The highs and lows of aphid control using alternatives to pesticides

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Most common aphids on potato

Peach-potato aphid, *Myzus persicae*

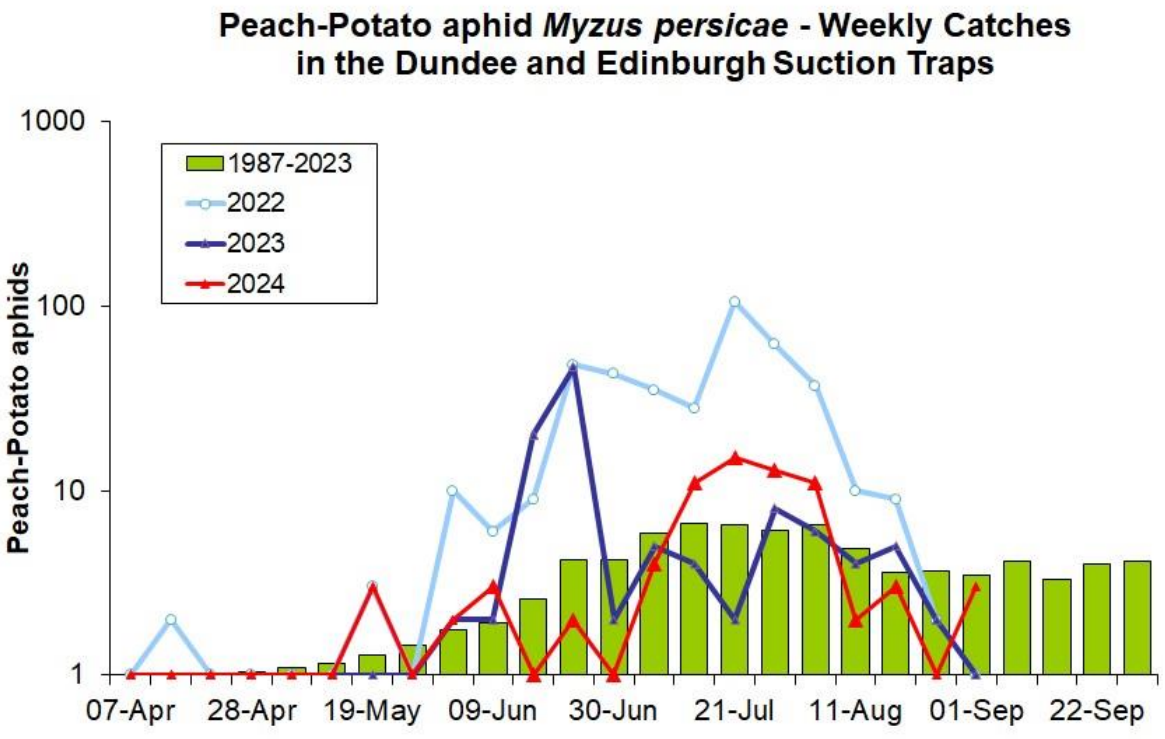
- Global distribution
- Highly polyphagous, attacking >400 plant species
- Transmits >100 viruses to economically important crops
- Efficient vector of PVY, moderately efficient vector of PVA
- Considered an efficient vector of PLRV

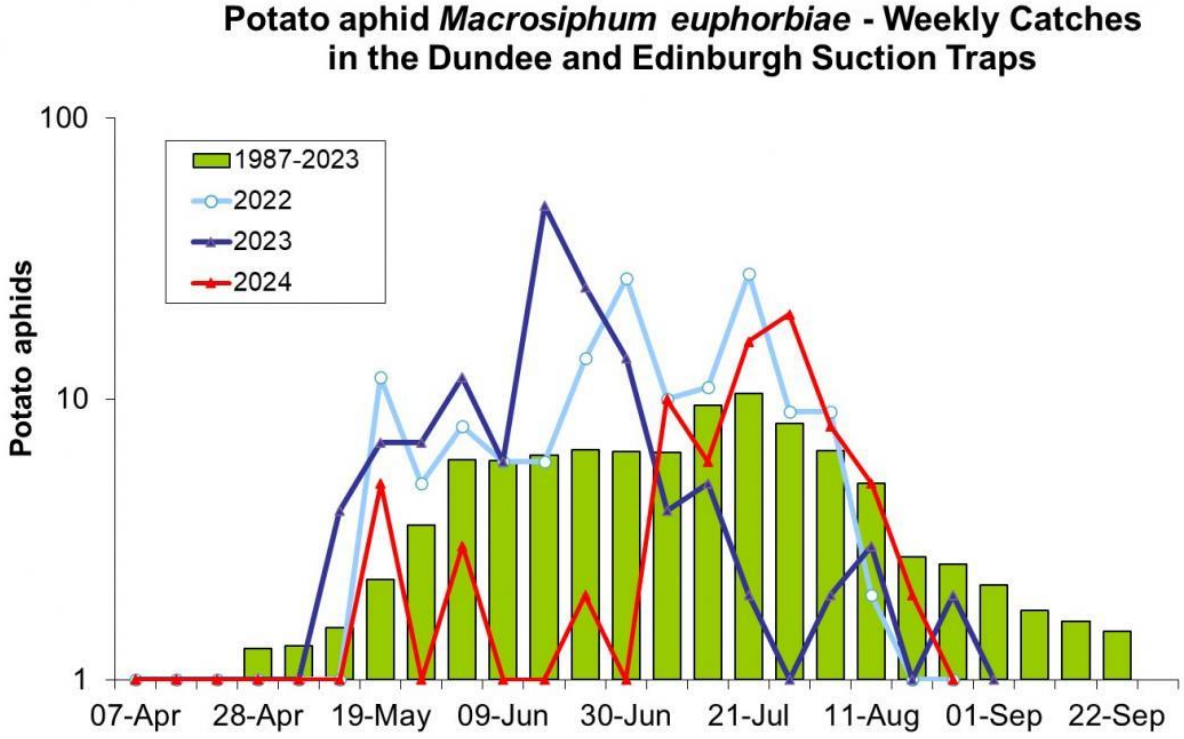
Potato aphid, *Macrosiphum euphorbiae*

- North American origin, present in UK since early 1900s
- Polyphagous, feeding on 200 plant species in >20 plant families
- Direct feeding damage and virus transmission
- Low (PVY) or moderate (PVA) efficiency of virus transmission
- Transmits PLRV, although considered less efficient

Aphids in a changing climate

Increasing aphid abundance in recent years

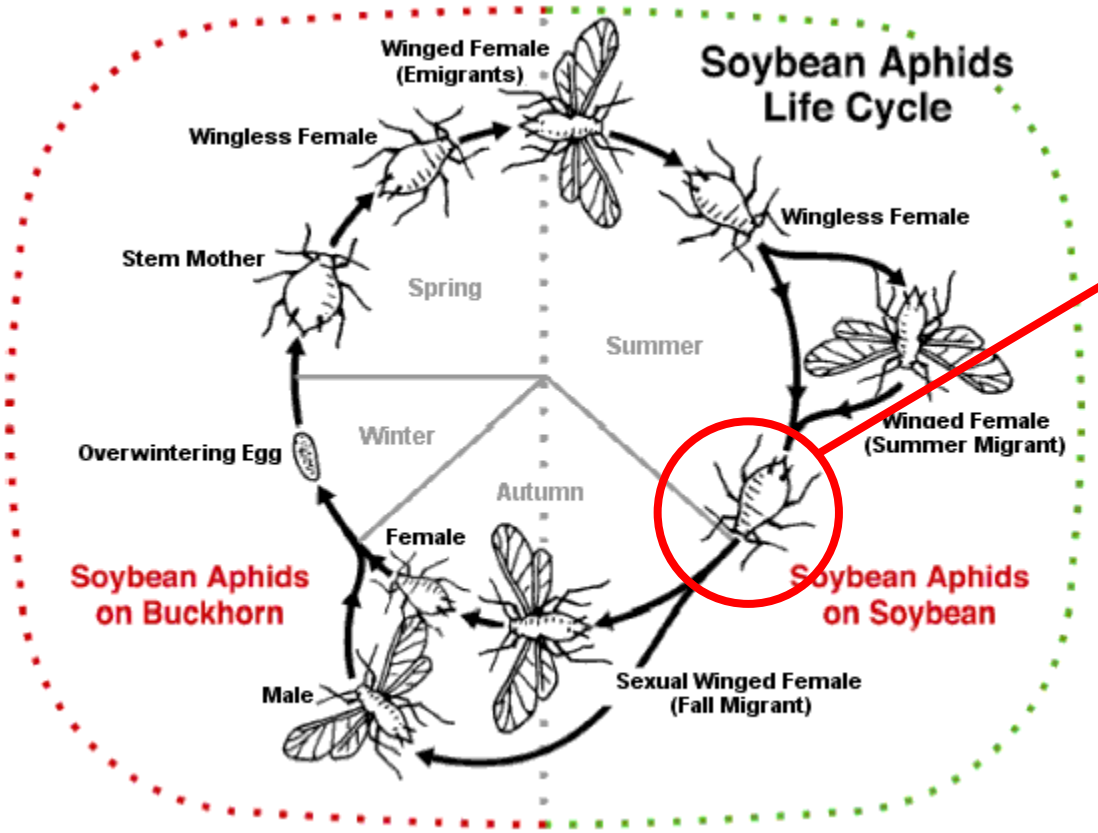


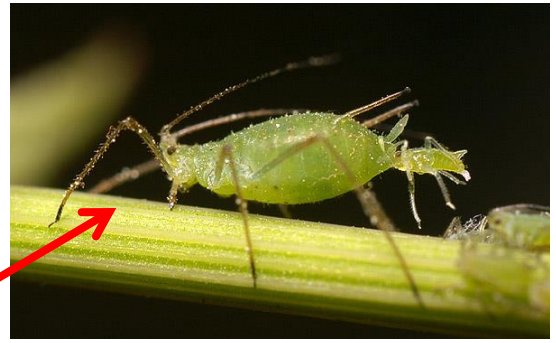


Source: https://www.sasa.gov.uk/wildlife-environment/aphid-monitoring/

Aphid life cycle

Successful herbivores and pests due to their life cycle and ‘telescoping’ of generations



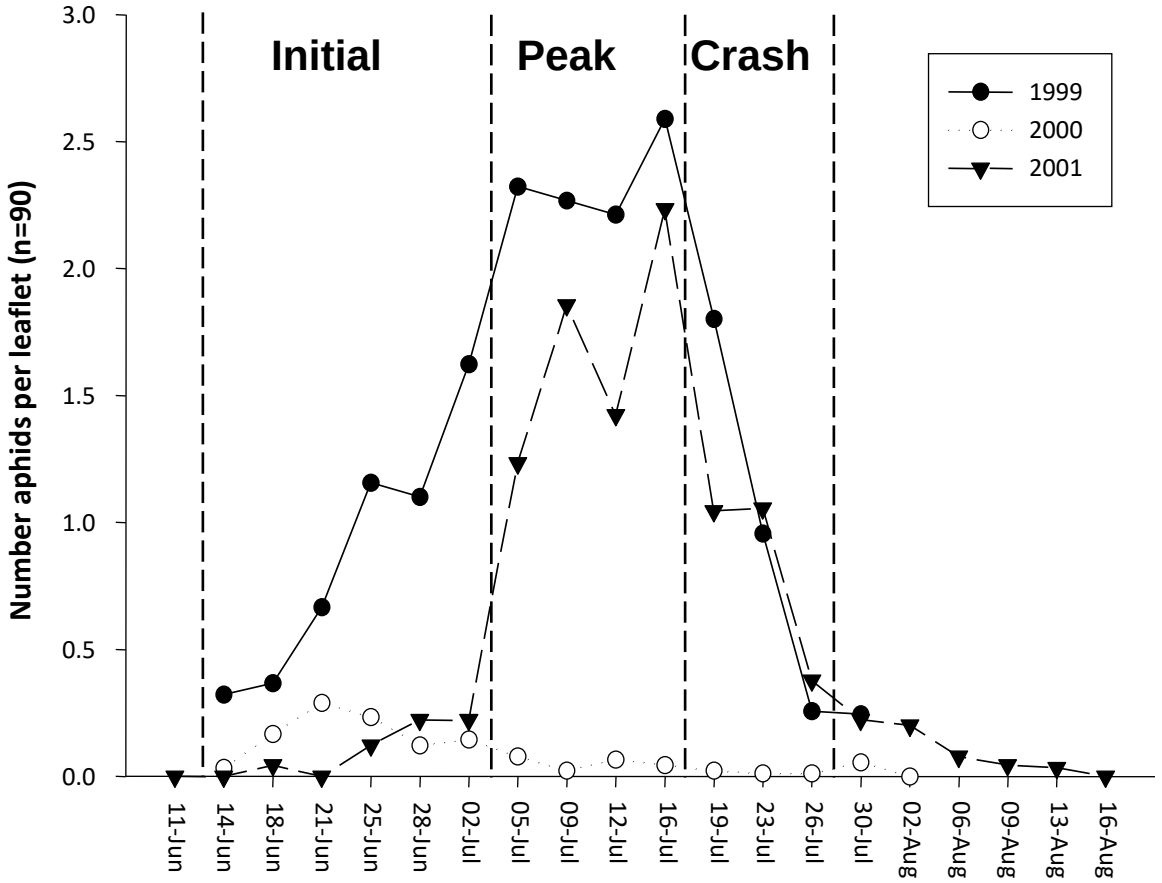


1 mg aphid gives rise to 1 kg in 46 days
(10 d development, 100 offspring per aphid over 4-5 week period)

Rapid response to selective forces (e.g. insecticides)

Summer aphid population dynamics on potato crops

Mid-summer aphid population crash occurs in crop and native vegetation



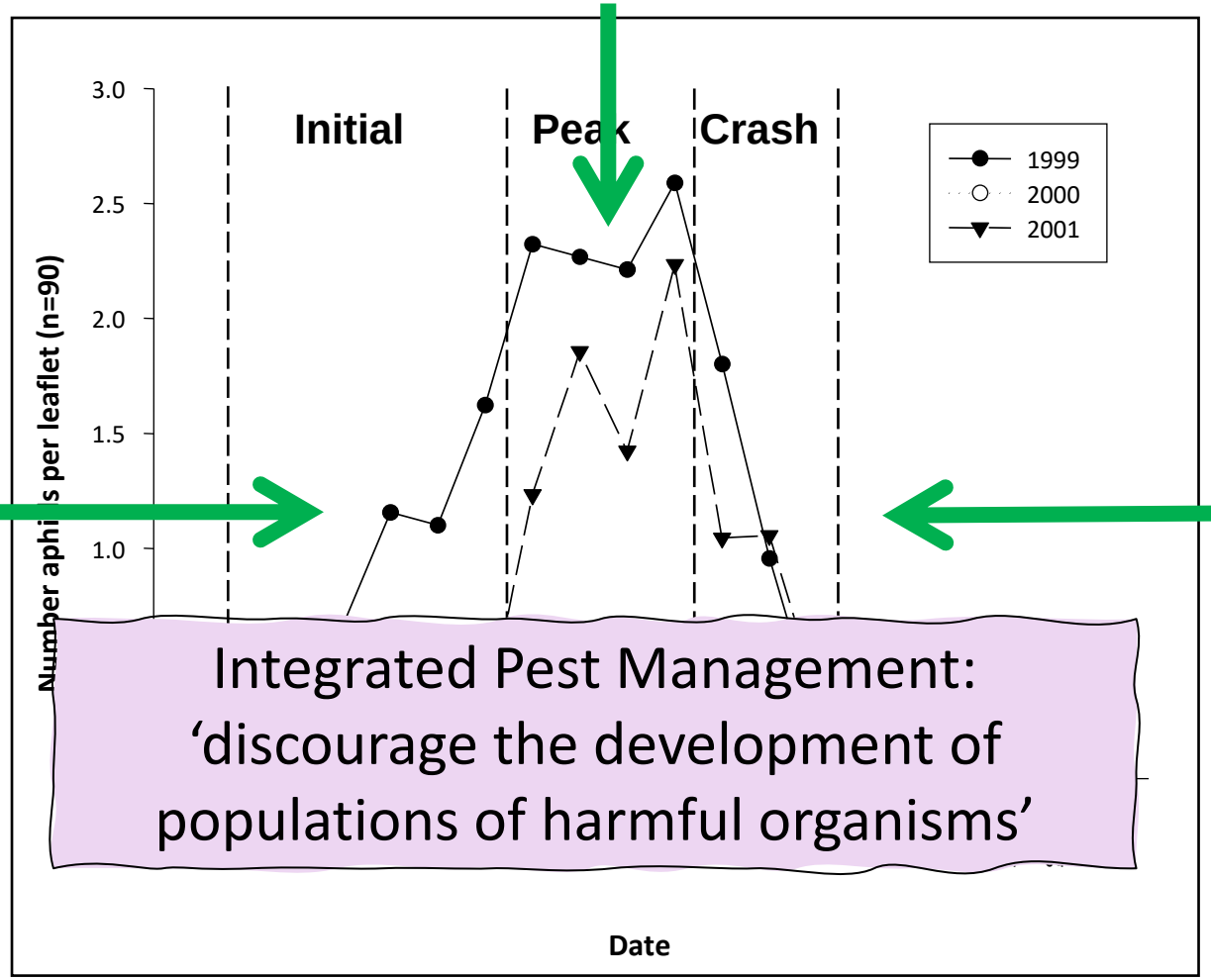
Karley et al (2003) Bull .Ent. Res . 93, 425-437

Factors regulating potato aphid abundance

High fitness of aphids colonising good quality immature plants (nutritional and physical traits)

Low natural enemy activity

Aphid recruitment (nymph production, winged aphids) continues up to peak



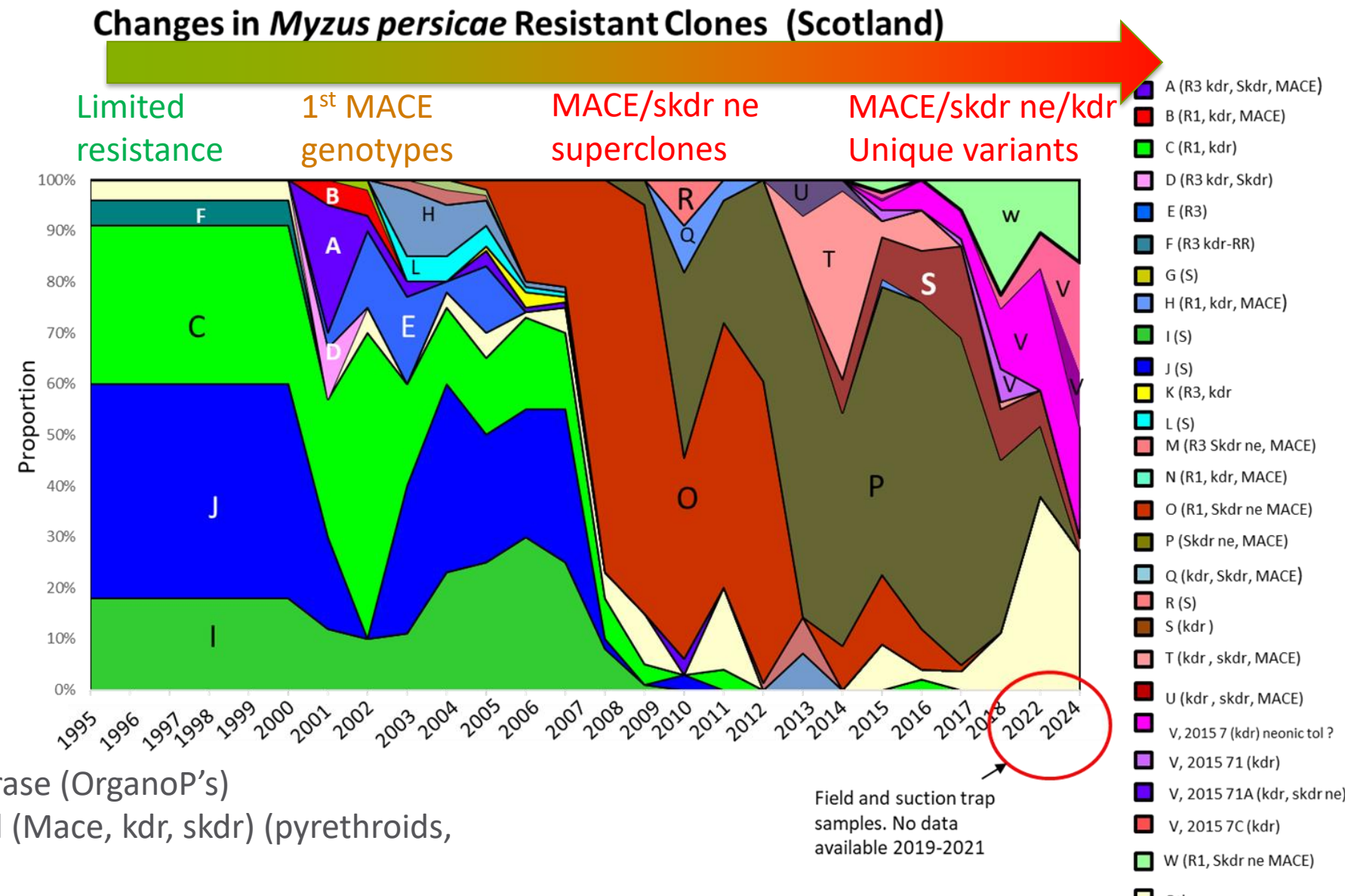
Integrated Pest Management: 'discourage the development of populations of harmful organisms'

Reduced aphid fitness on poorer quality mature plants (nutritional and physical traits, MPR)

Increased natural enemy activity

Karley et al. (2003) Bull. Ent. Res. 93, 425-437

Pesticide resistance



Rapid evolution of resistance to insecticides through multiple independent molecular mechanisms

Pesticide resistance

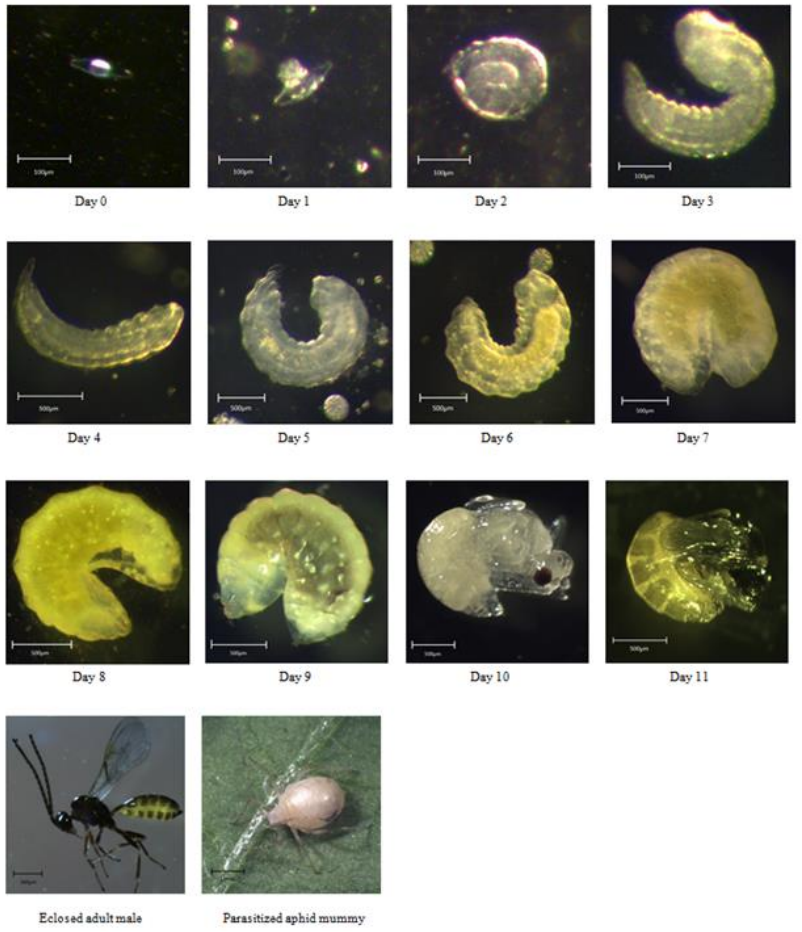
- Metabolic - esterase (OrganoP's)
- Target-site based (Mace, kdr, skdr) (pyrethroids, carbamates)
- Target and metabolic based (Neonics)

Natural enemies of aphids

- **Predators**: ladybirds adults & larvae, syrphid larvae, chrysopid larvae, generalist predators
- **Parasitic wasps**: parasitoids and hyperparasitoids
- **Entomopathogenic fungi**: *Beauveria bassiana, Verticillum lecanii, Neozygites fresenii, Pandora neoaphidis*

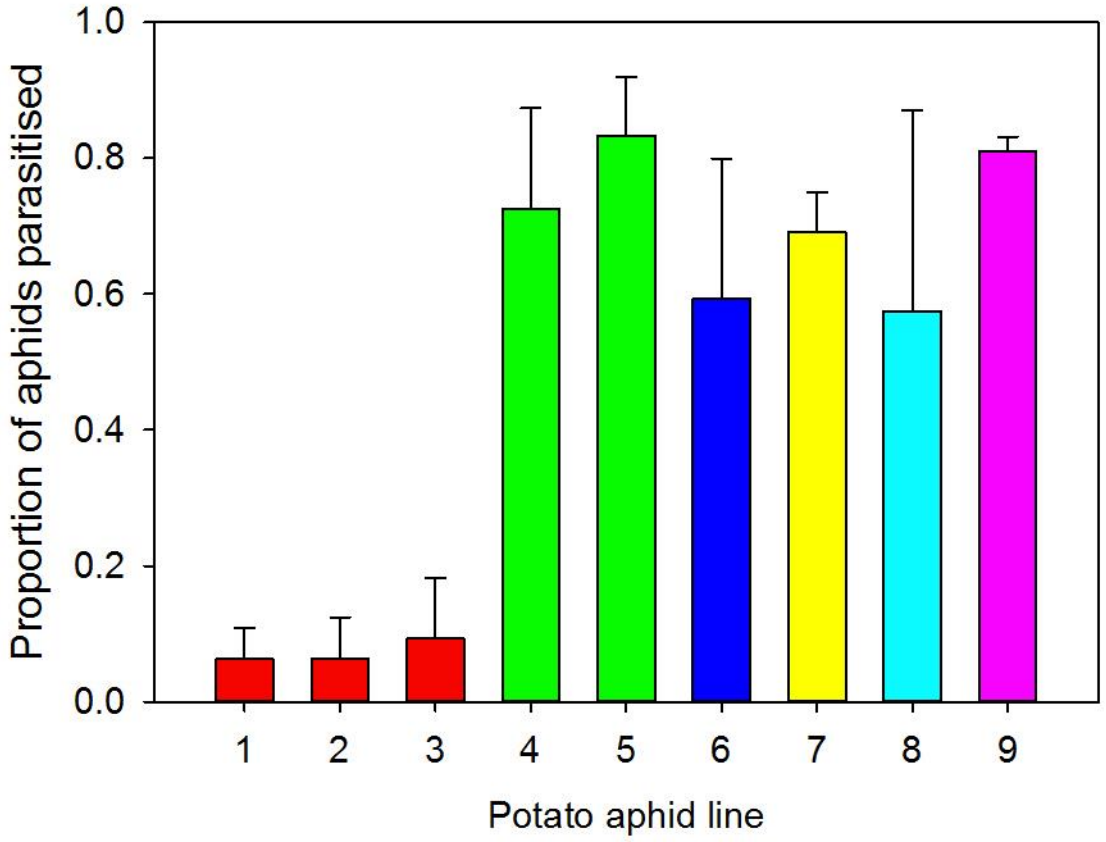
Natural enemy control of aphid populations: parasitism by braconid wasps

Aphidius ervi – common generalist parasitoid of aphids



Aphid resistance to parasitism

Potato aphid genotypes vary in susceptibility to *Aphidius ervi*

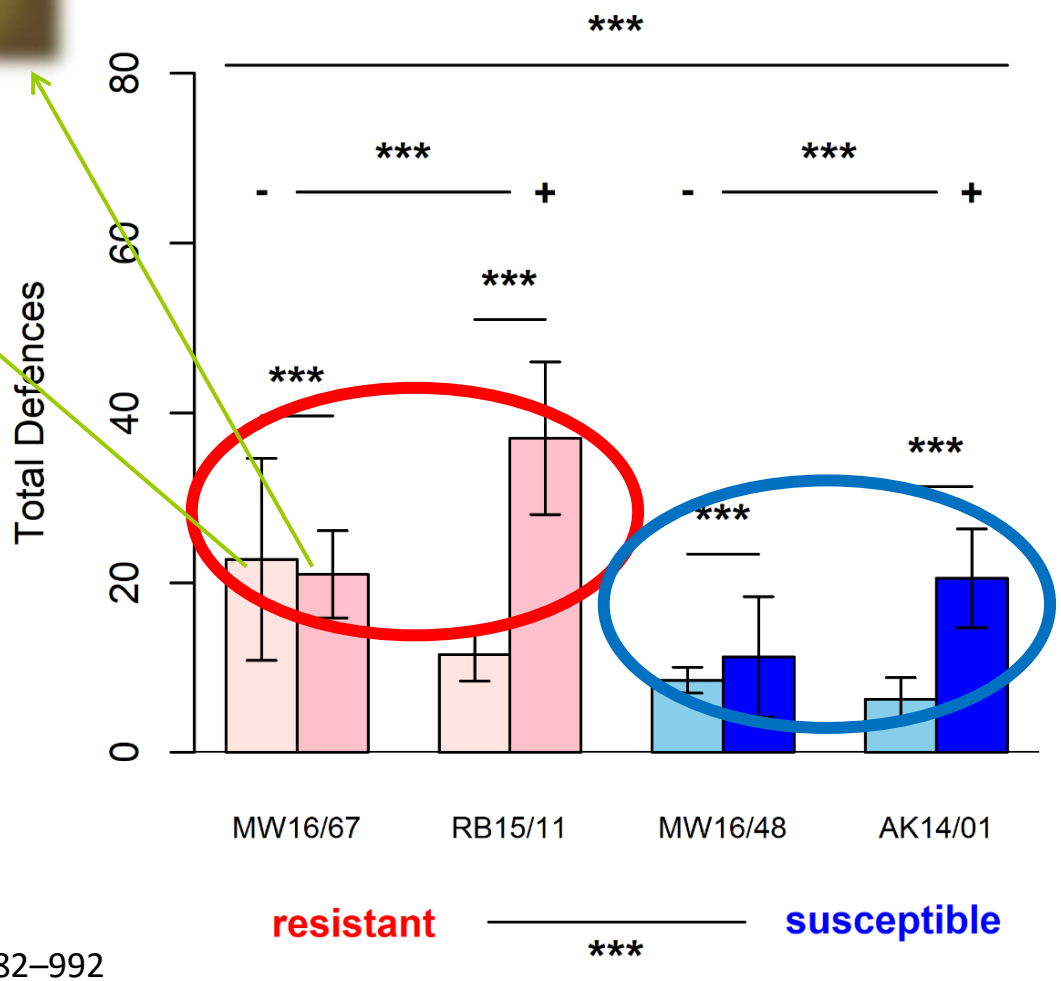


Parasitoid-resistant aphid genotypes have rapid development, high fecundity and long survival

Clarke et al. (2016) Entomologia Experimentalis et Applicata 162, 148-158. doi:10.1111/eea.12516

Interactions with aphid predators

Parasitoid-resistant potato aphid genotype more likely to defend against lacewing and ladybird attack



Behaviour/defence
No reaction
‘Shift’
Kick
Back-up/walk away
Drop

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University of St Andrews

Humphreys et al (2022) Ent. Exp. Appl. 170, 982–992
https://doi.org/10.1111/eea.13223

Aphid dynamics and IPM options

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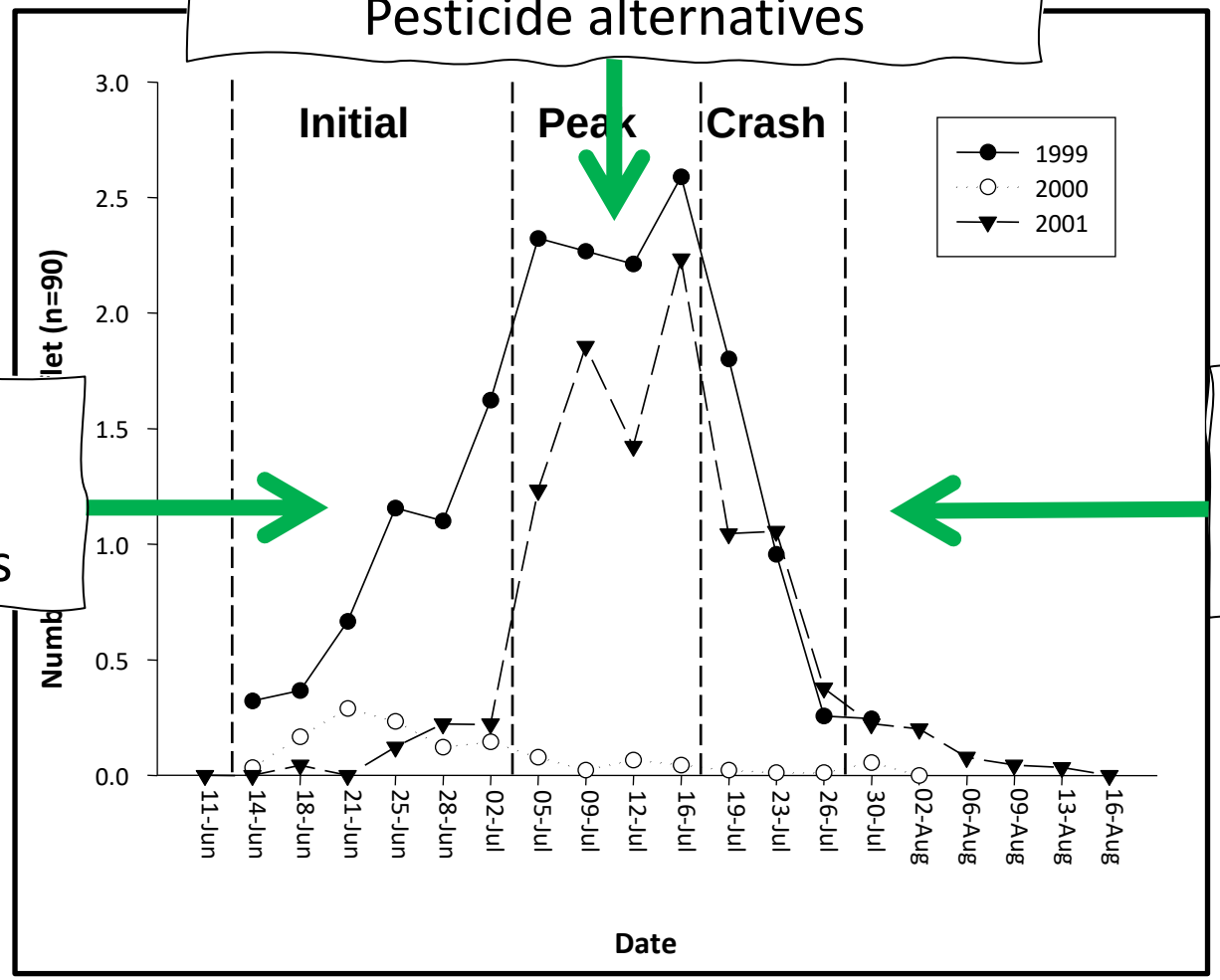
Monitor aphid population composition (species, phenotype)
Pesticide alternatives

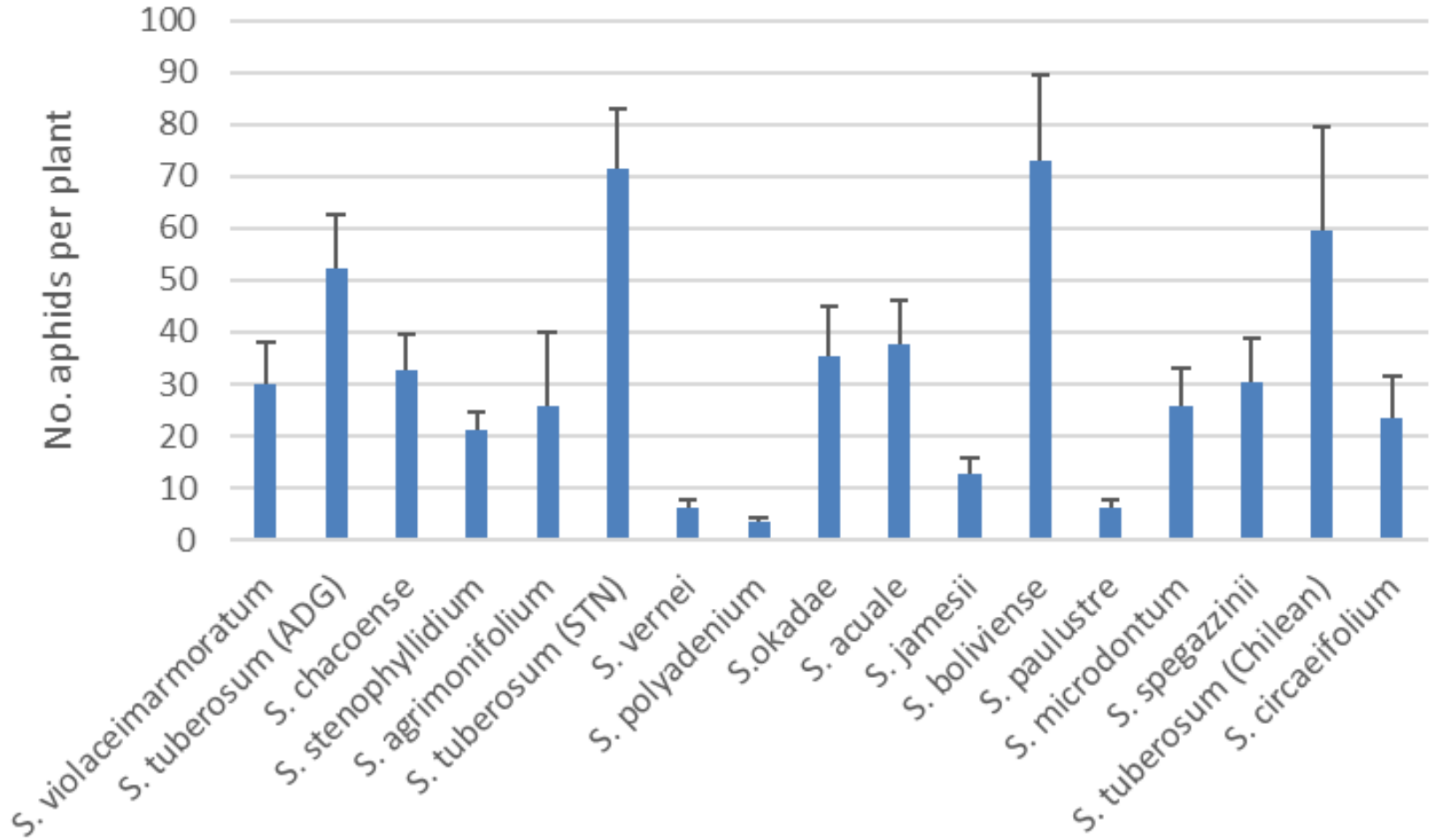
Deter aphid settling

Attract natural enemies

Mature plant resistance
Enhance natural enemy activity



Deter aphid settling - plant genotype

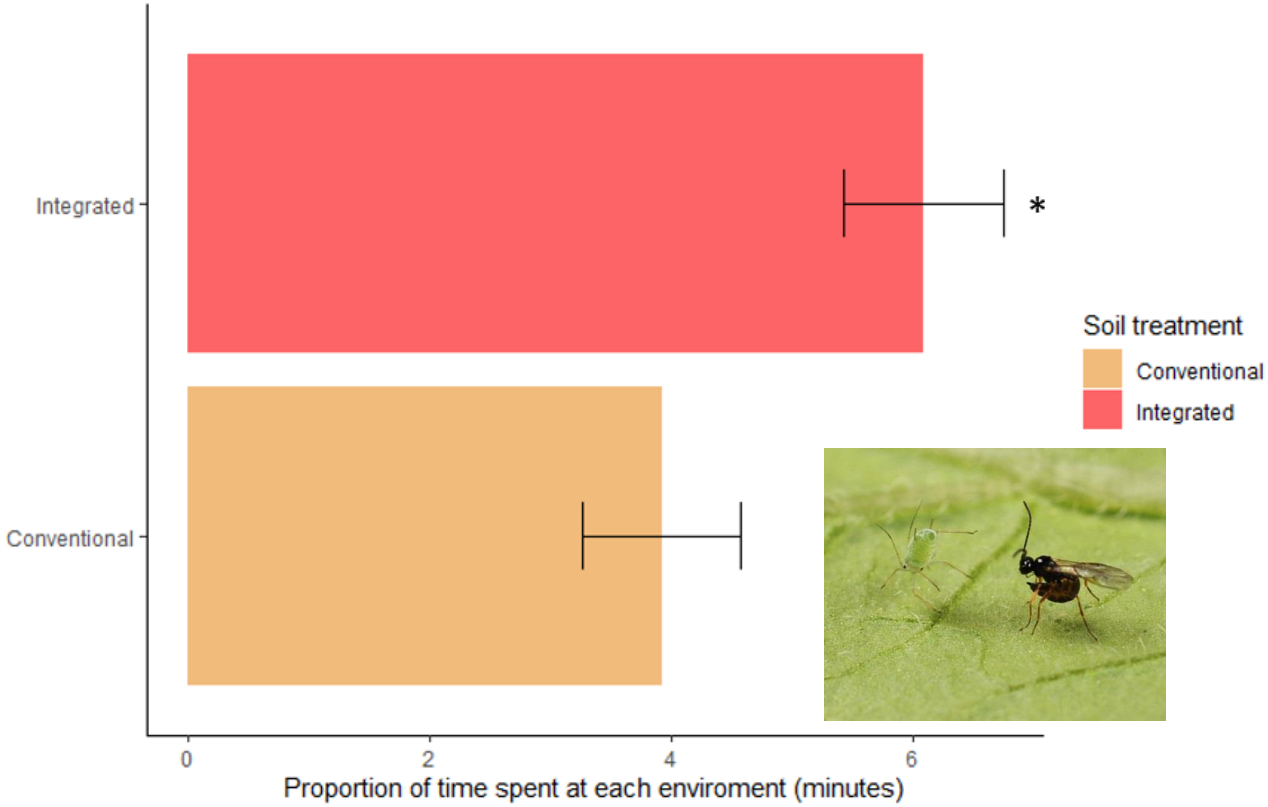


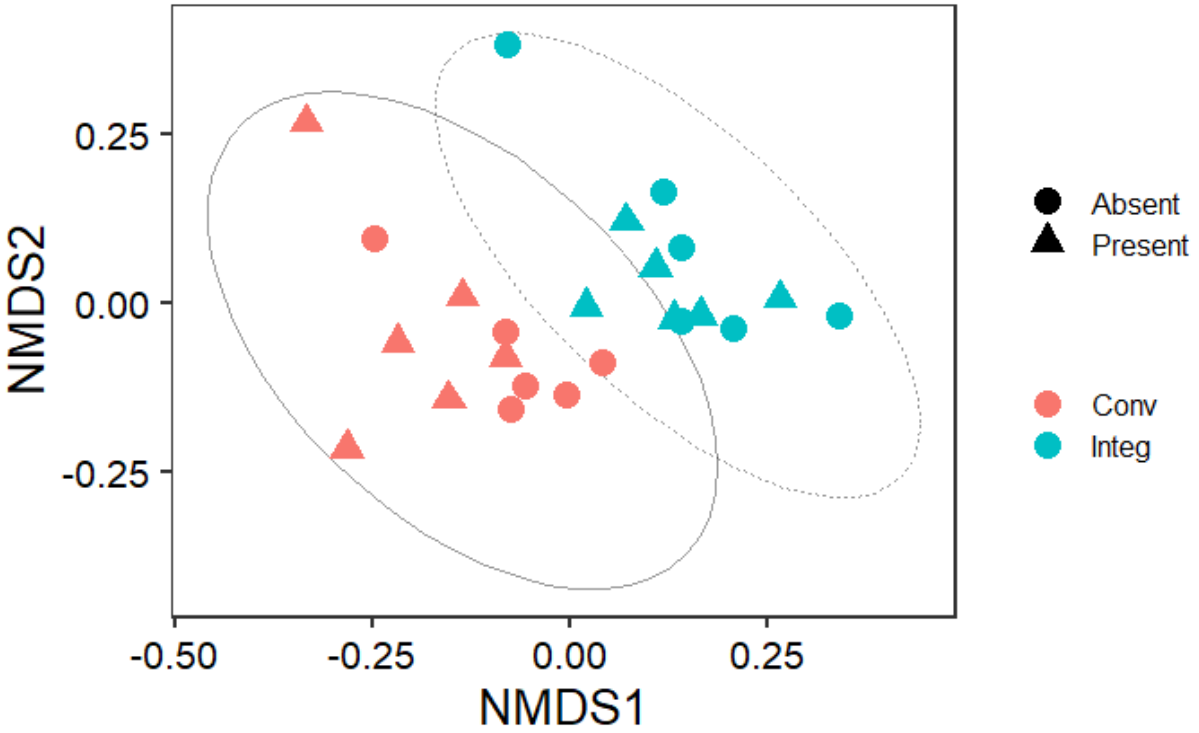
Differential suitability of *Solanum* spp. and genotypes to *M. euphorbiae*

Deter aphid settling

Lizzie Eddowes (Unpublished)

Attract natural enemies – integrated soil management





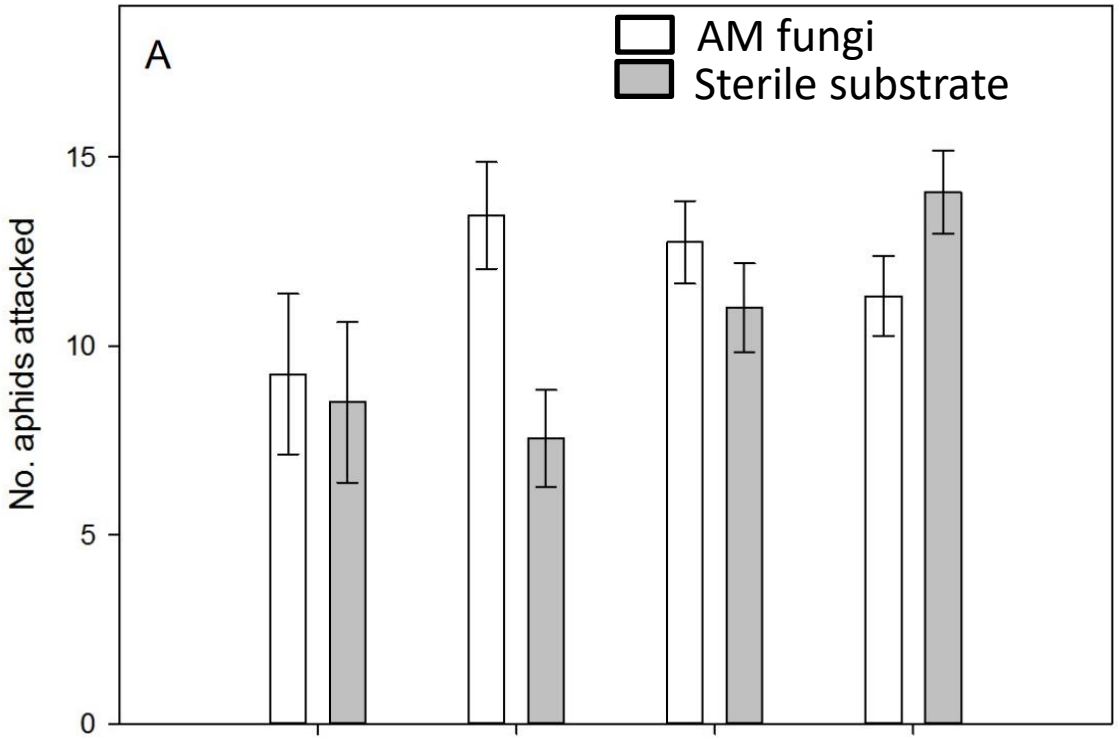
Aphidius ervi preferred odours from infested plants grown in integrated management soils

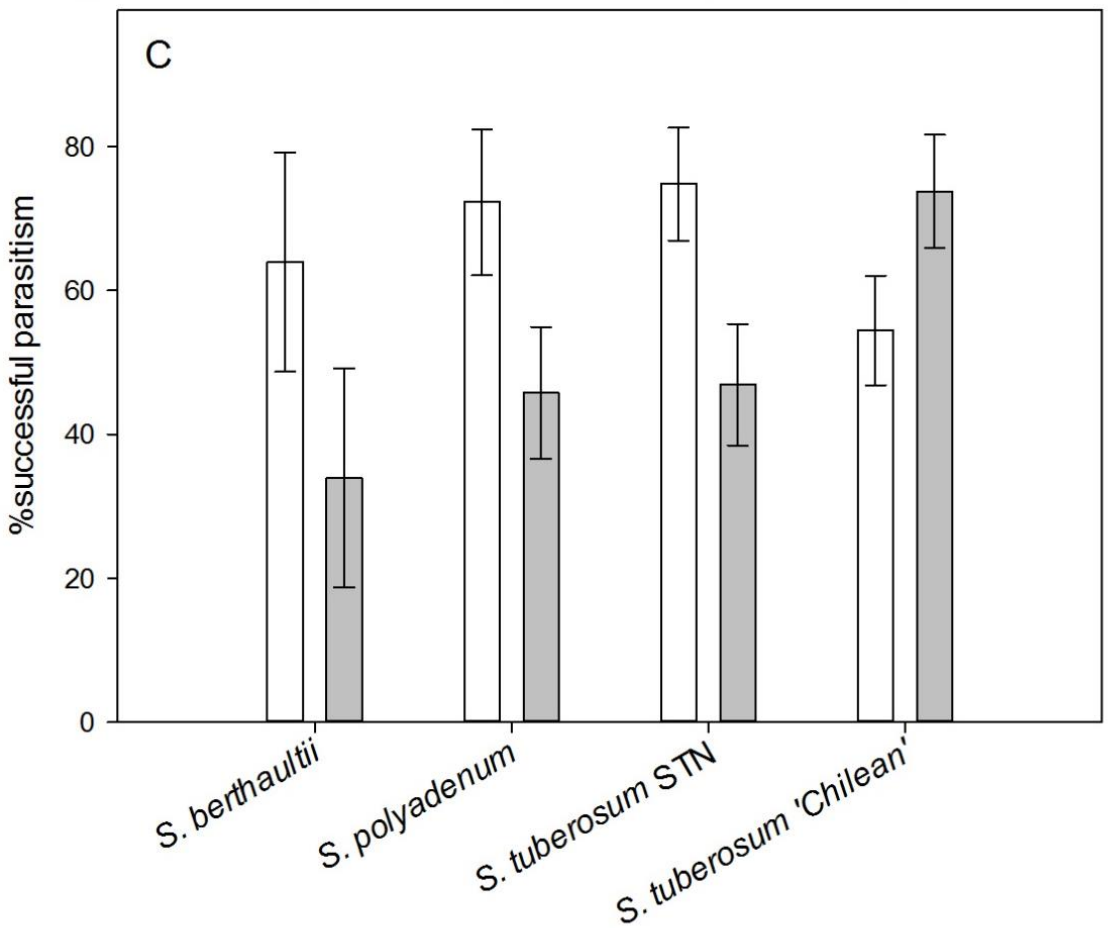
Differences in soil rhizobiome composition between soil types

Macheda (2023) PhD Thesis

Increase natural enemy success – AM fungi

M. euphorbiae feeding on plants colonised by AM fungi are attacked more frequently by *A. ervi* and show higher %mummification



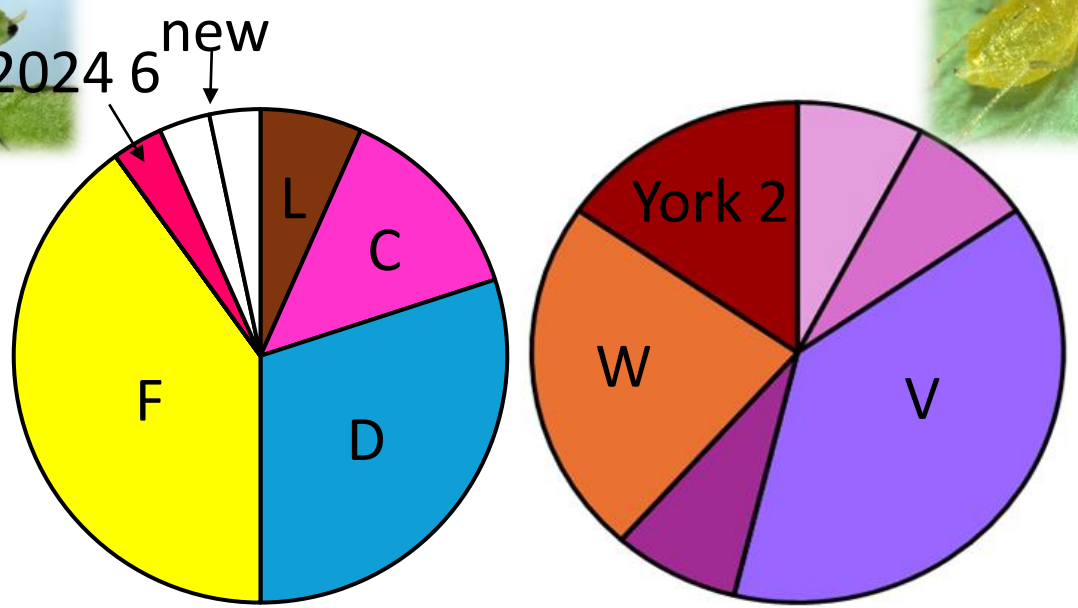


Bennett et al (2016) doi: 10.1111/1365-2745.12620

Companion cropping

Multi-year trial at Balruddery Farm Centre for Sustainable Cropping to investigate the efficacy of alternative agronomic measures for aphid control

- Co-crop (pea, vetch, rye) sown with the tubers
- Pest monitoring, aphid genotyping
- 3 year trial (each year = 1 replicate)

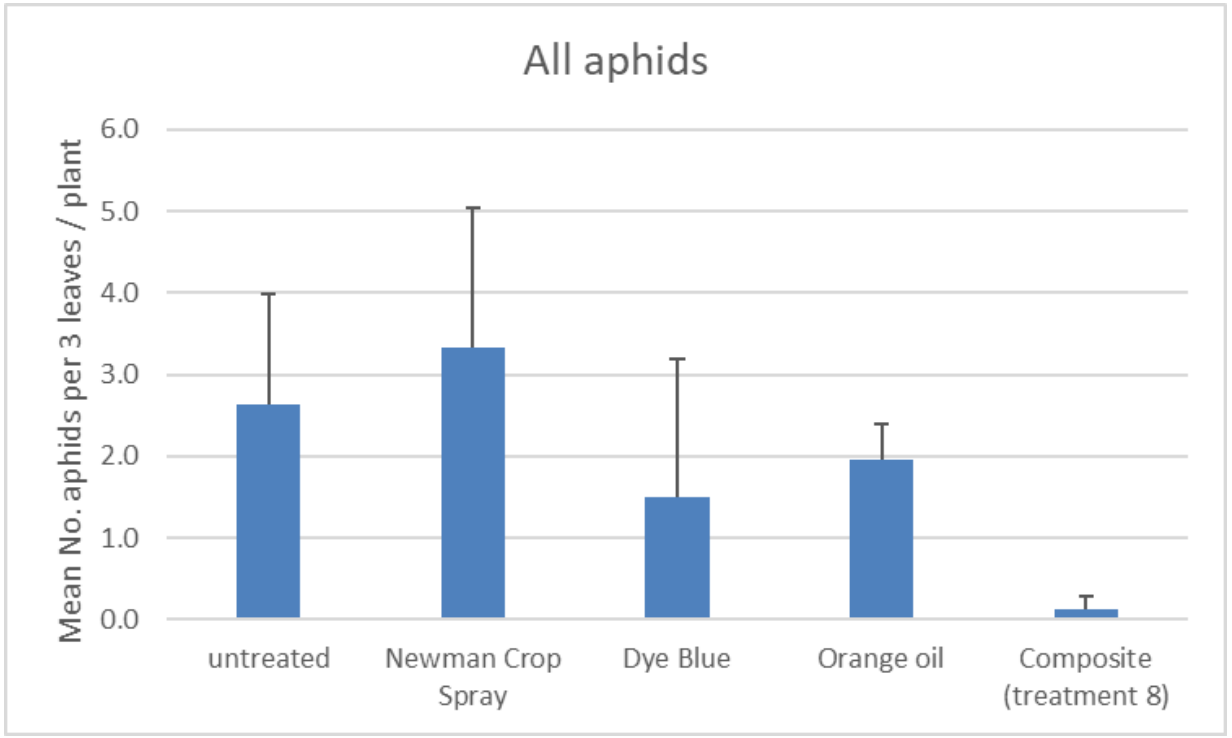


Pesticide alternatives

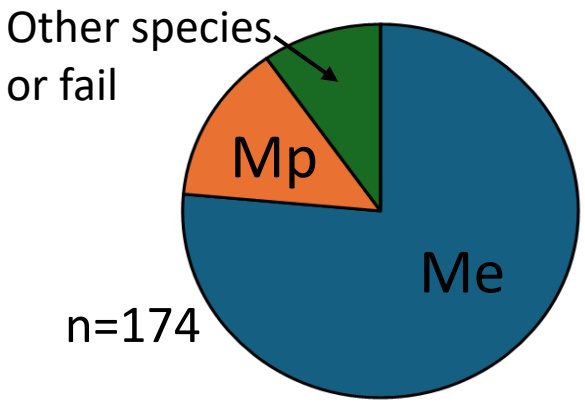
IPM trial of pesticide alternatives – virus infector strip - visited on 30th July 2024

- Aphid abundance scored on three leaves of three plants per replicate block
- Aphid samples collected to verify species and genotype
- Leaf samples collected for virus presence using ELISA (no PLRV detected)

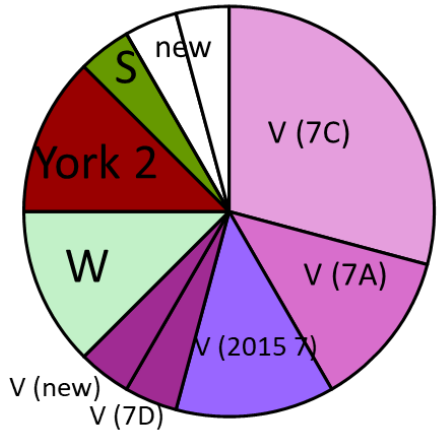
Pesticide alternatives



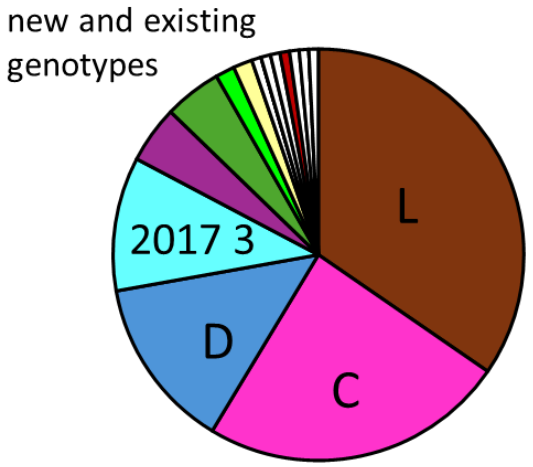
- Aphid abundance lowest on the composite treatment
- Dominated by *Macrosiphum euphorbiae*
- Existing and new aphid genotypes detected
- Tuber virus levels (PLRV, PVY) reflected aphid abundance



M. persicae
n=24



M. euphorbiae
n=133



Summary: aphid IPM options

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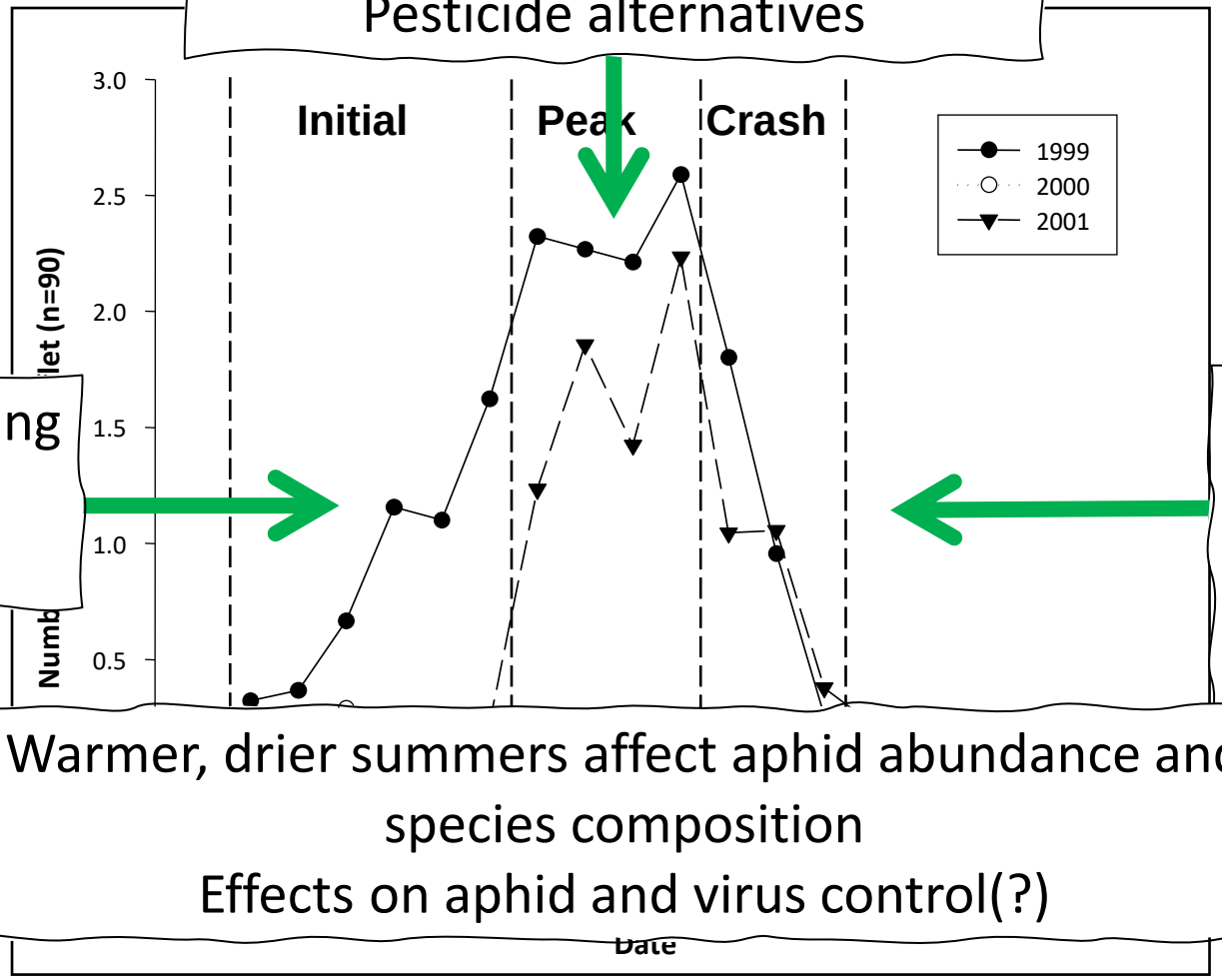
Monitor aphid population composition (species, phenotype)
Pesticide alternatives



Variety choice and breeding to deter aphid settling
(Companion cropping)

(Companion cropping)
Mature plant resistance
Soil microbiome management to attract natural enemies

Warmer, drier summers affect aphid abundance and species composition
Effects on aphid and virus control(?)

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Thank you for listening

Questions?