



Grower Summary

SF/TF 145a

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

Annual 2020

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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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Report: Annual report, Year 3, March 2020

Previous report: Annual report, Year 2, March 2019

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Key collaborators Berry Gardens Growers and Angus Soft Fruits

Location of project: NIAB EMR

Industry Representative: Marion Regan, Hugh Lowe Farms

Date project commenced: 01 April 2017

Date project completed (or expected completion date): 31 March 2021

GROWER SUMMARY

Introduction

Native to eastern and south-eastern Asia (Walsh et al. 2011), the Asiatic vinegar fly *Drosophila suzukii* Matsumura (spotted wing drosophila - SWD, *D. suzukii*) first invaded the UK in 2012 and immediately became a key pest of soft and stone fruits. Numbers have increased from year to year, causing severe fruit damage and increases in crop management and production costs. The invasion of *D. suzukii* across Europe has strongly disrupted existing and developing integrated pest management (IPM) control strategies, as currently crops are being protected against the pest with programmes of multiple sprays of plant protection products (PPPs) including broad spectrum products. This causes a deterioration of beneficial arthropod populations disrupting their ecological contribution in keeping pests below economic threshold values. In the EU there has also been an ongoing review and phase-out of chemical PPPs since the 1980s (pan-europe.info. 2008), including a recent restriction on neonicotinoid applications (eur-lex.europa.eu. 2013). There is also a continuing trend to reduce the risks and impacts of chemical PPP use and to promote the use of non-chemical alternatives (eur-lex.europa.eu. 2009). Internationally, the need for insecticide-based management programmes to control *D. suzukii* close to harvest has become problematic too, because of inconsistencies among export markets regarding maximum residue limits (MRLs) that are allowed for different insecticides on imported fruit (Haviland et al. 2012).

In Europe and America, 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, by studying its biology and evaluating control methods. This project builds on progress internationally and on the AHDB project SF145, but focuses on practical development and elaboration of new control technologies that can be used by UK growers within the short to medium term.

The specific objectives within this AHDB funded project in 2019 were:

1. Continue to monitor *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 but minimal applications
5. Integrate exclusion netting with other successful controls

6. Integrate approaches for season long control
7. Identification and quantification of *D. suzukii* parasitism in the UK
8. Identification of *Drosophila suzukii* tolerance to plant protection products

This Grower summary reports on the results of each of these objectives in turn.

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

Task 1.1. National Monitoring in England and Scotland (Yrs. 1-4; NIAB, JHI, NRI)

Task 1.2. Modelling of the 7-year National Monitoring dataset (Peter Skelsey JHI)

Headline

- *D. suzukii* numbers at NIAB EMR in 2019, overall, were slightly higher than 2017 and 2018.

Background and expected deliverables

Since the first detection of *D. suzukii* in the UK in 2012, populations of the pest have continued to rise in most regions of England. More frequent reports have been made both nationally and in Ireland. In the West Midlands and East Anglia the numbers are slightly lower than some of the fruit growing regions of England. In contrast to the general UK trend, populations in Scotland have been low since the pest was first detected there in 2014.

In collaboration with Berry Gardens, in 2017 and 2018 scientists at NIAB EMR and the James Hutton Institute monitored the main fruit growing regions by deploying 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 of each crop and one at the edge. 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 lower in the spring (Mar-May) of 2017 compared to 2018 due to the cold weather. However, the overall tally of *D. suzukii* for 2018 was lower than 2017. Variation in inter-annual trap catches appeared to be largely dependent upon temperature. Despite higher than average temperatures recorded in Scotland during the summer months of 2018 the number/activity levels of *D. suzukii* remained low.

Additionally, 2018 data from all three Scottish monitoring groups showed similar trends suggesting that the national monitoring data set is representative of the *D. suzukii* density/activity in Scotland. The density/activity was lower in 2018 than in 2017. The lack of

potential egg laying sites detected may have partially contributed to the reduction in overall catch.

Summary of the project and main conclusions following 2019 monitoring

In 2019, following consultation with the project steering group, monitoring in England was reduced with only 10 traps at NIAB EMR maintained. A warmer spring resulted in higher trap catches in comparison to 2018, and 2019 saw an unprecedented peak in June, which coincided with above average temperatures during this time. In September, the largest peak trap catch occurred (since monitoring began in 2013); during a period of increased temperatures. There continues to be a year on year increase in annual mean trap catch at East Malling, indicating we have not yet reached carrying capacity.

In Scotland, average peak trap catches from the three monitoring traps increased to 130 per trap, surpassing 89 per trap from 2014. The total number of *D. suzukii* caught during peak season, August-November (weeks 33-47), reached a mean of ~120; surpassing peak catches in 2014.

In the 12 m high Rothamsted suction trap network, *D. suzukii* were identified between August and November, which is consistent with previous years. Adults were detected at 12 m from the ground during the main flight/dispersal period which coincides with the emergence of the winter-form adults, a depletion in egg laying resources (fruit) and defoliation of trees (reduced refugia). Trap catches from 2019 will be analysed in spring 2020. NIAB EMR now hosts a suction trap replacing the trap that was removed from Rye. Rothamsted have agreed to share the Scottish suction trap catches from 2014, 2017 and 2019. Results are expected to be reported in the fourth Annual Report.

A predictive model is being developed at the James Hutton Institute using historic trap catch data coupled with environmental information. The model has been successful in predicting percentage cumulative abundance of historic data with 72-99% accuracy. Flight prediction has also been successful with 92% accuracy. This will be further developed in 2020.

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

Financial benefits

Gaining control of spotted wing drosophila does not just require additional crop protection sprays, it also requires good crop management and hygiene, which incurs additional labour costs.

Growers producing susceptible crops incur additional labour to monitor for the presence of the pest using monitoring traps and flotation testing for the presence of SWD larvae in the fruit.

They incur additional labour costs to remove old and damaged fruit from the plantation floor (to stop attracting SWD into the crop). They also incur additional labour costs to pick and remove late ripening fruits, which continue to develop several weeks after the main harvest has been picked.

Some growers employ narrow mesh netting to prevent SWD ingress into the crop to reduce population numbers in and around the developing fruits. This incurs expenditure for the netting and additional labour to erect it.

Typical additional costs incurred for all of this, coupled to the additional sprays required to control the pest are listed in the table below.

	SWD cost per hectare
Strawberries	£4,344
Raspberries	£6,557
Blackberries	£11,074

The continuing programme of research in this and other SWD projects, aim to develop novel and sustainable control methods, which will become available for growers to adopt in the short to medium term to reduce reliance on the use of conventional spray control and reduce the typical costs being incurred in the crops listed above.

Action points for growers

- Continue to monitor adult *D. suzukii* in hedgerow and cropping areas.
- Monitor for fruit damage throughout the cropping period to inform control measures.

Objective 2. Develop and optimise a push-pull system using repellents, and attract and kill strategies

Task 2.1. Analyses of fermentation products from yeasts attractive to *D. suzukii* (NRI and Rory Jones)

Headline

- Work has been initiated to collect and identify volatile compounds from yeast species associated with SWD as a route to discover new attractants for SWD.

Background and expected deliverables

Drosophila species have evolved strong mutualistic associations with yeast communities that best support their growth and survival, and it is reported that flies recognise these yeasts by the rich repertoire of volatile organic compounds produced by the yeasts.

Rory Jones of University of Lincoln is undertaking an AHDB PhD Studentship (CP171) to investigate the attractiveness of a range of yeast species to SWD, including those associated with SWD and exotic species exclusive to Lincoln University. To date, he has tested several species in a laboratory bioassay and field trapping tests. The aim of this work was to identify the chemicals produced and investigate whether there is any correlation between these chemicals and attractiveness to SWD. This work could lead to identification of new attractants for SWD.

Summary of the project and main conclusions

- Compounds produced by five strains of yeast grown on sterile strawberry juice were identified. These results will be correlated with bioassays of attractiveness of the yeasts in laboratory and field bioassays.
- Having established the methodology for collection and analysis of yeast volatiles, the work will be repeated with the same yeast cultures grown on a more neutral medium.
- No obvious new candidate attractants for SWD have been identified, although ethyl acetate, 2-phenylethanol and isoamyl acetate could be re-examined.

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Action points for growers

- This work has not resulted in any direct action points for growers to date.

Task 2.2. Investigating the potential of precision monitoring to reduce fruit damage in the neighbouring crop by reducing numbers of overwintering *Drosophila suzukii*

Headline

- Preliminary findings indicate that 'precision monitoring' in natural habitats reduces overwintering *D. suzukii* populations in woodlands and neighbouring crops.

Background and expected deliverables

In addition to commercially grown fruit, *D. suzukii* utilises wild fruits and habitats where it can find food and a shelter year-round (Grassi et al, 2011). Such habitats provide a source of *D. suzukii* at the beginning (winter form) and throughout the crop growing season (summer form), which migrate into crops. The UK *D. suzukii* national monitoring survey (Objective 1) shows high activity peaks of *D. suzukii* in woodlands during late autumn/early-winter when there is reduced availability of commercial and wild fruit. A trial was established in 2019 to investigate whether the deployment of precision monitoring traps in wild habitats has the potential to reduce *D. suzukii* populations and minimise the impact in crops in the early spring.

Summary of the project and main conclusions

In September 2019, a grid of 64 precision monitoring traps spaced at 8 metre intervals were deployed in isolated pockets of woodlands on six soft fruit farms in the South East of England. These were compared to a second woodland on each farm with no traps (untreated control).

A RIGA monitoring trap was positioned in the centre of each woodland and the respective neighbouring crop. These were checked fortnightly to monitor numbers of *D. suzukii*. In addition, a transect of precision monitoring traps were also checked for *D. suzukii* catches.

So far it is too early to conclude if precision monitoring can prevent invasions of *D. suzukii* into the neighbouring crop. However, six weeks after precision monitoring traps were deployed, numbers of *D. suzukii* in the RIGA monitoring traps in woodlands with precision monitoring and respective neighbouring crops decreased. Numbers of *D. suzukii* in the untreated control equivalents continued to rise (not statistically analysed). Thereafter, *D. suzukii* numbers have remained consistently lower in the precision monitoring trap treated areas.

To determine if precision monitoring can prevent or reduce *D. suzukii* numbers invading the neighbouring crop, in spring 2020, sentinel traps containing raspberries will be deployed in the woodlands and respective neighbouring crops to attract females to lay eggs. *D. suzukii* are being dissected weekly to test for the onset of fecundity. Subsequent numbers of adult *D. suzukii* emerging from these raspberries will be compared.

Habitat assessments around each of the precision monitoring traps are underway to identify why some traps consistently capture more flies than other traps. This will help to identify optimum locations for future trapping and inform growers on optimum trap positioning. To date there is some evidence that traps positioned on the woodland perimeter catch more *D. suzukii*. However, a more thorough investigation is required later in the season to determine the best place to concentrate traps. Aspect may also be playing an important role.

This trial will continue into 2021, to see if long-term placement of these traps can suppress local *D. suzukii* populations over time.

Financial benefits

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Action points for growers

- This work has not resulted in any direct action points for growers to date.

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

Headline

- Weekly applications of Benevia at 30 ml in 40L per ha, combined with *H. uvarum* or Combi-protec baits, were as effective in controlling *D. suzukii* numbers as two sprays of Benevia at 750 ml in 500L per ha (i.e. a reduction in Benevia application of more than 91% with the same *D. suzukii* control effect).

Background and expected deliverables

D. suzukii phagostimulatory 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 improve efficacy of a wider range of control product types, leading to reduced risk of pesticide residues and resistance occurring. In a series of laboratory assays we tested commercially available and novel baits for their attractiveness to *D. suzukii*, their toxicity when combined with a low dose of insecticide, and finally, their ability to prevent egg laying.

In 2018, the baits included were; fermented strawberry juice (FSJ), a suspension of the yeast *Hanseniaspora uvarum*, a combination of the two and Combi-protec, a proprietary mixture of protein, yeast and sugars. Experiments were done in the laboratory in jar microcosm bioassays. Chronophysiology assays (activity counts) using the activity of *D. suzukii*, in the presence of different baits was the more useful screening method of attractant baits than the large arena test.

Without insecticides, the baits did not affect *D. suzukii* mortality. With spinosad (Tracer), cyantraniliprole (Exirel) and lambda-cyhalothrin (Hallmark), the baits caused higher mortality of *D. suzukii* summer morphs, under summer conditions, compared with using the insecticides in water. The efficacy of insecticides, in terms of increased mortality and reduced egg laying, was greater with *H. uvarum*, FSJ + *H. uvarum* and Combi-protec treatments than with FSJ only bait. In addition, *H. uvarum* and FSJ baits increased the mortality of *D. suzukii* winter morphs held under winter conditions when used with spinosad or cyantraniliprole but not with lambda-cyhalothrin. When used with cyantraniliprole, *H. uvarum* reduced the egg laying of winter morphs that were transferred to summer conditions after three days of exposure to treatments under winter conditions.

Phytotoxicity on cherry and strawberry leaves in the field was observed in treatments including cyantraniliprole, both with and without baits, but was not seen in any other insecticide and/or bait combinations.

Phagostimulant baits improved the insecticidal control of *D. suzukii* summer and winter morphs by increasing mortality and reducing oviposition. The relative phagostimulant effect of the baits did not fully correspond with their olfactory attractiveness to *D. suzukii* determined using the chronophysiology equipment.

With insecticide treatments, *D. suzukii* mortality was lower using raspberry leaves than using blackberry, blueberry, cherry or strawberry leaves but the effect of leaf type on *D. suzukii* mortality was small (up to 12% difference) compared with the effects of baits and insecticides (up to 90% difference).

Summary of the project in 2019 and main conclusions

In 2019, baits were tested in mini tunnels containing strawberry plants in grow bags. Bands of Benevia combined with either *H. uvarum* or Combi-protec were applied as 30 ml per hectare in 40 L, twice during the experiment to the crown of the strawberry plants. This was compared to a water control (untreated) and a positive control (Benevia at maximum field rate). Male and female *D. suzukii* were released into the tunnels on several occasions to inoculate the fruit. Both baits, in combination with Benevia, significantly reduced *D. suzukii* in fruit compared to the water control. There was no significant difference between the positive control, Benevia at full field rate (750 ml in 500L/ha) and the two baits combined with Benevia (30 ml in 40L/ha). The cost of Benevia applied in the bait treatments amounted to £77.50/ha, a reduction from the full rate of £112.50/ha. Application time was reduced by 75% in the bait combined with Benevia treatments compared to Benevia alone.

In 2020 Combi-protec will be tested for efficacy on raspberry in mini tunnels at NIAB EMR.

Financial benefits

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Action points for growers

- At the time of writing, Combi-protec was an approved adjuvant for use with *D. suzukii* control plant protection products.
- Growers should consider using Combi-protec to enhance *D. suzukii* control in strawberry.

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

Task 4.2. Investigate the impact of different spray methods on cherry.

Headline

- Good spray coverage on cherry crops at two farms ensured minimum fruit damage from *D. suzukii* on a fortnightly spray programme.

Background and expected deliverables

In 2018 field trials were carried out to test the effects of increasing spray intervals for control of *D. suzukii* at two cherry farms in East Kent (see details outlined under Task 4.3 below). Fortnightly spray programmes gave equal efficacy of *D. suzukii* control to the grower's standard spray programme. In addition, very few fruits were damaged by *D. suzukii* egg laying in both spray programmes, even though adults were clearly in the crop and around the perimeter. Where insect excluding mesh was employed there were fewer *D. suzukii* adults in the crop.

The trials in 2018 recorded effects on insect populations, fruit damage and length of time of effectiveness of the spraying, but did not measure spray deposition.

Summary of the project in 2019 and main conclusions

In June 2019, the farms were re-visited, and the same tunnels were sprayed in the same way as in 2018. The spray deposition was measured using the handheld imaging fluorometer (developed in an IUK project) to quantify spray coverage and fluorescence intensity (a proxy for spray liquid volume on the leaf surface). The two farms had different spray application methods, using different spray machines, water volumes, and forward speeds. Using high water volumes generally provided much greater spray coverage on the target but was slower and more costly to spray. Using higher forward speeds can make navigating the orchard rows more challenging but may also improve deposition into the canopy by reducing the volume of air per tree. With a faster forward speed, the droplets' perpendicular momentum is reduced and they are more likely to deposit into the canopy rather than be pushed through and out the other side.

Although these trials were relatively small assessments of spray deposition, the results indicate that both farms achieved a good level of spray deposition overall. However, at Farm 1 there was very little spray deposition at the 'inner' canopy area, and the spray plume was seen to spray over the tops of the trees. Farm 2 had quite low spray coverage (due to the lower water application volume used), but still managed a good level of spray deposition

(measured by fluorescence intensity). The faster forward speed and better targeted spray plume at Farm 2 are likely resulting in improved spray deposition.

The 2-row beds used at Farm 2 may result in very low spray deposition on the leeward side of the trees. This area was not assessed in these trials due to time constraints.

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Action points for growers

- Spray intervals under protected cherry can be extended to two weeks from white fruit stage in combination with insect exclusion mesh and rigorous crop hygiene.

- Good spray coverage is essential to protect the fruit. Thorough coverage allows SWD to pick up the product and achieve further control.
- Continue to monitor adult SWD both inside and outside the mesh to ensure spray programmes are effective.
- Make regular inspections of fruits to ensure populations are not building inside the crops.

Task 4.3. Investigate the consequence of extending the spray interval from 1 to 2 weeks in raspberry

Headline

- Unlike cherry, a fortnightly spray programme in raspberry was not as successful at controlling *D. suzukii* as weekly applications of plant protection products.

Background and expected deliverables

The aims of this objective were to determine the length of time that cherry extrafloral resources were available to *D. suzukii* 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.

In 2017 we picked leaves weekly from the cherry varieties 'Penny' and 'Sweetheart' and developed laboratory trials to observe behaviour. 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. 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 appeared to be less feeding after a period of rain, indicating that potentially nectar and beneficial microbes could have been washed from the surface of the leaves making the extra floral nectaries less attractive to *D. suzukii*.

In the early years of the project, it was found that fortnightly sprays of effective rotated plant protection products (PPPs) on protected cherry were very successful at controlling *D. suzukii* in cherry fruit. Two small cherry trials were established in 2017; 1) Commercial trial on emergence of *D. suzukii* from fruit from netted tunnels, 2) Semi-field trial at NIAB EMR on mortality of adult *D. suzukii* in contact with residues. Either a weekly or fortnightly commercially approved spray programme was employed at both sites. 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 11), was lower than outside

the insect exclusion mesh (peak 70). Only 2 female *D. suzukii* emerged from fruits throughout the growing season; 1 from the weekly and 1 from the fortnightly spray programme.

In the semi-field leaf bioassay there was significantly higher *D. suzukii* mortality in the weekly and fortnightly spray programmes compared to the untreated control, but no difference between the two spray programmes while applications were made. Following the cessation of sprays, the effects of the insecticides declined over time (7-28 Aug).

In 2018, field trials were carried out to test the effects of increasing spray intervals for control of *D. suzukii* at two commercial farms in East Kent. Fortnightly spray programmes gave equal efficacy of *D. suzukii* control to the grower's standard spray programme on cherry. In addition, very few fruits were damaged by *D. suzukii* egg laying in both spray programmes even though adults were clearly in the crop and around the perimeter. Where insect excluding mesh was employed there were fewer *D. suzukii* adults in the crop.

Also in 2018 we began to pilot test extending the spray interval from one to two weeks in raspberry, but only on two primocane raspberry crops. This was expanded to eight raspberry crops in 2019.

Summary of the project and main conclusions

In 2019, trials investigated whether extending spray intervals on protected raspberry could adequately control *D. suzukii* damage to fruit. The trial employed fortnightly spray intervals in comparison to weekly spray intervals. The incidence of *D. suzukii* in fruit, adult mortality in contact with leaves and adult presence in the crop were assessed.

Fortnightly spray intervals were not as effective at protecting fruit from *D. suzukii* as a weekly programme. Hence, the fortnightly programme was not as successful in raspberry as it was for cherry production. In addition, the fortnightly sprayed plots were located on the edge of the fields and under higher pressure of *D. suzukii* immigration from wild host habitats, particularly later in the trial when fruit was fading.

Main conclusions

- Unlike cherry, a fortnightly spray programme in raspberry was not as successful at controlling *D. suzukii* as weekly applications of plant protection products.
- A fortnightly spray programme on raspberry for *D. suzukii* control was more challenging, partly because the fortnightly sprays were applied to the perimeter of the crop where the *D. suzukii* pressure is greatest.
- However, the weekly spray programme on raspberry was more effective at reducing numbers of *D. suzukii* in fruit and resulted in higher mortality of adults that were

exposed to treated leaves compared to a fortnightly spray programme.

Financial benefits

Gaining control of spotted wing drosophila does not just require additional crop protection sprays, it also requires good crop management and hygiene, which incurs additional labour costs.

Growers producing susceptible crops incur additional labour to monitor for the presence of the pest using monitoring traps and flotation testing for the presence of SWD larvae in the fruit. They incur additional labour costs to remove old and damaged fruit from the plantation floor (to stop attracting SWD into the crop). They also incur additional labour costs to pick and remove late ripening fruits, which continue to develop several weeks after the main harvest has been picked.

Some growers employ narrow mesh netting to prevent SWD ingress into the crop to reduce population numbers in and around the developing fruits. This incurs expenditure for the netting and additional labour to erect it.

Typical additional costs incurred for all of this, coupled to the additional sprays required to control the pest are listed in the table below.

	SWD cost per hectare
Strawberries	£4,344
Raspberries	£6,557
Blackberries	£11,074

The continuing programme of research in this and other SWD projects, aim to develop novel and sustainable control methods, which will become available for growers to adopt in the short to medium term to reduce reliance on the use of conventional spray control and reduce the typical costs being incurred in the crops listed above.

Action points for growers

- *D. suzukii* control on raspberry is challenging and research will now focus on raspberry.
- Until then, monitoring adults and fruit damage is key to tracking the progress of current control methods.
- Good spray coverage is essential to protect the fruit but also leave a residue for contact of adult flies on the foliage.

- Crop hygiene and insect mesh are critical to prevent build-up of numbers inside the crop and migration of new *D. suzukii* into crops.
- Precision monitoring in hedgerows around the perimeter may also reduce numbers entering the crop.
- It is essential to rotate modes of action of plant protection products to prevent insect resistance developing to these products.
- It is also vital to make sure that spray drift does not contact hedgerows and woodlands therefore preserving natural enemies of *D. suzukii* (parasitic wasps and a range of generalist predators).

Objective 5. Integrating exclusion netting with other successful controls

A decision was made to defer work under this objective until a later year, as a new Waitrose CTP PhD student will be working on this in collaboration with BerryWorld, the University of Reading and NIAB EMR from 2019.

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

Headline

- AHDB and the scientists leading this project at NIAB EMR and the James Hutton Institute promoted the results of this project and a year-round strategy through five peer reviewed publications and contributions to 16 industry and scientific communication events over the past year.

Background and expected deliverables

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. Results have been disseminated through publications and events. Over 14 presentations and courses were delivered in 2017, and 10 in 2018.

Summary of the project and main conclusions

In 2019, five peer reviewed manuscripts were published and 16 industry/scientific communications/presentations were given. This does not include all of the one-to-one discussions on *D. suzukii* control with individual agronomists and growers.

NIAB EMR monitoring data was regularly communicated to the AHDB and SWD Working Group, for dissemination to growers.

Financial benefits

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Action points for growers

- Keep abreast of the latest *D. suzukii* control strategies and research through AHDB communications.

Objective 7. Identification and quantification of *D. suzukii* parasitism in the UK

Headlines

- In Scotland, using sentinel *Drosophila melanogaster* larvae and pupae, potential *D. suzukii* parasitoid activity has begun to be identified.
- In England, attempts to identify the percentage parasitism in the wild has been thwarted by technical issues and squirrels! Methodology has been improved and data collected in 2019.

Background and expected deliverables

A Worshipful Company of Fruiterers funded project linked to SF/TF 145a, aimed to identify species of parasitic wasps parasitizing *D. suzukii* in the South East of England. Field surveys also aimed to monitor for the presence of the SWD parasitoid *Trichopria drosophilae*, and to investigate potential interactions of *D. suzukii* with native UK parasitoid species that may contribute to *D. suzukii* control. Field surveys were conducted across several fruit growing and wild sites in the South East of England in two consecutive years (2017 and 2018).

Five species of hymenopteran parasitoids were collected using *D. suzukii* larvae/pupae sentinel traps. Two species of larval parasitoids and three pupal parasitoids were recorded in 2018. All five species are generalist parasitoids of *Drosophila*. Habitat surveys highlighted how landscape diversity could influence parasitoid presence.

Summary of the project and main conclusions

In 2019, parasitoid surveys were conducted in Scotland using *D. melanogaster* baited traps from the end of July. From the numbers of parasitoids emerging from baited traps it indicates that parasitoid populations were already established prior to the deployment of traps. Due to staff shortages at NHM, species have not yet been identified, although it appears that there are two distinct morphotypes.

To determine the percentage of parasitism in the field, known numbers of *D. suzukii* larvae were deployed in areas with known parasitoid populations, as identified in 2018. Only one *D. suzukii* parasitoid was identified in 2019. It is likely that changes in trapping method reduced the numbers of parasitoids observed in 2019 compared to previous years.

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Action points for growers

- Ensure that spray drift does not contact hedgerows and woodlands to preserve parasitic wasps of *D. suzukii* and a range of other generalist predators.
- Continue to use crop hygiene measures and insect exclusion mesh to reduce the need for plant protection products.

Objective 8. Identification of *Drosophila suzukii* tolerance to plant protection products

Headline

- Variation in susceptibility level to three commonly used plant protection products between wild populations of *D. suzukii* was identified in comparison to an isolated laboratory culture.
- Baseline susceptibility from 2019 will be used as a comparison for future assessments to monitor resistance development.

Background and expected deliverables

Since its arrival in the UK in 2012, the use of plant protection products has played a vital role in suppressing *D. suzukii* numbers in vulnerable fruit crops. In 2018, an increased tolerance to spinosad was detected in Californian organic raspberries by Gress and Zalom (2018). Flies from spinosad treated areas required 4.3-7.7 times higher dose of spinosad for control than those from untreated areas. In 2019, laboratory trials were established to identify a baseline level of susceptibility in wild populations of *D. suzukii*.

Summary of the project and main conclusions

Three wild populations were collected from soft and stone fruit farms in the South East of England and mass reared in the laboratory. They were established from crops with a known insecticidal input and included two commercial crops and one with minimal inputs. These were compared to an unsprayed laboratory strain, which has been in culture since 2013 and is expected to have a very low tolerance to plant protection products (PPP). Between the three wild populations, there were varying levels of susceptibility to three tested PPPs; lambda-cyhalothrin (Hallmark), cyantraniliprole (Exirel) and spinosad (Tracer). Although there does not currently seem to be resistance in the populations we tested, there was an increased level of tolerance in some of the populations to one or more of the insecticide products tested. Annual baseline testing should be employed to monitor tolerance levels over seasons so that spray programmes can be adjusted in response.

Financial benefits

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Action points for growers

- Employ as many non-PPP *D. suzukii* controls (precision monitoring, mesh, crop hygiene, proper waste fruit disposal) as feasible, to reduce reliance on sprays and reduce the incidence of resistance.
- When applying plant protection products, ensure that there is good coverage, and that equipment is calibrated and set up correctly, ensuring the protection of the surrounding environment.
- Rotate modes of actions of products to avoid resistance in the future.
- Consult your BASIS qualified agronomist for the latest approvals.