DROSOPHILA SUZUKII

SPOTTED WING DROSOPHILA (SWD)

BEST PRACTICE MANAGEMENT GUIDELINE

MONITORING AND IDENTIFICATION

Monitoring of SWD is required to determine population dynamics (trends) of SWD in a particular area to initiate management practices as well as to evaluate whether management practices implemented are effective. Monitoring primarily takes place using traps baited with various lures, but fruit sampling for damage assessment is also critical since trap catches rarely accurately reflect potential levels of infestation.

SWD Identification: SWD adults resemble *Drosophila melanogaster* (vinegar fly) except for a few distinguishing characteristics. Adult SWD are about 3mm in length and the males can be identified based on a black/brown spot on the leading edge of the wing as well as setae (black hairs) on the front leg in two rows (Figure 1). It should be noted that the spots on the wings of the males are not visible when they first emerge; it takes 8-10 hours for them to be fully formed.

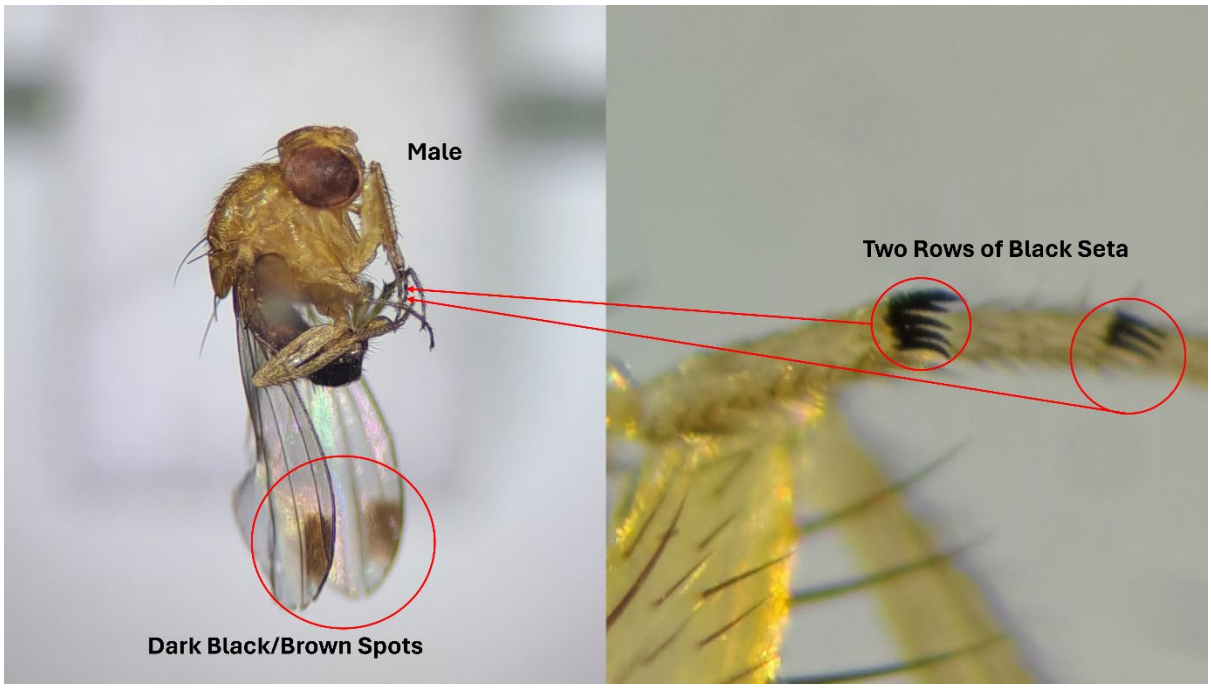

Figure 1 *The identification of Drosophila suzukii males (Image credit: Zion Jodamus).*

Females have a large, serrated ovipositor, easily distinguishable from females of other drosophilid species however, the females do not have the dark black/brown spots on the wings (Figure 2). Although the immature stages of SWD are easily distinguishable from members of the Tephritidae (e.g., Mediterranean fruit fly) (Figure 3), they are not easy to

distinguish from other members of the Drosophilidae and will have to be reared or identified using molecular tools. The use of a magnifying glass (X10 or bigger) will be required.

Figure 2 *The identification of Drosophila suzukii females (Image credit: Zion Jodamus).*

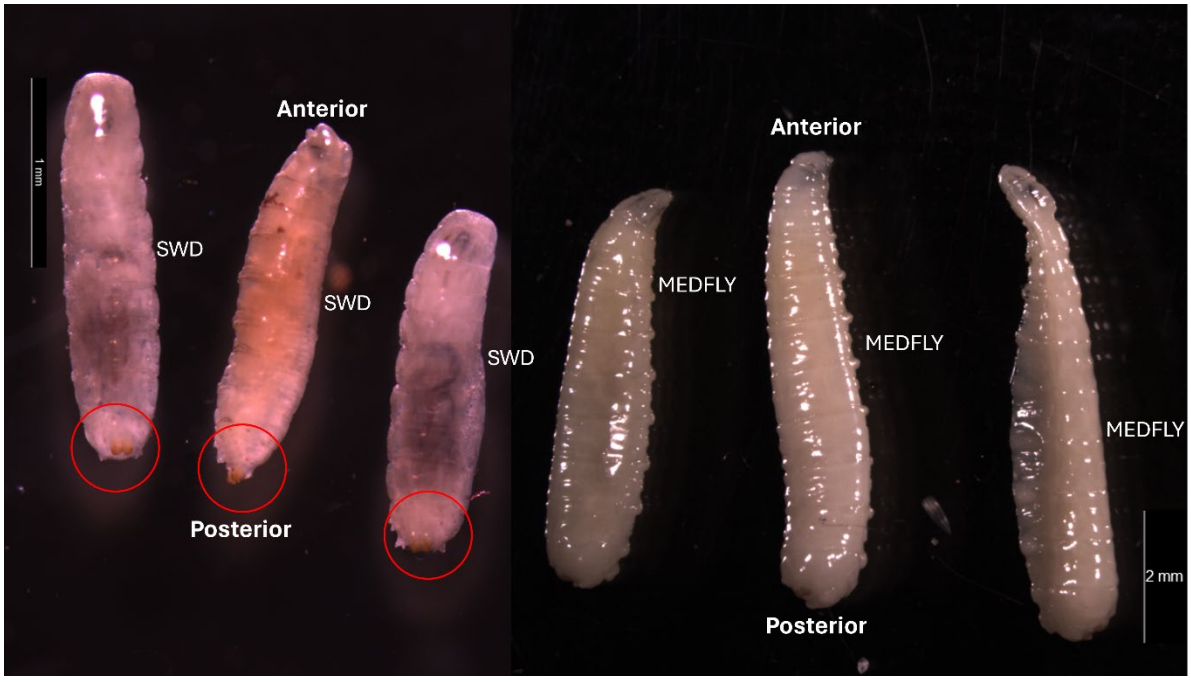

Figure 3 *The identification of Drosophila suzukii (SWD) larvae (left) and Ceratitis capitata (Medfly) larvae (right) (Image credit: Zion Jodamus).*

TRAPS

Adult SWD can be monitored using various types of homemade and commercially available traps and attractants.

When: Traps should be placed in orchards/blocks and on the periphery before fruit start to ripen (increased sugar levels) and change colour, which will depend on the fruit kind and cultivar. Trapping should continue throughout the entire season and will be influenced by temperature.

What: Commercial McPhail bucket traps (any supplier) or Droso-Trap can be used baited with a synthetic SWD lure (acetic acid) and an insecticide. Alternatively homemade traps made from clear plastic containers (i.e., honey jars or small square juice bottles) with small holes (±3mm diameter) drilled around the perimeter (see Figure 4 & 5 for examples) can also be utilized. Both homemade and commercial traps can be baited with synthetic SWD lures or baited with apple cider vinegar or water, yeast and sugar (mix), that has proven to be an effective attractant for SWD. The attractiveness of the apple cider vinegar can be improved by adding a small amount of red wine and sugar (or molasses). The addition of a small drop of dish soap will aid in breaking the surface tension. Dry traps consisting of sticky traps or cards baited with synthetic SWD lures is also effective and may aid in easier male identification. Liquid homemade traps can also be combined with a small sticky card suspended inside the trap.

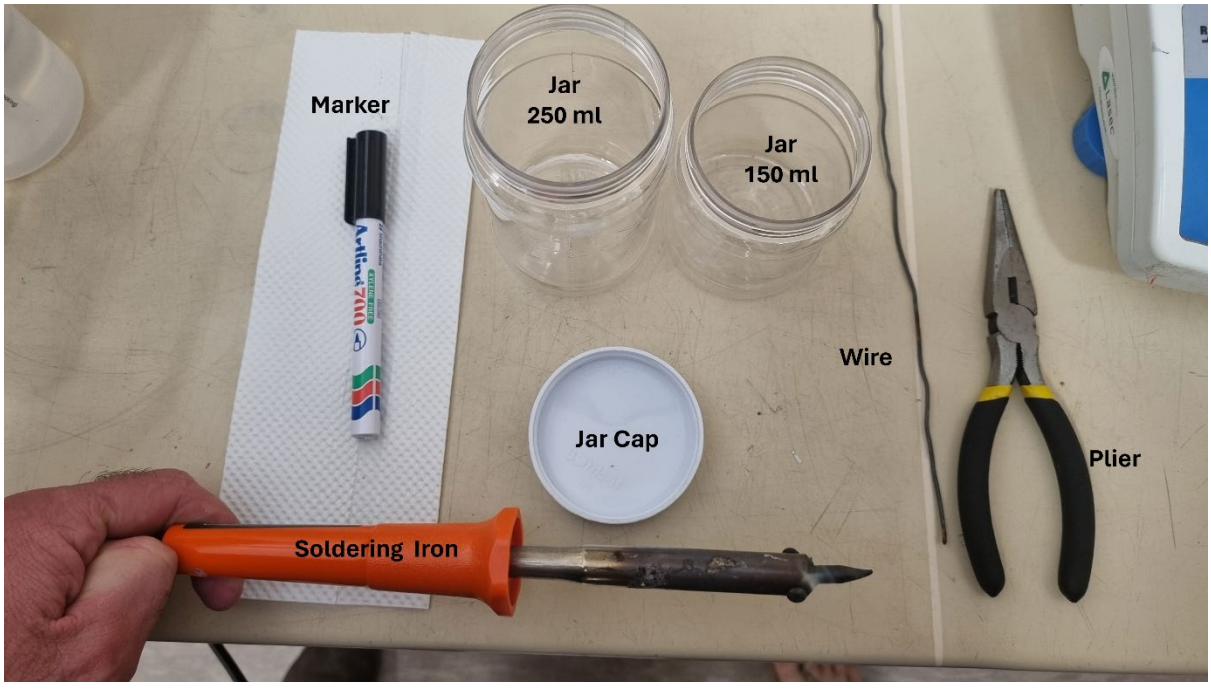

Figure 4 *Basic equipment needed to make homemade SWD traps.*

How: Traps should be placed in the shade within the canopy since SWD will search out shaded areas with high humidity. Traps should be serviced once a week and synthetic lures replaced as suggested by the manufacturer. Homemade liquid traps need to be rebaited every week, due to the liquid evaporating. If liquid levels are sufficient after a week no rebaiting is necessary. The attractive range of various traps are limited (approximately 30m) and therefore large numbers of traps should be placed on the periphery and within the orchard/block to detect SWD. To determine when SWD starts entering the crop place 1 trap every 30 meters on the perimeter of your crop, in hedgerows or other vegetation on the periphery of your orchards/blocks. As soon as populations are detected in the perimeter traps, start monitoring in the crop by placing traps 30 meters apart, 10 meters into the orchard/block from the edge.

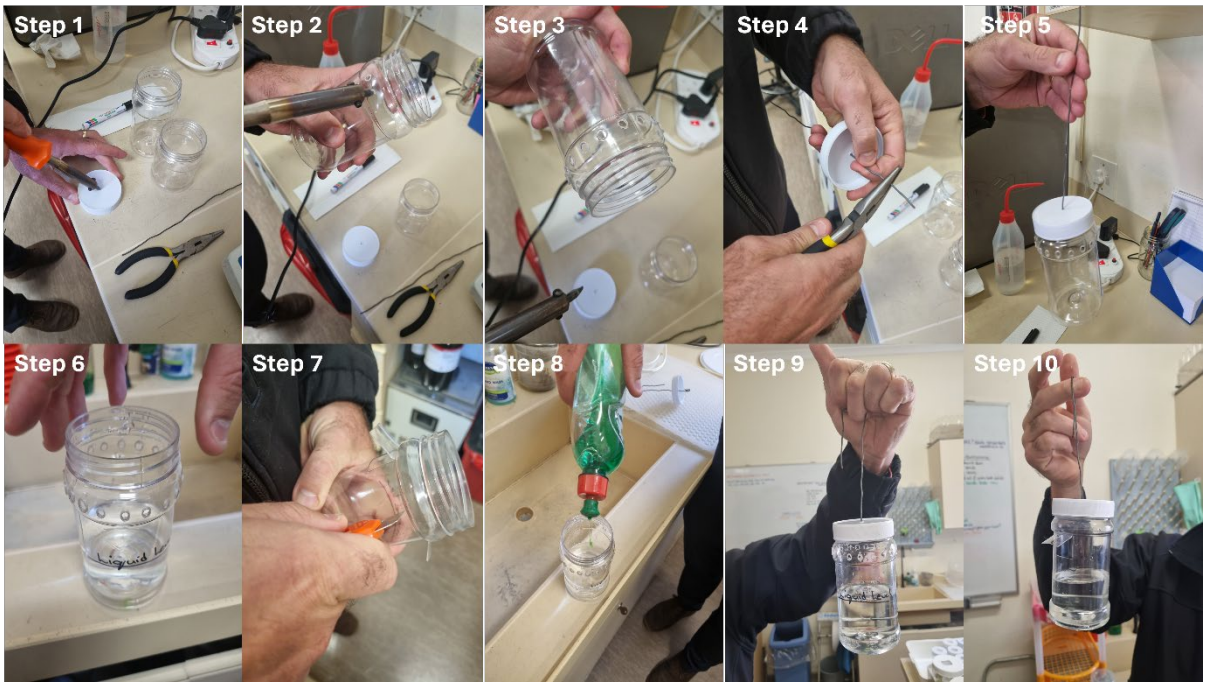

Figure 5 *Ten steps to following to assemble a homemade SWD trap.*

FRUIT ASSESSMENT

The fruit dunk or flotation method (information from Van Timmeren et al. 2017) can be implemented to monitor the presence of SWD larvae in fruit.

When: The method should be implemented when fruit colour starts to change and continue until harvest. This method provides fruit infestation levels several days prior to adult emergence.

Where: Fruit on the edge of the orchard/block adjacent to natural vegetation is at higher risk of infestation. Fruit should be collected from 10 random plants located 10 meters

into the orchard/block from the edge, repeated for all sides of the orchard/block that borders natural vegetation or alternate hosts (Table 1).

How: Collect a representative fruit sample per orchard/block. Place fruit in a plastic bag and lightly crush. This will allow the solution to reach the larvae. Prepare a saturated salt solution (table salt can be used) and add approximately 1 cup (250mL) until the crushed fruit are covered with the solution. Let the fruit sit covered for approximately 1 hour and then pour the contents of the bag through a course sieve, wash with additional water. Now filter the liquid through another filter (fine mesh or a coffee filter) and inspect the coffee filter for the presence of SWD larvae or eggs (Figure 6).

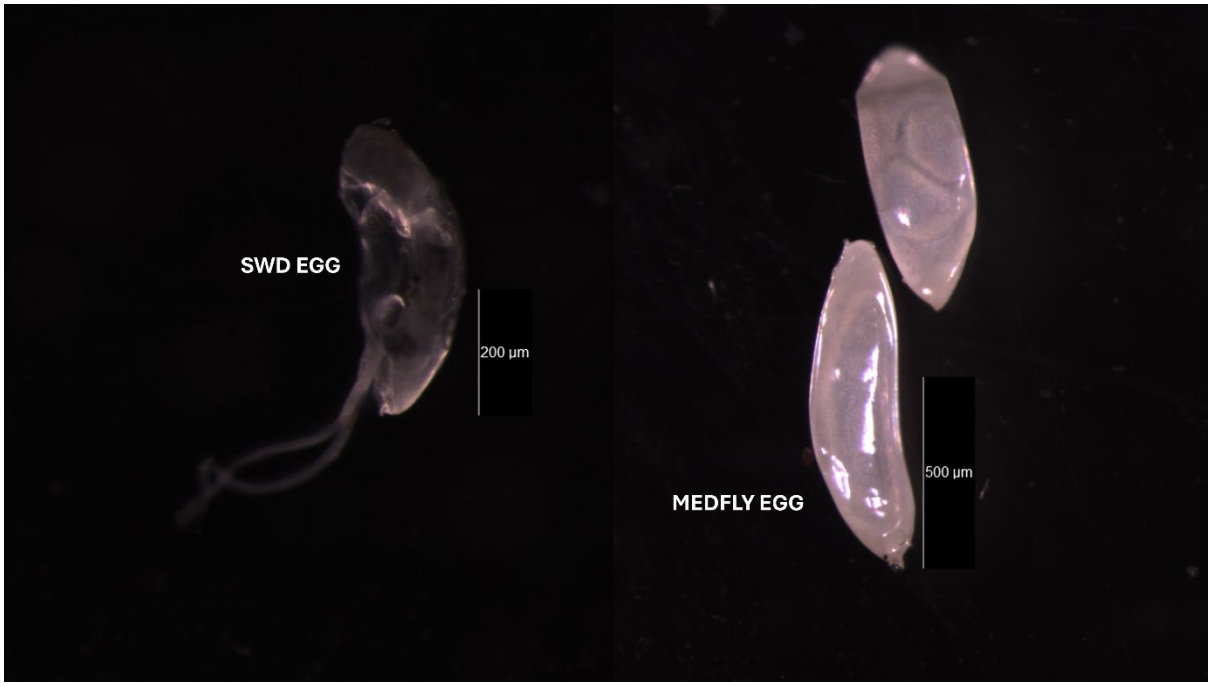

Figure 6 *The identification of Drosophila suzukii (SWD) larvae (left) and Ceratitis capitata (Medfly) larvae (right) (Image credit: Zion Jodamus).*

ALTERNATE HOST MANAGEMENT

The management of alternate hosts within the vicinity of susceptible crops, are crucial to manage SWD populations that will later invade your crop. Some of the main alternate hosts commonly found on farms and farm gardens are listed in Table 1. To determine host status, the fruit flotation method can be used as described above, however, contact your industry entomologist to confirm the identification of the larvae.

When: Depending on what hosts are present in your area, you will have to manage these hosts on a continuous basis, as some of them flower and bear fruit throughout the year.

Where: Manage alternate hosts in close vicinity of your crops, as these hosts will support SWD populations that will invade your crop when it becomes susceptible.

How: SWD populations can be managed either by physically removing alternate hosts or by fruit stripping (dispose of the fruit in the correct manner, see "Orchard/Block Sanitation" section).

Table 1: *Non-crop plants used as hosts by Spotted Wing Drosophila* in Europe, but also commonly found on farms and in farm gardens in South Africa. Note that this is not a complete list of hosts of SWD, but only serves as a guideline (Kenis *et al*. 2017).

Scientific Name	Common Names	Scientific Name	Common Name
Actinidia chinensis	Kiwi	*Prunus domestica*	Plum
Amelanchier lamarckii	Juneberry	*Prunus laurocerasus*	Cherry Laurel
Amelanchier ovalis	Snowy Mespilus	*Prunus lusitanica*	Portugal Laurel
Arbutus unedo	Strawberry Tree	*Prunus mahaleb*	Mahaleb Cherry
Arum italicum	Italian Arum	*Prunus padus*	Bird Cherry
Cornus alba	Red barked Dogwood	*Prunus serotina*	Black Cherry
Cornus kousa	Kousa Dogwood	*Prunus spinosa*	Blackthorn
Cornus mas	Cornelian Cherry	*Pyracantha sp.*	Firethorn
Cornus sanguinea	Dogwood	*Rhamnus cathartica*	Common Buckthorn
Cotoneaster franchetii	Orange Cotoneaster	*Ribes rubrum*	Red Currant
Cotoneaster lacteus	Late Cotoneaster	*Rosa acicularis*	Prickly Wild Rose
Cotoneaster rehderi	Rehder's Cotoneaster	*Rosa canina*	Dog Rose
Crataegus chrysocarpa	Fireberry Hawthorn	*Rosa glauca*	Red leaved Rose
Crataegus monogyna	Common Hawthorn	*Rosa pimpinellifolia*	Burnet Rose
Daphne mezereum	Mezereum	*Rosa rugosa*	Rugosa Rose
Duchesnea indica	Indian Strawberry	*Rubus caesius*	Dewberry
Eriobotrya japonica	Loquat	*Rubus fruticosus*	Blackberry
Ficus carica	Fig	*Rubus idaeus*	Raspberry
Fragaria vesca	Wild Strawberry	*Rubus phoenicolasius*	Wineberry
Frangula alnus	Alder Buckthorn	*Rubus saxatilis*	Stone Bramble
Gaultheria x wisleyensis	Wisley Heath	*Sambucus ebulus*	Danewort
Hippophae rhamnoides	Sea Buckthorn	*Sambucus nigra*	Elderberry
Lonicera caerulea	Blue Honeysuckle	*Sambucus racemosa*	Red Elderberry
Lycium barbarum	Goji Berry	*Solanum dulcamara*	Bittersweet Nightshade
Mahonia aquifolium	Oregon Grape	*Solanum nigrum*	Black Nightshade
Mahonia sp.	Mahonia	*Sorbus aria*	Whitebeam
Malus baccata	Siberian Crab Apple	*Sorbus aucuparia*	Rowan
Paris quadrifolia	Herb Paris	*Symphoricarpos albus*	Snowberry
Parthenocissus quinquefolia	Virginia Creeper	*Tamus communis*	Black Bryony
Photinia beauverdiana	Beauverd's Photinia	*Taxus baccata*	English Yew
Photinia villosa	Himalayan Photinia	*Vaccinium myrtilloides*	Velvetleaf Blueberry
Photinia prunifolia	Taiwan Firethorn	*Vaccinium myrtillus*	Bilberry
Phytolacca americana	American Pokeweed	*Vaccinium oldhamii*	Oldham's Blueberry
Phytolacca esculenta	Chinese Pokeweed	*Vaccinium praestans*	Dwarf Blueberry
Polygonatum multiflorum	Solomon's Seal	*Vaccinium vitis*	Lingonberry
Prunus armeniaca	Apricot	*Viburnum lantana*	Wayfaring Tree

Prunus avium	Sweet Cherry	*Viburnum rhytidophyllum*	Leatherleaf Viburnum
Prunus cerasifera	Cherry Plum	*Vitis vinifera*	Grapevine
Prunus cerasus	Sour Cherry		

ORCHARD/BLOCK SANITATION

Orchard/block sanitation is good farming practice not only for the management of SWD, but for other pests and diseases as well. Orchard/block sanitation is probably the most effective way of managing SWD populations over time and preventing rapid increases in populations, which can cause crop losses.

When: Preharvest orchard/block sanitation should be implemented whenever there is fruit on the floor, due to wind or thinning for instance. Orchard/block sanitation should also be done at harvest/picking and post-harvest.

Where: Implement orchard/block sanitation in your crop and in alternate hosts.

How: Fruit should be harvested as soon as possible/viable as overripe fruit are more vulnerable to attack by SWD. All unmarketable fruit should be removed from your orchard/block. All the fruit that has fallen to the ground during picking must be removed as soon as possible, preferably at picking. No unmarketable fruit should be left on your tree/bush or be left sitting in punnets/trays or bins anywhere on the farm. Fruit that was removed from the orchard/block during sanitation should be disposed of immediately, by burying the fruit at least 30 cm deep and immediately covering the fruit with soil and compressing the soil. Fruits can also be placed in black bags, tightly closed, and placed in direct sunlight for two weeks, after which the fruit can be buried.

MASS TRAPPING

Trapping can be used as a control measure, through mass trapping. The same lures and traps mentioned above for monitoring can also be used for mass trapping.

When: As soon as your monitoring traps have detected SWD populations initiate mass trapping.

Where Mass trapping should be implemented within and on the perimeter of your orchard/block.

How: In the orchard/block, traps should be evenly spaced, not more than 2-3 meters apart. This equates to roughly ±200 – 300 traps per hectare. On the perimeter place 1 trap every 2-3 meters around your orchard/block. If you are using liquid traps, check traps weekly and fill to original liquid level. When using dry traps, empty traps weekly and replace lure according to manufacturer's guideline.

CHEMICAL APPLICATION

Chemical applications should be informed by your fruit assessments and monitoring traps. Currently there are no thresholds that can be used to determine risk, based on trap catches. Aspects to consider when using chemical applications are registrations, specific label rates, withholding periods, preharvest intervals (PHI), maximum residue limits (MRL), rotation of chemical classes (resistance management) and the effects on bees, pollinators, and other natural biocontrol agents.

When: Due to SWD population's ability to rapidly increase, chemical applications should be initiated as soon as larvae are found within fruit during your fruit assessments or as soon as flies are caught in traps (whichever comes first).

Where: Only within the crop.

How: The efficacy of insecticides can be influenced by type of product, dose/concentration, tractor speed, nozzle type, pressure and spray volume, which you will have to determine based on the size and structure of your crop. The biggest proportion of SWD individuals are found in the centre of the fruit crop, where it is shady, cool and humid. Therefore, it is important to get good penetration within your crop when you spray. It is important to know that chemical applications for SWD should be cover sprays and not applied as baits, as is the case with Mediterranean fruit fly and other Tephritids.

What: Currently there are no insecticides registered under Act 36 of 1947 for the control of SWD in South Africa. However, the most commonly used active ingredients for SWD control by conventional growers in other parts of the world are spinetoram, cypermethrin (variations), cyantraniliprole and malathion/mercaptothion. Please consult your industry entomologist together with your chemical supplier for support on seasonal programmes to manage SWD populations.

MULTI-INDUSTY COLLABORATION ON MANAGING SPOTTED WING DROSOPHILA IN SOUTH AFRICA

Since the first report of SWD in South Africa, several fruit industries as well as their researchers have been part of a coordinated effort to address the threat that SWD holds for all these industries. Due to the risk that SWD holds for multiple crops, these industries have been supportive of a collaborative effort to conduct critical research to manage this pest in a heterogenous landscape. See below the proposed research that has been submitted for funding to garner much needed information across the different industries.

Some of the main objectives include:

- Determine the fruit type/cultivar and ripeness stage susceptibility to SWD attack.
- Conduct a survey of potential alternate hosts in the different fruit producing regions.
- Determine SWD population dynamics in different crops and fruit producing regions.
- Develop attractants and evaluate currently available commercial attractants for use in attract and kill applications for SWD in South Africa.
- Determine the diversity of Drosophilidae parasitoids in South Africa for the control of SWD.
- Determine the efficacy of candidate parasitoids (collected during the survey and commercially available) against SWD.