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

Final 2017

Disclaimer

While the Agriculture and Horticulture Development Board seeks to ensure that the information contained within this document is accurate at the time of printing, no warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.

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 AHDB Horticulture office (hort.info.@ahdb.org.uk), quoting your AHDB Horticulture number, alternatively contact AHDB Horticulture at the address below.

AHDB Horticulture,
AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

Tel – 0247 669 2051

AHDB Horticulture is a Division of the Agriculture and Horticulture Development Board.

GROWER SUMMARY

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

Headline

- Through this project a greater understanding of the biology and control of SWD in the UK has been achieved with findings directly relevant to UK soft fruit, stone fruit and vine growers.

Background and expected deliverables

Spotted wing drosophila (*Drosophila suzukii*, SWD) is a new invasive pest and was first identified in the UK in 2012. This pest which is of Asian origin, has caused considerable losses in fruit crops in mainland Europe and the USA. The overall aim of this project was to monitor the spread of *D. suzukii* within the UK, and to develop measures for its control. To this end, five objectives were set to;

1. 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. 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. Develop and evaluate sampling and extraction methods for quantifying *D. suzukii* infestations in different soft and stone fruits
4. Develop a synthetic lure and attract and kill technology for *D. suzukii* for incorporation into IPM programmes.
5. Obtain evidence for the effectiveness of different plant protection products including biopesticides to aid developing an insecticide resistance management strategy for *D. suzukii*.

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 range of wild hosts and overwintering sites.

Task 1.1. Determine the population dynamics of adult SWD in vulnerable polytunnel and outdoor grown fruit crops at 13 sites in the different fruit growing regions of England and Scotland throughout the year for four successive years

In 2013, 130 modified biobest traps with Cha-Landolt synthetic bait were deployed at 14 sites in wild and cropping areas across five regions of the UK (Kent, Surrey, West Midlands, East England and Scotland) and monitored from 20 May 2013 onwards. The first *D. suzukii* adult was captured and identified at NIAB EMR in August 2013. Since then adult *D. suzukii* trap catches have increased year on year, with the following peaks in mean adult *D. suzukii* trap catches of ~5, ~163, ~885 and 530 in 2013, 2014, 2015 and 2016 respectively. A pattern in adult *D. suzukii* trap catches has been observed each year with very low numbers caught from March through to July, before increasing rapidly from early August onwards. Counts of *D. suzukii* trap catches comparing wild and cropping areas has also been recorded. *D. suzukii* trap catches consistently remained low throughout the beginning of the fruiting season. Then from late July onwards trap catches in fruit cropping areas started to increase and often reached a peak in October before decreasing at which point *D. suzukii* trap catches in woodland areas increased rapidly.

In 2016, the national monitoring of adult *D. suzukii* numbers was continued at a network of 15 sites across the UK: 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. A further site was added in Yorkshire in 2016.

Catches of *D. suzukii* going into January 2016 increased two fold (~530 *D. suzukii* per trap) from the previous season (~200 *D. suzukii* per trap) in wild areas. This may have been aided by the warm November and December in 2015 potentially increasing the activity of the adult flies. As in 2014 and 2015, catches of adult *D. suzukii* in the traps were very low in England until late July. It was anticipated, given the high overwintering population and geographical spread in 2015, that numbers in the spring and summer of 2016 might be very high. However, the low catches might be explained by the trap lures competing with commercial and wild fruits during the summer and so they are probably not representative of 'real' in-field populations. Catches of *D. suzukii* adults continued at low levels, similar to 2015, until early August, at which point catches increased rapidly.

D. suzukii numbers in Scotland remained low – typically less than a peak of 20 per trap, and no adults were captured until April, with only one individual up to August at the four sites. Fruit damage has been reported in all regions, thus far, with the exception of Scotland.

Task 1.2. Estimation of fecundity of D. suzukii throughout the year

Following studies in 2014 and 2015, the fecundity of adult female *D. suzukii* at two farms in Kent was assessed at the start and end of the growing season in 2016. Mature eggs were detected from 18 April at both sites. Overall, the period of fertility was similar to 2015, with a later start in the season compared to 2014, in which the first mature eggs were detected in March.

Farm 2 appeared to have a longer period of fecundity than Farm 1, as found in the previous two years. Mature eggs were still detected in the last recorded samples (24 October) whilst mature eggs were not detected at Farm 1 after 10 October. The two farms are geographically close (~ 5 km apart), and so this difference is unlikely to be climatic. However, the polytunnels at Farm 2 remained in place longer than Farm 1, which may explain the slightly longer period of fecundity.

Task 1.3. Determine the phenology, population dynamics and spatial distributions of SWD on two fruit farms in SE England, throughout the year for four successive years (EMR; 1-4)

More intensive monitoring was undertaken on two farms using the same design of traps as the national monitoring scheme continued through 2016. The trap catch pattern was similar to that nationally with a large increase in adult catches in woodland in the autumn and early winter. As in 2015 it was noticeable that catches also increased in the cherry orchard in early autumn, presumably as it resembled woodland in terms of shelter. A similar pattern was found in the plum orchard, although in both cases catches fell after leaf fall.

The ratio of males to females in 2016 for both farms was 1.15 male to female, comparable to the ratio of 1.13 and 1.14 found in 2014 and 2015. A similar pattern to 2015 was found throughout the year, with higher female numbers at the start of the year reflecting the overwintering population and then a peak of males in late March/ early April before higher female numbers in the early summer and more males thereafter.

Task 1.4. Determine the attractiveness of cherry and plum extrafloral nectaries to D. suzukii

The attractiveness of extrafloral nectaries on leaves of cherry and plum was assessed. *D. suzukii* adults were attracted to the nectaries and were observed feeding on the nectar in the laboratory. *D. suzukii* fed on cherry extrafloral nectaries for longer than plum, possibly reflecting their higher nectar content. This information has commercial significance as it may account for the early activity of *D. suzukii* in cherry orchards, before fruit is ripening.

Task 1.5. Assessment of the susceptibility of six of the main blackcurrant varieties grown in the UK to Drosophila suzukii (SWD) and the potential future risk to the crop

Six UK-grown blackcurrant varieties (Ben Gairn, Ben Vane, Ben Starav, Ben Hope, Ben Klibreck and Ben Tirran) were tested for vulnerability to *D. suzukii.* A comparison was made between harvested fruit, which was either incubated to assess natural infestation in the field in relation to trap catches or inoculated with a laboratory culture of *D. suzukii*.

D. suzukii naturally emerged from three of the varieties; Ben Vane, Ben Hope and Ben Tirran. The plantations of Ben Hope and Ben Tirran had significantly higher natural emergence of adult *D. suzukii* than the other varieties. There was also a significantly higher *D. suzukii* trap catch (field pressure) at the site growing Ben Tirran compared to all other varieties.

In the laboratory, *D. suzukii* was able to lay eggs and develop in all varieties. However, Ben Hope and Ben Tirran were significantly more vulnerable to egg laying and adult emergence.

D. suzukii was present at all sites tested and could potentially lay eggs and develop into adults in all varieties screened. Preliminary data suggests that skin strength and thickness at time of harvest may be important but this needs to be confirmed.

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.

This objective was completed in year 3 of the project with an accompanying AHDB factsheet (19/16 *Disposing of fruit waste affected by spotted wing drosophila*). Treatment in anaerobically sealed pallet 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, 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 in 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 between fruits.

Mixing treated waste with at least 90% (w/w) organic matter such as manure or slurry was shown to prevent re-inoculation, as was incorporation in the surface of field soils 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 considered less attractive due to the high moisture content and low calorific value of fruit wastes, while transport and gate fee costs were high.

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

This objective was completed in year 3 of the project with an accompanying AHDB wallchart and training DVD (both available on the dedicated SWD pages of the AHDB Horticulture website).

The researchers assessed low cost methods of detecting all stages of *D. suzukii* larvae in ripe and ripening fruit (blueberries, cherries, raspberries, blackberries and strawberries). The fruits were immersed in solutions of strong sugar (180 g per l water), salt (75 g per l water) or a weak detergent. Freezing whole fruit overnight was also assessed. These methods were compared to both emergence testing (keeping fruits in boxes at room temperature for 3 weeks and counting adult emergence) and dissecting the fruits to directly count the numbers of larvae.

Immersion in sugar and salt solutions were 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.

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

Task 4.2. Develop target device and identify suitable insecticide(s) for attract and kill formulation (EMR, NRI, yrs 2-3)

A non-saturating attract and kill (A&K) device was further developed with field and laboratory tests to optimise efficacy. Decis (deltamethrin) was confirmed as effective in the field over a season. Initial comparisons of two prototype A&K devices with a commercial alternative found lower catches of *D. suzukii* but improvements in design and orientation of clear and red areas improved relative efficacy. The numbers of entrance/exit holes influenced the kill of *D. suzukii*. Now these advances have been made, future tests should estimate the efficacy of the device when the insects are allowed to enter and leave the device or die by dropping from the open bottom of the device.

Task 4.3. The evaluation of pheromone components of Cha-Landolt baits for the efficiency of trapping D. suzukii

In previous work, open vial dispensers for acetoin and methionol could be replaced by sealed polyethylene sachets without loss of attractiveness. However, lures with the ethanol and acetic acid also dispensed from polyethylene sachets were generally not as attractive as the Cha-Landolt lure. Adjusting the release rate of ethanol did not appear to improve the trap catch of *D. suzukii*. Preparation and maintenance of large numbers of the Cha-Landolt lures is inconvenienced by difficulties associated with producing acetic acid, ethanol and methionol sachets.

A series of experiments were done in 2016 that aimed to optimise the release rate, ratio and component compounds used, to produce a convenient lure combination with a high *D. suzukii* catch and low by-catch.

Adult *D. suzukii* trap catch was significantly higher from traps where acetic acid and ethanol was released from the drowning solution. Varying the release rate of acetic acid or ethanol over an 8 fold range in the sachets did not improve catches of *D. suzukii*. However, through doubling the number of sachets thus, the release of acetic acid and acetoin components to 36 mg/d and 16mg/ day, respectively, it was possible to double the number of adult *D. suzukii* caught in the traps. Replacing ethanol with 3-Methyl-1-butanol did not increase the *D. suzukii* trap catch.

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*.

Task 5.1. Addition of bait attractants to increase insecticide efficacy for control of D. suzukii

Novel and commercial baits were tested for strength of attractiveness to *D. suzukii* adults in a range of laboratory tests. The relative *D. suzukii* attractiveness of different substances differed between laboratory methods and duration. A 30-60 minute Petri droplet test showed that sugar + yeast suspensions were the most attractive substances whereas Gasser at 5 to 100% was relatively unattractive; however, the reverse trend occurred in a 12-hour choice test in a large arena. Solutions of molasses at 5-50% were moderately attractive in both systems and the most attractive substance in a 3-day chronophysiology apparatus test. A species of yeast found in the gut of *D. suzukii* (*Hanseniaspora uvarum*) was more attractive to *D. suzukii* than bakers' yeast (*Saccharomyces cerevisiae*) when used with the same concentration of sugar and at an equivalent yeast cell concentration. Further work is needed to optimise sugar + yeast suspensions, to test the relative attractiveness of the above substances in the field and their effect on *D. suzukii* control with pesticides.

Task 5.2. Determine compounds that repel D. suzukii and prevent egg laying

In small scale field trials five compounds placed close to fruit in delta traps in a *D. suzukii* infested cherry orchard prevented *D. suzukii* laying eggs in fruits compared to an untreated control. These compounds are worthy of further investigation. Repellent compounds as large point sources (sachets) in trees did not deter egg laying in fruits. However, it should be noted that the latter trial was done in the autumn when populations of *D. suzukii* were high and did not have alternative feeding or egg laying resources in the orchard – hence pest pressure would have been high. Further studies should investigate the early use of repellents, in the spring, before *D. suzukii* migrates from wild habitats and the use of smaller, higher numbers of point sources.

Financial benefits

D. suzukii poses a clear threat to the fruit industry and has had a commercial impact on UK grown fruit since 2014. The impact not only includes damage to fruits and the cost of quality and control, but increased labour due to removing unmarketable fruits from the crop and then handling and treating the waste material. Growers have reported significant financial losses in

cherry and soft fruit crops. The soft fruit growing sector is increasing by 10-15% p.a. with increases in cherry and blueberry production in Scotland.

Action points for growers

- Use a recommended trap and bait to monitor adults in susceptible crops and wild areas year round. This will help to establish the pest pressure from year to year.
- Monitor for larval infestation in the crop. The flotation technique using sugar solution is recommended for rapid detection of larvae and dissecting and inspecting fruits in the crop whilst crop walking.
- Consider winter trapping and deploy perimeter trapping around vulnerable crops before fruit begins to ripen to potentially delay the movement of *D. suzukii* into the crop.
- Use barriers to help prevent ingress of the pest from wild areas to crops. Netting of ~0.9 mm gauge is recommended. Complete netting gives best control but monitoring should still take place within the netted area.
- Ensure that other pests are well controlled using biological methods from early in the season, before sprays need to be targeted against *D. suzukii*.
- Estimate the risk to crops on the farm by assessing vulnerability of each crop and adjacent sources of *D. suzukii*.
- Keep humidity to a minimum, with good control of irrigation, where possible as *D. suzukii* prefers high humidity.
- Ensure that fruit picking staff are well trained and understand the impact of the pest and the need to remove all fruit from the crop.
- Consider crop canopy management to reduce humidity and ensure that fruits in the centre and lower down in the canopy are not missed during picking.
- Remove all damaged and unmarketable fruit from the crop every 2-3 days where possible in soft fruit. Remove waste fruit from cherry crops.
- Crop hygiene is one of the best measures of population control and should be maintained by waste fruit being treated to eliminate SWD by containing it in sealed vessels and then disposing of it responsibly.
- Ensure saleable fruit is cold stored to prevent further development of *D. suzukii*.
- Consult BASIS trained advisers for the latest approvals for effective plant protection products and contact the AHDB for further advice.
- Control damage by *D. suzukii* by employing year round multiple control strategies which consider all developmental stages of the pest – Integrated Pest Management.