The use of insect exclusion mesh to protect soft and stone fruit from damage by SWD (Spotted Wing Drosophila): Summary by Dr Michelle Fountain and Nick Buck for AHDB

Spotted Wing Drosophila (SWD), or *Drosophila suzukii*, is a fruit fly native to South East Asia, capable of causing yield reductions by laying eggs in soft and stone fruit, increasing fruit susceptibility to pathogens and overall degradation. SWD overwinters in habitats neighbouring soft fruit crops especially in the winter months. These neighbouring habitats (e.g. woodland and hedgerows) provide shelter and wild hosts for SWD, which are then attracted into crops often before fruit begins to develop the following spring. Insect exclusion mesh (hereafter referred to as mesh) is one method of SWD control which acts as a protective barrier, inhibiting entry of SWD into the crop, reducing egg laying in the fruit once it ripens. INSERT FIG 1

Current evidence on efficacy of insect exclusion mesh

Several studies have focused on the use of mesh to protect soft fruit from SWD damage.

- A US study in raspberry high tunnel systems demonstrated that mesh (0.95 x 0.95 mm gauge) reduced the presence of SWD adults in the crop, and eggs/larvae in fruit by 48% and 70%/58% respectively, compared to unmeshed tunnels. There was little difference in the numbers of other pests and natural enemies present, or fruit quality between the two treatments.
- In another US study on blackberries, mesh (0.85 x 1.4 mm) reduced SWD egg laying by 92% when compared with the open control plots treated with an organic insecticide.
- In small-plot blueberry trials, where it was easier to erect mesh (0.6 x 1 mm) structures over small numbers of plants there was no evidence of SWD egg laying in the meshed fruit. In the control plots, 16 adult SWD were trapped and around 72 SWD adults were reared from the 100 blueberries picked from the unnetted plots on the final harvest.

There is good preliminary evidence that insect exclusion mesh can deter SWD egg laying in commercial fruit. As part of a Waitrose funded and University of Reading, Berry World and NIAB EMR supported PhD study, Nick Buck will assess the impact of mesh in UK polytunnel protected raspberry crops but, importantly, consider the side-effects of protecting polytunnel crops with mesh.

In 2019, Nick set up a replicated experiment with mesh door barriers from the first sign of raspberry ripening. INSERT FIG 2 Where the plastic cladding did not reach to the ground on the outer leg rows, mesh was also installed along the edges, sealing the crop from the surrounding environment. In tunnels where the integrity of the mesh was maintained (e.g. no holes or doors left open) numbers of SWD in monitoring traps inside the meshed tunnels was significantly lower (82%) than in unmeshed tunnels. In addition, raspberry fruit produced under mesh protection had significantly fewer (94%) eggs than those without mesh.

Side effects of mesh on pests

Studies of mesh side effects on crop production are scarce or incomplete, although some have demonstrated that insect exclusion mesh can incidentally reduce numbers of other pests. For example, one study showed an overall 35.5% reduction in pest numbers (24% for mites, 20% for thrips, and 46% for aphids) in raspberries covered in a meshed high tunnel system compared with those unmeshed. However, there was also a 26% reduction in parasitoid wasps and predatory mites, and 32% reduction in spiders in meshed compared to unmeshed tunnels. In the PhD study in UK raspberries, pilot data suggested that there were no effects on numbers of natural enemies or other pests, but this work will be repeated in 2021 with increased replication and include data on pollinating insect visits to raspberry flowers.

Side effects of mesh on pathogens and tunnel climate

Another gap in knowledge is the impact of mesh on crop pathogens. It is proposed that potential microclimate changes caused by mesh and the inability to fully vent tunnels will reduce air flow and raise temperature and humidity. In 2021, we will record climatic conditions including temperature, humidity, and dew point inside meshed and unmeshed tunnels. Our experiments in the first year of the PhD suggested that raspberries produced under meshed tunnels had a significantly higher instance (12%) of sooty shoulder. This may have been the result of increased humidity and/or less frequent flower visits by pollinating insects to remove nectar from the flowers, a factor also known to cause sooty shoulder.

How and when should mesh be installed and when can I vent the tunnels?

Mesh can be placed directly over the crop and anchored to the trunks or stems, however this makes access and spray penetration difficult, especially for crops that need picking every 2-3 days. More commonly, in polytunnels, mesh is placed as a barrier at tunnel entrances – creating mesh doors, and along the outer leg rows of the tunnels.

For maximum effectiveness mesh should be deployed before fruit ripening. However, SWD enter some crops much earlier, e.g. at flowering in cherry. For this reason, it might be advisable to allow pollination and then apply an effective SWD plant protection product to remove adults from the cropping area after installing the mesh. In addition, managed pollinators can be introduced to help with pollination and nectar removal. INSERT FIG 3

Ideally mesh is applied around the perimeter and across the entrance of tunnels, especially next to areas from where SWD is known to disperse. This will vary according to location and SWD pressure – which can be monitored using traps in the adjacent hedgerows and woodlands. During hot conditions when tunnels are being vented SWD is likely to be less active and does not generally lay eggs above 30°C. Venting tunnels at the hotter parts of the day are likely be less of a risk of SWD incursion because generally SWD does not prefer hot dry weather.

What are mesh requirements?

Adult SWD are 2-3 mm in size, hence a mesh gauge of 0.6-1 mm x 0.6-1 mm will prevent SWD entering the crop. Larger hole sizes risk smaller sized SWD adults entering tunnels whilst smaller gauge mesh increases the risk of reduced air flow. There are a range of mesh manufacturers and qualities so it is recommended that growers speak to their agronomist about experience with installing mesh and which they would recommend. It is imperative that mesh is of good quality and does not tear. Inadequately installed, or poor-quality mesh, which tears easily creating multiple gaps significantly increases the risk of SWD entering the crop. Likewise – doors left open for prolonged periods of time during spraying and picking operations, or if forgotten overnight, compromise efficacy and in extreme circumstances require a ‘clean’ start. Ideally growers designing new plantations would consider the incorporation of mesh infrastructure to make it easier to manage and vent. Modern venting systems, such as those demonstrated at the NIAB EMR WET Centre remotely detect and automatically vent according to environmental conditions in the tunnels. In addition, machinery access into tunnels and turning points on the headland could be engineered so that, where space permits, only one door into and out of the areas is required. INSERT FIG 4

Economics

The mesh purchase, implementation, and management can vary depending on manufacturer and quality, but some studies have provided estimations.

- A study assessing the benefits of anti-hail insect exclusion netting (2.4 × 4.8 mm gauge for codling moth control) in Italian apple orchards reduced the number of insecticide sprays required by 7. Growers saved up to €1,050/ha (£983.35/ha*), with costs of

€2300/ha (£2155/ha*) overall, while controlling damage by multiple fruit pests and pathogens (this study also showed a 62% reduction in SWD catches in the netted treatment compared with the unnetted, despite the larger mesh hole size).

- Another study conducted a cost-benefit analysis of controlling damage by SWD in soft fruits in Italy, where there was high SWD pressure. Covering one hectare with mesh cost €8,500 (£7480*), amortized over a ten-year period. It was estimated that installation and removal of the mesh took approximately 100 labour hours/ha.
- A study in 2020, which included purchase of the mesh support system, mesh, and labour costs calculated $10,000 (£7,300)/ha, for mesh that has a 7-10 year lifespan.

*Prices calculated through exchange rate of the year the study was conducted.

Final word

While the effectiveness of mesh in limiting SWD entry into a cropping area, and subsequent reduction in fruit damage, has been demonstrated, Nick's PhD will consider other impacts of mesh on ecosystem services (e.g. pest and disease regulation, and pollination) associated with soft fruit production. Nick will also calculate the costs and benefits of employing mesh in UK raspberry systems.

Mesh should be part of an Integrated Pest Management programme alongside other methods of SWD control, e.g. precision monitoring, regular fruit removal, waste treatment and rigorous monitoring throughout the year.

This article was written by Nick Buck (PhD student) and Michelle Fountain (NIAB EMR). The PhD studentship is supported and supervised by the University of Reading, NIAB EMR, Berry World, and Waitrose CTP. Pictures by Nick Buck.

Figures

Fig 1 Underside of female SWD showing serrated ovipositor at tip of abdomen

Fig 2 A meshed and open ‘control’ tunnel on a raspberry farm in the UK, August 2019

Fig 3. Meshed raspberry tunnel with commercial bumblebee hive at the end of the row. UK, July 2019

Fig 4. Section of raspberry polytunnel (70 m in length) meshed off as part of the trials