosm bioassay were aligned with chronophysiology (activity counts) methods in comparison to large arena tests. Chronophysiology assays using the activity of *D. suzukii*, in the presence of different baits was, therefore, a more useful screening method of attractant baits than the large arena test.

Attractant baits significantly enhanced the efficacy of Tracer (spinosad) when used at 3.3% of the recommended field rate for protected strawberries. When used in combination with Tracer at the above rate, a suspension of the yeast *Hanseniaspora uvarum* in sugar solution was more effective in killing *D. suzukii* than fermented waste strawberry juice and sugar or Gasser bait. When used with Tracer at 3.3%, fermented strawberry juice and sugar, Gasser liquid or a suspension of *H. uvarum* in sugar solution were all effective in reducing egg laying to a low level. A suspension of *H. uvarum* in sugar solution or fermented strawberry juice and sugar improved the efficacy of Tracer, Hallmark (lambda-cyhalothrin) and Exirel (cyantraniliprole) in terms of *D. suzukii* mortality. Calypso (thiacloprid) was not effective at 50% of the field rate for protected strawberries, either with or without attractant baits. This work shows good promise for the use of feeding stimulant baits to improve the mortality and reduce egg laying of *D. suzukii* in crops.

**Objective 4.** *Investigate prolonging spray intervals for maximum effect but minimal applications*

The aim of the studies in this objective were to determine the length of time that cherry extrafloral resources were available to *D. suzukki* in a cherry orchard and to investigate the length of time that PPPs targeted against *D. suzukii* in spray programmes were active in order to prolong the spray intervals beyond 7-10 days.

For the first aim, each week we picked leaves from \`Penny\` and \`Sweetheart\` orchards at NIAB EMR. The trees were not under polythene and therefore exposed to rain. From 5 April to 14 September, five leaves from each variety were collected and introduced, individually, onto on the floor of a culture cage of *D. suzukii*. The number of *D. suzukii* that landed and fed, the time to find the extrafloral nectaries and the length of feeding time over a five-minute period was recorded.

The first fecund *D. suzukii* was found on 6 April, then a week later more than half (57%) of the female *D. suzukii* in the traps were fecund; this coincided with flowering. As the season progressed the time taken to locate nectaries in the leaves tended to increase, but demonstrated that there was a food source available to *D. suzukii* until after fruit harvest. There was a weak link with less feeding after a period of rain, indicating that nectar and beneficial microbes could possibly have been washed from the surface of the leaves making the extra floral nectaries less attractive to *D. suzukii*.

To investigate spray intervals on cherry, two small trials were established; 1) Commercial trial with two replicate tunnels, 2) Semi-field trial at NIAB EMR in one tunnel. In the commercial trial, all plots were insect meshed but no untreated control was used. In the semi-field trial no insect mesh was installed and an untreated control was included.

Either a weekly or fortnightly commercially approved spray programme was employed at both sites. At the commercial site, 50 fruits were collected weekly. At the semi-field site leaves were collected weekly, just before the next spray was applied and a laboratory bioassay done to test the mortality of *D. suzukii* that came into contact with the leaves. In the commercial trial on fruit, there were two replicates of two cherry fruit varieties (Kordia and Regina) and in the semi-field trial there were four replicates of five leaves. Fruits collected from the commercial trial were incubated to record emerging *D. suzukii*. Monitoring traps were in place at both sites on the perimeter and inside the crop.

At the commercial site, the numbers of adult *D. suzukii* captured inside the insecticide treated tunnels (peak number, 11), inside the mesh, was lower than in the perimeter (peak 70), outside the insect mesh. Only two female *D. suzukii* were found in all of the fruits sampled throughout the growing season; one from the weekly and one from the fortnightly spray programme.

In the semi-field leaf bioassay the mortality in the untreated control plots was usually less than 10%. There was significantly more *D. suzukii* mortality in the weekly and fortnightly spray programmes compared to the untreated control, but no difference between the two spray programmes until the spray applications ceased. Following the cessation of sprays, the effects of the insecticides declined over time (7-28 August). Hence, in this study, either weekly or fortnightly applications of insecticides to cherry leaves gave significantly higher mortality (~90%) compared to untreated leaves (up to 10%) 48 hours after exposure.

### **Objective 5.** *Integrating exclusion netting with other successful controls*

Work on this objective will begin in 2019.

### **Objective 6.** *Develop, design and communicate a year round strategy for UK crops for D. suzukii control*

In collaboration with the AHDB communications team we are producing recommendations for year round control of *D. suzukii* that targets all life stages and habitats to reduce year on year populations, damage to fruit and the use of plant protection products used for control. In 2017, over 14 presentations and courses were delivered in 2017 by the entomology team in both Scotland and England. National Monitoring data was regularly communicated to the AHDB and SWD Working Group for dissemination to growers.

## Financial benefits

In 2014, there were 9,440 hectares of soft fruit grown in the UK, producing 143,000 tonnes worth a total of £393 million. There were 752 hectares of plums producing 11,700 tonnes worth £27.5 million 600 hectares of cherries, producing 4,500 tonnes of fruit worth a value of £22.5 million (Sources: Defra Horticulture Statistics and British Summer Fruits).

SWD is capable of causing total crop loss in cherry crops and potentially up to 75% crop loss in other soft fruit and plum crops, so is seen as an existential threat to the industry.

All new management and control methods developed by research work such as that being funded in this project will therefore protect against losses of the magnitude listed above.

## Action points for growers

- Use a range of control measures to control SWD on affected fruits.
- Prevent migration of SWD into the crop in the spring by using insect mesh and maintain the barrier.
- Protect fruits with applications of approved products. Consult your BASIS qualified agronomist for the latest approvals.
- Good spray coverage is essential to gain effective control.
- Preliminary data shows that fortnightly sprays in protected and insect meshed cherry give comparable efficacy to weekly sprays.
- Continue to monitor for adult SWD inside the mesh and outside the mesh to ensure spray programmes are effective.
- Make regular inspections of fruits using flotation testing in the lead up to and during harvest to ensure populations are not developing in fruit.
- Consult past reports (SF 145) for guidance on crop hygiene and product efficacy.