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# Fruit Fly "Best Practice" Notes

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# Summary

## What you need to know...

1. Queensland Fruit Fly (QFly) is the main fruit fly pest species that damages intact fruit on the tree (vinegar flies only attack previously damaged fruit).
2. Identification of damage: between 2-20 larvae per fruit (may be more), 2-9mm long, black feeding hook visible in mature larvae, host fruit is soft & spongy, may be starting to rot. Sting marks are easy to see on light coloured fruit, harder on vegetables.
3. Female usually lays eggs into mature fruit, but will choose unripe fruit if no option or many flies are present.
4. Eggs only laid into fruit that is still attached to the tree (but sometimes infected fruit will fall).
5. As soon as adults emerge they need a drink within 48 hours or they die.
6. They eat liquid food like nectar, juice from damaged fruit, honeydew or exudates on leaves.
7. Adults need to feed on protein to become sexually mature (esp. female).
8. Adults can live at least 3 months and overwinter as adults. Few survive below 2.6°C.
9. They can breed when daily max temp is 20°C.
10. Females can store sperm and use it for weeks. Once they've mated they find host fruit to lay into by sight and smell.
11. Their preferred habitat is trees. They will briefly enter the edge of a vegetable patch to find suitable host fruit if necessary, but quickly retreat to trees.
12. They can't fly strongly, usually only 5-50cm from branch to branch or close to the ground between trees. 90% of flies never travel more than 600m from where they emerged. They rarely fly across open country. They can only fly at temps over 16°C.
13. Flies only mate for 30 minutes at dusk. At this time groups of males gather and produce pheromone to attract females.
14. The main way flies move to a new area is on vehicles, equipment, plants or infected fruit.
15. They prefer dark spaces to brightly lit ones.
16. They are attracted by fruit smells, ammonia, trees, the colour yellow and dark spaces. They are repelled by white and brightly lit spaces, and will not enter greenhouses.

## What you need to do...

1. Find out whether you have QFly with monitoring traps containing lures to attract the flies. These mainly attract male flies.
2. Monitor traps regularly and record your findings.
3. If flies are present, use a protein bait spray like Naturalure every 3-7 days. Use more rather than less, at the highest recommended rate, or you risk breeding resistance. Adding carbohydrates and thickeners and spraying in the morning can improve effectiveness.
4. If you know flies are present, MAT traps can also be used. These kill male flies, however they make monitoring traps ineffective. Space traps every 20 m or closer.
5. Female-biased traps can also be used. They can catch a lot of flies, but need regular servicing and haven't been proved to reduce stings. The more you have, the better.
6. Enclose fruit trees in white netting as much as possible; a full frame is best, but simply draping the net over the trees is also worthwhile.

7. Spraying fruit (particularly apples and pears) with kaolin can reduce the number of larvae in fruit by 90-100%. However it's expensive, needs re-applying after rain, and can be difficult to remove from harvested fruit.
8. Pick up all fallen fruit—if it's already infected it can become a breeding ground.
9. Manage trees with pruning.

# 1: Species

There are lots of different flies that damage fruit (including fruit vegetables), and can be confused for each other. Here's the most common ones, and a little about each one:

## Queensland Fruit Fly (QFly)—*Bactrocera tryoni*



The species most people think about when talking about 'fruit flies'. They can infest nearly all fruits & fruiting vegies.

Adults are about 5-8mm long with reddish eyes, are generally brown with yellow 'shoulder pads' and other markings including a yellow triangle at the base of the thorax (mid-section). Native to Australia and found across the NT and throughout eastern Australia.

- Number of larvae: usually 2-10 per fruit (can be up to 20 or more)
- Larvae appearance: white to cream, black feeding hook visible in mature larvae, smooth bodied, 2-9mm long
- Larvae shape: wedge shaped, plumper at tail than head
- Spiracles (breathing holes): very slight bumps at tail end
- Host material (fruit/veg): soft, spongy, starting to rot. Can be fully eaten out with only skin left
- Pupae appearance: like a large grain of brown rice, variable colour

## Vinegar Fly—*Drosophila melanogaster*



In general, if larvae are found in fruit already rotting on the ground, it has probably been infested by vinegar fly.

It's important to be able to tell the difference between these larvae and those of QFly; fruit fly damages intact fruit, whereas vinegar fly only attacks previously damaged fruit.

- Number of larvae: usually more than 30, rarely less than 10
- Larvae appearance: white with black feeding hook, slightly notched along body, 1-5mm long
- Larvae shape: slender throughout
- Spiracles (breathing holes): distinct long breathing tubes at tail end
- Host material (fruit/veg): liquefied and rotting
- Pupae appearance: like a small slender grain of brown rice with two small prongs at the end

## *Atherigona* sp

This is another larvae sometimes found in rotting capsicums that looks very like fruit fly, but has distinct black spiracles (breathing holes) at its tail end and a large mouth hook. They only lay eggs in damaged or rotting fruit, so are not a threat like fruit fly.

### Mediterranean Fruit Fly (Medfly)—*Ceratitis capitata*

A native of Africa, it was introduced to eastern Australia but is rarely found there (mainly due to competition from QFly), and is mainly only found in south-west WA and north along the coast to Carnarvon. Can infest a very wide range of fruit and fruiting vegetables. Smaller than QFly, only 3-5mm long and quite colourful.

### Lesser Queensland Fruit Fly—*Bactrocera neohumeralis*

Infests a similar range of crops as QFly. Hard to distinguish from it as they are closely related and look very similar, but it's slightly darker and lacks one set of yellow 'shoulder pads'. The main difference is that Lesser QFly mates during the day, and QFly mates at dusk.

### Cucumber Fly—*Bactrocera cucumis*

Outbreaks are becoming more common in areas producing cucurbit vegetables (e.g. squash, cucumbers), and can occasionally infect solanacea vegetables (e.g. capsicums). Occurs in south-east Queensland and northern NSW. Lighter brown and more slender than QFly, and has a distinctive yellow keel in the centre of its back.

### Jarvis's Fly—*Bactrocera jarvisi*

Increasingly being recognised as a pest of fruiting vegetables, especially capsicums and chillies. Very common in north Queensland, also in WA around Broome, and throughout the Northern Territory. Looks like QFly but has a distinct, wide cream band with dark stripe either side on its abdomen.

## 2: Life Cycle of the Queensland Fruit Fly

At the right temperature, a fruit fly can complete their life cycle in less than a month - which helps to explain why they're so successful!

### Laying eggs

A single female fly can lay more than 500 eggs in her lifetime. Females have a sharp 'ovipositor' (or egg layer) sticking out behind them, which they use to deposit eggs just under the skin of the fruit. The ovipositors are not very strong, so they'll often use an existing opening like a split or wound. (The ovipositor makes it easy to tell males from females, as males just have a rounded abdomen.)

- Fruit usually has to be ripe, but flies will lay eggs in unripe fruit if there's not a better solution, or if there's a lot of flies.
- Eggs are only laid into fruit that is still attached to the tree. Fruit that is already rotting or on the ground is not attractive, however, infected fruit that has started to decay will sometimes fall from the tree, and orchards and gardens with a lot of fruit lying on the ground can become breeding grounds for fruit fly.
- It takes 2-5 minutes to lay a batch of 6-20 eggs.
- The eggs are thin and white, around 1 mm long (barely visible).
- They hatch after 1-2 days at 26°C.
- Sting marks where the flies have laid eggs are easy to see on light coloured fruit, but harder on vegetables.

### Larvae

Larvae are less than 2mm long when they hatch, but grow quickly (the different stages are called 'instars'). They mature after 6 days at 26°C, reaching 5-9 mm long. They're creamy colour with guts the colour of the food they're eating.

- The larvae are associated with bacteria which break down the fruit flesh into semi-liquid for easy digestion.
- Larvae feed underneath the fruit skin so damage can be hard to see from the outside, though sometimes there's sunken or discoloured areas
- If you break the fruit open you'll find soft, cavity-riddled flesh but without obvious fungal infection
- In stonefruit and apples, the larvae can burrow into the centre of the fruit which can become brown and slimy

### Pupae

Once larvae are mature they hop from the fruit and bury themselves in the soil and form pupae, which look like large grains of brown rice. After about 10 days, the young fly breaks the top off the pupal case and emerges from the soil.

### Adults

As soon as the adult emerges and spreads its wings, it needs a drink of water - if it doesn't get one within the first 48 hours or so it will die.

Flies can't eat solid food, so they need either liquid food or food they can dissolve in regurgitated gut liquid, like nectar, juice from damaged fruit, honeydew or exudates on leaves. Both males and females need to feed on protein to become sexually mature, especially the female for producing viable eggs. The more protein she can find, the more eggs she can lay. Natural sources include bird droppings and bacteria on leaves.

Adults can live for at least 3 months, possibly longer. It's widely believed that flies overwinter as adults, not pupae or larvae, however survival is poor if average yearly minimum temps are below 2.6°C.

## Mating

Fruit flies can breed when daily maximum temps are at least 20°C. At this temp, adults become mature within 10-14 days, then they search for a mate. Flies only mate for about 30 minutes at dusk. Males gather in groups in trees (lekking points) and emit a cloud of pheromone to attract females. Males are more likely to mate if:

- they've fed on the para-pheromone cue-lure;
- they are able to "sing" (produce a buzzing noise)

Females may mate once or many times. They're more likely to re-mate if they sense their first mate lacked fitness. Female flies can store sperm from a single mating and use it to fertilise eggs for weeks.

Once the females have mated, they search for a suitable host to lay eggs, mainly using eyesight, but also smell. Preferred hosts are soft fruit like peaches, loquats and feijoas. Less common (but acceptable) hosts are lemons, grapes and passionfruit.



## 3: Queensland Fruit Fly behaviour

Understanding how fruit flies behave and their likes and dislikes helps to 'set the scene' for how we can best prevent them moving into areas where they are not yet established.

Fruit flies come from the forest, where they like to hang out at the edges. Trees provide the right habitat for them to mate, as well as find food, moisture, host fruit and shelter. Bird droppings on trees and bacteria on leaves are good food sources for them. In contrast, veggie patches are relatively barren places for them.

This means that although flies will enter a crop to search for host fruit, they usually only travel a short distance into it, especially if there are trees nearby. Fruit near the patch edge is most vulnerable, and because the main reason for being in a veggie patch is to lay eggs, it's likely that more female flies enter than males.

### Flight

Fruit flies can't fly very strongly! They spend more time walking around in trees than flying around. When they do fly, it's often short distances (5-50cm) from branch to branch, or close to the ground in between trees (around 2m off the ground).

They can only fly at temps above 16°C, and it's harder for them to fly if it's very windy or low humidity. Adults can fly better if they were well-fed as larvae.

If food and host fruit are available, a whopping 90% of flies won't travel more than 600 m from where they emerged. They rarely travel more than 1 km during their lifetime, and rarely fly directly across open grassland or grain crops. One of the reasons for this is because it's easier to find mates if they stay close. They only mate for around 30 minutes at dusk. During this brief time, groups of males gather together producing a plume of pheromone to attract females, which makes it likely that the small amount of pheromone produced by one male makes it hard to attract distant females.

On the rare occasions flies travel long distances, it's probably by accidentally being moved on vehicles, equipment or plants, i.e., human-assisted journeys! Most outbreaks of fruit flies in remote areas have been linked to infested fruit carried into the region, rather than incursions by travelling flies.

### Likes and dislikes

- Yellow seems to attract QFly, which is why many monitoring traps are this colour;
- They seem to be repelled by white (use of white plastic may be one of the reasons that fruit flies almost never enter greenhouses);
- Reflected UV light can attract them, especially at dusk;
- They prefer to gather in dark spaces rather than brightly lit ones;
- They are attracted by certain fruit volatiles;
- They are attracted by ammonia;
- They like trees and 'tree-shaped' objects

Damp, tree-lined areas around creeks and dams are good habitats, and it's been suggested that creek-lines are the main route they use to move through the landscape.

## 4: Monitoring

The purpose of monitoring is to find out whether flies are present in your garden, and whether the numbers are increasing or decreasing. This won't tell you how many flies are in your actual crop, if females are present, or whether your fruit is infested. Even significant numbers of flies in the trap might not mean you have any flies in your fruit (which is good news!) However monitoring does help to tell you whether your control strategies are working or not, and it can also help you to focus your control methods on areas where there are more flies.

The government monitors fruit fly in lots of areas including the Sunraysia Pest Free Area in Victoria/NSW, and around ports to see if flies are coming into the area. This is probably not any practical use to you, but if you're in Victoria you can check their monitoring page here to see if there have been any recent outbreaks.

It's also useful to note the government protocols are what actions are taken if flies are found (this applies to monitoring traps on a 1 km grid):

- Up to 4 males in a 2 week period - do nothing
- 5 males or more in a 2 week period - put out more traps
- Gravid (pregnant) female - put a control program in place
- Larvae in fruit - put a control program in place

In an urban situation 1 km spacing is too far, and traps should be 400 m apart, or even closer if you're in a high-risk area or have risky sources (e.g. unmanaged fruit trees) nearby.

### Parapheromone Lures

Monitoring usually involves traps baited with 'parapheromones', which are manufactured chemicals that mimic pheromones. The one that attracts QFF is called 'cuelure' and it attracts male flies, not usually females. It's thought that this type of monitoring trap only attracts flies from within 10-20 m.

### Other Lures

If cuelure is being used as part of an "attract and kill" strategy, it's not as effective as a way to monitor the population so it's best to use a different type of lure (or bait). Some options include:

- liquid lures based on food, protein and/or volatiles—however these have a smaller zone of attraction, can attract females as well, and the liquid needs regular topping up and can become smelly and messy;
- gel lures—these are becoming available but still untested;
- fruit mimics e.g. the 'Ladd' trap, which has a sticky yellow sheet with a red ball in the centre.

### Trap Types

There are lots of different types of traps sold for monitoring QFF. Except traps like the Ladd trap, they all contain a dispenser for the cuelure. The "FT Mallett-CL Wafer" is a new type of dispenser that uses a waxy 'wafer' rather than a fabric wick, which seems to provide a better result.

Traps also contain a contact insecticide (you may need to add this, or it might already be inside the trap when you buy it).

Here's some common traps you can buy (but essentially they all do the same thing, so it doesn't matter which one you use):

**McPhail trap** - the original fruit fly trap once widely used in government trapping grids. It has a yellow base and clear lid. The lure can be suspended from the lid (inside), or have a liquid protein lure added. Flies enter through a hole in the base. They used to be hard plastic but new models are more lightweight and cheaper.

**Biotrap** - also has a yellow base and a clear lid, and can also take either cue lure or a liquid lure. When baited with a wax wafer impregnated with cue lure + maldison (insecticide) it's been shown to be a very good monitoring tool.

**Probodelt Conetrap** - comes flat packed, and is easily clipped together. The inside of the lid is coated with an insecticide, and the cue lure is inside a sachet which is put inside the trap. Flies enter through inverted holes in the side but then move towards the light, and are killed on contact with the lid.

**Lynfield trap** (and similar versions) - usually baited with dental wicks that have been soaked in cue lure + maldison (insecticide). A version of this trap made by Organic Crop Protectants (OCP) avoids handling risks by using a baited fabric wick that is secured inside a plastic protector, which is installed under the lid.

### Where to Put Traps

As we covered last week, fruit flies come from the forest, and they like to rest and feed in trees, especially those near wet areas like dams or creeks. Therefore, the best place to put traps is in tree lines around the edge of your garden, orchard or crop area.

Extra traps can be put around areas where infestations might come from (like neighbour's backyards with un-managed fruit trees), or creeks.

Under cold conditions flies are likely to be attracted to warm areas like the north side of trees, but if conditions are hot and dry they're more likely to be on the south side.

### Checking Traps

If you have multiple traps, number them and list them on a property map so anyone can check them.

They need to be checked weekly when populations might be increasing or high, i.e. when daily maximum temps reach 22°C. At cooler times it's still good to have monitoring traps out, but they only need checking every 2-4 weeks.

Keep a spreadsheet, and record whether any flies are found and if possible, record whether they're male or female, because finding a female inside a trap can indicate you've got a LOT of flies around and action needs to be taken.

## 5: Protein Bait Sprays

Monitoring traps (containing cue lure) are designed to attract mainly male flies - to let you know if there are flies about.

The protein baits we're talking about this week can attract both male and female flies, but are especially attractive to newly hatched females which need protein to mature and lay eggs - it's a method to attract and kill flies.

Sprayable baits contain PROTEIN + INSECTICIDE (and some have other ingredients as well). There are many different commercial versions available, but the only ones you can use in organic gardens use a natural insecticide called Spinosad, so that's the only commercial one we'll talk about. You can also mix up your own Protein Bait Spray at home.

### Protein

Yeast autolysate is the usual protein source used. If you're buying a bait based on Spinosad such as Naturalure, it will have been pre-mixed with the protein component. If you're making your own bait spray at home you can use Vegemite (or similar yeast extract) as the protein source. Insecticide

Spinosad is the only insecticide registered to kill fruit fly that is allowable in certified organic growing, so it's the only one we'll recommend. It's made from a naturally occurring soil bacterium and has very low toxicity to everything except fruit flies.

Spinosad kills by ingestion (i.e., the flies have to eat it), so it's safer for bees and other beneficial insects as they're not attracted to the baits.

It's degraded by UV light and only remains active for 3-7 days (depending on the weather), so bait spray should be re-applied at least weekly, and more often if possible because the baits are most attractive when they're fresh.

Another factor to consider is that flies must eat enough of the bait to die. If it only eats a small amount it won't die, and this can breed resistance. If flies have already fed on protein they'll be less attracted and eat less bait. Naturalure is therefore less effective against female flies that have already fed on protein.

The Naturalure label suggests two different dilution rates (applied at different volumes so the same total amount of Naturalure is put out).

- 1 part of Naturalure in 1.5 parts water - this is thicker and harder to put out, but is the most effective rate and lasts longer in the environment.
- 1 part of Naturalure in 6.5 parts of water - easier to put out through regular spray equipment, but less likely to deliver a lethal dose, and it doesn't last as long.

### Other ingredients

- Carbohydrates (i.e. sugars) can also be added to baits to make them better at attracting flies, but then they're also more likely to attract non-target insects like ants and bees.
- Thickeners can help stop the bait from drying out or being washed off by rain. xanthan gum is a great thickener to use. You can buy a certified product online for about \$30/kg, or less if you buy

in bulk (you can also get smaller quantities but it's much more expensive). The xanthan gum helps the spray mixture to stay in good sized droplets on the bark and leaves of your trees, which makes it easier for the flies to ingest enough to kill them. It will also help the spray to stay effective for 5-7 days, but you'll still need to re-spray at least once a week (or more often if you've had enough rain to wash the previous spray off). Here's how to use it:

- The day before you plan to spray, mix the xanthan gum in water to give it a good chance to dissolve, as it's hydrophobic, and give it plenty of agitation. Use 5g per litre of water. You can then store this solution.
- On the day you'll be spraying, 3/4 fill your spray tank with the xanthan + water mix first, then add the Naturalure slowly, mixing thoroughly as you do so.
- Spray each tray with a continuous stream spray (rather than fine mist).

### Where to put your bait

- In commercial orchards, bait sprays are usually applied to the base of the trees every second row to attract flies emerging from the soil looking for a protein source. In the garden you can spray the bait around the bottom of all your fruit trees.
- In vegie crops you can't spray the vegetables, so the baits are applied to vegetation around the perimeter. This is a good idea anyway, because trees next to the vegie garden are where flies are likely to hang out, rest and mate.
- Baits work best when sprayed on vegetation rather than other things like fences because flies are more likely to eat them from leaves.
- Try to spray your baits at about 1 to 1.5 m off the ground because that's the height that QFly like to rest and mate in the trees usually roosts.
- To compromise between spraying the base of the trees and the zone where the flies roost, it's probably best to spray the trunks and lower foliage of the trees about 1 m from the ground.

### How & when to spray

- If possible, use spray equipment with a coarse spray, resulting in droplets of 2 mm across.
- If there's more than 5 mm rain you'll need to re-apply the bait.
- After emerging from pupae it takes females about 2 weeks to reach maturity, and it's during this time that they're most actively searching for protein so they can mature their eggs. Having fed once, they're less likely to eat protein again. Bait sprays should therefore start when young female flies are starting to emerge.
- Fruit flies most actively look for food in the morning, so spraying early in the day not only reduces risk to bees, it ensures fresh bait is there when the flies want it.
- If you decide to use bait sprays as one of the tools in your fruit fly management 'toolbox', it's also a good idea to keep a record of every time you spray.

## 6: Male Annihilation Technique

So, on to Male Annihilation Technique (MAT) - this is a technique that uses the same lures and insecticides that are used for monitoring, but without the trap to retain the dead flies.

It's part of the 'toolbox' that can be used in large commercial orchards, but has little application for backyard growers, who are better to just increase the number of traps they have in their garden.

### How it works

An absorbent material (similar to the 'wick' inside the monitoring traps we've already covered, or caneite blocks, or compressed cardboard) are soaked with parapheromone (cuelure) + insecticide. These are just then hung in the fruit trees, they attract male flies, which come into contact with the insecticide and die.

### Pros

- Cheaper than the monitoring traps (because there's no vessel to catch the dead flies), therefore you can have more about the orchard or garden at a lower cost
- It kills more male flies, leaving less to breed
- The insecticide usually lasts quite a long time, for 3-6 months

### Cons

- It doesn't kill all the male flies (most effective on young males)
- Only attracts flies from 10-20 metres away (and not all of them), therefore need to space them at least every 20 metres apart
- Males can mate lots of times, so even if you kill most of them, the remaining ones can impregnate lots of female flies so you may not be reducing the problem very effectively
- If you're using the same lure+insecticide mix as in your monitoring traps, using MAT can affect your monitoring results - by killing lots of males with MAT you won't see as many in your monitoring traps and you may think the population is decreasing but the female population may actually be increasing.

The take-home message? Don't use MAT alone, only as part of a comprehensive management plan, and focus on the more effective tools first.

## 7: Female Biased Traps

Traps that target female fruit flies aim to lure and kill a large percentage of the population. They can be based on food, fruit volatiles or fruit mimics (because there are no pheromone-based lures for females available).

Unfortunately, though they can be very effective in catching a lot of flies, there's no real evidence that they reduce the amount of damage in crops! Think of them not as a solution in themselves, but as another tool in the toolbox, best used with a range of other anti-fruit-fly techniques.

### Cera Trap

The Cera Trap is food based, containing a liquid protein mixture with a mild ammonia smell. It's great for organic gardens because no insecticide is needed — the flies simply drown. The liquid needs to be kept well topped up, so the traps need regular servicing in hot weather.

One downside is that the trap can also attract significant by-catch like blowflies, ants etc, especially once captured insects start to rot. If large numbers are caught, it's a good idea to strain the contents to remove dead insects and put the cleared liquid back in the trap (which can be a bit messy and time consuming, but worth it).

Cera traps actually attract both male and female fruit flies, but have a bias to females.

Liquid protein doesn't have a very strong smell so these traps have a fairly small zone of attraction — so the more you have, the better (though as mentioned above, these traps haven't actually been shown to reduce the number of infested fruit in commercial crops).

### Fruition Trap

This combines a slow-release sachet of fruit volatile aromas with a large, sticky, cobalt blue sphere. Flies attracted by sight and smell can become stuck on the sphere. The developers claim the smell remains attractive for up to 8 weeks. Again, the downside is that you can accidentally catch non-target species. It's fairly new and therefore its effectiveness isn't really known.

### Biotrap with gel attractant

This is an ammonia- and fruit-volatile-based gel which is stated to last up to 3 months. It's combined with a DDVP cube which kills flies entering the trap. Suggested spacing is 15-metre intervals around the perimeter of the crop, but again these are relatively new so their effectiveness in reducing damage to the crop is not really known.

## 8: Physical Protection: Netting

Finally, some good news on Fruit Fly! So far we've described traps that are part of the solution, but don't make a big dint in the problem. This week we're talking about netting, and it provides much more hope than you might think.

Previously, it was thought that your crop had to be fully enclosed in insect-proof netting (which has much smaller holes than the more common bird or hail net), with "air-locks" for entry of people and equipment—beyond the scope of most backyard growers (and many orchardists!).

It's now been found that most of the benefits of netting can be obtained with much lower levels of security. Experience with orchard fruit has shown that installing white hail netting on both top and sidewalls of an enclosure around fruit trees greatly reduces the entry of flies into the orchard. It seems that white mesh is better than any other colour (green, black and even red are not unusual netting colours), as white is repellent to fruit flies.

Flies use both visual and scent cues to find host fruit. Hail netting and windbreaks hide the crops from flies, and may even reduce drifting fruit aromas. If flies can't see or smell the fruit, there's no reason for them to go inside the enclosure (the same is true for greenhouses, but we'll go more into that later).

However, none but the most diligent home fruit grower builds a full enclosure around their fruit trees—most rely on drape netting (if they have any netting at all), so the big question is—does drape netting work?

The wonderful (and amazing) answer is YES! Drape nets provide a similar visual barrier to fruit flies, and even if a few flies get through the netting, experience with commercial orchardists and vegetable growers has shown that the number of infested fruit can be reduced to almost zero!

Drape netting over fruit trees can either be draped on the tree itself, or over a frame, and then secured to the ground somehow (a few shovelfuls of dirt works as well as any other method). Various grades of netting can be used, from quite coarse windbreak materials through to very fine nets designed to exclude all pests.

Apart from the fruit fly protection, there are lots of other benefits from using nets:

- protection from wind, heavy rain, hail and sunburn;
- they reduce water requirements;
- can exclude various pests (depending on the pest and the grade of net used);
- light is diffused and evaporation reduced, often resulting in larger, healthier plants
- improved fruit set may be seen in vegetable crops

A trial with a type of net called VegeNet (from a company called NetPro) showed that it was an effective visual barrier to fruit fly but did not exclude natural predators from the crop. No QFF infected fruit was found under the material while it remained intact. This particular net is very lightweight, weighing only 45 g/m<sup>2</sup> with a mesh size of 1 x 3mm.



Trials were also done with the finer meshed Insect Net (0.8mm holes, 70g/m<sup>2</sup>) which is relatively transparent, but this net also excluded beneficial insects and so the vegetables ended up being infested with aphids.

A third trial was done with Vent Net, and even though this trial let more flies through than the other two, the amount of fruit damaged was still almost zero! It seems likely that male flies were strongly attracted by cuelure in traps under the nets, motivating them to find their way through the mesh, whereas females didn't get through.

Placing netting over the crop while the plants are still small, even before fruit set, has been shown to give the best improvements in plant health in vegetable crops.

Like anything, there are pros and cons. Netting adds costs, both in materials and labour. It makes accessing the fruit more difficult (which is even more of a nuisance if you're picking from the same tree multiple times).

Most netting can be re-used a number of times; the more lightweight the net is, the more likely it is to tear. Single use frost protection nets are relatively cheap and can also make effective insect barriers, but they tear easily in the wind and can end up being a false economy.

So, to sum up, netting is highly effective against fruit fly, and will probably also give you a host of other benefits!

## 9: Physical Protection: Greenhouses and Kaolin Clay

Greenhouses offer even better protection than nets, as fruit flies rarely, if ever, enter them. How great is that? Maybe the solution to the threat and spread of QFF is just to grow all our produce in greenhouses...

...or not. When we're aiming to establish biodiverse systems that are part of the bigger ecosystem in which they exist, greenhouse growing may be a part of the mix, but not the solution.

There's a few reasons fruit flies don't usually enter greenhouses:

- the physical barriers of the walls;
- the crop inside is usually obscured from view;
- fruit flies are attracted to dark, tree-shaped objects not light box-shaped objects;
- fruit flies usually fly low to the ground or dart from tree to tree, and so are not attracted to doors and are therefore unlikely to enter even an open or mesh door;
- they are only like to enter roof vents if strongly attracted by fruit aroma, or if they're blown there accidentally.

### Kaolin clay

Kaolin is aluminium silicate, and comes from kaolinite, a natural mineral. It's allowed for use in organic systems. It's available commercially as products like Surround, and is most commonly used in apple and pear crops to prevent sunburn.

It's worth mentioning as part of the anti-QFF 'toolbox' because fruit sprayed with kaolin looks white and is therefore repellent to fruit fly. It also disguises the fruit and makes it harder for the flies to distinguish it from foliage, and the fine clay particles are believed to irritate flies that land on the fruit, discouraging them from settling.

The clay suspension is sprayed on using an agitated tank, coating the plants with fine, white powder.

### Pros:

- Trials using kaolin clay have found that it can reduce the number of larvae in fruit by 90% to 100% compared to untreated controls.
- The crystalline structure of the clay reflects red light wavelengths and diffuses sunlight, so photosynthesis is actually increased.
- It lowers temperatures on the leaf surface and reduces water loss.

### Cons:

- It's relatively expensive.
- It needs to be applied several times to get a good coating and re-application after rain or if overhead irrigation is used,
- After harvest fruit needs thorough washing to remove the clay, and it can be difficult to remove all the residue from odd-shaped fruit.

**Thanks to Horticulture Innovation Australia for this information, which comes from their 'Fruit Fly Management for Vegetable Growers' best practice manual.**