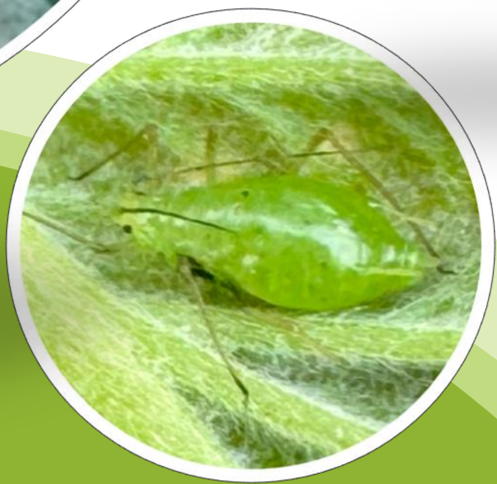


Aphid management in ornamental crops masterclass

Harper Adams University (HAU), Edgmond, Newport
TF10 8NB

Tuesday 3rd June 2025

Contents

Agenda

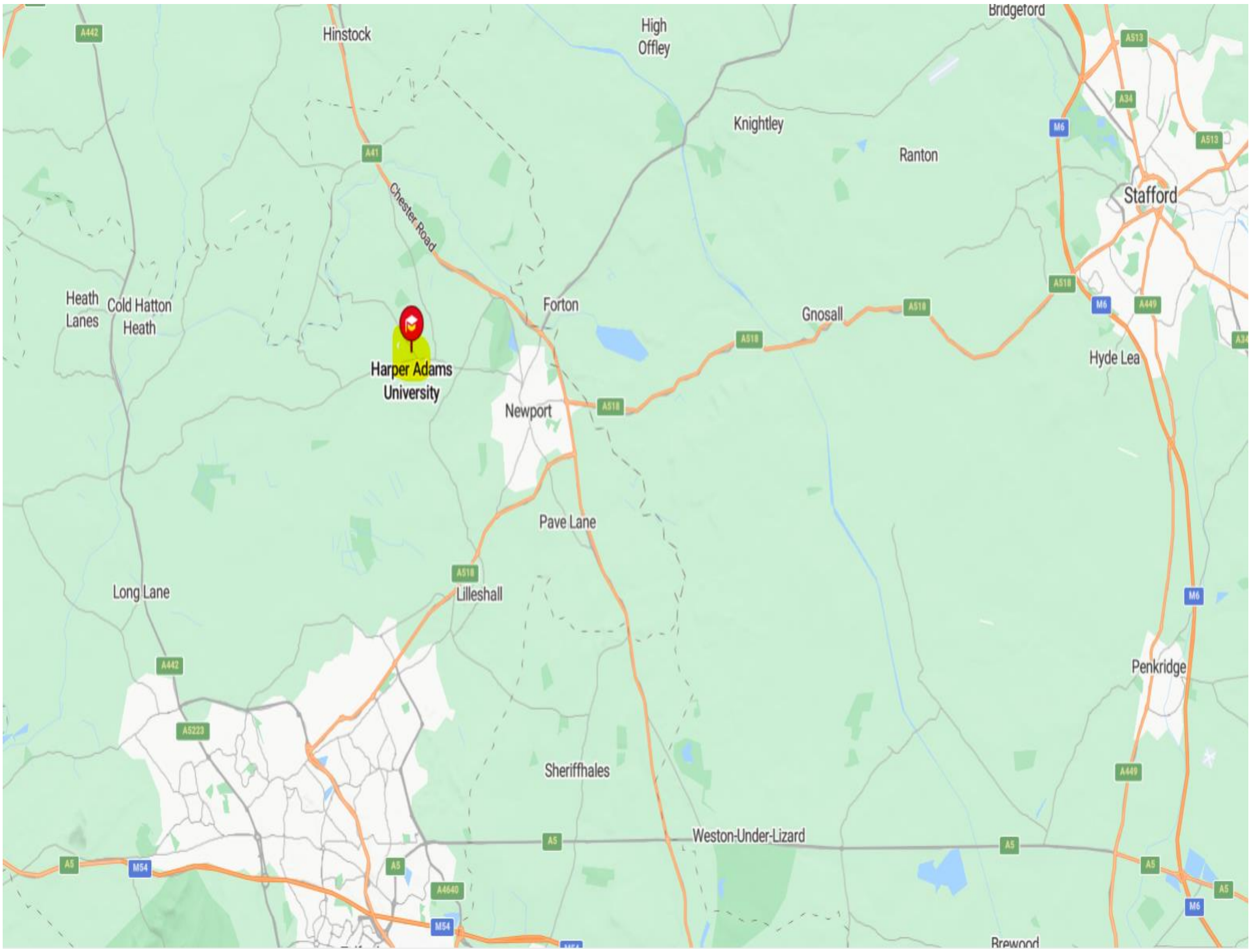
Time	Content	Speaker
Harper Adams University (HAU), conference room		
09:00 – 09:30	*Coffee, tea, and refreshments*	
Presentations		
09:30 – 10:10	**Common aphid species found on ornamental crops – aphid biology, lifecycles, and identification.** **Practical identification exercise**	Dr. Joe Roberts and Prof. Tom Pope, **HAU**
10:10 – 10:50	**Monitoring and biological control strategies for ornamental crops**	Selchuk Kurtev, **Zest Sustainable ICM**
10:50 – 11:00	*Coffee, tea, and refreshments*	
11:00 – 11:30	**Understanding aphid host plant location for improved monitoring**	John Owen, **HAU**
11:30 – 12:00	**Next generation of aphid biological control**	Prof. Tom Pope, **HAU**
12:00 – 12:40	**Crop protection options for aphid management and integration into control programmes**	Selchuk Kurtev, **Zest Sustainable ICM**
12:40 – 13:15	*Lunch buffet*	
Practical session at HAU		
13:15 – 14:15	**Tour of entomology department and laboratories at HAU**	Dr. Joe Roberts and team, **HAU**
14:15 – 15:00	**Desktop exercise – planning an aphid management programme using example crops –** delegates will be given an example crop to create a control programme	**All delegates**
15:00 – 15:30	**Summary quiz to establish learnings from the day** – an engaging multiple-choice quiz to round off the masterclass	**All delegates**
15:30	*Wrap up and depart*	

BASIS and NRoSO continued professional development points will be available on the day of the workshop.

Location

Addresses and locations:

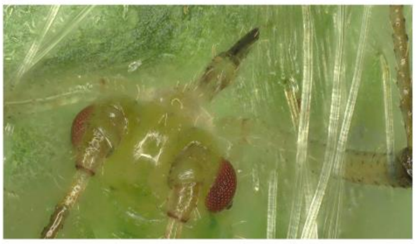
Harper Adams University, Edgmond, Newport TF10 8NB (highlighted in yellow and A on the map) *What3words: ///laugh.bolts.exhales*



Common aphid species found on ornamental crops – aphid biology, lifecycles, and identification

Prof. Tom Pope, HAU

Common aphid species found on ornamental crops – aphid biology, lifecycles and identification



HTA Grower Technical Workshop, 3rd June 2025

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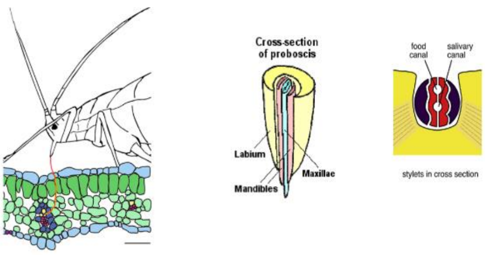
Aphids belong to the insect order Hemiptera

- Hemipteran insects are characterised by having piercing mouthparts



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Aphids belong to the insect order Hemiptera

- There are thought to be around 100,000 species of Hemiptera globally and around 2,000 species found in the UK
- The order Hemiptera is split into three main sub-orders:
  - Heteroptera e.g. mirids or capsids (**generally pests**) and anthocorids (**biological controls**)
  - Auchenorrhyncha e.g. leafhoppers (several pest species) and plant hoppers (**increased interest due to *Xylella fastidiosa***)
  - Sternorrhyncha – **aphids**, mealybugs, scale insects and whitefly

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Notes

Notes

Aphids

- Sternorrhyncha from the Greek words ‘sterno’ meaning ‘chest’ and ‘rhyncose’ meaning ‘nose’
  - This is because the mouth starts between the front legs!
- There are 16,000 species, all are sap feeding and many have lost the ability to walk or flying during parts of their life-cycle

Aphids

- There are three families of aphids:
- Adelgidae - often covered in wax, produce galls and associated with conifers
- Phylloxeridae - most notable species is grape phylloxera (*Daktulosphaira vitifoliae*)
- Aphididae - the most diverse family and includes all species discussed today
- In total there are around 5,000 species of aphid
- Characterised by complicated lifecycles and rapid reproduction

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Aphids

- In addition to piercing mouthparts, aphids are characterised by having siphunculi and a cauda:



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Notes

Aphids – life cycles

- Aphids may reproduce asexually and sexually throughout the year or asexually only - holocyclic or anholocyclic

- Eggs are cold tolerant and sexual reproduction leads to greater genetic mixing
- Asexual reproduction often leads to formation of dominant clones

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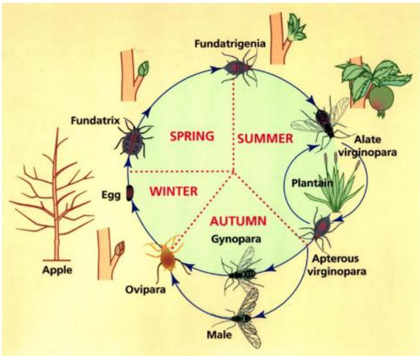
Aphids – life cycles

- Aphids may feed on related hosts throughout the year or switch between unrelated hosts (typically a woody host and an herbaceous host) - autoecious or heteroecious
- Host switching is typically linked with sexual reproduction



Aphids – morphs

- How many species can you see?

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Notes

Aphids – reproduction

- Asexual reproduction is characterised by the birth of live young
- Inside the aphid you see, eggs have hatched and developed (daughter) and inside the daughter, eggs have hatched and developed (granddaughter)!
  - This is known as telescoping of generations
- Aphids can complete their development in as little as 7 days

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Aphids – reproduction

- In a season the potential descendants of one female aphid contain more substance than 500 million stout men' - Thomas Henry Huxley (1858)

- 'In a year aphids could form a layer 149 km deep over the surface of the earth. Thank God for limited resources and natural enemies' - Richard Harrington (1994)

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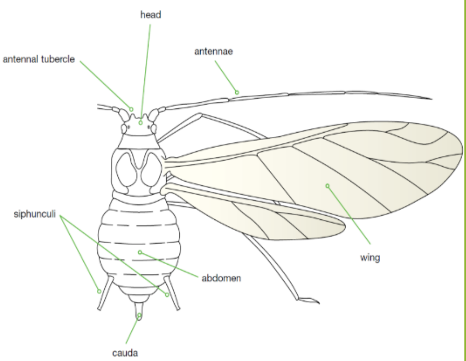
Identifying aphids

- Head and antennal tubercle shape
- Antennal length vs body length
- Siphunculi shape, size and colour
- Abdominal markings
- Cauda length vs siphunculi length
- Wing vein darkness



University

HTA

Peach-potato aphid (*Myzus persicae*)

Identification

- Very wide host range
- Typically, asexual only in the UK
- Small/medium (1.5-2.5mm) aphid, variable body colour
- Antennal tubercles very well developed, characteristic 'W' shape
- Darker patches at base of siphunculi
- Siphunculi with slight flange and black tips
- Typically, overwinters as active forms in the UK
- Widespread insecticide resistance e.g. pyrethroids

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Shallot aphid (*Myzus ascalonicus*)

Identification

- Fairly wide host range, only found in UK from 1940s onward
- Typically, asexual only in the UK
- Small (1-2mm) aphid, variable body colour from pale brown to green-brown to yellow-brown
- Antennal tubercles well developed
- Siphunculi are slightly swollen
- Wing vein closest to abdomen is darker
- Colonies distort foliage

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Melon and cotton aphid (*Aphis gossypii*)

Identification

- Very wide host range
- Small (1-1.5mm) aphid, with variable body colour from almost black to pale yellow
- Generally larger and darker at cooler temperatures and smaller and paler at warmer temperatures
- Antennal tubercles not developed
- Siphunculi slightly longer than cauda
- Colonies cause leaves to turn yellow and wilt
- Widespread insecticide resistance e.g. to pyrethroids

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Notes

Notes

Black bean aphid (*Aphis fabae*)

Identification

- Fairly wide host range
- Overwinters as eggs
- Small/medium (1.5-3mm) aphid
- Antennae shorter than body
- Matt black but may develop white wax markings
- Legs are white in colour
- Regularly ant attended
- Colonies distort leaves, buds and flowers

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Glasshouse-potato aphid (*Aulacorthum solani*)

Identification

- Fairly wide host range
- Medium (2-3mm), shiny green yellow aphid
- Antennal tubercles well developed
- Darker patches at base of siphunculi
- Siphunculi long with black tips
- In winged aphids, veins closest to abdomen are dark
- May overwinter as eggs or active forms but diverse life cycles reported
- Colonies distort leaves

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Potato aphid (*Macrosiphum euphorbiae*)

Identification

- Very wide host range
- Large (1.7-3.5mm) aphid, shiny green, yellow or pink as adults
- Introduced to UK around 1917
- Immature forms are waxy coating and darker stripe running down back of aphid
- Legs, siphunculi, and cauda are characteristically long
- Adults often have red spots on abdomen (eyes of unborn nymphs)
- May overwinter as eggs but more often as active forms

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Notes

Lupin aphid (*Macrosiphum albifrons*)

Identification

- Narrow host range, associated with lupins and other legumes
- Very large (3.2-4.5mm) aphid, pale bluish-green in colour but dusted with wax
- Native to North America but found in UK from 1981 onwards
- Thought to reproduce asexually only in Europe
- Legs, siphunculi, cauda all long and siphunculi have darker tips
- May overwinter as eggs but more often as active forms

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Rose aphid (*Macrosiphum rosae*)

Identification

- Fairly narrow host range, associated with roses and other Roseae
- Large (1.7-3.6mm) aphid, shiny dark green to pink to red-brown in colour
- Siphunculi are long and characteristically black in colour
- Cauda is pale and rather elongated
- Produces masses of honeydew and may check plant growth
- Overwinters as eggs

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Mottled arum aphid (*Neomyzus circumflexus*)

Identification

- Fairly wide host range
- Adults are shiny and pale to bright green in colour
- Characteristic dark markings on abdomen, often horseshoe shaped
- Antennae, siphunculi, and cauda are pale
- Very rapid reproduction and colonies produce masses of honeydew
- Winged forms rarely seen and overwinters as active forms

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Notes

Woolly beech aphid (*Phyllaphis fagi*)

Identification

- Narrow host range, associated with beech trees
- Overwinters as eggs
- Large (2.-3.2mm) aphid that is yellowish-green in colour – there is a smaller summer form)
- Coated in a mass of wax
- Siphunculi are pore like (no tube), cauda is similarly small
- Produces masses of honeydew

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Strawberry aphid (*Chaetosiphon fragaefolii*)

Identification

- Narrow host range, associated with strawberries and some species of Potentilla
- Small (1-2mm) pale aphid
- Antennal tubercles well developed
- Body of wingless aphids covered in fine hairs
- Pale thin siphunculi with flange at end (twice as long as cauda)
- Antennae have a long final segment
- Overwinter as active forms

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Finding information

- Online
  - InfluentialPoints: https://influentialpoints.com/Gallery/Aphid_genera.htm
  - Aphids on the Worlds Plants: https://aphidsonworldsplants.info/
- Books
  - Aphids on the World's Herbaceous Plants and Shrubs: https://www.wiley.com/en-hk/Aphids+on+the+World's+Herbaceous+Plants+and+Shrubs%2C+2+Volume+Set-p-9780471489733 very expensive!

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Monitoring and biological control strategies for ornamental crops

Selchuk Kurtev, Zest Sustainable ICM

HTA

Notes

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Monitoring and biological control strategies for ornamental crops

Selchuk Kurtev, Zest Sustainable ICM

WHAT I WILL COVER

HTA

- **Importance of monitoring**
- **Monitoring guidelines**
- **Monitoring methods**
- **Biological control of aphids**
- **Summary**

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Importance of monitoring

HTA

- Assessment of aphid species and levels
- Aid in decision making on control strategies
  - Biocontrol
  - Chemical control
- Early intervention before becoming a problem
- Provides better understanding of pest vs beneficial ratios
- Provides clues for poor control strategies

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Notes

Monitoring guidelines

- Presence and evidence of aphids – look for honeydew, aphid skins, actual aphids
- Presence of natural enemies – are there parasitic wasps, ladybirds, hoverflies etc.
- Evidence of potentially contributing factors – plants under stress, weeds, others
- Evidence of damage:
  - Is the damage caused by aphids or other factors
  - Where the damage is found
  - Are live aphids still found in the crop
- Consider the time of year (seasonal peaks)
- Frequency of monitoring should match the aphid development by species
- Indicator crops

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Frequency of monitoring

- Regular intervals
- Determined by:
  - Species – host specific species easier than generalist species
  - Crop – some crops are also used as indicator crops
  - Situation crops are grown in
  - Crop value, crop volume, sales window

Months	Outdoor	Protected	Glasshouse
January to March	Monthly	Fortnightly	Weekly
April to October	Fortnightly	Weekly	Twice weekly
November to January	Monthly	Fortnightly	Weekly

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Size of area, speed and records

Score	
1	0-5% Low infestation
2	6-10% Medium infestation
3	11- 25% High infestation
4	> 25% Severe infestation

- Depends on the crop, size of batches, and nursery size
- Enough to provide field representation
  - For every 1,000 pots minimum 10 pots
  - Outdoor field grown crops – minimum 10m for every 100m of crops
- Use of set patterns – S, X, W, V, Z, U
- Glasshouse crops – on $60m^2$ minimum $1m^2$ of plants (for 2L pots 28-36 pots)
- Walking speed 1-2m/s for field and 0.5-2m/s for protected situations

Area	Bed	Crop	Pest	Presence of beneficials?	% of crop	% of plant	Score
Tunnel	5	Veronica 'First Love'	Shallot aphid	2 ladybird larvae	3	10	2

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Notes

Monitoring methods

- **Visual / crop walking** – count, identification, location, crop damage
- **Sticky / water traps** – only relevant if monitoring winged adults
- **Indicator plants** – informative, but not the only approach
- **Nursery staff** – unreliable, but never ignoring it
- **Field and crop history** – important for building a control strategy
- **Sales complaints –** too late, but a learning opportunity

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Biological control of aphids

1. Cannot rely on the biocontrol strategy alone!
2. Cannot rely on the biocontrol strategy alone!
3. Cannot rely on the biocontrol strategy alone!
4. Backbone of effective control is a reduction in the background level of aphids
5. Particularly effective in glasshouses and to an extent in tunnels
6. Requires proactive approach, i.e. introduce before aphid populations increase
7. Do not use as a curative option
8. Risk of hyperparasitism if not carefully monitored

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Which biocontrol methods

1. **Banker plants** – mainly for mono cropping situations
2. **Parasitic wasps** – good range available, some clever marketing by the biocontrol companies, effective but slow
3. **Predatory insects (lacewings, hoverflies, ladybirds, predatory midges) –** veracious feeders, good for hot spot treatments, can be costly, sensitive to crop protection products

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Parasitic wasps
HTA
Aphidius colemani
Aphidius ervi
Aphidius matricarea
Aphelinus abdominalis
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Parasitic wasps
HTA
Ephedrus cerasicola
Praon volucrae
Ervipar
OrnaProtect
Aphiline Berry
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Predatory insects
HTA
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Notes

Notes

Biocontrol planning

1. **Light and temperature –** minimum 9 hours of light and 8°C for 4 hours. Around WK 10-14
2. **Introduction rates** – always start with higher rates at the beginning – 0.5/m^2
3. **Cropping types** – check potting plan vs current stock
4. **Sales windows** – the worst sale is the one that hasn't made it out of the door!
5. **Crop protection programme** – avoid pyrethroids during low light intensity
6. **Irrigation system in place** – overhead is not good news

SUMMARY

- Monitoring is the first and most important step of IPM
- Monitoring, aphid identification, and record keeping are crucial to decision making
- Biocontrol alone is not an option for aphid control on ornamentals
- Background pressure of aphids must be reduced to a minimum
- Biocontrol introduction and planning should be based on your own nursery
- Good availability of products and formats, but cost can be prohibitive in some crops/sectors
- Crop protection product choice is very important

NURSERY PRODUCTION

Zest-ICM

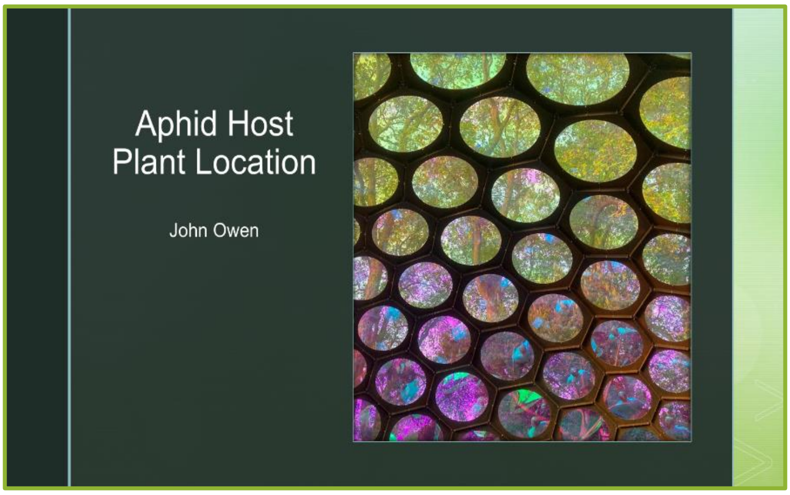
0333 005 0167

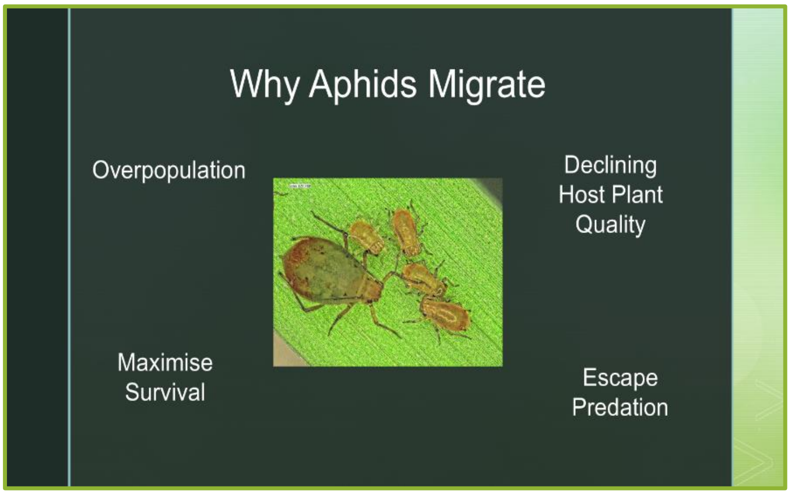
nurseryproduction@hta.org.uk

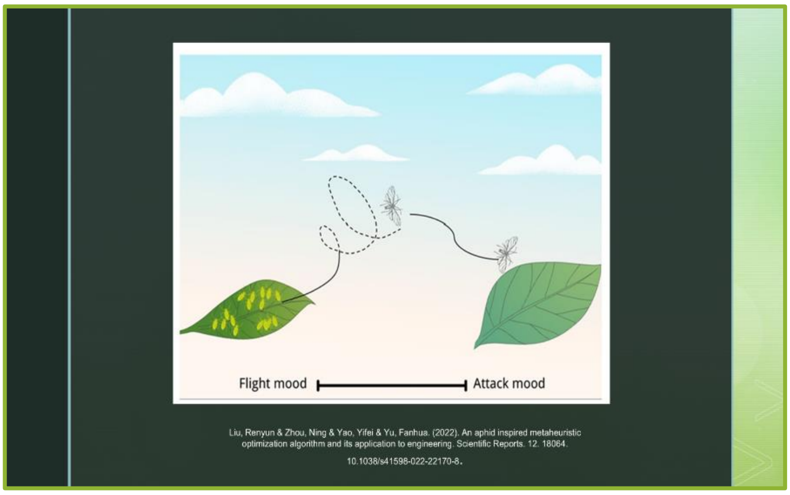
zest®
Sustainable ICM

Understanding aphid host plant location for improved monitoring

John Owen, HAU







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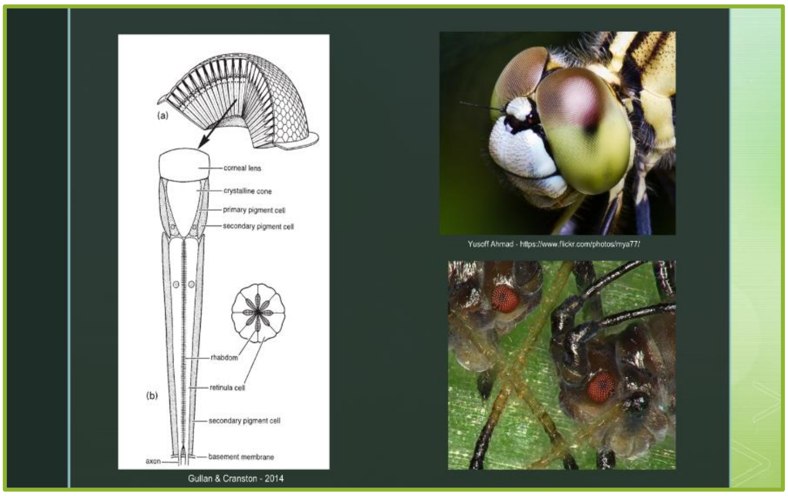
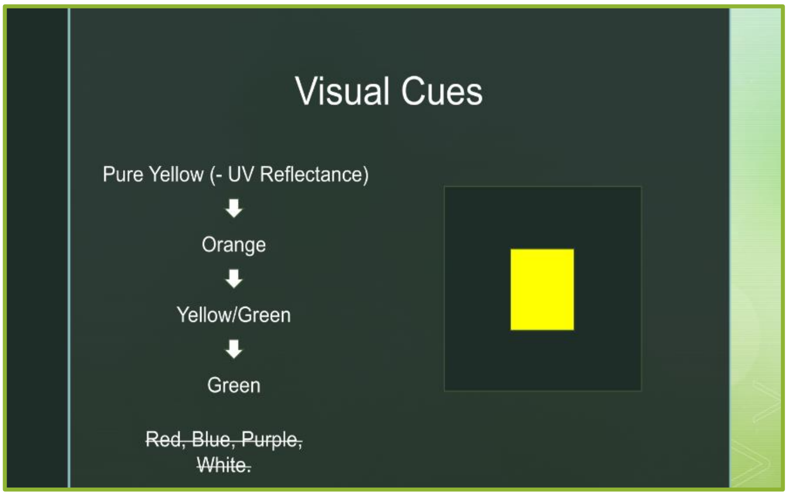
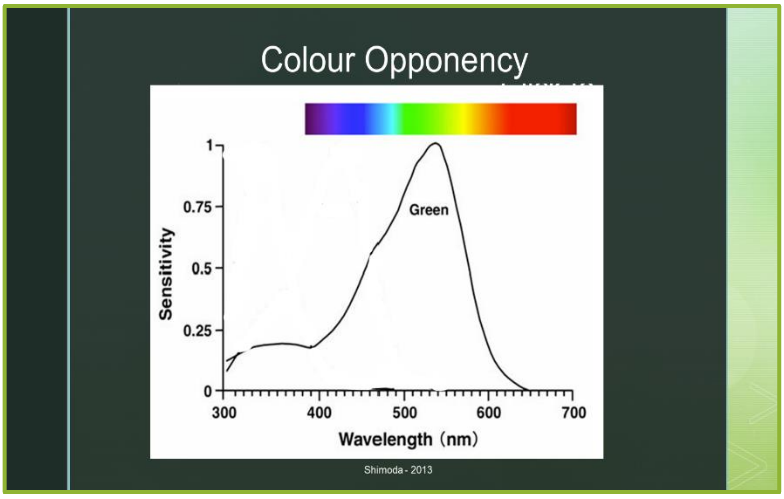

(a)
corneal lens
crystalline cone
primary pigment cell
secondary pigment cell
rhabdom
retinula cell
(b)
secondary pigment cell
basement membrane
axon
Gullan & Cranston - 2014
Yusoff Ahmad - https://www.flickr.com/photos/mya77/


Visual Cues
Pure Yellow (- UV Reflectance)
Orange
Yellow/Green
Green
Red, Blue, Purple,
White.


oregonstate.edu/ua/ncs/archives/2003/apr/new-concerpts-co...

Notes


Shimoda - 2013


Colour Opponency
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Sensitivity
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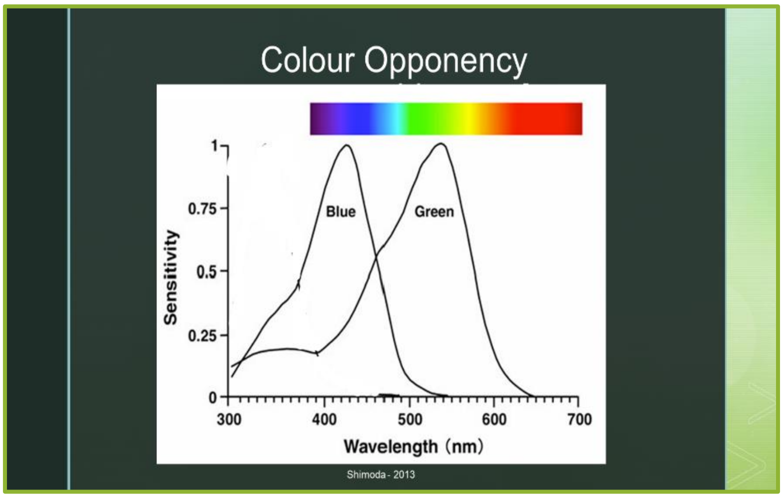
Wavelength (nm)
Shimoda - 2013

Notes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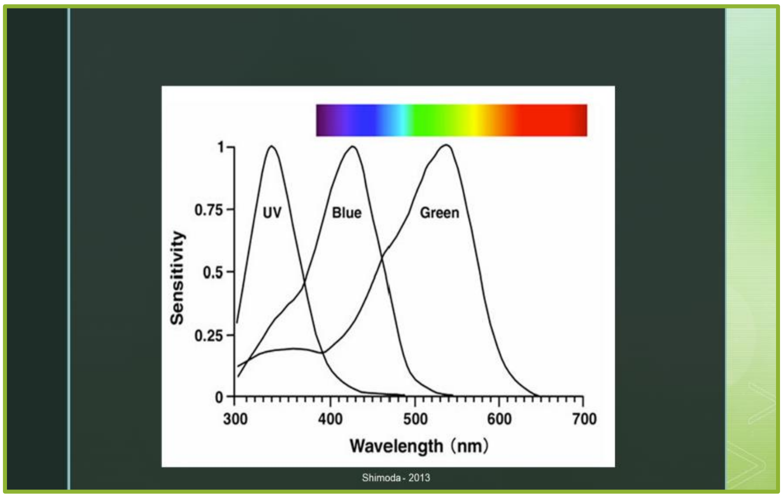
Shimoda - 2013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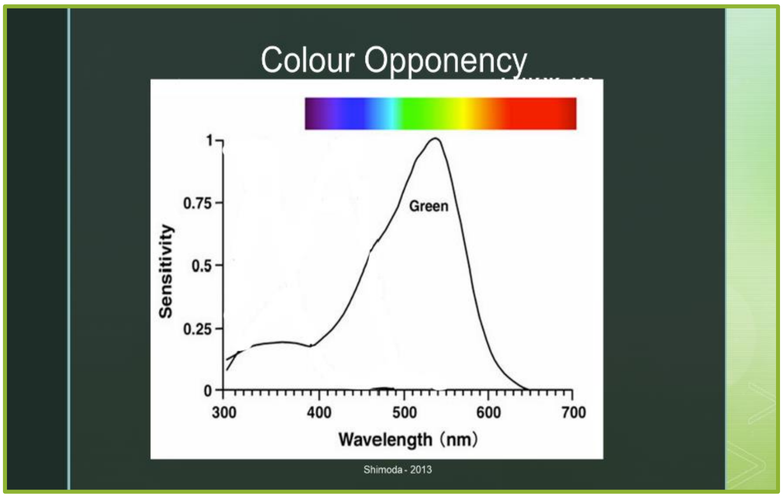
Shimoda - 2013


Colour Opponency
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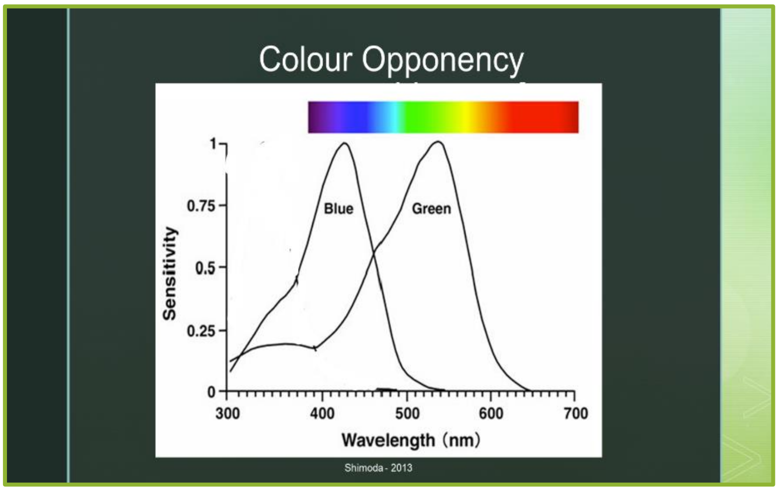
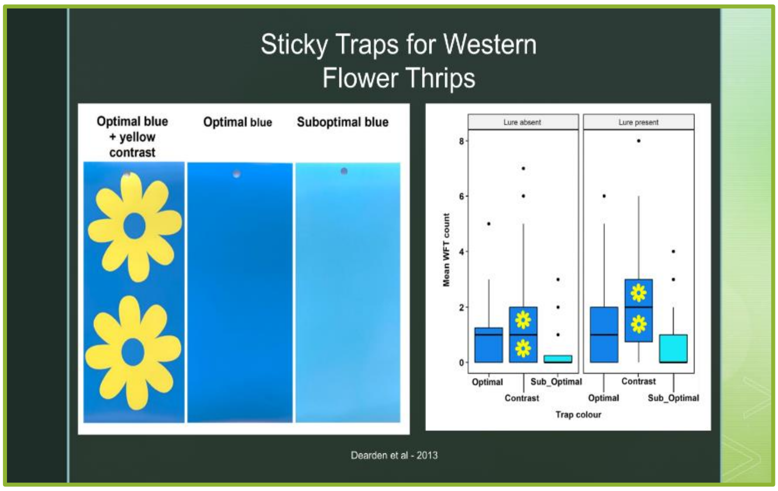
Shimoda - 2013

Notes





Olfactory Cues

- Carvone - Carrot willow aphid (*Cavarielta aegopodii*)
- Primary host location
- Positive and negative Anemotaxis
- Arrestment
- Reduced landing behaviour

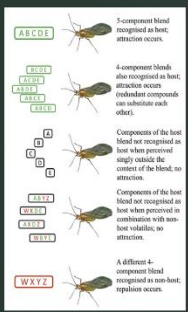
Notes

Host Specific Compounds

Alium species - dipropyl trisulphide and diallyl disulphide

Brassicas - isothiocyanates

Blend of Ubiquitous Compounds



T.J.A.Bruce, J.A.Pickett/Phytochemistry72(2011)1605–161

Other Volatile Compounds

Semiochemicals

(*E*)-β-farnesene (Eβf)

Herbivore Induced Plant Volatiles

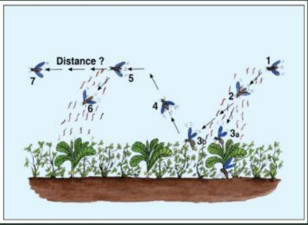
methyl salicylate (MeSA)

HTA

Notes

Host Selection

- Stage 1: Pre-alighting Behaviour
- Stage 2: Initial Plant Contact And Assessment Of Surface Cues Before Stylet Insertion
- Stage 3: Probing The Epidermis
- Stage 4: Stylet Pathway Activity
- Stage 5: Sieve Element Puncture And Salivation
- Stage 6: Phloem Acceptance And Sustained Ingestion



Powell (2006)

Finch and Collier (2003)

Agritech + Add to myFT

Scientists test new biological alternatives to toxic pesticides

Ladybirds, food dye and fungi are all being pressed into the war on harmful insects

The beet goes on: 'camo-cropping' uses dye to make sugar beet crops harder for aphids to detect ©

Harper Adams University

Harper Adams University Entomology Group

Supervisors

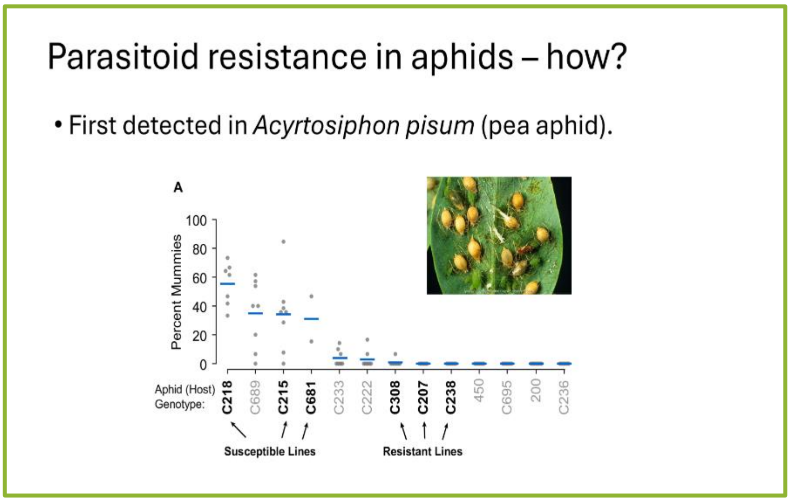
Dr Tom Pope, Dr Joe Roberts, Dr Matthew Back

John Owen – JOwen@live.harper.ac.uk
X - @bugsnbrass

NIAB | UKRI Biotechnology and Biological Sciences Research Council | CTP Sustainable Agricultural Innovation | CUPGRA

Next generation of aphid biological control

Prof. Tom Pope, HAU



Notes

Notes

Parasitoid resistance in aphids – how?

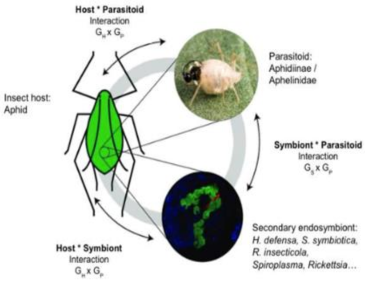
- Complex trait.
- **Intrinsic resistance**: encoded in the aphid genome.
- Multiple traits provided by **secondary endosymbionts (SE).**
- Three SE have been described to provide parasitoid resistance.

Table 1. Summary of some host benefits associated with harbouring secondary symbionts. '*' Even though *Buchnera* is not a secondary symbiont, it has also been linked to thermal tolerance.

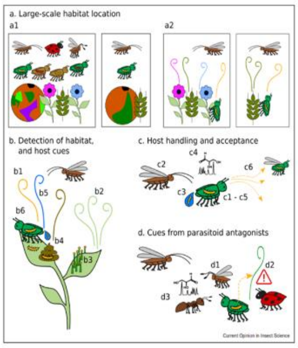
Phenotype	*associated symbiont*	*reference*
Aphid thermal tolerance	*Serratia symbiotica*	Montllor *et al.*, 2002
	**B. aphidicola*	Dunbar *et al.*, 2007
Parasitoid resistance	*Hamiltonella defensa*	Oliver *et al.*, 2003, Oliver *et al.*, 2005 & Ferrari *et al.*, 2004
	Regiella insecticola	Vorburger *et al.*, 2010
	X-type	Heyworth & Ferrari, 2005
Reduced lady beetle survival	*H. defensa/S. symbiotica*	Costopoulos *et al.*, 2014
Resistance to fungal pathogen	*R. insecticola*	Scarborough *et al.*, 2005
	X-type	Heyworth & Ferrari, 2005
Colour polymorphism	*Ca. Rickettsiella viridis*	Tsuchida *et al.*, 2010

The complexity of parasitoid resistance

- Specific interactions between aphid – parasitoid species.
- Genotype by genotype interactions between aphids- symbionts- parasitoids.



Other impacts of secondary endosymbionts



- Modulation of plant and host volatile chemical cues.
- Directly emanation of volatile cues.
- Modulation of plant defences by reducing HIPVs emissions or altering physical structure.
- Alteration of host emitted cues from frass, honeydew, body colour.
- Changes on host defensive behaviours and dispersion to avoid parasitism.
- Alteration of risk cues associated with parasitoid antagonists (modulating competition).

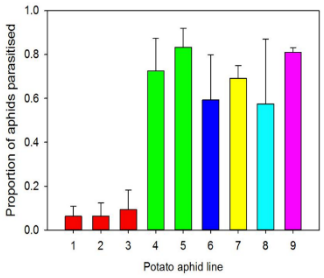
Notes

The potato aphid (*Macrosiphum euphorbiae*)

One genotype from potato crops has been described as resistant to parasitism, associated with genotype.

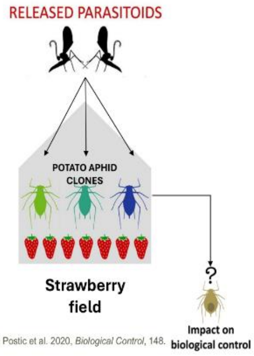
Genotype	Secondary endosymbionts present
1	*H. defensa*
1	*H. defensa* (+ APSE)
1	None found
2	*H. defensa* (+ APSE)
2	*H. defensa* (+ APSE)
3	None found
4	None found
6	None found
7	None found

Adapted from Clarke, H.V., 2013. PhD thesis.



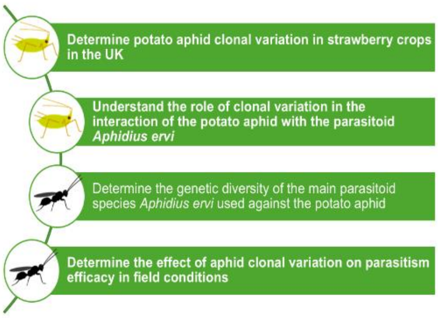
The problem and the questions

- Early-season aphid control problems in strawberry
- Are there resistant clones of ***Macrosiphum euphorbiae*** infesting strawberries?
- Is parasitoid resistance affecting biological control and IPM strategies in strawberry crops in the UK?



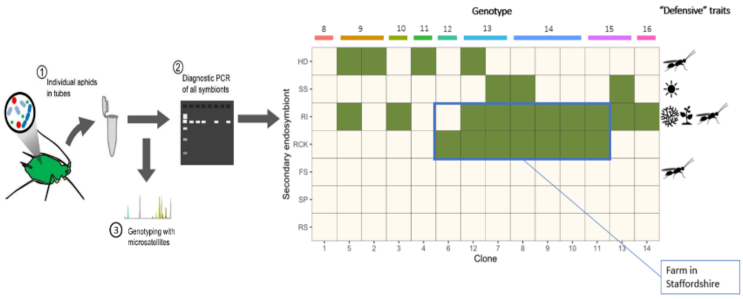
Adapted from Postic et al. 2020, *Biological Control*, 148.

How are we approaching this?

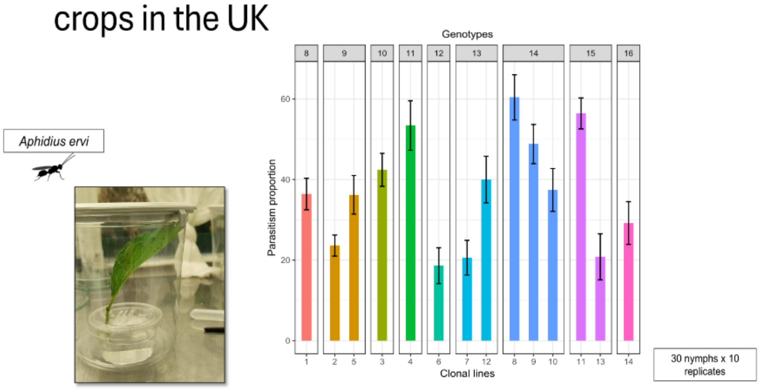


Notes

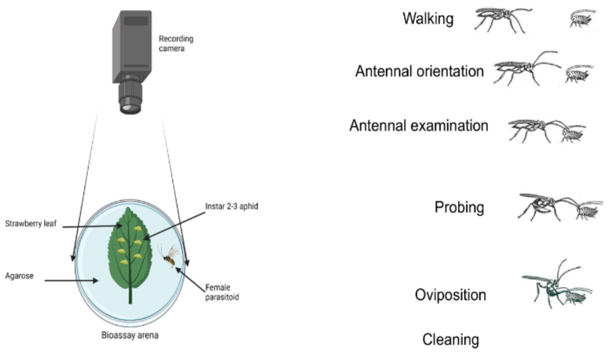
1. Potato aphid clonal variation in strawberry crops in the UK



1. Potato aphid clonal variation in strawberry crops in the UK

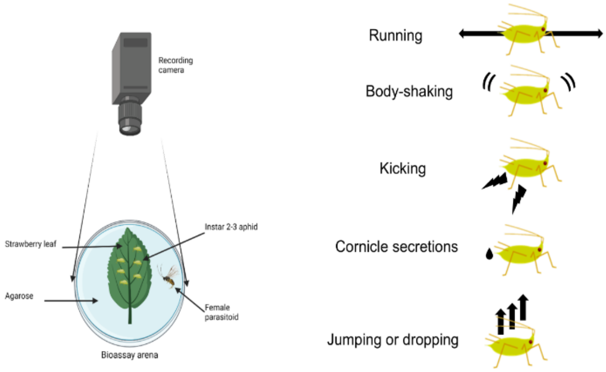


2. The role of clonal variation in the interaction

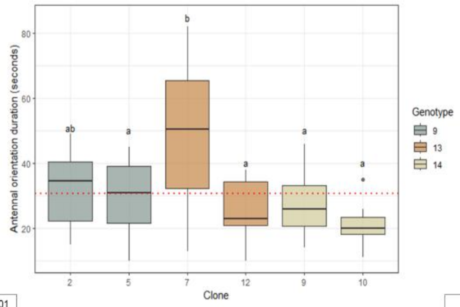


Notes

2. The role of clonal variation in the interaction



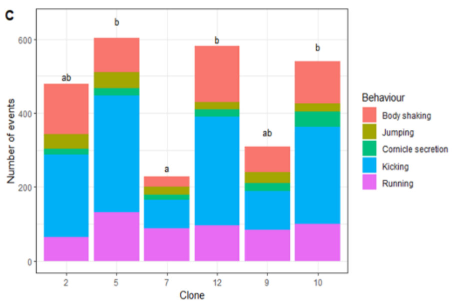
Checking the role of genotype – parasitoid searching behaviour



Clonal line: $X2 = 5.87$, $df = 3$, $P < 0.001$
Genotype: : $X2 = 4.82$, $df = 2$, $P < 0.05$

GLM w/ gaussian dist. with EMM pairwise comparisons

Checking the role of genotype – aphid defensive behaviours

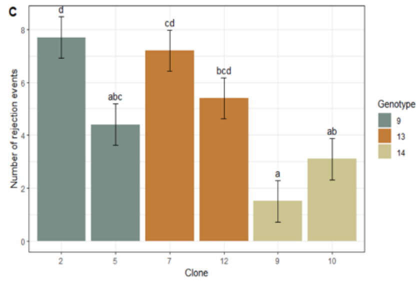


Clonal line: $X_2 = 19.7$, $df = 5$, $P < 0.001$
Genotype: : $X_2 = 2.2$, $df = 2$, $P > 0.05$

GLM w/ gaussian dist. with EMM pairwise comparisons

Notes

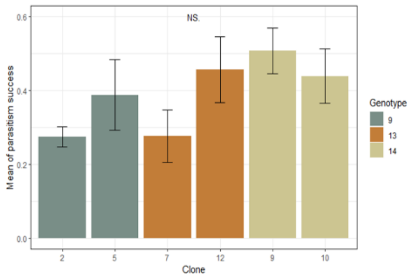
Checking the role of genotype – rejections by parasitoids



Clonal line: $X2$ =6.02, df= 3, P <0.001
Genotype: : $X2$ =2.04, df= 2, P <0.05

GLM w/ gaussian dist. with EMM pairwise comparisons

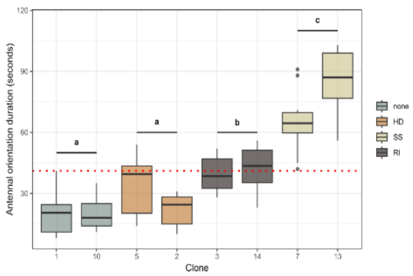
Checking the role of genotype – parasitism success



Clonal line: $X2$ =1.56, df= 3, P >0.05
Genotype: : $X2$ =2.04, df= 2, P >0.05

GLM w/ gaussian dist. with EMM pairwise comparisons

Checking the role of endosymbiont infection– parasitoid searching behaviour

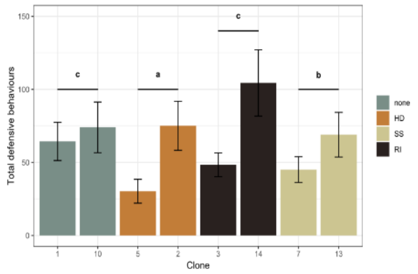


Clonal line: X_2 =19.1, df= 4, P <0.001
Endosymbiont : X_2 = 219, df= 3, P < 0.001

GLM w/ gaussian dist. with EMM pairwise comparisons

Notes

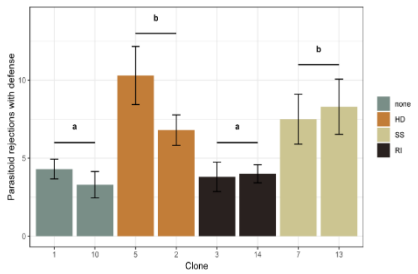
Checking the role of endosymbiont infection– aphid defensive behaviours



Clonal line: X_2 = 111, *df*= 4, P <0.001
Endosymbiont : X_2 =463, *df*= 3, P <0.001

GLM w/ gaussian dist. with EMM pairwise comparisons

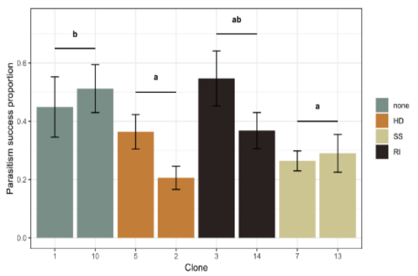
Checking the role of endosymbiont infection – rejections by parasitoids



Clonal line: X2 =8.9, *df*= 4, P >0.05
Endosymbiont: X2 =66.4, *df*= 3, P < 0.001

GLM w/ gaussian dist. with EMM pairwise comparisons

Checking the role of endosymbiont infection – parasitism success

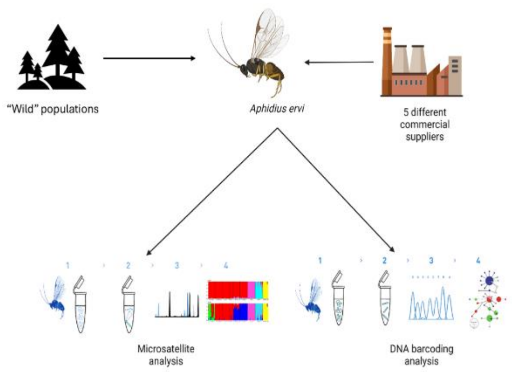


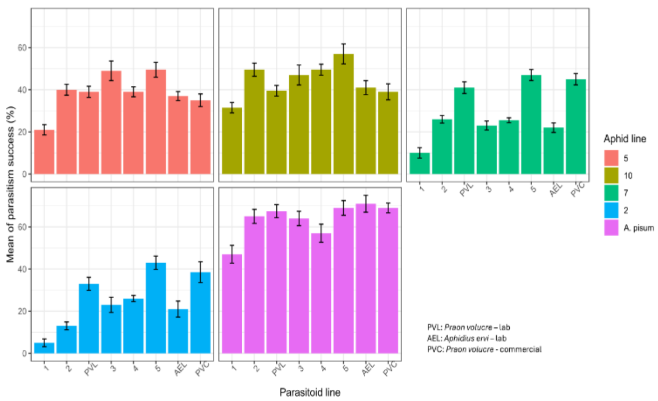
Clonal line: X_2 =6.06, *df*= 4, P >0.05
Endosymbiont : X_2 =14.2, *df*= 3, P <0.001

GLM w/ gaussian dist. with EMM pairwise comparisons

Notes

3. Genetic diversity of *Aphidius ervi*





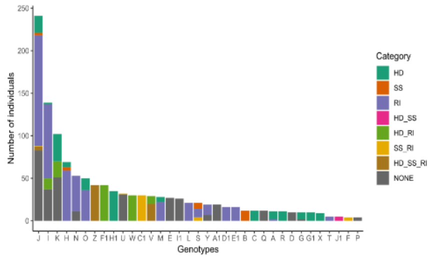
4. The effect of potato aphid variation on field conditions

Over 2 seasons

Notes

4. The effect of potato aphid variation on field conditions

- α diversities
- β diversities
- Endosymbiont prevalence vs parasitism pressure
- Parasitism pressure correlations
- Effect of polytunnel size



4. Summary

- **Variation** on potato aphid susceptibility to *Aphidius ervi* in the UK.
- **Limited** aphid genotype effect on parasitoid searching behaviour, aphid defensive behaviour and parasitism success. **BUT significant effect** of endosymbiont infection status.
- Importance of **genetic diversity** on parasitoid populations.
- Importance of understanding the aphid-parasitoid **dynamics** in field conditions.

ACKNLOWEDGMENTS

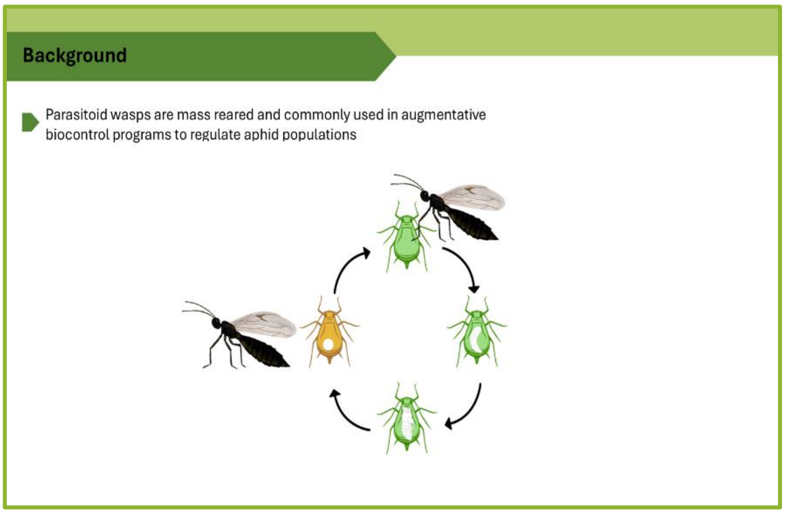
Harper Adams University NIAB The James Hutton Institute

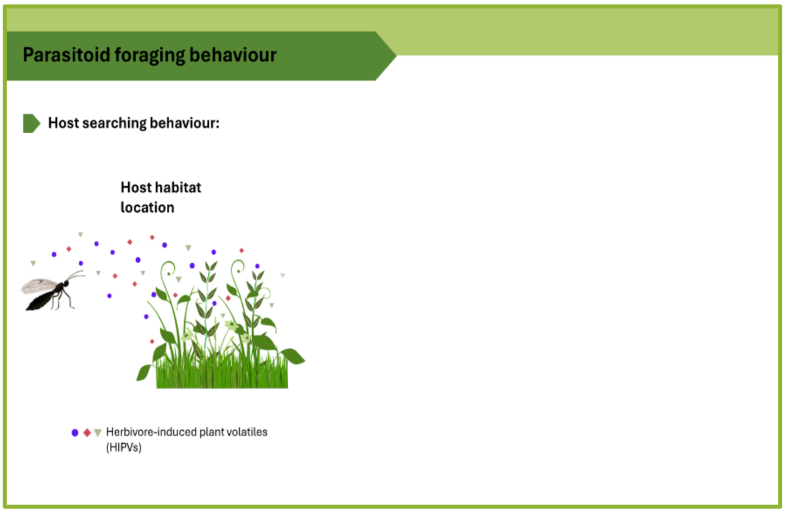
Dr. Tom Pope, Dr. Joe Roberts, Dr. Ali Karley, Dr. Francis Wamonje, Dr. Michelle Fountain, Dr. Bethan Shaw, Harriet Duncalfe, Gaynor Malloch, Danielle Henderson-Holding.

FUNDING

CTP FRUIT CROP RESEARCH BBSRC bioscience for the future BERRY GARDENS


Harper Adams University
Enhancing Biological Pest Control:
Learning Mechanisms and Olfactory Conditioning in Parasitoid Wasps
Nikoletta Foskolou
nfoskolou@haper-adams.ac.uk


Background
Parasitoid wasps are mass reared and commonly used in augmentative biocontrol programs to regulate aphid populations


Parasitoid foraging behaviour
Host searching behaviour:
Host habitat location
Herbivore-induced plant volatiles (HIPVs)

Notes

Notes

Parasitoid foraging behaviour

Host searching behaviour[2]:

Host habitat location → Host location

● ◆ ▼ Herbivore-induced plant volatiles (HIPVs)

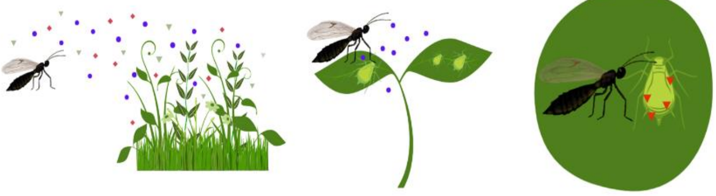
● HIPVs and host-originating chemical cues

2. Vinson, S.B. (1976) 'Host selection by insect parasitoids', *Annual Review of Entomology*, 21(1), pp. 109–133. doi:10.1146/annurev.en.21.010176.000545.

Parasitoid foraging behaviour

Host searching behaviour:

Host habitat location → Host location → Host acceptance



● ◆ ▼ Herbivore-induced plant volatiles (HIPVs)

● HIPVs and host-originating chemical cues

▼ Chemical cues directly derived from the host

Parasitoid foraging behaviour and learning

Parasitoid behavioural responses to chemical cues

- **Innate**
  - Fixed responses
- **Learned** → "The process that produces an adaptive change in an individual's behaviour as the result of experience"[3]
  - Associative learning

Notes

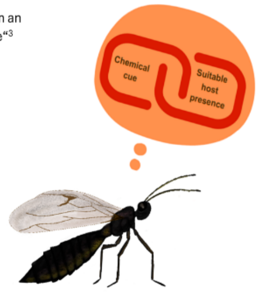
Parasitoid foraging behaviour and learning

Parasitoid behavioural responses to chemical cues

- **Innate**
  - Fixed responses
- **Learned** → "The process that produces an adaptive change in an individual's behaviour as the result of experience"[3]
  - Associative learning

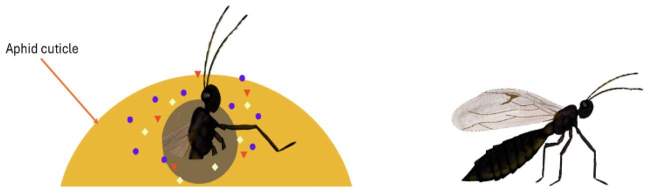
↓

"The establishment through experience, of an association between two stimuli or between a stimulus and a response"



Parasitoid foraging behaviour and learning

Naïve wasps



Parasitoid foraging behaviour and learning

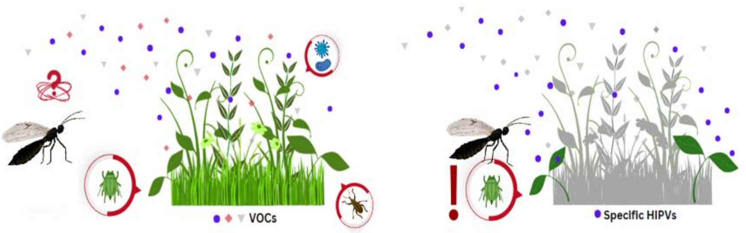
Naïve wasps

Notes

Applying parasitoid olfactory conditioning

- The training of commercially reared parasitoids to respond specifically and/or more strongly to cues involved in the target pest system using the learning mechanisms

Before Conditioning | **After Conditioning**

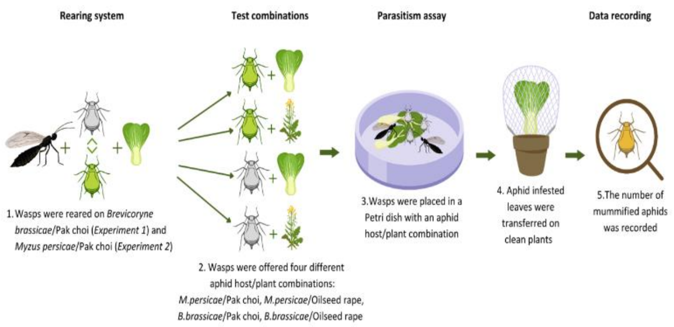


Project Aim and Objectives:

Explore how insect learning can be used to improve the efficiency of parasitoids as biological controls in sustainable crop protection

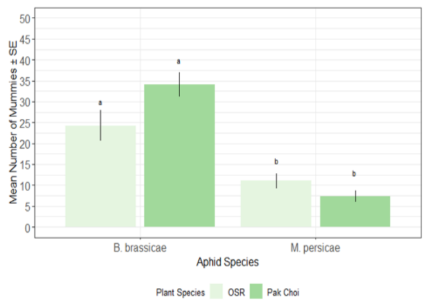
- Characterise chemical cues associated with host-searching behaviour
- Determine the learning abilities of commercially available parasitoids
- Develop mass-rearing techniques that incorporate parasitoid learning
- Evaluate the impact of improved parasitoid learning on biological control efficacy under semi-field conditions

Initial experiments

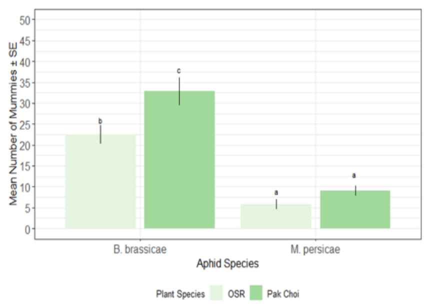


Notes

Experiment 1 – wasps reared on *B. brassicae* / Pak choi



Experiment 2 – wasps reared on *M. persicae* / Pak choi



Future work

- Parasitoid behavioural observation experiments
- Start working with commercially available parasitoids e.g., *A. colemani*
- Experiments in a larger scale

Notes


Thank you for listening!
Supervisory Team
Prof Tom Pope
Dr Matthew Back
Dr Joe Roberts
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nfoskolou@haper-adams.ac.uk
Harper Adams University
SUSTAINABLE CROP MANAGEMENT

Crop protection options for aphid management and integration into control programmes

Selchuk Kurtev, Zest – Sustainable ICM

Notes

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HTA

Crop protection options for aphid management and integration into control programmes

Selchuk Kurtev, Zest Sustainable ICM

WHAT I WILL COVER

HTA

- Approved insecticides
  - Conventional
  - Bioprotectants
- Products exempt from regulations
- Integrating products within an IPM programme
- Summary

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Approved products - conventional

HTA

CAUSAL ORGANISM(S)	EXAMPLE CONTROL PRODUCT NAME AND MAPP NUMBER	ACTIVE SUBSTANCE(S) (a.s)	IRAC CODE	COMPATIBILITY WITH BIO CONTROLS	MODE OF ACTION	FIELD / PROTECTED	FIELD RATE (Max. approved rate listed)	PROTECTED RATE (Max. approved rate listed)	ERADICANT / PROTECTANT	APPROVAL STATUS AND EXPIRY DATE*	NUMBER OF APPLICATIONS	MAXIMUM TOTAL DOSE	SPECIFIC RESTRICTIONS	COMMENTS
Aphids (*Aphis gossypii, Macrosiphum euphorbiae, Myzus persicae* and various other species)	Aphox (MAPP18562)	Pirimicarb 500g/kg	1A	MS	C, F, Tr	P	280g/ha	280g/ha	E	EAMU 4196/19 - 15/09/2027	1	-	Container-grown crops only. Use in a min water volume of 300L/ha (max concentration of 50g/100L)	Application rate is too low for *Myzus* and other species, OK as tank mix with Mainman
	Batavia (MAPP18449)	Spirotetramat 100g/L	23	-	S, Tr	F/P	750ml/ha	750ml/ha	E	EAMU 1267/22 EAMU 1268/22 - 31/01/2027	2	-	For outdoor crops: only apply after flowering has finished. For protected crops: 14 days before flowering or following flowering. 39 days handling restriction for protective clothing	Risk of phytotoxicity to crops, check on a small scale before commercial application
	Decis Protech (MAPP16160)	Deltamethrin 15g/L	3	H	C	F/P	500ml/ha	1.2L/ha	E	EAMU 1662/13 EAMU 3553/22 - 15/02/2029	3	-	For outdoor crops: SRSU gloves for 6 weeks handling restrictions. Do not apply with handheld equipment. Buffer zones based on crop height. For protected crops: SRSU gloves for 13 weeks handling restrictions. Use of respiratory equipment and managers must complete a thermal comfort checklist	Risk of phytotoxicity to some crops
	Gazelle SG (MAPP20034)	Acetamiprid 200g/kg	4A	H	C, S, Tr	F/P	250g/ha	500g/ha	E/P	On label - 24/01/2027	1 (2)	-	Do not apply with handheld equipment under protection. Managers must complete a thermal comfort checklist. Not to be used on field-grown, non-bulb, cut flowers and hardy nursery stock. Protective clothing and SRSU gloves for 10 weeks after treatment	14 day spray interval for protected crops. For use on container-grown ornamentals only less than 50cm. Only 1 application to outdoor crops
	Hallmark WZT (MAPP12629)	Lambda-cyhalothrin 100g/L	3	H	C	F/P	90ml/ha	50ml/ha	E	EAMU 2944/08 - 09/09/2099	4 (3)	270ml/ha/yr	A min interval of 14 days must be observed between applications	
	Mainman (MAPP13123 and 20214)	Flonicamid 500g/kg	29	MS	S	F/P	140g/ha	140g/ha	E/P	EAMU 0045/13 EAMU 2832/22 - 28/02/2029	3	-	An interval of 21 days must be observed between treatments	Very slow acting but long lasting, lower water volumes work better, good in mixtures with contact insecticides
	Sequoia (MAPP18938)	Sulfoxaflor 120g/L	4C	MS	S	P	-	400ml/ha	E/P	On label - 18/02/2028	2	400ml/ha/yr	No handling for 8 days, vents, doors and other openings must be closed during and after application until the applied product has fully settled	Same group as Gazelle, don't abuse. 1 application at 400ml/ha or 2 x 200ml/ha. Separate whitefly and aphid recommendations. Latest time of application 1 day before harvest
	Sumi-Alpha (MAPP18637)	Esfenvalerate 25g/L	3	H	C	P	-	50ml/100L	E	On label - 09/09/2099	2	-	Max 1,200L/ha water volume	

Notes

Aphox

- Better at large aphid species
- Use low water volumes, ideally 400-500L/ha
- Vapour activity – best applied mid-morning
- Contact, translaminar, and vapour
- Good in a tank mix with Mainman for difficult to control species – peach potato and melon cotton aphids
- Limited use
- Compatible with biological control
- Good crop safety
- Good in mixtures

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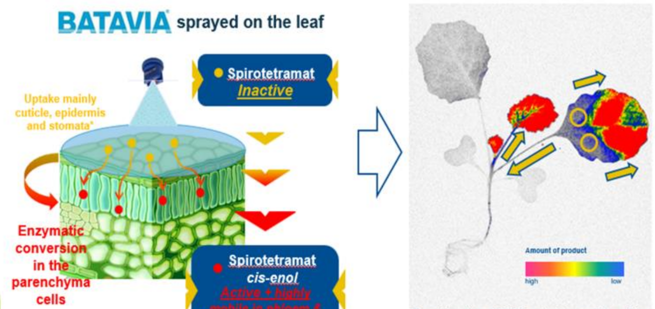
Batavia



Translocation of [^{14}C]-spirotetramat in cabbage after application to the 1st true leaf (yellow circles)

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Batavia

- Can provide a long-lasting effect
- Effective on all aphid species without exception
- Translocation and systemic
- Lifecycle breaker, NOT a knockdown product!
- Actively growing crops
- DO NOT MIX (no exception)
- Useful for scale insects, mealy bugs, and other sap sucking pests
- Good beneficial profile
- Do not use on flowering crops
- Can be phytotoxic

Alstroemeria spp., Begonia spp., Cyclamen spp., Euphorbia spp., Ficus spp., Fuchsia spp., Hedera spp., Hydrangea spp., Impatiens spp., Pelargonium spp., Populus spp., Salix spp., Saintpaulia spp., Tilia spp., Quercus frainetto.

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Notes

Pyrethroids – Decis, Hallmark Zeon, Sumi-Alpha

- Persistent under low light levels, especially in tunnels
- Contact ONLY but some anti-feedant effect
- Broad spectrum, but many resistant populations exist
- Abused too much by some of the smaller grower/retailers
- Useless on aphid species with sub canopy habits – shallot, lupin, and helichrysum aphids for example
- Risk of phytotoxicity under hot and sunny conditions
- Only use where you have more than one pest on same crop – i.e. aphids + caterpillars etc.
- Hallmark Zeon a better choice
- Incompatible with biocontrol long term

Gazelle SG

- Effective on all aphid species except woolly aphids and root aphids
- Fast acting contact, systemic translaminar
- Good persistency – 10-14days
- Knockdown and lifecycle breaker
- Side effects on other sap sucking and chewing pests
- Do not rely on for whitefly control – too weak for this
- Some concerns over decline in efficacy
- Can help with reducing virus transmission
- Good crop safety
- Does benefit from adjuvant use
- Compatible with biocontrol, but must leave time between introductions

Mainman

- Lifecycle breaker
- Systemic only with high persistency (up to 21 days)
- Movement only upwards
- Slow to work but effective on all species
- Taken up by roots, stems, and leaves
- Side effects on other sap sucking pests
- Good tank miscibility
- Good crop safety
- Compatible with biocontrol

Notes

Sequoia

- Similar to Gazelle SG, but considered more effective
- Systemic, contact and translaminar with good persistency (up to 14 days)
- Movement only upwards
- Fast acting and effective on all aphid species
- Taken up by leaves
- Side effects on other sap sucking pests
- Good tank miscibility
- Good crop safety
- Compatible with biocontrol, but must leave time between introductions

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Sustainable ICM

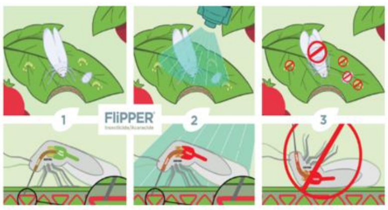
Approved products - bioprotectants

CAUSAL ORGANISM(S)	EXAMPLE CONTROL PRODUCT NAME AND MAPP NUMBER	ACTIVE SUBSTANCE(S) (a.s)	IRAC CODE	COMPATIBILTY WITH BIO CONTROLS	MODE OF ACTION	FIELD / PROTECTED	FIELD RATE (Max. approved rate listed)	PROTECTED RATE (Max. approved rate listed)	ERADICANT / PROTECTANT	APPROVAL STATUS AND EXPIRY DATE*	NUMBER OF APPLICATIONS	MAXIMUM TOTAL DOSE	SPECIFIC RESTRICTIONS	COMMENTS
Aphids (*Aphis gossypii, Macrosiphum euphorbiae, Myzus persicae* and various other species	Flipper (MAPP19154)	Fatty acids C7-C20 479.8g/L	-	MH	C	F/P	10.0L/ha	16.0L/ha	E	EAMU 3171/19 EAMU 1415/20 - 15/06/27	5 (8)	-	For outdoor and protected crops. Buffer zones based on crop height. Min 400L/ha and max 1,000L/ha water volume and 1.6L/100L concentration. Applications between 1 March and 30 August. Max 8 applications in 3 blocks. For glasshouse: 400-1,600L/ha water volume. Protect bees, close doors and vents	Requires rain or soft water or water conditioner, only use in cooler parts of the year
	Spruzit (MAPP18434)	Pyrethrins 4.59g/L	3	H	C	F/P	6.0L/ha	12.0L/ha	E	On label and EAMU 0911/22 - 15/06/2027	2	-	The max concentration must not exceed 2L of product in 100L of water. This product must not be used on crops taller than 2m in outdoor situations	Do not apply in sunny conditions, risk of scorch

zest
Sustainable ICM

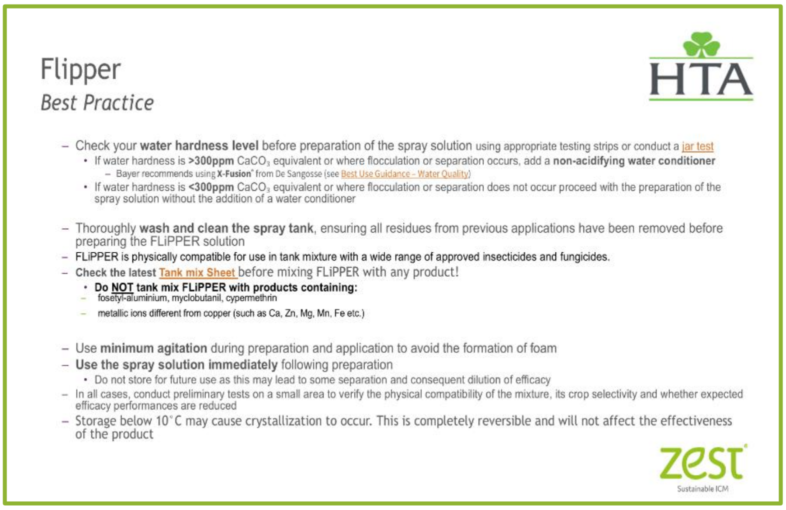
Flipper

- The effectiveness of FLiPPER's active ingredient – Unsaturated Carboxylic Acids (carbon chain lengths C14 – C20) is achieved by the lipophilic carbon chains penetrating the external layers of the target pest.
- These unsaturated part of the carbon chains interacts with multiple vital metabolic processes. This interferes with feeding activity, resulting in mortality.



Carboxylic acids are derived from the production of extra virgin olive oil – thus exempt from EU MRL testing.

Notes


Flipper
Best Practice
– Check your water hardness level before preparation of the spray solution using appropriate testing strips or conduct a jar test
• If water hardness is >300ppm CaCO3 equivalent or where flocculation or separation occurs, add a non-acidifying water conditioner
– Bayer recommends using X-Fusion® from De Sangosse (see Best Use Guidance – Water Quality)
• If water hardness is <300ppm CaCO3 equivalent or where flocculation or separation does not occur proceed with the preparation of the spray solution without the addition of a water conditioner
– Thoroughly wash and clean the spray tank, ensuring all residues from previous applications have been removed before preparing the FLiPPER solution
– FLiPPER is physically compatible for use in tank mixture with a wide range of approved insecticides and fungicides.
– Check the latest Tank mix Sheet before mixing FLiPPER with any product!
• Do NOT tank mix FLiPPER with products containing:
– fosetyl-aluminium, myclobutanil, cypermethrin
– metallic ions different from copper (such as Ca, Zn, Mg, Mn, Fe etc.)
– Use minimum agitation during preparation and application to avoid the formation of foam
– Use the spray solution immediately following preparation
• Do not store for future use as this may lead to some separation and consequent dilution of efficacy
– In all cases, conduct preliminary tests on a small area to verify the physical compatibility of the mixture, its crop selectivity and whether expected efficacy performances are reduced
– Storage below 10˚C may cause crystallization to occur. This is completely reversible and will not affect the effectiveness of the product
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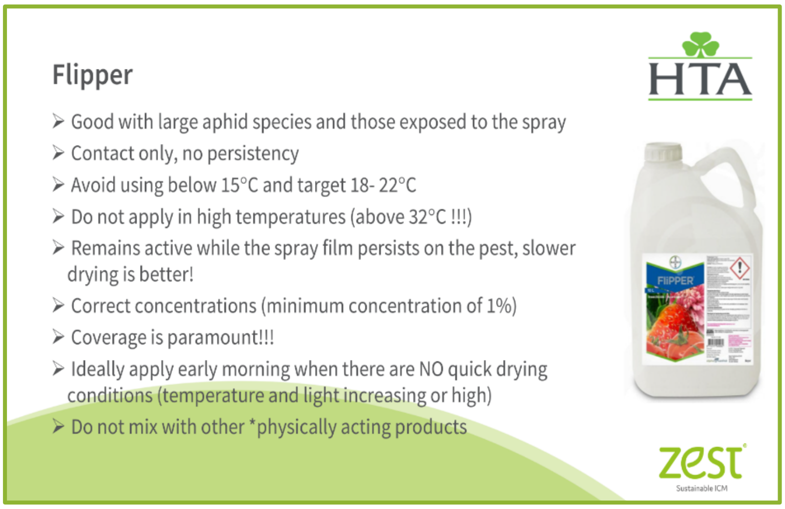
Flipper
X-Fusion
DE SANGOSSE
Solutions of FLiPPER
Water Hardness = 300 ppm CaCO3 equivalent
FLiPPER (de-ionised water) pH = 9.62
FLiPPER (hard water (200ppm CaCO3 equivalent)) pH = 9.81
FLiPPER (hard water (300ppm CaCO3 equivalent)) pH = 9.71
FLiPPER + X-Change 0.1% v/v pH = 8.23
FLiPPER + X-Change 0.25% v/v pH = 7.24
FLiPPER + X-Fusion 0.1% v/v pH = 9.69
FLiPPER + X-Fusion 0.25% v/v pH = 9.83
Rob Suckling, rob@desangosse.co.uk
zest
Sustainable ICM


Flipper
➢ Good with large aphid species and those exposed to the spray
➢ Contact only, no persistency
➢ Avoid using below 15°C and target 18- 22°C
➢ Do not apply in high temperatures (above 32°C !!!)
➢ Remains active while the spray film persists on the pest, slower drying is better!
➢ Correct concentrations (minimum concentration of 1%)
➢ Coverage is paramount!!!
➢ Ideally apply early morning when there are NO quick drying conditions (temperature and light increasing or high)
➢ Do not mix with other *physically acting products
FLIPPER
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Notes

Spruzit

- Natural pyrethroid
- Contact only, no persistency
- Low concentration + high concentration rapeseed oil
- 2L/100L concentration can be very effective, but risk to crops
- Side effects on many chewing and sucking pests and mites
- Does leave a glossy appearance on the leaves
- Good knockdown, useful in corrective approach
- 600L/ha water volume works best, woolly aphid control too
- Do not mix with other *physically acting products

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Regulatory exempt – SB Plant Invigorator

- Anionic surfactant - sodium lauryl ether sulphate (SLES)
- Useful for easily accessible aphid species
- Can be tank mixed with Mainman to improve melon cotton aphid control
- Best applied in 600-800L/ha water volumes
- Requires regular applications
- Side effects on many sap sucking pests and mites
- Can be phytotoxic especially on fresh growth and yellow or variegated foliage
- It can be costly if more than three applications applied per crop
- Compatible with IPM, but….

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Regulatory exempt – Protac

- Silicone polymers
- Effective with most aphid species, except woolly aphids and roots aphids
- Concentration based product
- Requires dry warm conditions
- Can result in picking up residues from previous applications in spray tanks
- Side effects on many sap sucking pests and mites
- Can be phytotoxic especially on new growth and under hot and sunny conditions
- Do not mix with other products
- Compatible with IPM, but….

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Notes

Integrating aphicides within programmes

- Glasshouse, 14-week crop cycle from week 10 (early March)
- Glasshouse aphid, potato aphid, peach potato aphid
- Key considerations include:
  - Monitoring
  - Plant growth
  - Pest pressure
  - Biocontrol establishment

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SUMMARY

- Demise in product availability
- Increase of resistance issues!
- Challenges with HSE and compliance
- Insufficient monitoring
- Proactive approach to aphid control always required
- No 'one size fits all' approach
- Need to understand the dynamics between the pest, beneficials, crop cycles and history, production and sales windows and plant knowledge
- Much more reliance on contact product, so coverage becomes very important

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NURSERY PRODUCTION
Zest-ICM
0333 005 0167
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zest® Sustainable ICM

Appendix

1. How to crop monitor - https://www.youtube.com/watch?v=IqXLutRZ0GI
2. Top 5 tips before you start your biological control programme - https://www.youtube.com/watch?v=COkT8yJj5PA
3. Biological maintenance – the right tools, at the right time, in the right place - https://www.youtube.com/watch?v=j-RcWgNwvnU
4. IPM application techniques - https://www.youtube.com/watch?v=QRv7TVpL408
5. Selection and use of biological control agents in the production of ornamental crops - aphid and whitefly - https://www.youtube.com/watch?v=0UxPqztz7N0
   Selection and use of biological control agents in the production of ornamental crops – mites and thrips - https://www.youtube.com/watch?v=bYndw8Rptgk
6. Biocontrol introduction - Part 1 (English) - https://www.youtube.com/watch?v=GF2O5nh53ns
7. Boosting biocontrols within IPM programmes - https://projectblue.blob.core.windows.net/media/Default/Horticulture/Publications/Boosting%20Biocontrols%20Within%20IPM%20Programmes.pdf
8. Sticky traps tips - https://www.youtube.com/watch?v=76zv7d_Zrq8
9. AHDB Crop walkers' guides - https://horticulture.ahdb.org.uk/knowledge-library/crop-walker-guides

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