Fruit fly management for vegetable farms

ahr applied horticultural research

Jenny Ekman

This talk - How to kill flies

Copper arsenate

Lead arsenate

Tartar emetic

Sodium fluosilicate

Nicotine

DDT

The organophosphates

- Fenthion
- Parathion
- Dimethoate
- Maldison
- Trichlorfon

Spinetoram?

Methomyl?

Bifenthrin?

Imidacloprid?

Systems approaches – tools in the toolbox

- Ecology – what the fly does, where it goes, when it is vulnerable
- Chemical attack – cover sprays
- Food based baits
- Lure and kill
- Repellants and barriers
  - physical and chemical
- Biological controls
  - sterile insect technique, parasitoids

What fly is that?

- At least 78 species of fruit fly in Australia
- Only a few attack vegetables ***BUT*** can limit market access
- Little is known of most species
  - Existing lures may not work
  - May be mis-identified

Island fly – *Dirioxa pornia*

Queensland fruit fly (Qfly) – *Bactrocera tryoni*

- Australia's worst pest?
  - Attacks nearly all fruit and fruiting vegetables
  - Includes *Solanaceae* and *Cucurbitaceae*
- Features
  - Brown with yellow "shoulder pads" and yellow triangle at base of the thorax
  - Reddish eyes
  - Female with fairly short ovipositor

Qflies ♥ Horticulture

Original distribution

Mediterranean fruit fly – *Ceratitis capitata*

- A native from Africa, now found in
  - Europe
  - Central and South America
  - Middle East
- Introduced to Australia ~1897
  - Not found on east coast since 1953
  - In WA along the coast north to Carnarvon
- Features
  - Smaller than Qfly
  - Black and silver thorax
  - Striped brown abdomen

Cucumber fly – *Zeugodacus cucumis*

- Outbreaks are increasingly frequent
  - pumpkin, zucchini, squash, melons…
- *May* lay eggs in rotting products
- Does not respond to lures used for other species
- Features
  - Lighter brown and slender compared to Qfly
  - Yellow stripe in the center of its back

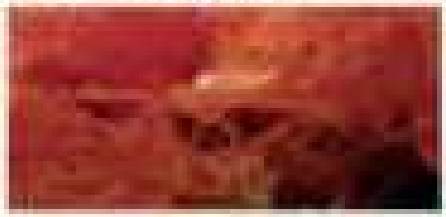
Lesser Qfly – *Bactrocera neohumeralis*

- Very similar to Qfly
  - Infests same products
  - Common in northern areas
  - Quarantine pest in some markets
- Differences from Qfly
  - Lacks one set of yellow ‘shoulder pads’
  - Mates during the day instead of at dusk…

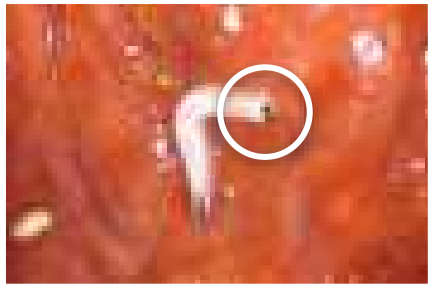
Jarvis's fly – *Bactrocera jarvisi*

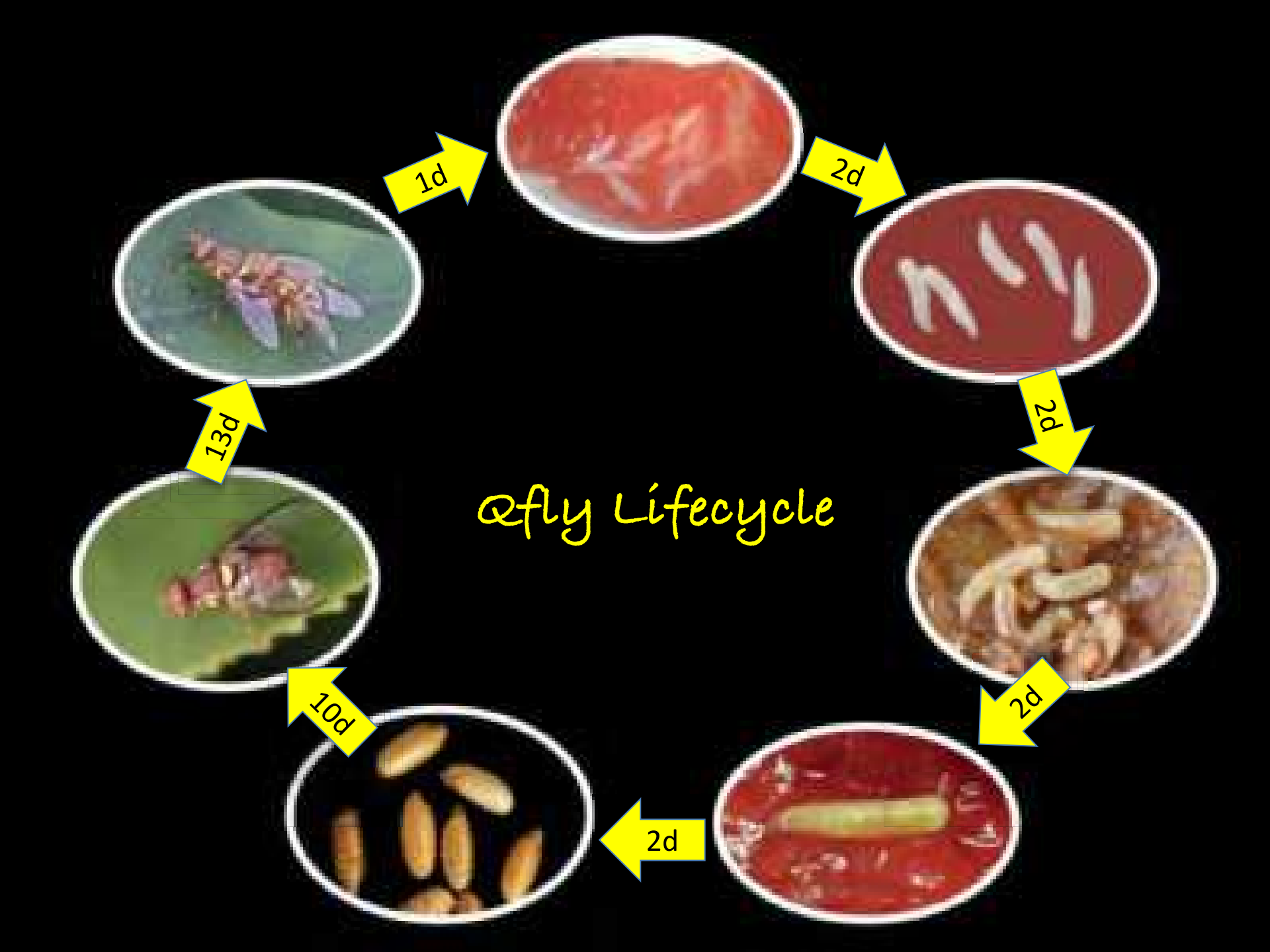
- Attacks capsicums, chillies, possibly other vegetable crops
- Very common in northern Australia
  - Loves mangoes
  - Can outnumber Qfly
- Similar to Qfly BUT
  - Intense striping on abdomen with cream band and dark keel
  - Thorax not striped
  - Long ovipositor

Fruit flies *vs* vinegar flies

Larvae number	Usually 2 - 10 per fruit, but can be 20 or more.	Usually >20 per fruit, rarely <10 per fruit.
Larvae appearance	White to cream, black feeding hook visible in mature larvae, smooth bodied. 2-5mm long.	White with black feeding hook, slightly notched along body. 1-5mm long.
Larvae shape	Wedge shaped, plumper at tail than head.	Slender throughout.
Larvae breathing holes (spiracles)	Very slight bumps for breathing holes in tail end.	Distinct, long breathing tubes coming out of tail end.
		
Host material	Soft, spongy, starting to rot. May be fully eaten out with only skin left.	Liquified and rotting.
		
Pupae appearance	Like a large grain of brown rice, variable colour.	Like a small, rather slender grain of brown rice, with two small prongs at one end.
		

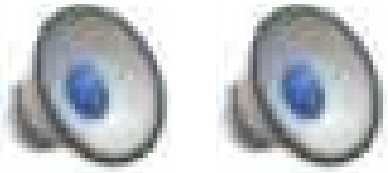
Atherigona sp.




Qfly Lifecycle
1d
2d
2d
2d
2d
10d
13d

Fruit fly lifecycle

calling courting



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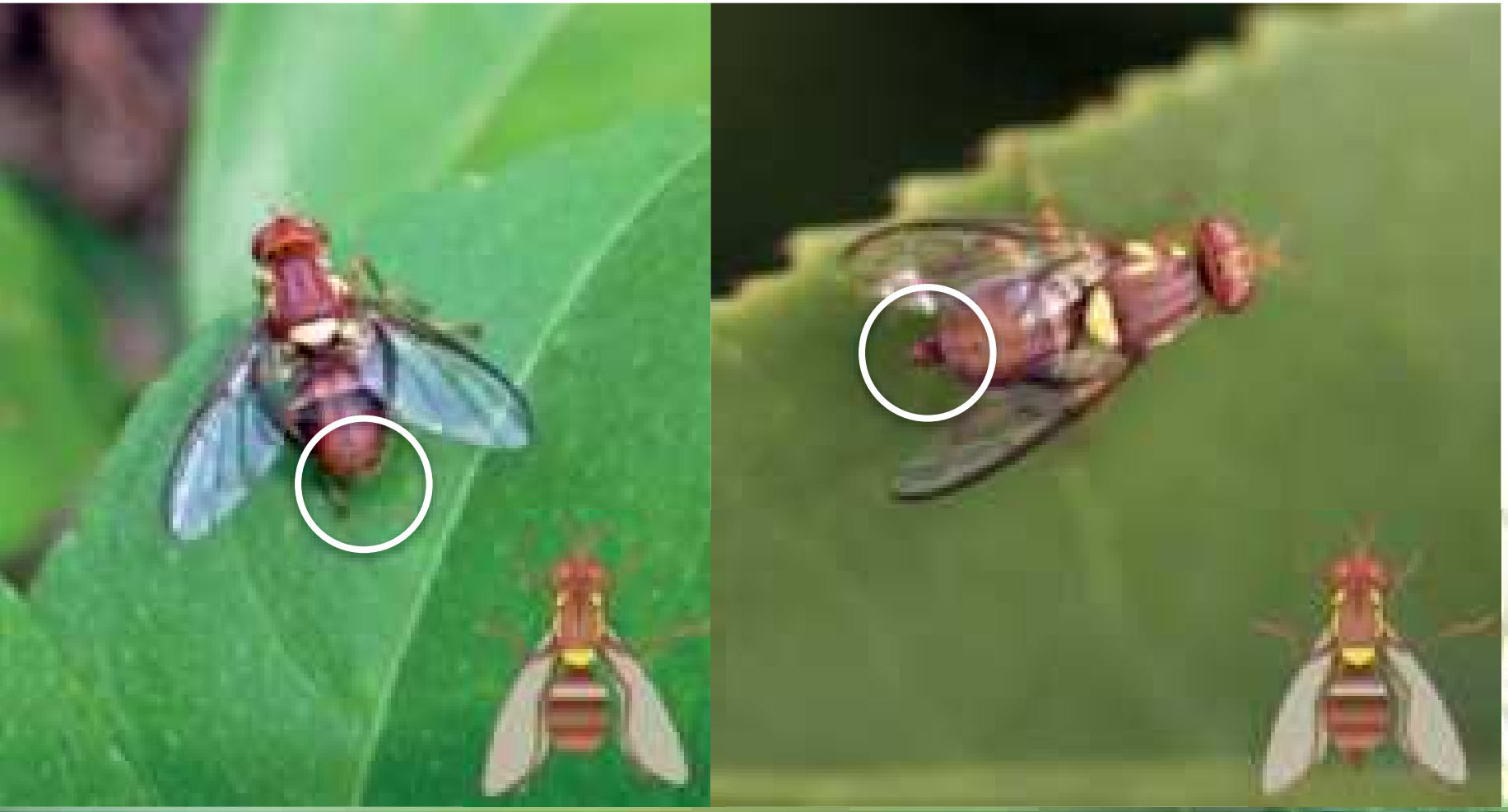
Telling boys from girls

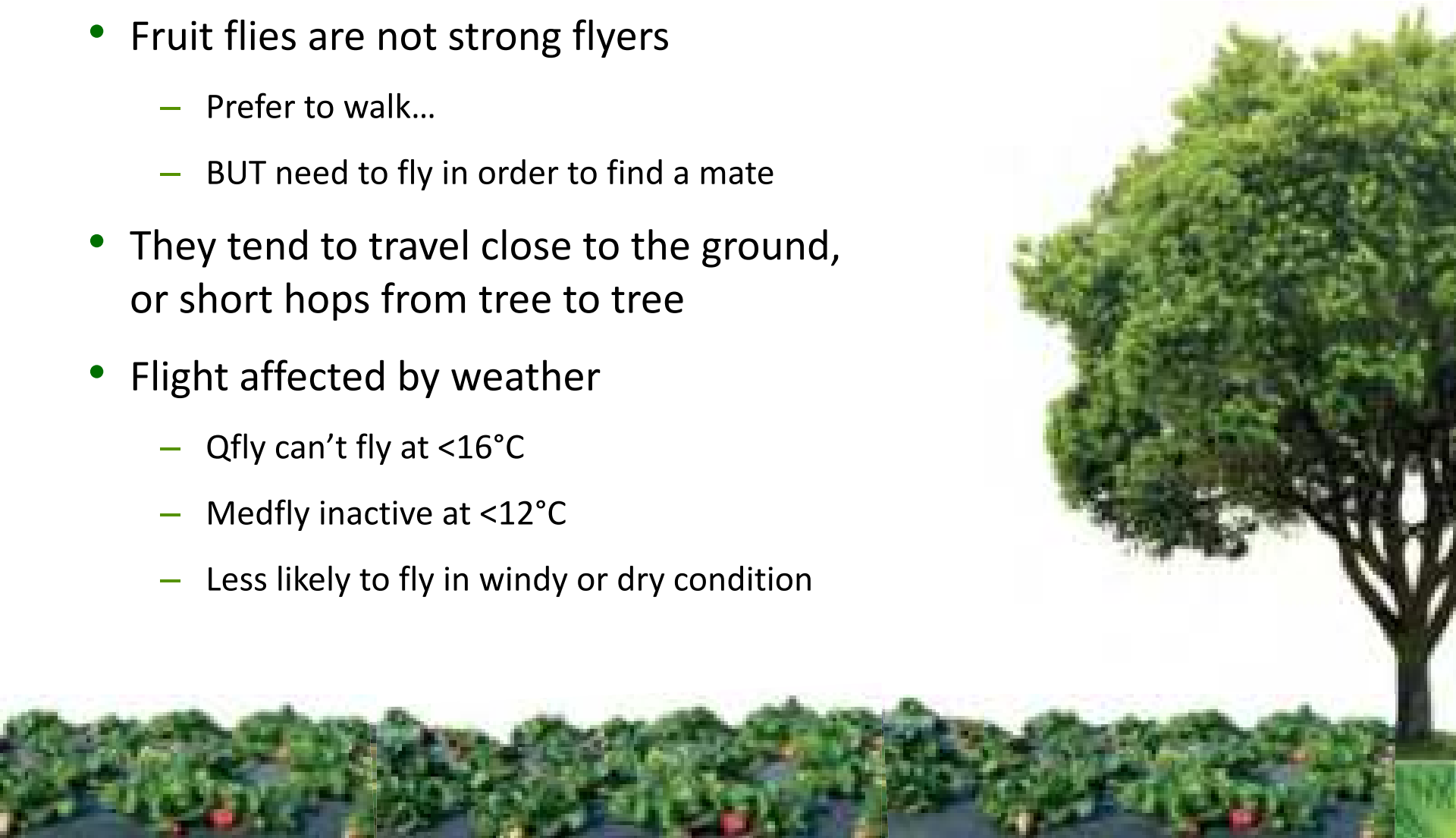


Where they go

- Natural habitat is the forest, especially the forest edges
  - Trees provide food, shelter and lekking points
  - Creeks provide water and are humid
  - Fruit flies are attracted to dark, sheltered places.
- Vegetable crops are not a good place to hang out!

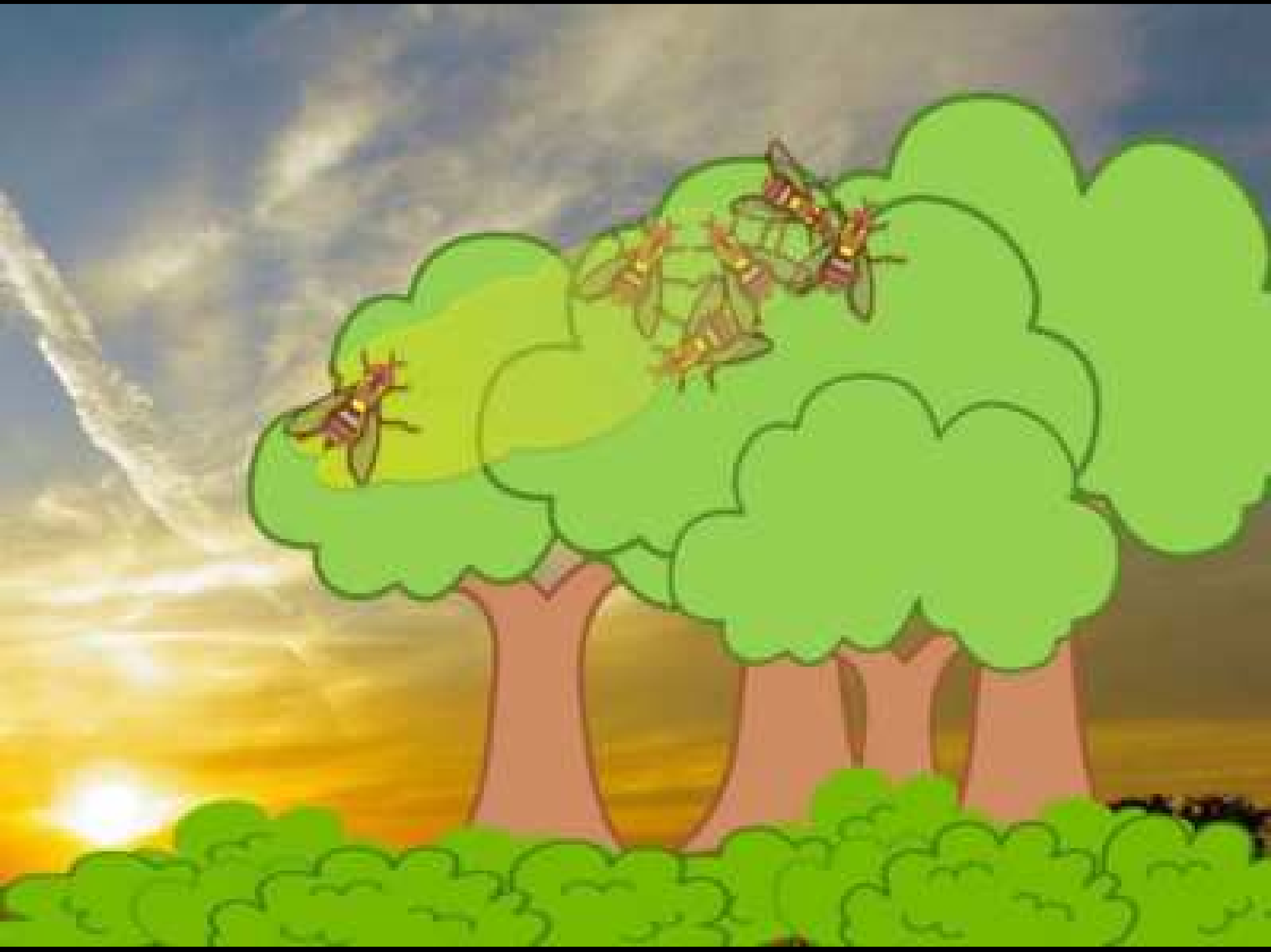
Host architecture

- Fruit flies are not strong flyers
  - Prefer to walk…
  - BUT need to fly in order to find a mate
- They tend to travel close to the ground, or short hops from tree to tree
- Flight affected by weather
  - Qfly can't fly at <16°C
  - Medfly inactive at <12°C
  - Less likely to fly in windy or dry condition



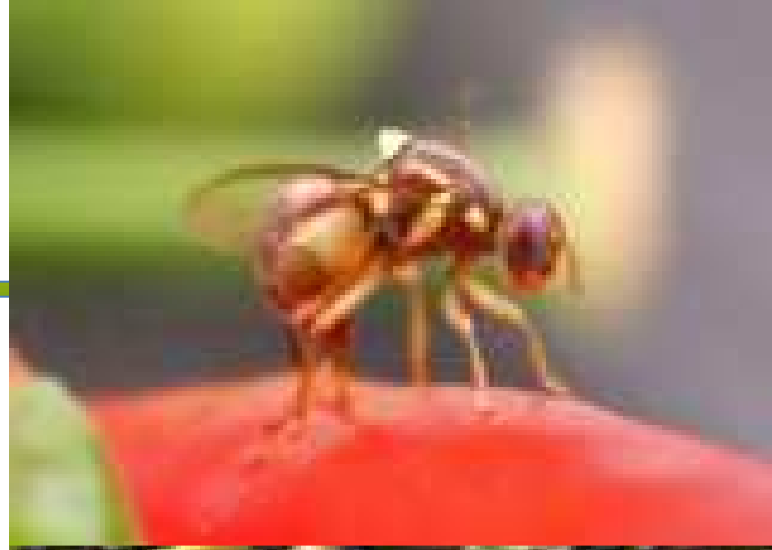
How far can a fly fly?

- Most fruit flies don't travel far during their lives
  - 98% of Qflies trapped within 500m of a release site
  - Mean radius of 24 Qfly outbreaks was 200m
  - One fly doesn't make an outbreak (unless a pregnant female)
  - As flies disperse they find it harder to find a mate



Laying an egg

- Optimum temperature 25-30°C (Qfly)
  - Female Qflies re-sorb their ovarian follicles at <13.5°C – no more eggs
  - Larvae stop developing, killed at 3°C
  - Maximum temperature ~ 36°C
- Finding hosts
  - Visual cues most important
  - Aromas also attractive
  - Soft, ripe fruit are preferred
  - If populations are high, flies lay into non-preferred hosts – such as grapes, lemons and eggplant



Laying an egg

- Fruit flies lay into intact fruit
  - *Cucumber fly may be an exception!*

Infested fruit sometimes detach

Premature drop can be a sign of infestation

Monitoring

Monitoring – why

- The purpose of monitoring is to find out….
  - Whether flies are there
  - Whether numbers are increasing or decreasing
- Monitoring DOES NOT indicate
  - How many flies are in the crop,
  - Whether females are present or
  - Whether the product is infested
- Monitoring DOES indicate
  - Whether control strategies are working
  - Where ‘hot spots’ are developing

Monitoring - how

- Monitoring usually involves a **male** attractant – a ‘parapheromone’
  - Cuelure attracts Qfly and Lesser Qfly
  - Trimedlure attracts Medfly
  - Methyl eugenol mainly attracts exotic species (eg Oriental fruit fly)
  - Zingerone attracts Jarvis’s fly
- Approximately 40% of species have no known parapheromone lure
  eg cucumber fly
- Zone of attraction is limited…
  - Cuelure (likely) 10-20m
  - Trimedlure = 32-50m

Monitoring - how

- Parapheromone impregnated into cotton wick or wax matrix
- Mixed with insecticide eg malathion, DDVP (dichlorvos)

Dental wick

Bugs for Bugs

FT Mallett-CL wafer

Traps

Bugs for Bugs

Cone Trap

BioTrap

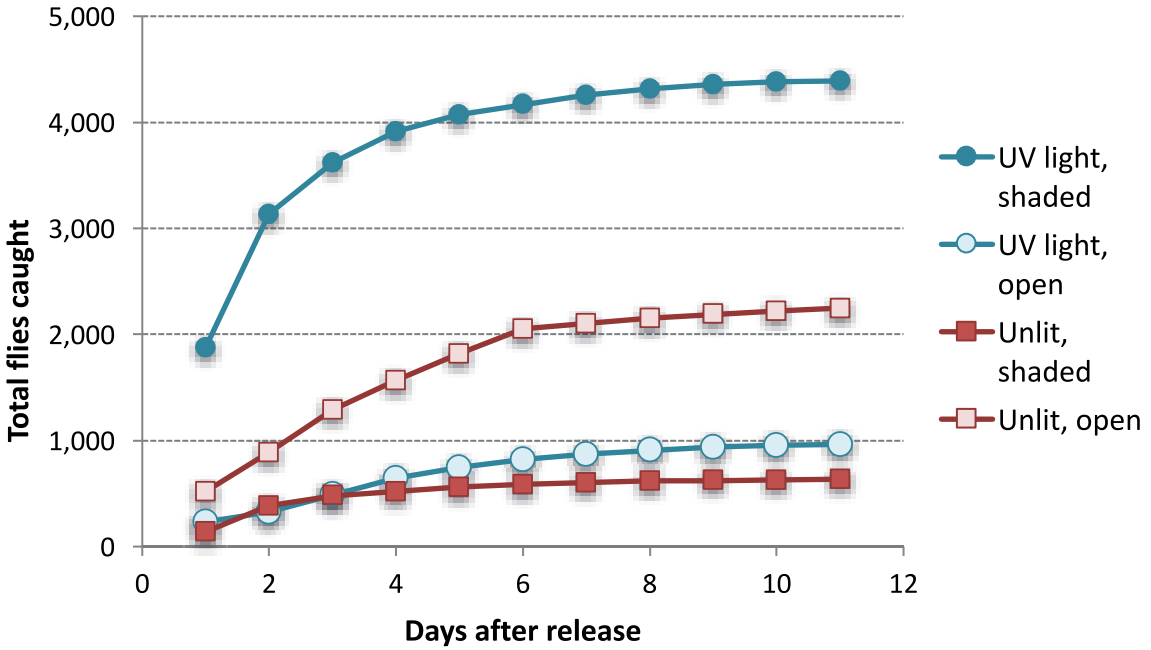
Monitoring - how

- Lures can also be based on food, volatiles or fruit mimics
  - Used if para-pheromones are included as part of an attract-and-kill strategy
  - Zone of attraction very small
  - Food lure = messy
  - Sticky trap = by-catch + potentially labour intensive

Ladd trap

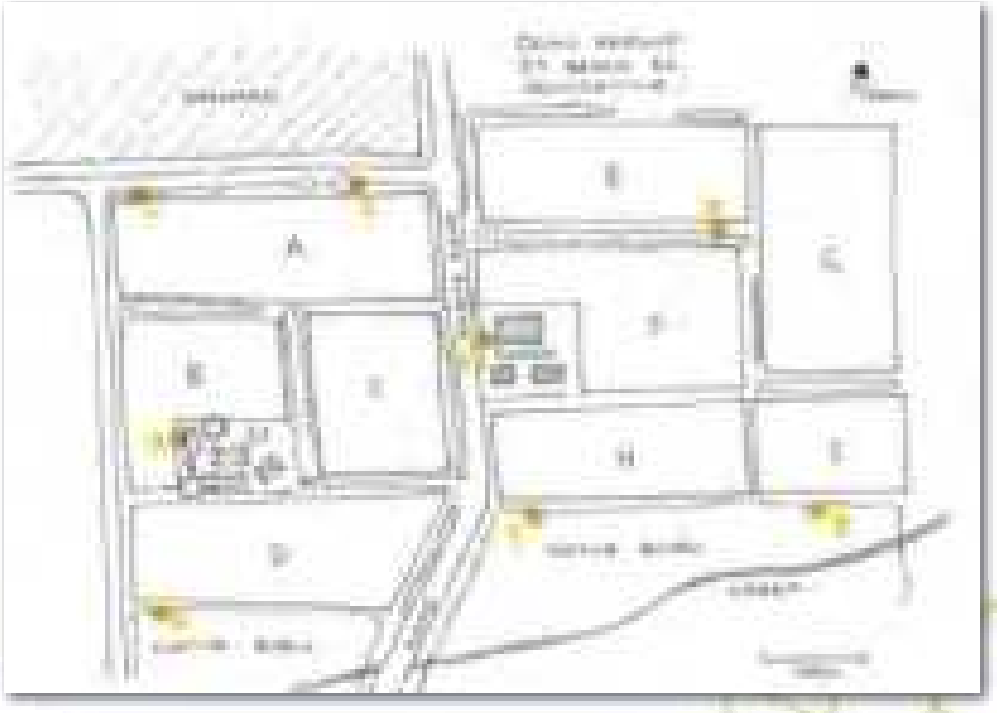
Monitoring - how

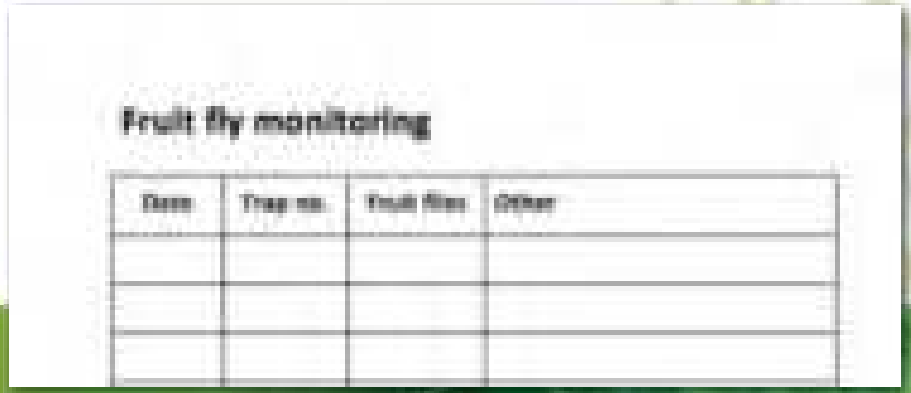
- New work has shown UV-C light to be attractive to fruit flies
  - Worked best when light was against a dark background



Trap placement

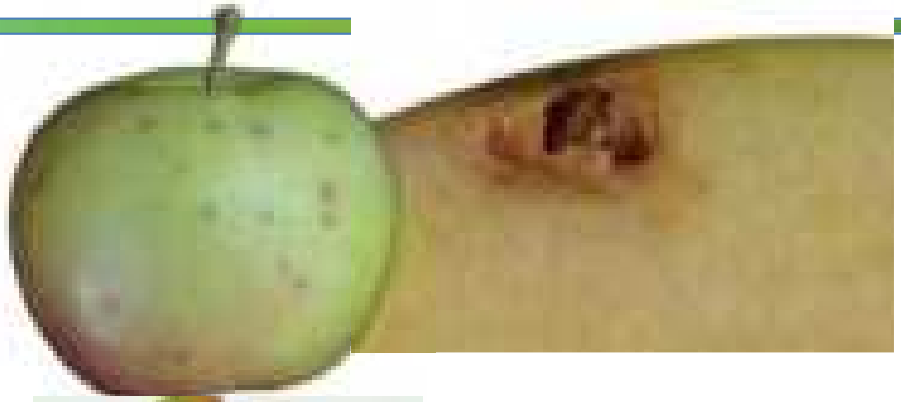
- Standard spacing = 400m
- Where flies are likely to be
  - Creeklines
  - Neighbouring orchards
  - Tree lines
  - Warm spots in winter
- Check traps regularly
  - Weekly when daily maximums are >22°C (Qfly)
  - 2-4 weeks when conditions are cool



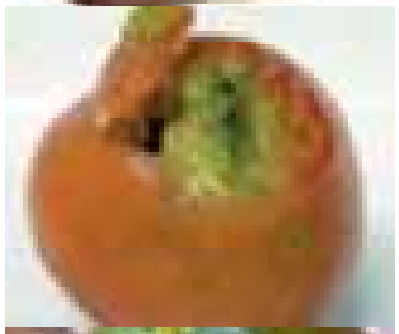


Finding infested fruit

Apples are easy



Tomatoes are OK



Capsicum are harder

Monitoring drives other management strategies

Food based baits

Food based baits

- Baits can attract both male and female flies
- They are most attractive to newly emerged females
  - Need protein to mature
- Ingredients affect effectiveness

Proteins

- Not all proteins are created equal
  - Attractiveness and phytotoxicity vary widely

Protein product	Formulation	Protein content	Bait consistency
Fruit Fly Lure™	Thick liquid	420 g/L	Suspension
Natflav 500™	Thick liquid	420 g/L	Suspension
CERABAIT™	Liquid	360 g/L	Suspension
Flavex® FL622	Liquid	140 g/L	Liquid
HYM-LURE™	Liquid	425 g/L	Liquid
ANAMED™ SPLAT (protein)	Paste		Paste
Flavex SPA400	Powder	420 g/L	Liquid
DacGEL™	Powder		Gel

Final Report MT12050
Farm wide fruit fly management for the east coast
Stef DeFaveri et al

Cucumber fly, Jarvis's fly

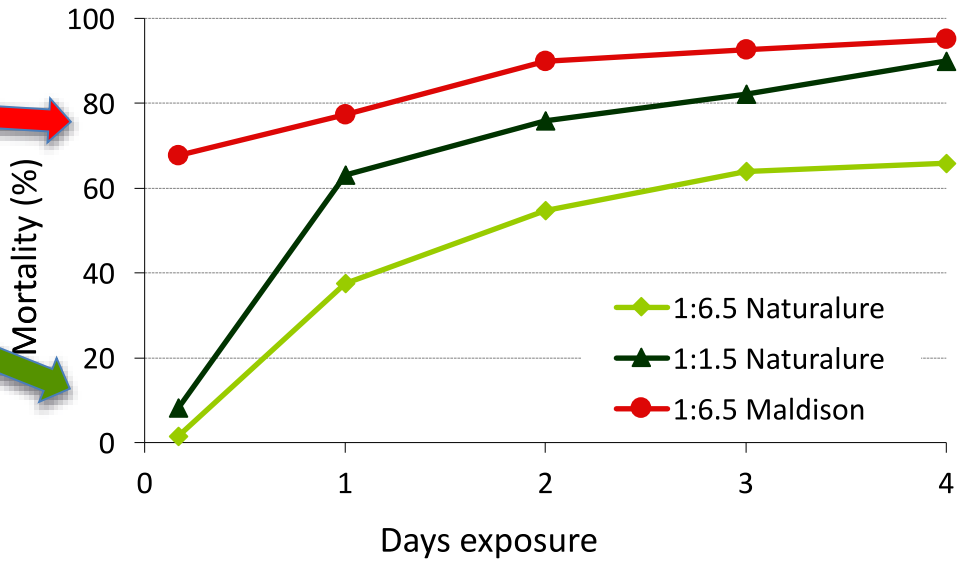
Qfly, Cucumber fly

Qfly, Jarvis's fly, Cucumber fly

Qfly, Cucumber fly

Killing flies

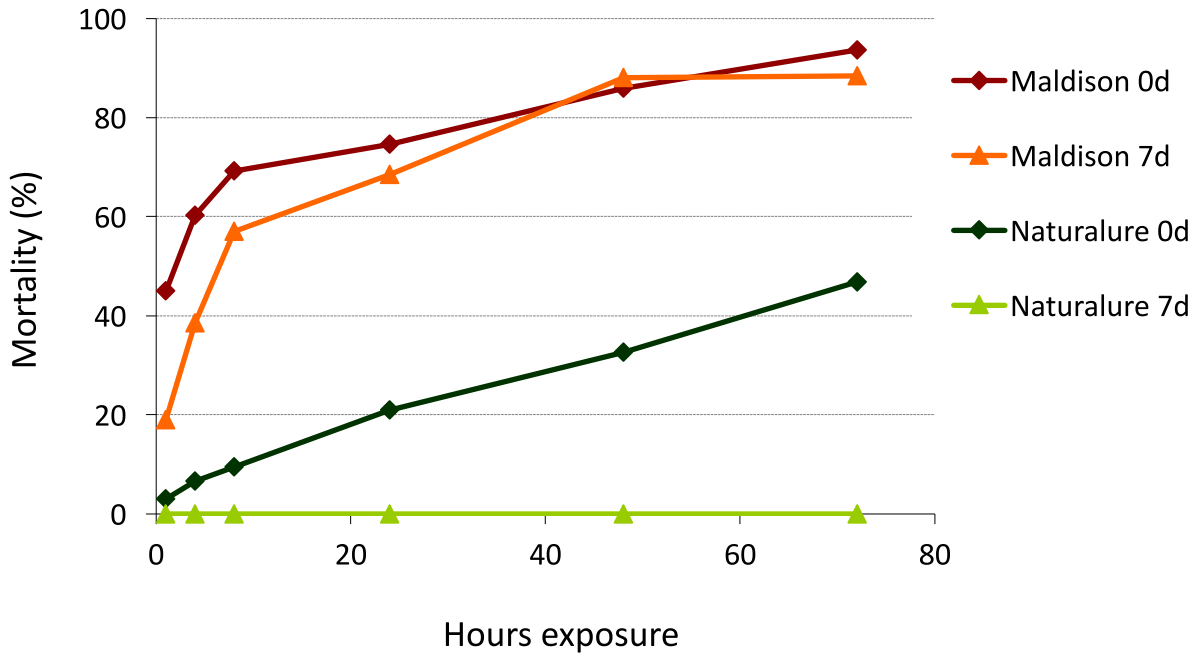
- Registered insecticides;
  - Maldison (Malathion)
  - Trichlorfon (Dipterex 500)
  - Spinosad (Naturalure)



- Concentration is important
  - Flies eat baits - Naturalure
  - Concentration less important for contact insecticides
  - BUT HyMal also most effective at high concentrations

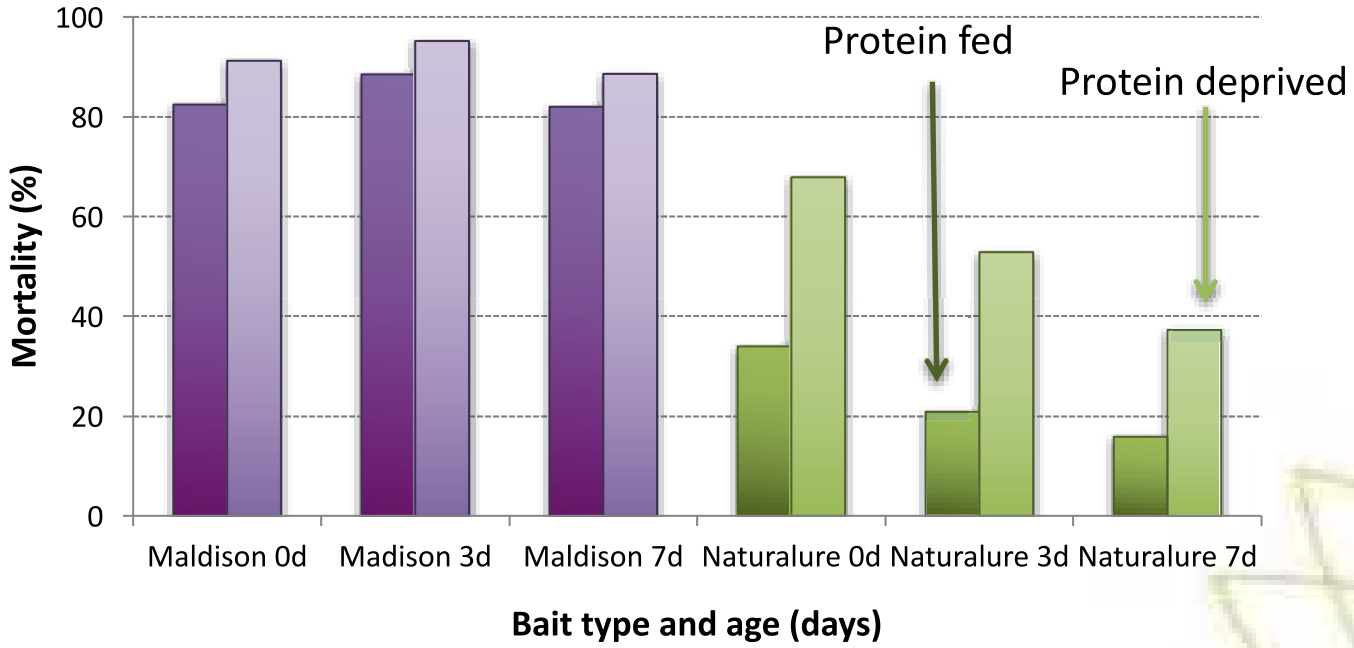
When to apply

- Bait needs to be freshly applied
  - Dried out bait has little aroma, not attractive
  - Insecticides degrade with UV light



When to apply

- Bait needs to be there when flies are emerging
  - Once female flies have fed on protein they don't search for more



When to apply

- Thickeners help bait remain in the environment
- BUT if it rains (>5mm), re-apply the bait

SPLAT

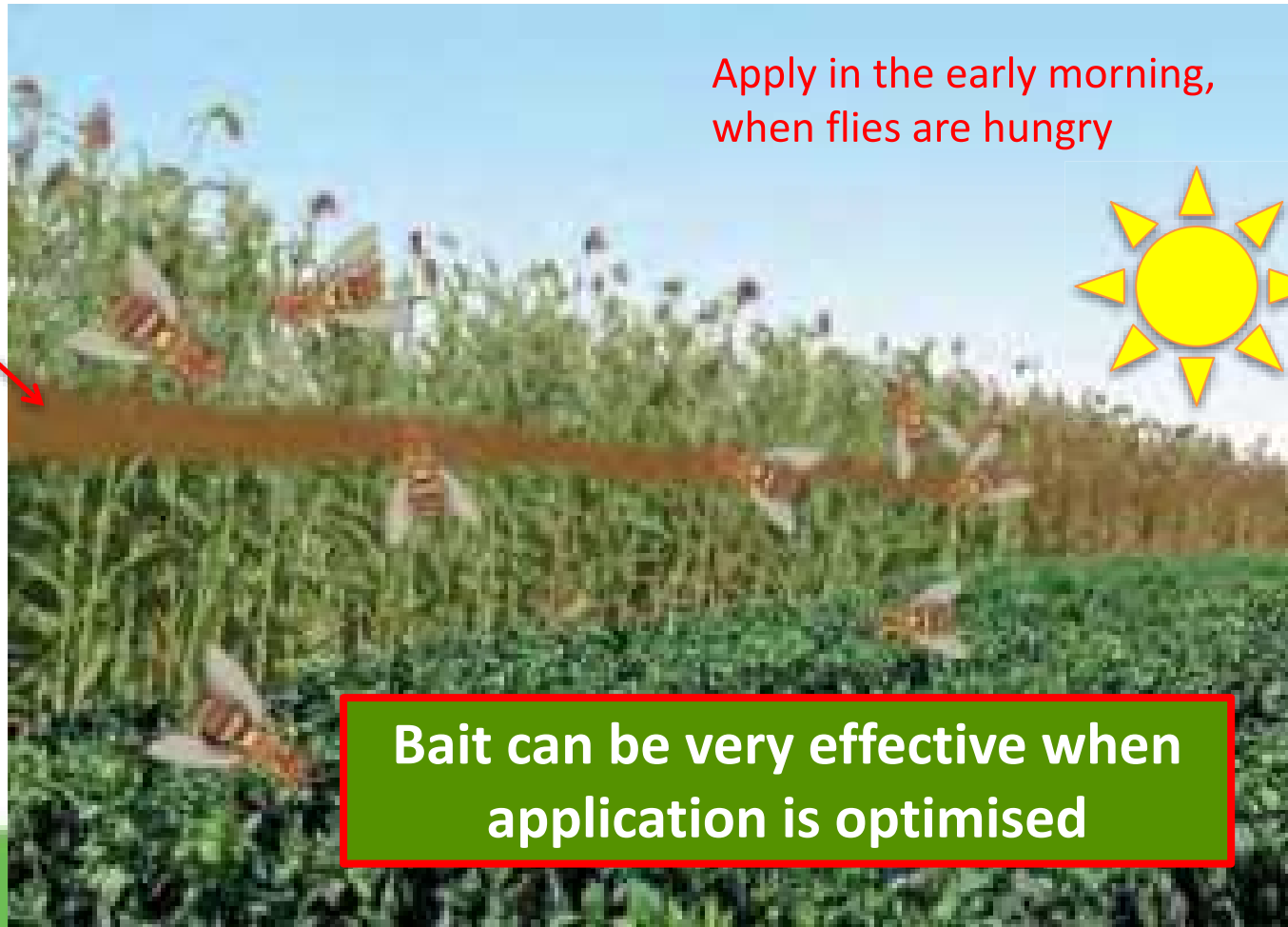
Where to apply

- Bait needs to be where flies are foraging

Coarse spray droplets

Qfly, Medfly >1.5m

Cucumber fly 1m



Lure and Kill

Male Annihilation Technique

- MAT
  - Easy, cheap, long lasting
  - Para-pheromone + insecticide

Caneite block

Amulet

Bugs for Bugs

Magnet MED (medfly)

MAT – how and when

- Para-pheromones increase mating success
  - Likely most attractive to maturing male flies
- Not a very large zone of attraction
  - Need to be spaced regularly in places flies are likely to gather
  - Recommended spacing every 20m
- Replace every 3-6 months
  - Ensures insecticide is effective

Species	Device
Qfly	Cuelure MAT
Lesser Qfly	Cuelure MAT
Medfly	Magnet MED
Jarvis fly	Zingerone lure
Cucumber fly	Unknown

MAT - issues

- Disrupts the results of monitoring
  - Reduces the number of males caught in traps but NOT the number of females
- Biggest problem – males can mate many times….
  - Females only need to mate once

MAT best used as part of a wider strategy

Mass trapping

- Female biased
  - Food or aroma based with/without insecticide
- Issues include;
  - Cost (spacing every 15m)
  - Labour
  - Attraction zone
  - ‘yuck factor’
- Evidence???

Cost and labour big issue

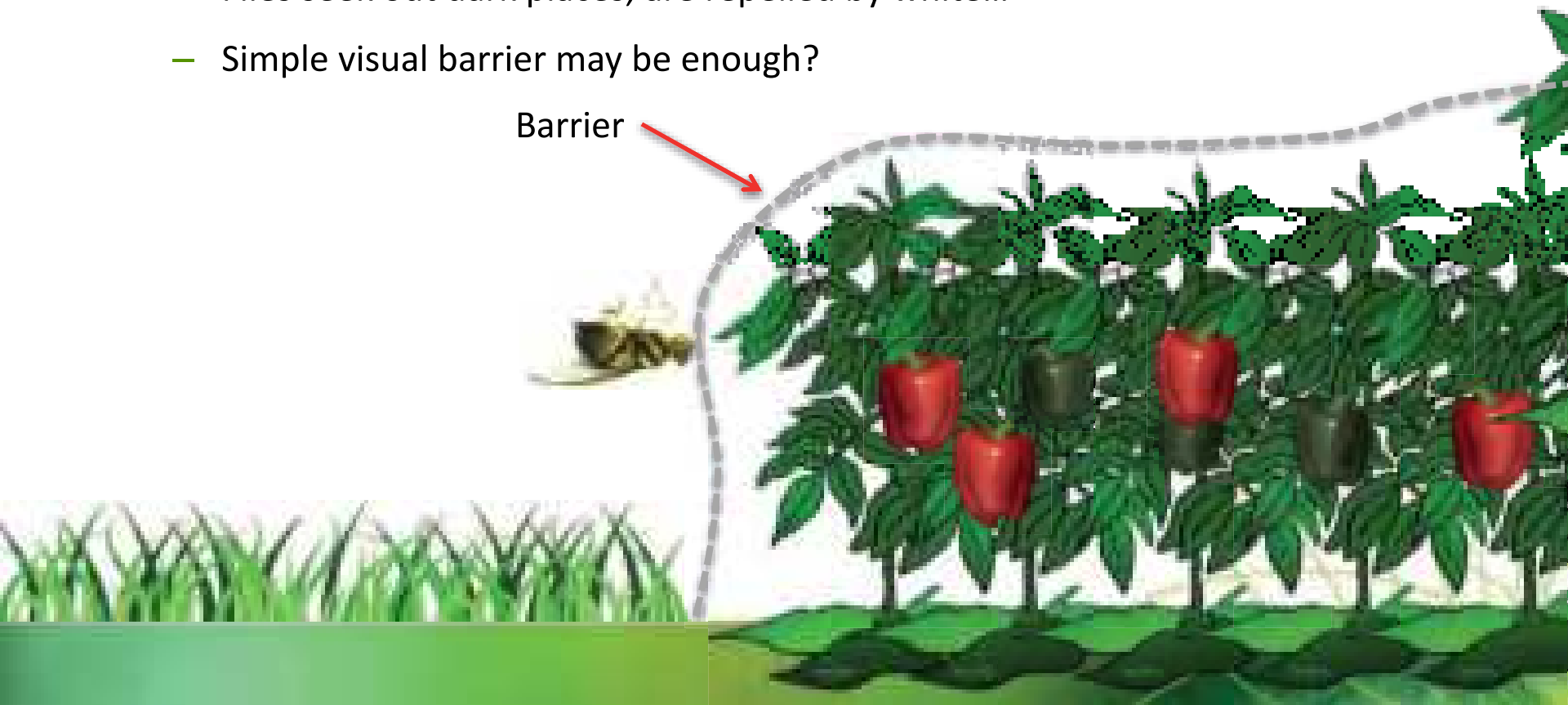
Physical protection

Protected cropping

- Can be expensive, and not suitable for every crop
- BUT highly effective at excluding fruit flies
- Additional benefits in
  - Productivity
  - Quality
  - Reduced irrigation
  - Pest management generally

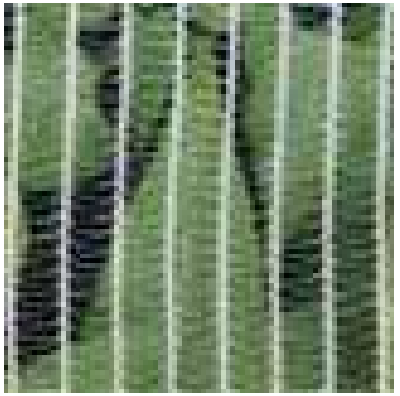
Physical barriers

- How does a fly find fruit? Sight or smell?
  - Exclusion netting expensive and difficult to work with
  - Flies seek out dark places, are repelled by white…
  - Simple visual barrier may be enough?



Net houses

- Structures don’t need to fully exclude flies to be effective!
  - Retractable roof – Cravo House
  - Hail netting on orchards
  - Net houses for wind and sun protection



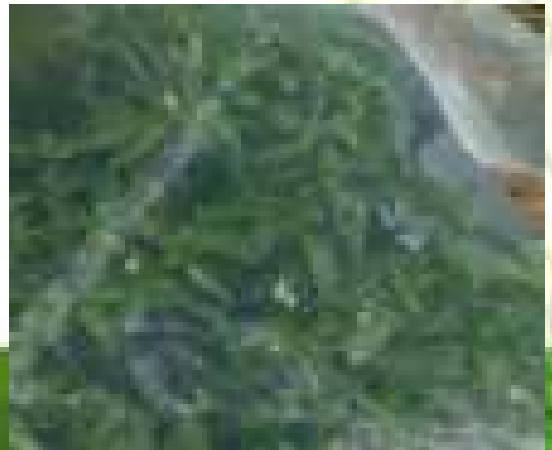
Floating covers

- Trials in Bundaberg and Sydney
  - VentNet, VegeNet, Aphid Net, fleece
  - Capsicums and chillies
  - Bundaberg = natural trap catches and fruit yield + quality
  - Sydney = flies released, then trap catches, yield and quality

VentNet

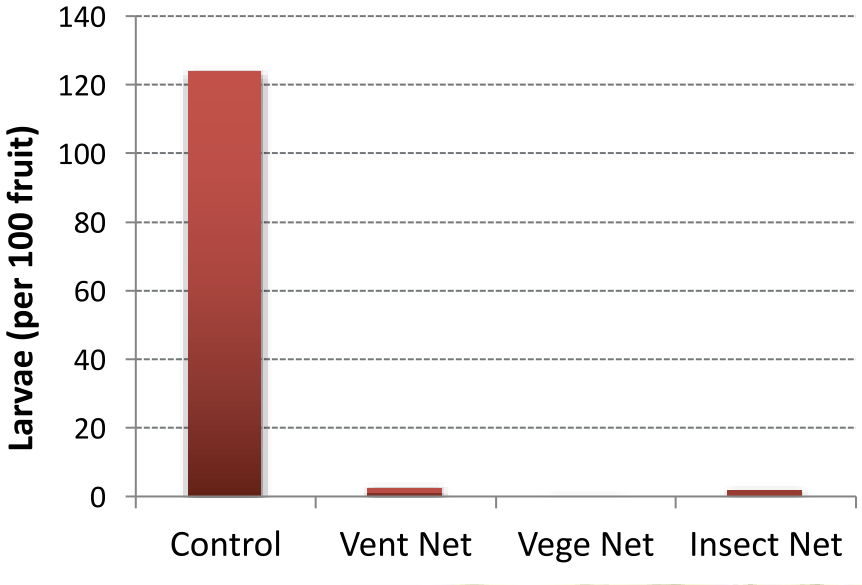
VegeNet

AphidNet

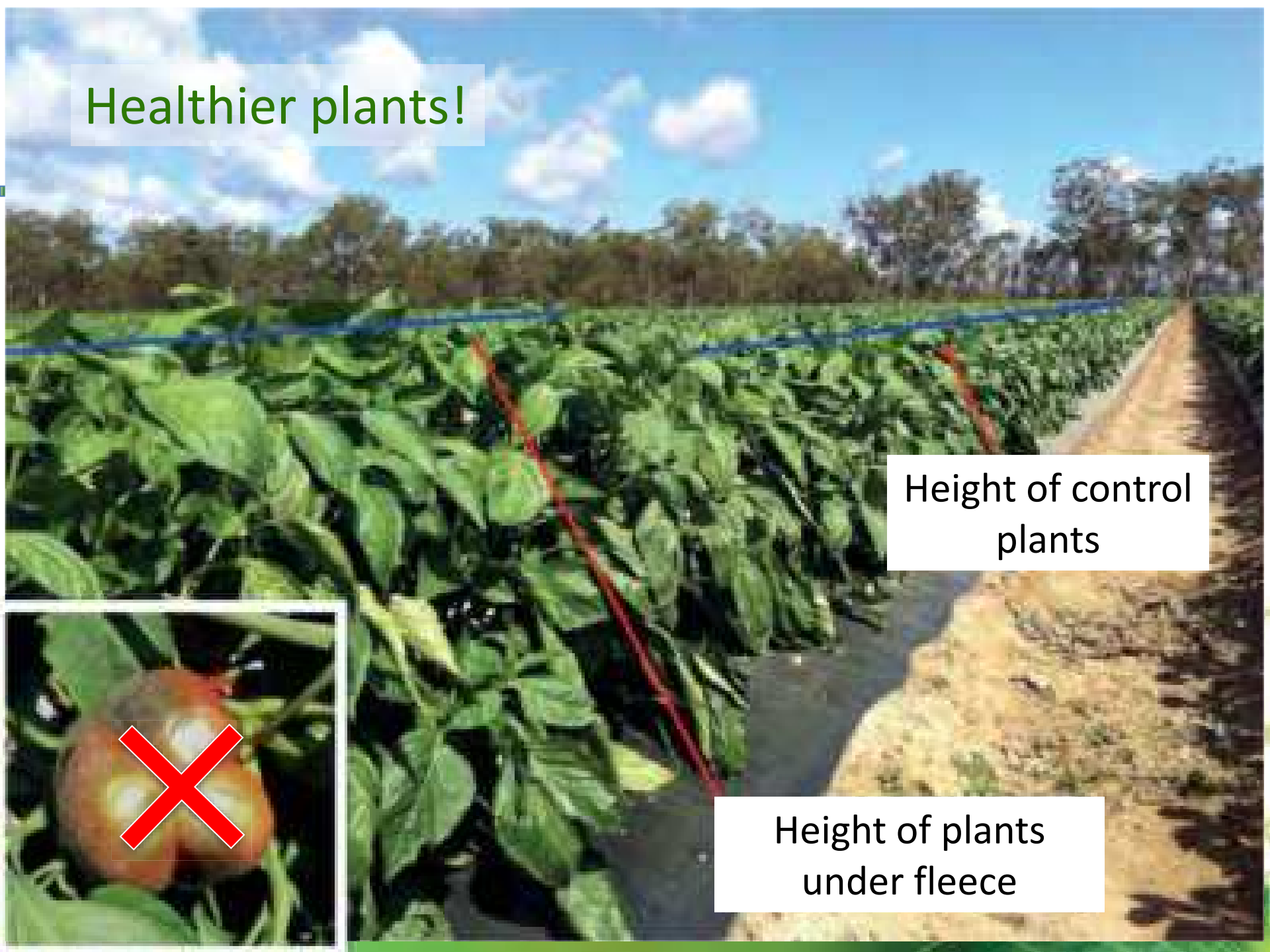


Trial results

- Flies excluded

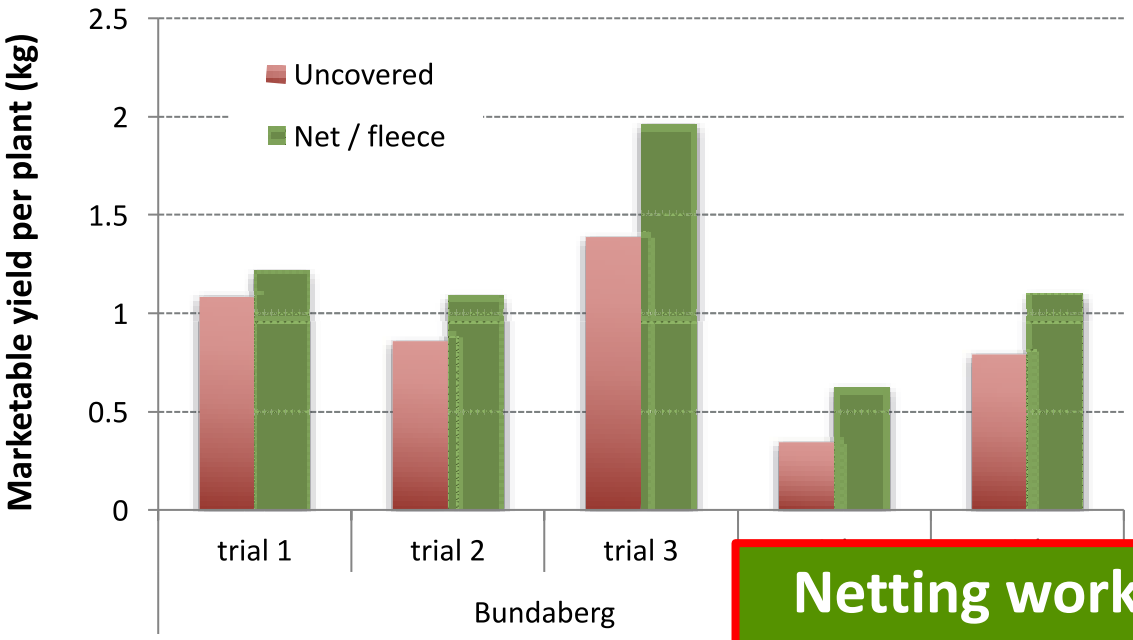


Healthier plants!



Trial results

- Yield increased
  - Best results when net was applied to young plants



Fleece is inexpensive, single use only, but tears easily

Netting works, but needs to be well secured and cleaned between uses

Repellents

- Kaolin clay (Surround, and other sunscreen products)
  - Natural product, organic
  - Turns plants white
  - **Reduced the number of infested fruit by 90–100%!**
- Issues
  - Expensive
  - Hard to get coverage
  - Re-apply after rain (or overhead irrigation)
  - Hard to get off postharvest

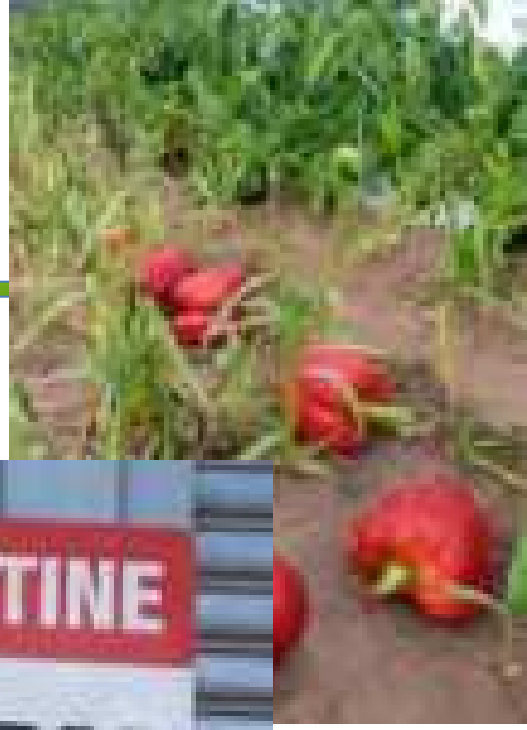
Limiting incursions and spread

Isolating the crop

- Fruit flies don't travel far
  - Grassy fields and vacant paddocks are like deserts to fruit flies
- Vacant areas around crops are a significant barrier to incursions
  - 200-400m maybe enough

Hygiene

- Feral trees and abandoned crops are major sources of incursions
  - Backyard trees
  - Urban areas
  - Holidaymakers



Biological controls

- Fungi
  - Metarhizium kills pupae
- Parasitoids
  - Many native species
  - Mass release possible
- Nematodes
  - Mass delivery through irrigation

Cannot protect crop…
Could be useful for cleaning up?

Sterile insect technique (SIT)

- Involves release of large numbers of sterile flies
  - Mate with wild flies = no eggs
  - But female flies mate more than once….
- Factors for success
  - Steriles need to be “fit”
  - Overflooding ratio 25 to 150:1 (wild population?)
  - Target population must be isolated
- Other issues
  - Females still try to oviposit – fruit damaged
  - Mis-marking of sterile flies

Sterile insect technique

- SIT-Plus facility built in Port Augusta
  - $20million+ project
  - CSIRO / State Departments / Plant and Food NZ / Universities
  - Aim to produce male only strain
  - Find out more about movement / ecology

Unproven for vegetable crops

So, what to do?

- Systems approach uses ALL of the tools available
- Focus on;
  - Monitor the crop regularly to understand what is going on
  - Remove / manage feral trees and other hosts within 600m of crop
  - Apply protein baits weekly in summer, continue even during winter, using optimum protein + insecticide, focus on windbreaks and other places flies are found.
  - Protected cropping, whether glasshouse, net house, or simple floating row cover can give a high level of control
  - MAT can be a useful addition but remember this affects monitoring results
  - Mass trapping, biologicals and SIT may reduce fly numbers, but not yet proven effective for Australian vegetable crops


Thankyou for your interest!
Now watch the videos! Links at ahr.com.au