FACTSHEET 06/17

Cross Sector

Project SF 145
Scott Raffle, AHDB and Michelle Fountain, NIAB EMR

Management and control of spotted wing drosophila

This factsheet outlines the threat posed by the spotted wing drosophila (SWD – Figure 1) to the soft and stone fruit industries in the UK and offers guidance to growers on how best to monitor, manage and control it.

Figure 1. Adult male spotted wing drosophila

Figure 2. Monitor for SWD adults from March using Drosotraps

Action points

- Start monitoring regularly from March using Drosotraps (Figure 2), particularly in woodland and hedgerows. The denser the wild habitat, the more likely it is that SWD will have survived there over the winter. The trap contents should be monitored weekly and the bait replaced on each occasion.
- Consider the use of smaller disposable traps for precision monitoring around crops early in the season to delay the movement of SWD adults into the crop. For maximum efficacy, change these every four weeks.
- In cherry and other stone fruit crops, two Drosotraps per hectare should also be positioned within the crop about 10 metres inside the perimeter from early leaf stage when floral nectaries are known to attract SWD into the orchard. Checking the numbers of SWD caught in the traps will help to monitor for their presence and gain an understanding of how well control tactics are working.
- For soft fruit crops, the two traps per hectare should be erected at the stage when fruits start to swell.
- As the fruit begins to ripen, all growers should use the flotation test every week to check for presence of larvae in developing fruits.
- As soon as picking commences, the test should be carried out at every pick on a representative sample of fruits.
- From early fruit ripening, if SWD populations are present in the crop, use recommended control products ensuring that harvest intervals are met and products/chemistry is rotated. Be mindful of the maximum number of applications permitted for a product and do not exhaust these before populations of the pest reaches a peak.
- Always be guided by a BASIS qualified advisor before applying crop protection products.
- During harvest, maintain strict hygiene measures ensuring the removal of every fruit from the crop, including all damaged, diseased or overripe fruits and any that have dropped to the ground.
- All wasted fruit and any affected by SWD should be completely enclosed for at least 48 hours at 14°C in a sealed plastic pallet bin to kill larvae. Longer times may be necessary at lower temperatures.
- The fruit waste is still likely to be attractive to SWD adults, so it should be spread and incorporated into the soil.

Background

The spotted wing drosophila (*Drosophila suzukii*) is a fruit fly which originated in Japan and has spread across the world, first to the USA, then mainland Europe, before first being detected in the United Kingdom in 2012 at NIAB EMR in Kent. It is an invasive pest of soft and stone fruit crops and if left uncontrolled, can result in complete crop loss. Unlike the common fruit fly found in the UK (*Drosophila melanogaster*) which is only attracted to ripe and overripe fruits, the spotted wing drosophila (SWD) is attracted to under-ripe fruits and therefore finds its way into fruit crops both before and during the harvesting period.

Armed with the knowledge that SWD was spreading to new countries in mainland Europe, the AHDB, working through then soft fruit panel chair Harriet Duncalfe (H&H Duncalfe), developed an SWD Industry Working Group to alert the industry to the threat of the pest and how to monitor for it. As soon as it arrived in the UK, the Working Group initiated an industry-funded research project (SF 145). This ran from 2013 until 2017 and aimed to improve our understanding of how it was spreading in UK climatic conditions, how best to monitor and sample for its presence, how to dispose of affected fruits and how to manage and control it. The findings and guidance emanating from the project are summarised in this factsheet.

Identifying SWD

SWD (*Drosophila suzukii*) looks like its fruit fly relative, the common fruit fly (Drosophila melanogaster) but there are some distinctive characteristics that are specific to SWD. The males have a large spot along the front edge of each wing and it also has two dark sex combs on the forelegs (Figure 3).

Figure 3. Adult males are distinguished by their spotted wings and sex combs on the forelegs

The female can be recognised by its unusual serrated ovipositor (Figure 4) which allows it to penetrate the skin of fruit.

Drosophila larvae cannot be identified to species. Only adults are identifiable. Most of these characteristics can be seen with the naked eye, but a hand lens is useful.

Figure 4. Adult females are distinguished by the serrated ovipositor at the rear of the abdomen

Crop damage

Crop damage is caused by the adult female whose serrated ovipositor allows her to make an incision in the skin of the fruit and lay her eggs underneath. On hatching, the resulting larvae not only contaminate the fruit, but also feed on the flesh which results in fruit collapse. Damaged fruits lose their shape and juice can often be detected running out.

Vulnerable crops and host plants

Early experience in the UK and from other countries where SWD is prevalent suggests that cherry is the most suceptible UK grown fruit crop followed by cane fruit crops (raspberry, blackberry and hybrid berries), blueberry and strawberry. Since SWD arrived in the UK, damage has been found in all of these crops. SWD has also been found in UK grown grapes. Other crops thought to be susceptible are blackcurrant, redcurrant, whitecurrant, gooseberry, plum, apricot, peach, nectarine and kiwi fruit. Damaged tomatoes are also thought to be at risk.

Apart from fruit crops, other hosts include: wild blackberry (Figure 5), wild cherry, dogwood, elderberry, hawthorn, honeysuckle, mahonia, mountain ash (rowan), mulberry, nightshade, wild raspberry, rose and snowberry. Early and late sugar sources include; holly, insect honeydew and ivy.

A range of other soft skinned fruits borne by ornamental garden plants are also likely to act as hosts.

Figure 5. Wild blackberry is a common host of SWD in rural areas of the UK

Figure 6. Adults seek refuge in woodland and hedgerows during the late autumn and winter months

Life cycle and population dynamics

Experience from Japan has shown that SWD can have up to 13 generations per year. Depending on the temperature it can take between 12 and 79 days to develop from egg to adult. The warmer it is, the quicker the development and reproduction rate. Females can lay 7-16 eggs per day, over 300 eggs in a lifetime and are active from around 10°C. Development and activity peaks at 27°C. Eggs are laid at any time between spring and autumn.

The pest overwinters as adult females and males. Although prolonged periods of low temperature in the winter can help to reduce populations, SWD is known to develop a winter morph which can withstand very low temperatures below freezing. This helps populations to survive from one season to the next and explains why populations manage to thrive in more northern areas including Canada and Scandinavia. First detection in the spring is dependent upon the coldness and longevity of the winter. Mild winters will result in earlier occurrence of SWD in fruit crops.

UK research project findings on habitat and dynamics

Studies in project SF 145 were made on habitat preferences and population dynamics in the UK using a comprehensive nationwide monitoring scheme which included monitoring traps in both crops and wild areas. By the end of the project (March 2017), SWD had been found in all fruit growing areas of the UK and Ireland and the numbers of adults being caught in traps had increased year on year. By the end of the project, SWD was being recorded in traps in every week of the year.

Populations in fruiting crops were found to decline at the end of harvest when fruits were no longer present to attract SWD into the crop. It was found that during the autumn and winter months, SWD populations were migrating into hedgerows and woodland (Figure 6) where they could find shelter from the winter elements. In each of the years of the project, SWD populations and activity began to increase between April and June, with numbers rising steeply from July/August and reaching a peak in December. The higher numbers being caught continued until February, when catches declined before rising gradually again from April.

It had been thought the populations did not start to increase in fruit crops until the fruits began to ripen, but in 2016 it was observed that SWD moves into cherry orchards long before it is able to lay eggs in fruits and that adults can feed on the nectar from extra-floral nectaries at the base of the newly opened leaves. A similar finding has been made in plum, although these leaves do not produce as much nectar.

Monitoring for the pest

Monitoring for the pest is vital if it is to be managed and controlled adequately. It is best to monitor for the presence of adult SWD all year round, while monitoring for the presence of larvae in fruit should also be carried out leading up to and during the harvest period.

Monitoring for adults

There are numerous commercial traps and their design is constantly evolving as we learn more about the biology of the pest. In project SF 145, a comparison was made of the most promising of the commercially available traps and baits with results suggesting that the most practical for growers to use is the 2014 Biobest Drosotrap (Figure 2) combined with Dros Attract or Gasser lure liquid bait. However, it was shown that because of the larger entry hole sizes in this trap, a significantly greater number of >4 mm insects are captured making identification of adult SWD more time consuming for monitoring. A dry bait produced by the Natural Resources Institute containing the same 4 components as the Cha-Landolt bait was trialled in a cherry crop and shown to be attractive to SWD and more selective for this species, with less by-catch of other insects. However, this is not yet commercially available. Growers should keep abreast of the latest trap developments for SWD specificity.

Smaller disposable traps (Figure 7) which are the size of a yoghurt pot are also commercially available. These already contain a liquid bait when purchased. Because they are cheaper than the Drosotrap, many growers prefer to use them for precision monitoring which requires traps to be located every two metres around the perimeter of the crop. However, they have a shorter life span than the Drosotrap and need to be replaced every four weeks.

When is the best time to monitor

In wild areas, such as hedgerows and woodland (Figure 8), it is best to monitor for the presence of SWD throughout the 12 months of the year using precision traps and checking them every week. This will indicate whether populations are present on your farm and whether the population size is increasing or decreasing. From March onwards, it is also wise to set out precision monitoring traps every two metres around the perimeter of susceptible crops to detect if the pest is moving into the crop.

As soon as populations are being caught in wild areas or in the perimeter traps around the crop, then start monitoring in crops, but not until fruits start to swell. The exception to this is cherry and other stone fruit crops which are known to attract adult SWD into the crop earlier, so traps should be set out in these crops from early leaf onwards.

Figure 7. Smaller disposable traps are commonly used by commercial growers for precision monitoring around the perimeter of susceptible crops

Figure 8. In hedgerows and woodland, it is best to precision monitor for SWD all year round

Locating the monitoring traps

At the start of the production season, it is best to use traps in wild areas of the farm, such as hedgerows and woodland. Traps in wild areas should be hung one metre above ground level and out of direct sunlight. Clear any tall vegetation away from the trap so that it's easily accessible.

Precision monitoring traps should be placed around the perimeter of the crop in adjacent wild areas at a two metre spacing.

When monitoring within the crop, use **two** traps per cropping situation about 10 metres from the perimeter of the crop, but remember that traps should be hung on the shady side of crop rows.

- In stone fruit, cane fruit, bush fruit and vine crops, hang the traps at one third of the canopy height (Figure 9).
- In outdoor strawberry crops, position above the ground but below the spray boom height.
- In tunnel strawberry crops, hang in the leg row at a height of 10 cm.

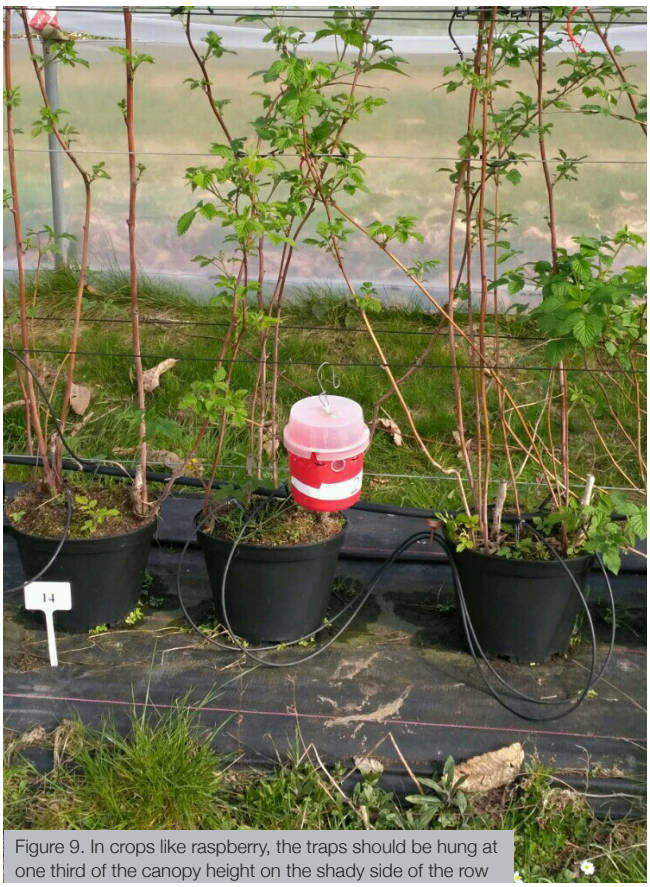

Figure 9. In crops like raspberry, the traps should be hung at one third of the canopy height on the shady side of the row

How to use the traps

Diagramatic guidelines on how to assemble the 2014 Biobest Drosotrap are available on the dedicated SWD pages of the AHDB Horticulture website.

The trap should be filled with 300ml of Dros Attract or Gasser lure liquid bait to attract SWD into it. In the summer months during warmer conditions, the liquid does tend to congeal and this can be overcome by adding a teaspoon of boric acid, which can be purchased from internet sites. The traps should be checked and the liquid changed once every week. This both enables trap catches to be made and recorded and helps to refresh the bait to maintain attraction to SWD.

When assessing the trap catches each week, the liquid bait should be decanted through a funnel of filter paper (fine mesh paint filter will suffice – Figure 10) into a container. The spent liquid should be disposed of responsibly, but well away from the vicinity of the plantation. It should not be poured onto the ground as it will continue to attract SWD into the cropping area. The filter paper should be placed into a sealable plastic bag and the crop name and date recorded on the side. This way, filter papers can be returned to the office for examination to assess the insects caught. If the paper can't be examined instantly, it should be placed in a freezer for a couple of hours, which will kill any living insects and prevents any SWD from decaying.

The numbers of SWD caught in each trap in each crop should be recorded carefully so that the numbers can be reviewed over a period of time to assess how population numbers are changing over time.

- Training videos on how to use traps can be viewed on the AHDB Horticulture website.

Figure 10. Liquid bait should be decanted through filter paper into a container for disposal

Monitoring for larvae

The quickest way to determine if SWD larvae are present in developing and ripe fruits is through flotation testing. A sugar solution is used to extract existing larvae from the fruits. It works on cherries, plums, raspberries, blackberries, blueberries, currants, grapes and strawberries. For larger fruits like plums and strawberries, it is best to cut the fruit into quarters to make it easier for the larvae to escape.

- Make a sugar solution by dissolving 1kg of sugar in 5.5 litres of water.
- Place 100g of ripe or semi-ripe fruit in a small clear polythene bag.
- Very gently crush the fruit to break the skin, in the bag on a work surface. Don't be too firm as this can kill the larvae.
- Add the sugar solution to the bag, with just enough solution to cover the fruits.
- Seal the bag with a cable tie wrapped round the neck of the bag to prevent the solution from running out and compress the fruit a little more on a work surface.
- Leave the bag for around 10 minutes, then mix the fruit a little more in the solution.
- After a further 10 minutes, you should be able to see the larvae in solution if they're present (Figure 11).
- Look for fine white lines between 1-4mm in length. These should still be moving after 20 minutes, which makes them easier to see.

When to monitor for larvae in fruit

It is important to monitor for the presence of larvae in fruits both before harvest begins and after every pick. Detecting a problem early allows control measures to be implemented before the next pick. Detecting a problem after picking can save on packing costs (Figure 12) and prevent damaged/affected fruit reaching the market.

Sampling fruit in the lead up to harvest

- Sample weekly from all plantations at risk, as fruits begin to colour.
- Select more than 100 ripening fruits from a transect across the crop.
- Include fruits from the edges of plantations near wild hosts.
- Collect fruits from the lower centres of plants and avoid fruit on the ground.

Sampling fruit during the harvest period

- Decide upon the punnet sampling frequency (eg. 1/100).
- Take a sample from each crop in each field at each picking time.
- Record numbers: lot size, sample size, number where pest detected.
- Work out incidence and confidence intervals.
- Reject the consignment if SWD larvae are found.

Figure 11. Flotation testing releases larvae from the fruit into solution, making them visible to the naked eye

Figure 12. Detecting affected fruits early can save on unnecessary packing costs

Crop management and hygiene to reduce the risk of SWD damage

Lessons from other affected countries have shown the best approach to managing and minimising the potential impact of SWD is an integrated management programme of early crop monitoring, early control, scrupulous hygiene and housekeeping together with thorough disposal of damaged fruit combined with targeting spraying of approved, effective crop protection products.

Comprehensive information about crop monitoring has already been provided in this factsheet. In addition to monitoring, it is vital that all susceptible crops are managed correctly to discourage influx of SWD adults into the crop area. To this end, all ripe, overripe, damaged and diseased fruits should be removed from the crop at every pick throughout the ripening period and also after harvest has been completed.

Increasing the number of harvests per week, or harvesting earlier will leave the fruit less vulnerable to attack. Experience in Italy has demonstrated that picking cherries earlier has reduced the scale of the problem considerably.

During or after harvest, no fruit should be left on the crop plant or tree or on the plantation floor (Figure 13), where it will continue to attract new adult SWD into the crop. Any fruit that is not picked for sale, should be disposed of in a way that will avoid further attraction of SWD into the vicinity of the cropping area.

Figure 13. Leaving old or damaged fruits on the plantation floor will attract more SWD into the crop

Correct disposal of waste fruit

In project SF 145, much time and energy was spent in researching the best way to dispose of waste fruit and fruit that was already affected by SWD and which contained SWD larvae or pupae.

Work in the first two years of this project identified that anaerobic treatment of fruit waste in sealed plastic pallet bins (Figure 14) with a capacity of between 500-670 litres, effectively kills all life stages of SWD in the waste. A combination of depleted O_2 and high CO_2 concentration is needed to kill the SWD. Holding the waste in the sealed bins for two days at waste temperatures of at least 18°C will ensure eradication of SWD. If waste temperatures are below 18°C, at least three days are required.

Work in the third year showed that there can be a low level of survival of SWD in stone fruit waste treated for three days, particularly if the waste temperature is below 16°C, so a four-day treatment should be used for stone fruit.

Figure 14. It is essential that fruit waste undergoes anaerobic treatment to kill SWD larvae and pupae within the fruit

The treated waste is still attractive to SWD adults, so must be disposed of in a way which no longer attracts the insect. Rotavation of treated waste into soil to a depth of 20cm is a suitable disposal route. The rate of application to land should not exceed 125 tonnes/ha.

Mixing the treated waste with other organic waste (at least 90% w/w) is an alternative suitable disposal route.

- As a result of this work, Factsheet 19/16 '*Disposing of fruit waste affected by spotted wing drosophila*' was published by AHDB which offers comprehensive guidance to growers.

Control options for SWD

Following the hygiene and management practices outlined above will help to reduce the attraction of SWD into soft and stone fruit crops in the UK. However, as populations of the pest continue to increase in the UK, it is inevitable that adults will be attracted into crops and additional forms of control will be required.

In its native country, Japan, SWD has associated parasitoids. Unfortunately these species are not found in Europe, although some closely related species are and these are currently being investigated further. However, it is almost certain that UK fruit growers will be unable to rely solely upon these to provide commercially acceptable control.

Growers will therefore need to rely upon the use of traditional crop protection products (Figure 15) along with other integrated control measures. Research and experience both overseas and in the industry funded project (SF 145) have demonstrated that organophosphate, synthetic pyrethroid and spinosyn spray products offer significantly better control than other groups of compounds. In the UK, there are no longer any organophosphate products approved for use. Synthetic pyrethroid products are broad spectrum in their activity and are known to have an adverse effect on both naturally occurring and introduced predatory insects which are relied upon to control other pests of fruit crops. For this reason, most growers are very reluctant to use these.

The spinosyn product spinosad (Tracer) is effective and has worked extremely well at controlling adult SWD in project SF 145 on all crops in which it has been tested. It has had full approval for use on some fruit crops in the UK but not all. Another product cyantraniliprole (Exirel 10 SE) has offered good control of adults in SF 145 trials, but had no approval for use on UK fruit crops. A further coded product assessed in these trials has offered comparable levels of control.

Figure 15. Traditional crop protection products will need to be applied to susceptible crops to gain commercially acceptable control

AHDB has worked closely both with the manufacturers of spinosad and cyantraniliprole and the CRD to secure EAMU and emergency authorisations for their use on fruit crops which had insufficient numbers of effective control products approved for use. AHDB will continue to work to secure further approvals in the coming seasons.

As the approval status of these and other products is continually changing, the control options are not listed in this document, but AHDB provides growers with frequently up-dated lists of products approved for use on all suceptible crops which offer activity against SWD.

- Always be guided by a BASIS qualified advisor when choosing the optimum crop protection product.

Practical considerations when spraying

As soon as adults are found in or around the crop, use recommended control products regularly until the fruits ripen.

In considering when to commence control measures for SWD, growers should be aware that if they start spray programmes too early, then it is likely that the permitted number of approved products may be reached before populations of SWD have risen to a peak, when significant fruit damage may occur. However, it is equally important to start a control programme before populations build to a point where fruit damage starts to appear.

Ensure that harvest intervals are met and products/chemistry is rotated. Be mindful of the maximum number of applications permitted for a product and do not exhaust these before populations of the pest reach peak levels during the harvest period.

New AHDB funded research into SWD

Following the completion of the industry funded project (SF 145) in March 2017, the AHDB has commissioned a new project to continue research into the management and control of SWD in UK growing conditions. The project will be led by Dr Michelle Fountain at NIAB EMR, but will also include input from scientists at the James Hutton Institute and the Natural Resources Institute, based at the University of Greenwich.

The research work will encompass six main objectives:

1. A continuation of the national monitoring of populations of SWD in Scotland and England.
2. The development and optimisation of a push/pull system for controlling SWD using repellents and attract and kill strategies.
3. The development of bait sprays for controlling SWD.
4. Prolonging spray intervals for maximum effect whilst reducing applications to a minimum.
5. Integration of exclusion netting with other successful control methods.
6. Draw upon the results of the other 5 objectives to develop, design and communicate a year round strategy for SWD control in UK crops.

Further information

Research projects on SWD

A number of research projects on spotted wing drosophila with relevance to growers in UK conditions have either been done or are in progress. The most relevant are:

SF 145 (UK industry funded project) – Managing spotted wing drosophila (SWD) in the UK

DROSKII – Damage potential of Drosophila suzukii and development of risk management and control measures. An EU funded project with UK input by scientists at Fera

DROPSA - A four year project involving partners from Europe, Asia, New Zealand and North America to develop innovative and practical approaches to protect major European fruit crops from pests and pathogens

PhD Studentship and other research in the UK – A number of PhD studentship projects on SWD are in progress in the UK, two of which are funded by AHDB. Further details on these and other research are available on the AHDB dedicated SWD web pages at: horticulture.ahdb.org.uk/swd.

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horticulture.ahdb.org.uk

AHDB Horticulture, Stoneleigh Park,
Kenilworth, Warwickshire CV8 2TL

T: 024 7669 2051 E: hort.info@ahdb.org.uk

@AHDB_Hort

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