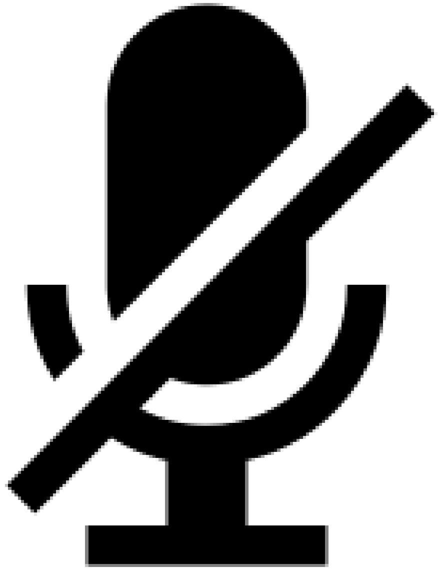
Soft Fruit Technical Webinar 2024

Scott Raffle, Knowledge Exchange Manager, NIAB

Housekeeping



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CPD Points - BASIS

BASIS Ref. No: **PN/140464/2425/c**

Plant Nutrition: 2 points

Integrated Pest Management: 2 points

Total: 4 points

To Register: use QR Code or click on the link in the 'Chat Facility'

Full name; BASIS Account Number; Postcode

BASIS

Soft Fruit Webinar - BASIS

CPD Points - NRoSO

NRoSO Ref. No: **NO503812c**

Total: 4 points

To Register: use QR Code or click on the link in the 'Chat Facility'

Full name; NRoSO Account Number; Postcode

Soft Fruit Webinar - NRoSO

Session 1: New developments and resource use efficiency

09.20: Graham Dow – Introducing The Soft Fruit Genetic Improvement Network

09.35: Mark Else – Matching nitrogen supply to demand in container grown raspberry

09.50: Katia Zacharaki – Optimising the propagation environment for strawberry

10.10: Trevor Wignall – The WET Centre – What have we learnt since 2016?

10.35: Ece Moustafa – The effects of short-term water stress on raspberry

10.45: Break

Each presentation will be followed by 2-3 minutes to allow for questions

Session 2:Novel approaches to sustainable soft fruit production

11.00: Louisa Robinson-Boyer – Optimising raspberry propagation for improved plant uniformity

11.15: Mat Papp-Rupar – Recent developments in coir recycling and Phytophthora management

11.35: Sarah Arnold – Improving bee management and precision pollination in soft fruit

11.50: Celine Silva – The impact of landscape complexity on pest management in soft fruit

12.05: Francis Wamonje – Investigating biocontrol methods for large raspberry aphid under protection

12.20: Rachel Turner – Novel approach to managing earwigs in strawberry crops and advances in Probandz testing

12.35: Lunch break

Each presentation will be followed by 2-3 minutes to allow for questions

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Session 3: Developments in SWD control

13.15: Rob Moar – Sterile insect technique for SWD control in blackberry

13.30: Michelle Fountain – Adopting augmentoria to deliver parasitoids for SWD control

13.45: Adam Walker – Developing a push-pull approach to SWD management

14.00: Feli Fernandez – Screening strawberry and raspberry varieties for resistance to SWD

14.15 Close

Event wrap-up

- Thank you to all our presenters
- Last chance to submit your BASIS and NROSO details on the link in the chat box
- Any further questions can be submitted directly to scott.raffle@niab.com and I'll pass them onto the presenters
- The recording will be made available on the NIAB website www.niab.com

Future interaction with NIAB

- Invitation to sign up to receive information and event alerts

- Contact Scott Raffle at:

Scott.raffle@niab.com

Soft fruit Genetic Improvement Network

Project Leads: Xiangming Xu and Julie Graham

Genetic Improvement Network (GIN)

- A new GIN on soft fruit crops funded by Defra for a collaborative approach to genetics and breeding
  - Initially from July 2024 to June 2029
- Three partners
  - Niab
  - JHI
  - ADAS

The need for soft fruit GIN

- Soft fruit, grown in substrate under protection, is a high-value sector, demanding high and precise input of crop management

- There is a high turn-over of commercial cultivars

- There are several breeders (SME) of soft fruit crop species in the UK

- Breeding is hampered by the lack of genetic knowledge on key traits related to
  - Water use
  - Nutrient use
  - Pest and disease resistance
  - Crop architecture (particularly for mechanical picking)
  - Flowering pattern

Overall Goal

Realise benefits to the overarching challenges highlighted by DERFA through the development of genetic resources, tools, knowledge and infrastructure

(1). **Enhanced Productivity;**

(2). **Enhanced Environmental Sustainability;**

(3). **Enhanced Resilience;**

(4). **Enhanced Quality** in terms of nutrition and meeting market requirements.

Fruit crops included

Current main crops:

Strawberry

Blueberry

Raspberry

Minor crops:

Blackberry

Honeyberry

Expected results

- Characterisation of genetic loci associated with
  - Water Use Efficiency (WUE) in strawberry
  - Nutrient (nitrogen) Use Efficiency (NUE) in blueberry
  - Resistance to aphid in raspberry
- Genetics/genomics resources developed for honeyberry and blackberry
- Tool and technology development
  - Precision gene editing tools for strawberry and raspberry
  - Tools for managing and integrating bioinformatic resources
- Realising the value of the soft fruit GIN through engaging and collaborating with
  - Industrial stakeholders (primarily breeders and growers)
  - Research community
- Effective dissemination and knowledge exchange

2 PhD projects to be agreed

1 at Niab

1 at JHI

Discussions are underway to determine suitable topics for the two studentships

Project management and key members

- Project Leads – Xiangming Xu and Julie Graham
- Work Package leads
  - WP1. Major crops: Graham Dow and Rob Hancock
  - WP2. Minor crops: Nikki Jennings and Feli Fernandez
  - WP3. Tools and technology: Paul Shaw and Julia Lambret-Frotté
  - WP4. Network development: Abi Johnston and Andrew Gladman
  - WP5. Dissemination: Nikki Harrison and Susan McCallum
  - Project administrator – Mitzi Else

Matching nitrogen supply to demand in container grown raspberry

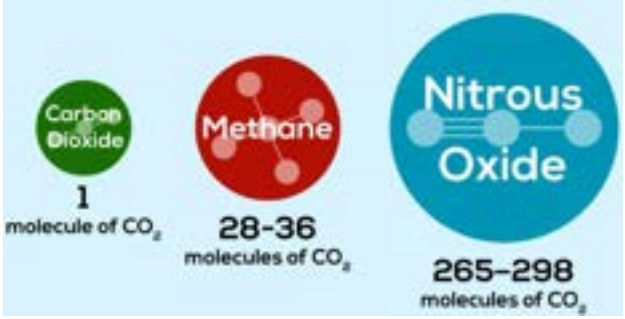
Dr Mark Else

Niab Soft Fruit Day, 28 November 2024

Matching crop N-demand with supply

Current growing practices include the application of fertilisers in excess of crop requirements, causing:

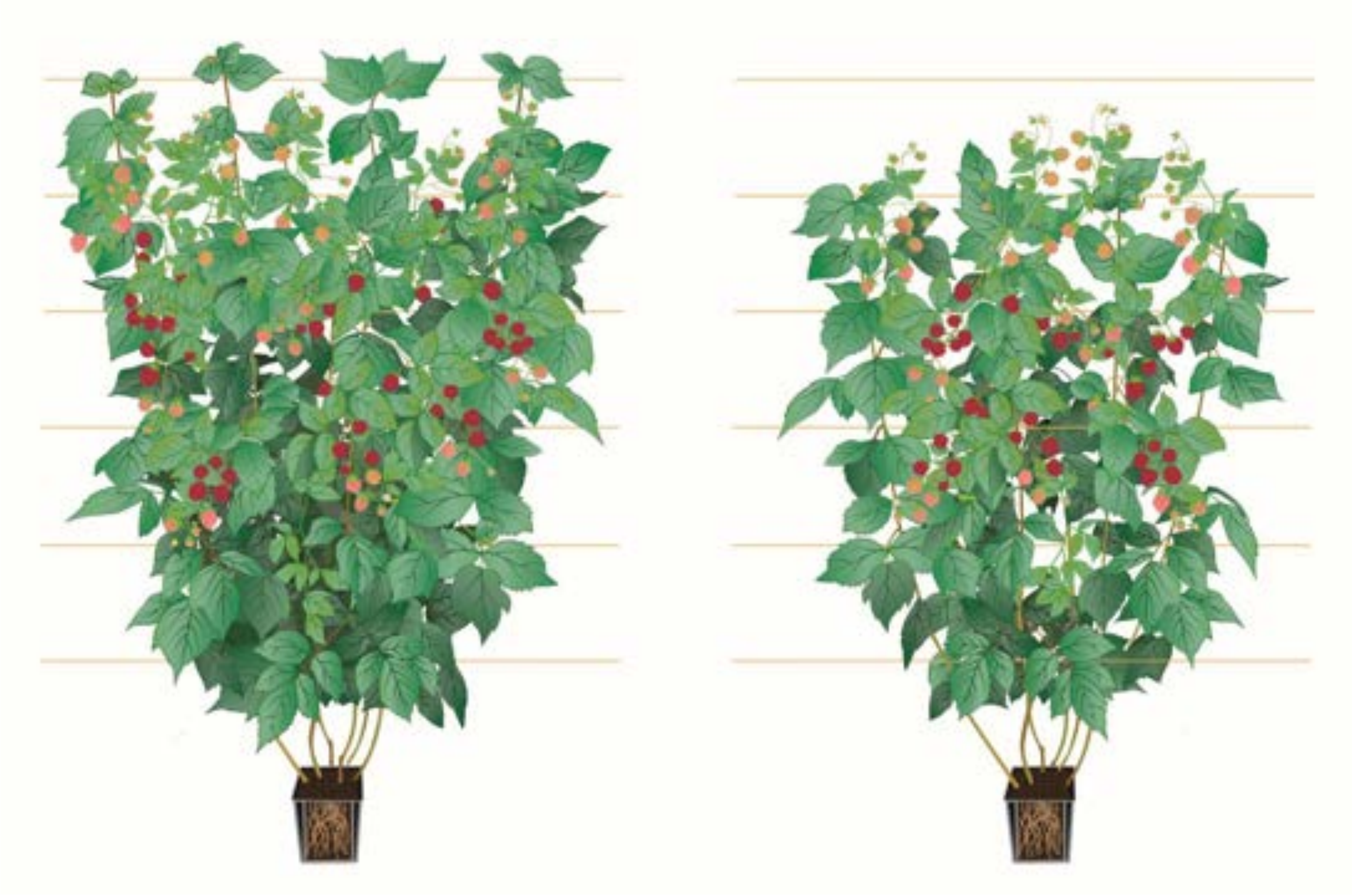
- Vigorous canopy growth – reduces light interception, complicates crop management, increases picking costs
- Unfavourable microclimate that increase risk of disease
- Accumulation of “ballast ions” in coir, which necessitates flushing events
- Groundwater contamination and increased GHG emissions



Objective

To predict and supply raspberry crop nitrogen demand during different developmental stages in changeable weather

Aim – canopy vigour control without lowering



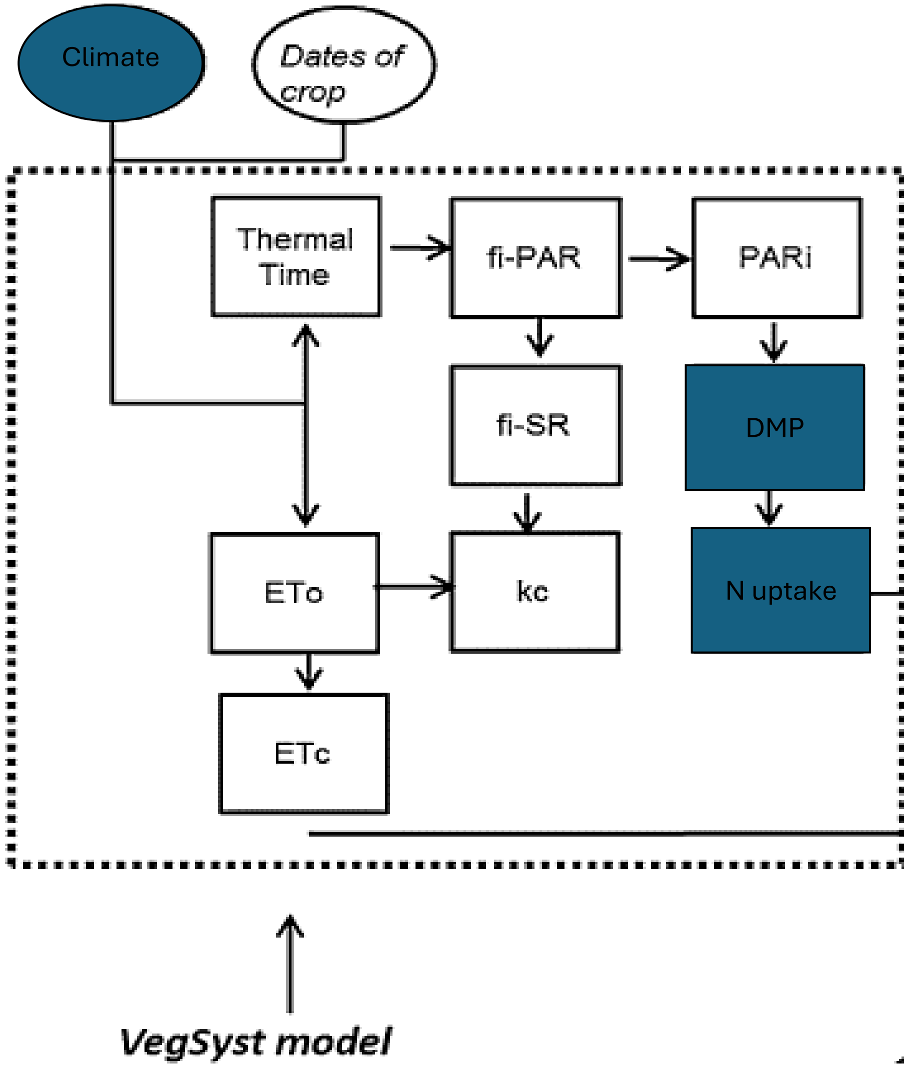
Commercial formulation

Low-N model

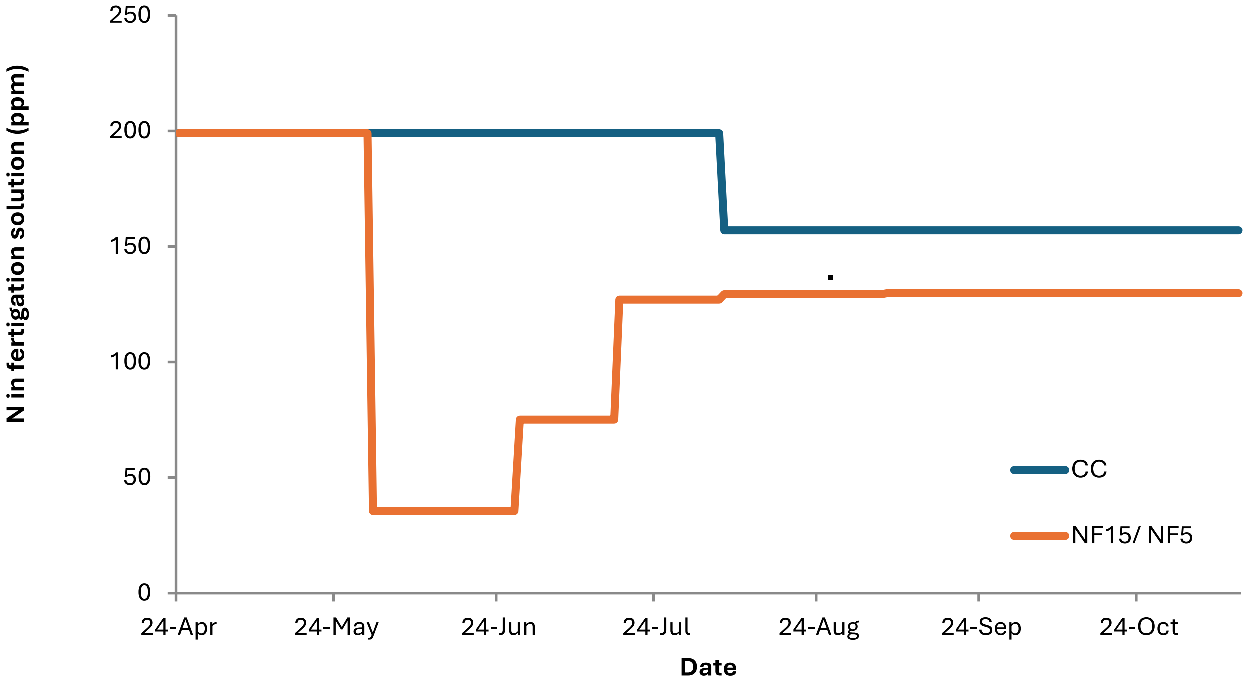
- Better vigour control
- Lower inputs (water, N *et. al*)
- Lower emissions
- Better light penetration
- More favourable phytoclimate
- Ease of harvesting
- Greater resilience
- Class 1 yields and berry quality maintained or improved
- Higher production efficiency

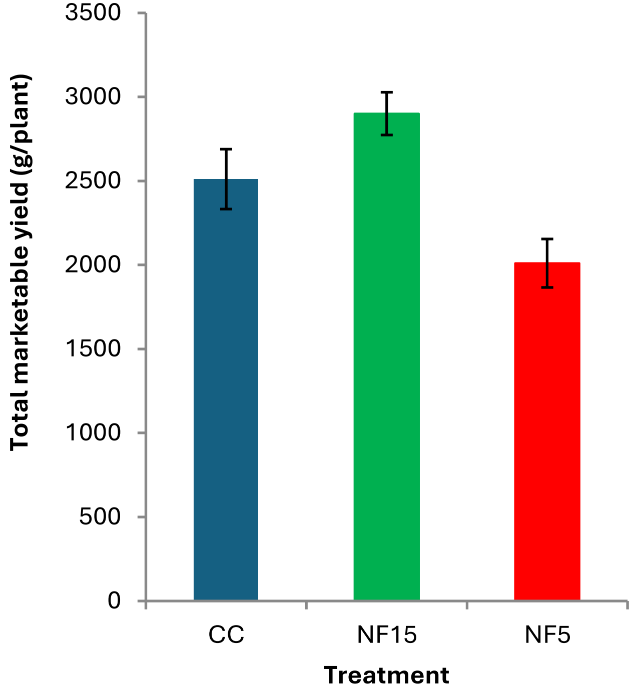
N-demand model...

- We adapted an existing nutrition model (VegSyst) for a range of strawberry and raspberry varieties
- VegSyst was developed for soil-grown tomatoes in southern Spain
- The model uses temperature and PAR to estimate crop growth and nitrogen uptake. We can then predict:
  - Weekly nitrogen requirements
  - Weekly irrigation requirements…



Variety-specific N-demand model (Maravilla)

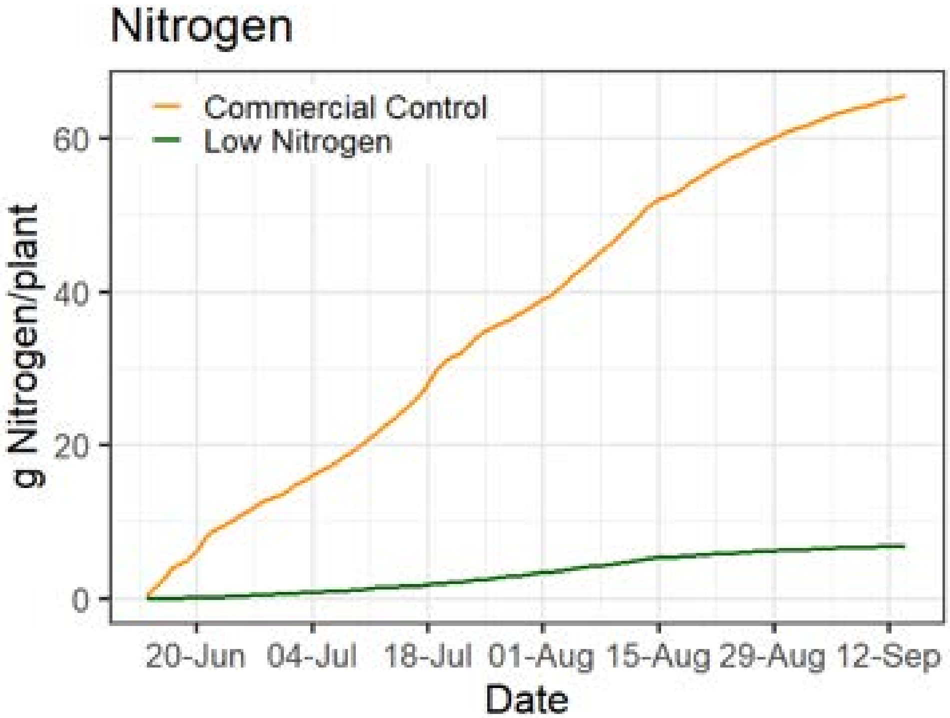


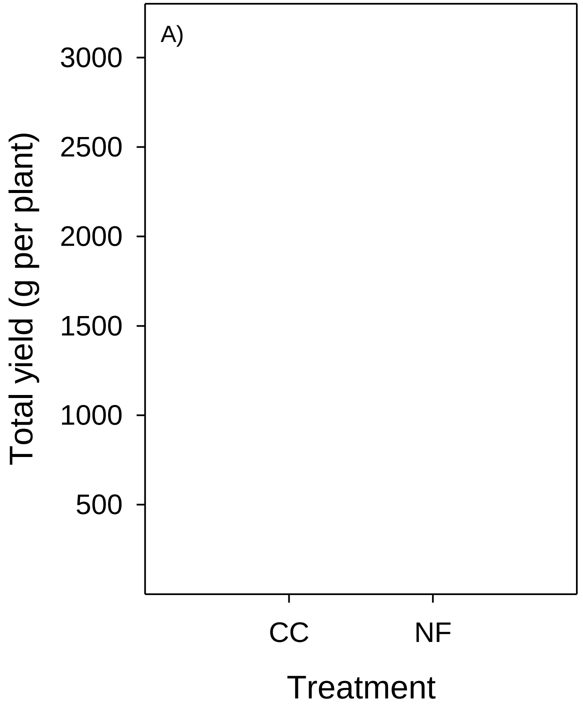


Thermal time → Intercept PAR → Daily PAR → DMP → N uptake → Daily N demand → Daily water demand → Weekly N requirement

- 30% less Nitrogen applied using model outputs to schedule inputs (BGG Agronomy)
- Class 1 yields and berry quality maintained or improved

N input reduced by 90% without affecting Class 1 yield (long cane)





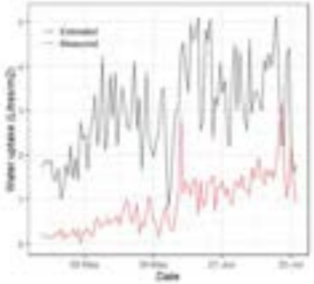
- In the low-N treatment: 90% less Nitrogen and 24% reduction in water
- No (significant) effect on Class 1 yields/plant
- No differences in berry number or quality between treatments
- Total plant biomass was not affected by the low-N treatment

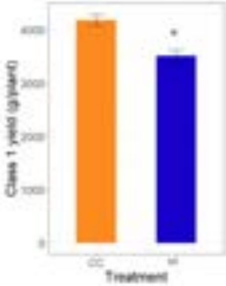
Nitrogen: matching demand with supply in primocane Malling™ Bella

Our approach…

- x480 Malling™ Bella plants were grown in four polytunnels next to The NIAB WET Centre
- Two fertiliser treatments were applied:
  - Commercial control (CC)
  - Nitrogen forecasted (NF) based on the model:
- Formulations were updated every 2 weeks
- Irrigation inputs estimated using embedded crop co-efficients
- Six destructive harvests were carried out throughout the season
- Berry quality, fruit size and SSC were measured at each harvest date
- Calculate Nitrogen and water use efficiency / productivity

Accurate estimates of water demand are crucial (2022)





- In the nitrogen forecasted treatment:
  - 63% less nitrogen
  - 39% less water
  - 16% less yield (3.5 kg/plant)
- Excessive N reduction at the beginning of the season due to inaccurate crop coefficients lowered yield

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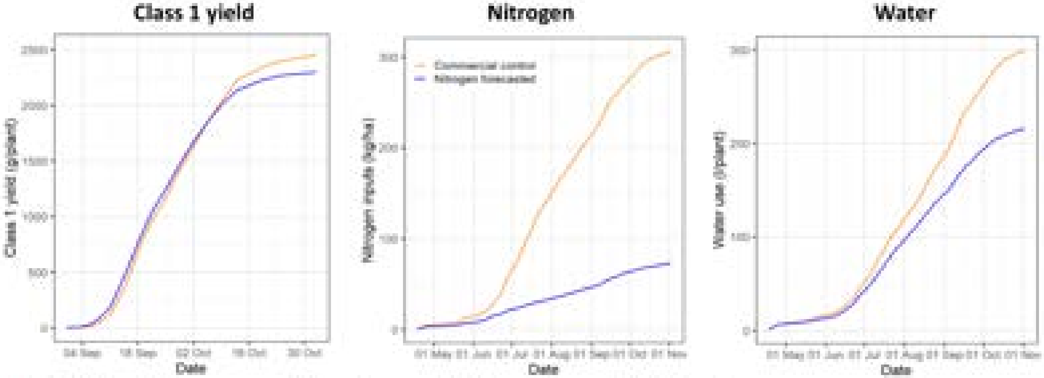
Lowering N inputs whilst maintaining Class 1 yield (2023)



- 76% less Nitrogen applied using model outputs to schedule inputs
- 27% less water used due to smaller canopy in NF-treated plants

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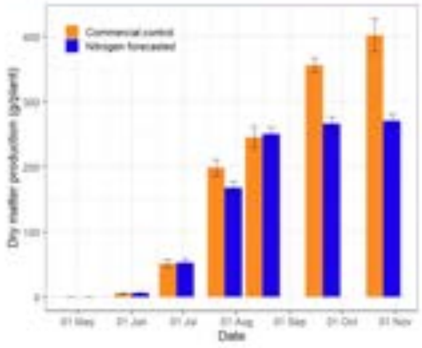
Reduced biomass in the N forecasted treatment



- In the NF treatment:
  - No leaf / cane removal needed
  - More open canopy – easier to pick

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Summary of Malling™ Bella work to date (2022-2023)

- 2022
  - 2-year-old root blocks, 50 cm spacing
  - 63% saving of N, 39% saving of water, 16% lower Class 1 yields (4.1 vs 3.5 kg/pot)
  - Yield reduction caused by inaccurate estimates of water use (crop co-efficients)
  - This resulted in N deficiency in vegetative stage
  - Photosynthesis reduced…
- 2023
  - First year primocanes, 50 cm spacing
  - Used actual water use to predict future demand
  - 7% reduction (not significant) in Class 1 yields (2.46 vs 2.3 kg/pot)
  - 76% less Nitrogen applied using model outputs to schedule inputs
  - 27% less water used due to smaller canopy in NF-treated plants
  - No need to thin canes
  - More open canopy – easier to pick – should raise production efficiency

IUK 10097323: SmartFert+

Commercial development of nutrient sensors and related technology to improve productivity and reduce waste and emissions in the production of soft fruit and other cropping/farming systems

2024-2025

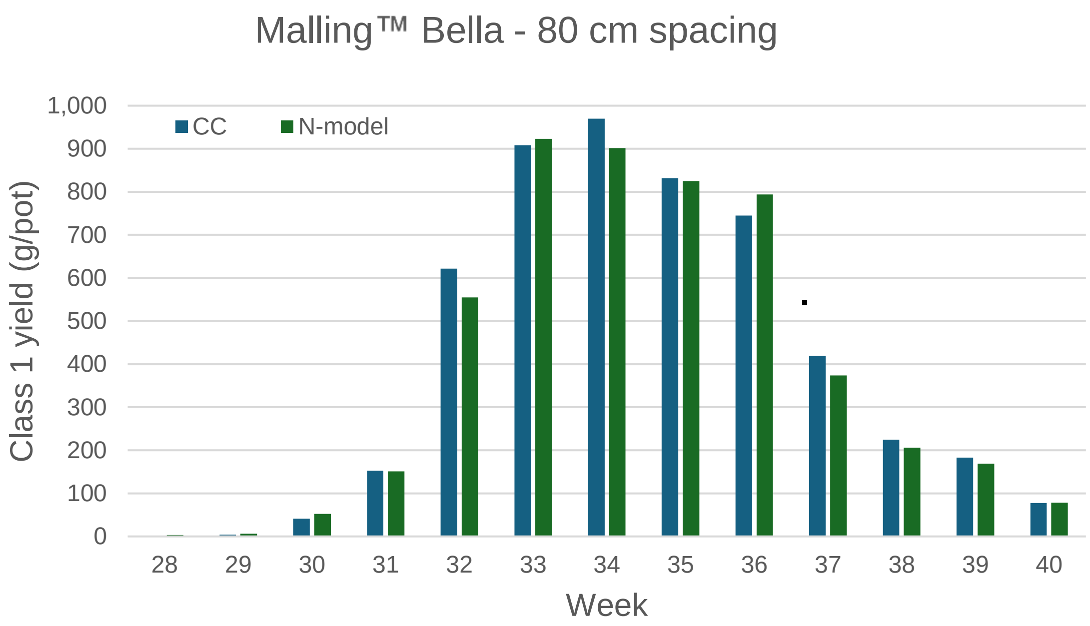
N-demand model for Malling™ Bella was adjusted in 2024

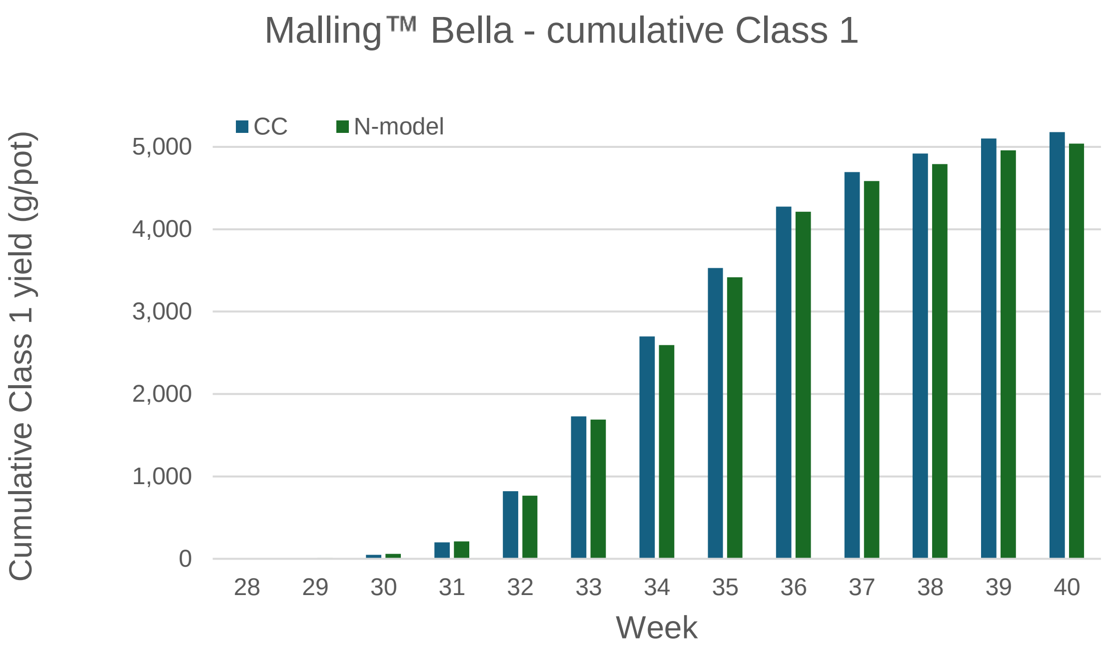
- 1-year-old root blocks, 80 cm spacing
- 10 canes per pot, fan-shaped growing system (PAR)

- Adjustments made to account for biomass produced / ha
  - Number of canes per pot
  - Planting density

- Challenging some assumptions
  - Fertiliser recommendations / ha
  - Fertiliser purity / N content
  - Consistency of made-up formulation
  - Consistency of fertigation delivery (temporal & spatial)
  - Sampling procedures, accuracy of lab. results etc

Lowering N inputs during vegetative phase only (2024)





- Class 1 yields of 5.2 (CC) and 5.0 (NF) kg/pot
- Water and N-savings of 36% and 48% under NF treatment (over the season)
    - Low-N growing under water-restricted conditions (and avoid stress legacy effects)
- Dry matter production was lowered under NF treatment in July & August
- No yield impact of lowering N input by 35% (wrt CC value) during cropping…

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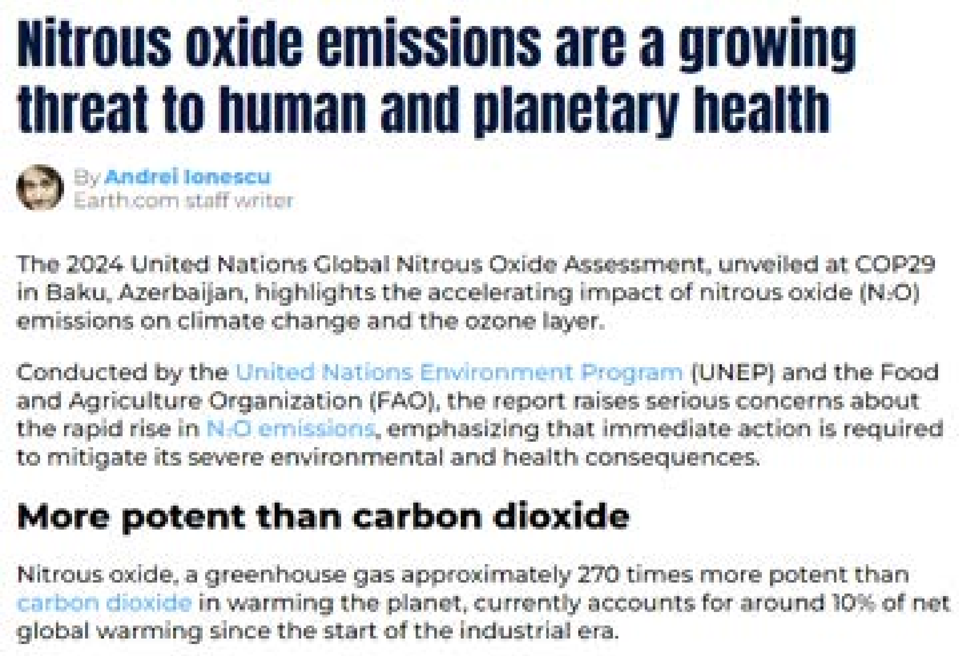
Checking N delivery in fertigation solutions

EDT directION
ELECTROCHEMISTRY PRODUCTS

- Accurate and precise quantification of N and K concentrations
- Two-step manual measurement of P concentrations
- Very good feedback from growers
- Measurement kit launched commercially in 2024
- Automated real-time measurements of NPK, and expand capability to include Ca…

Next steps...

- Quantify any legacy effects of low-N treatments in subsequent cropping years
- Agree on planting density/number of canes per linear m in commercial production
- Automate real-time measurements of NPK & Ca
- Work with growers to implement low-input growing commercial raspberry varieties:
  - Test N-model on commercial grower sites
  - Monitor model performance via real-time NPK data in input/run-off solutions
  - Develop user-friendly N-demand model (NIAB data science team)
- Quantify impact of low-N treatments on N_2O emissions…



Nitrous oxide emissions are a growing threat to human and planetary health

By Andrei Ionescu
Earth.com staff writer

The 2024 United Nations Global Nitrous Oxide Assessment, unveiled at COP29 in Baku, Azerbaijan, highlights the accelerating impact of nitrous oxide (N_2O) emissions on climate change and the ozone layer.

Conducted by the United Nations Environment Program (UNEP) and the Food and Agriculture Organization (FAO), the report raises serious concerns about the rapid rise in N_2O emissions, emphasizing that immediate action is required to mitigate its severe environmental and health consequences.

More potent than carbon dioxide

Nitrous oxide, a greenhouse gas approximately 270 times more potent than carbon dioxide in warming the planet, currently accounts for around 10% of net global warming since the start of the industrial era.

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Thank you…

CSPS staff

Niab Farm team at East Malling

Stephen Kember

Penny Greeves

Cocogreen

Optimising strawberry yield potential for Total Controlled Environment Agriculture systems

Katia Zacharaki

Soft Fruit Day Niab
28 November 2024

Soft Fruit Total Controlled Environment Agriculture

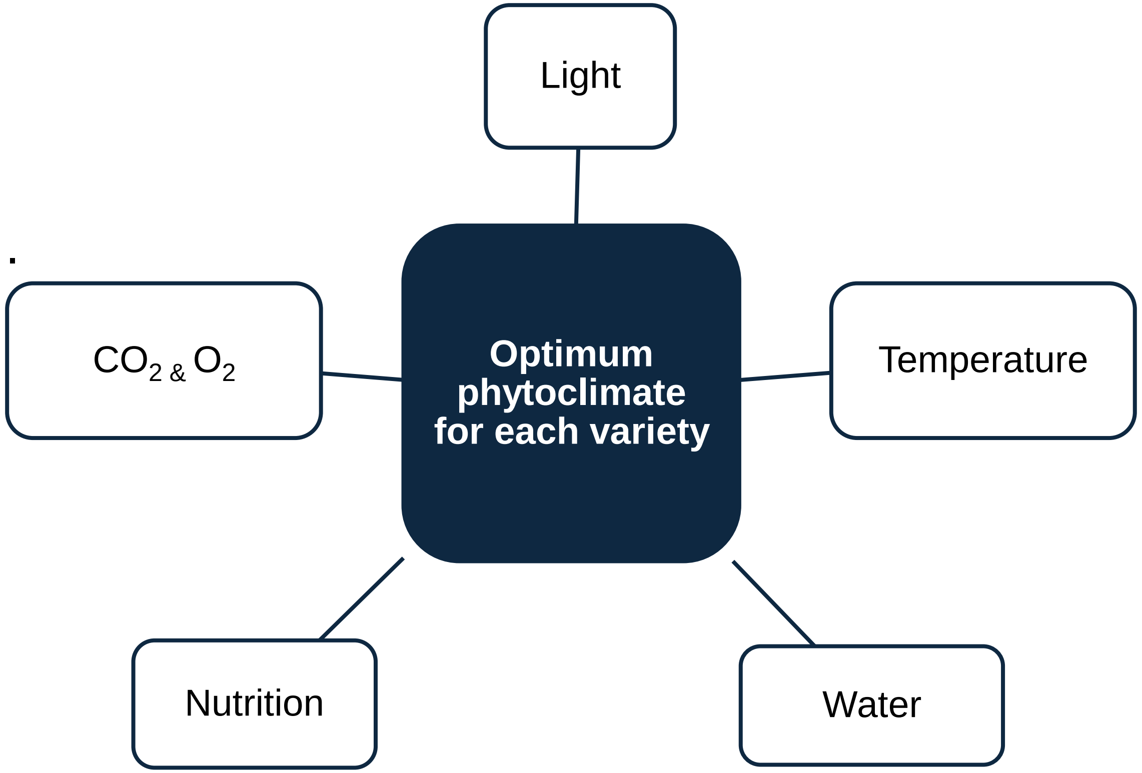
- Global production of soft fruits annually reach 11 million tonnes of which 9 million are strawberries.
- Vertical farming is projected to grow at CAGR of 24-26% by 2030
- Strawberry is the most popular soft fruit for TCEA
- Propagation of fruiting crop is a very attractive proposition

Effects of the environment on cropping potential

G x **E** x M

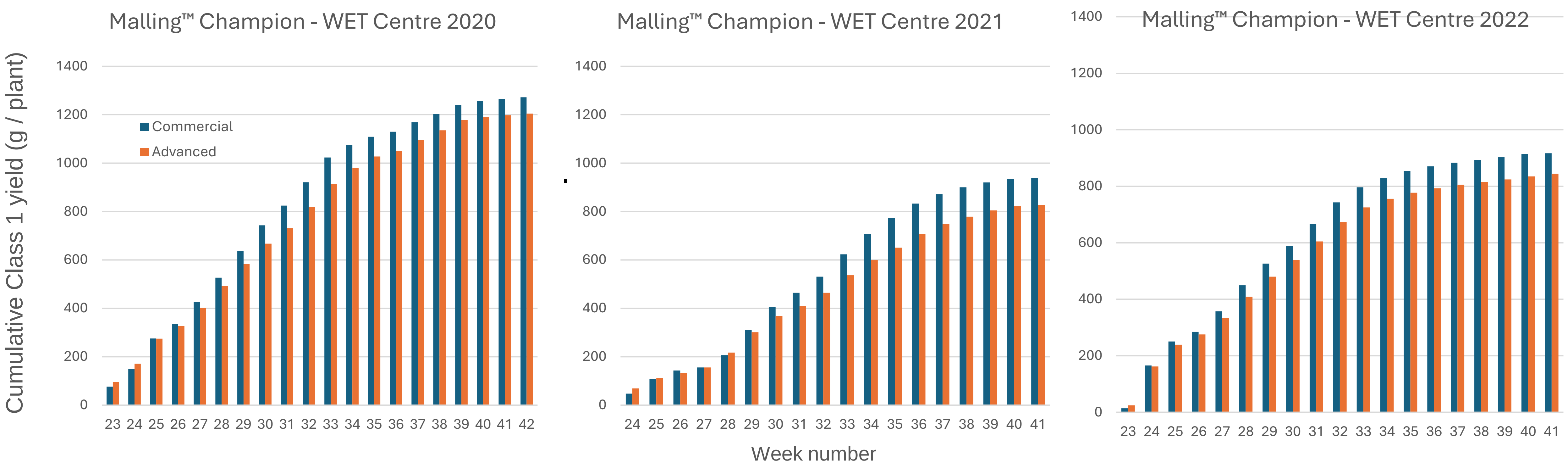
Understand and manipulate crop/environment interactions to achieve full genetic cropping potential

Inform growers' management practices



- The growing environment is constantly changing…

Malling™ Champion - Class 1 yields in 2020, 2021, and 2022



- Same variety, same location, similar planting date, same planting density
- Management and agronomy advice similar and consistent (BGG Agronomy Team)
- Average Class 1 yields of 1.25 kg per plant achieved in 2020 (high PAR in spring)
- *Class 1 yields in first flush down by 50% in 2021 – fewer Class 1 fruit*

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Malling™ Champion in TCEA - 2021/22

- Class 1 yields from Malling™ Champion at NIAB's WET Centre averaged 999 g/plant in 2021
- Average Class 1 yield per plant in TCEA room was 2.5 kg (Aug 2021 – May 2022)
- Highest Class 1 yield in TCEA was 3.2 kg / plant, lowest was 1.6 kg / plant

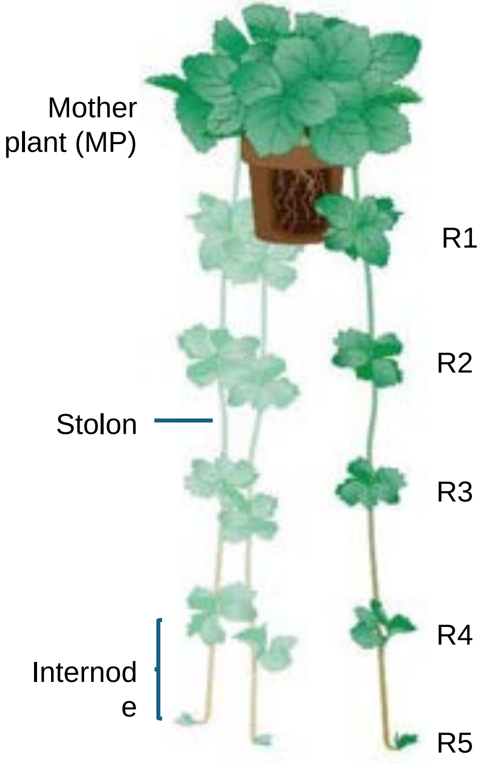
Malling™ Champion – yield heat map

	4	3	2	1
1	1,912	2,298	803	2,594
2	1,161	2,551	2,048	1,943
3	2,483	2,242	2,345	1,764
4	2,250	2,229	2,597	2,320
5	2,185	2,622	869	1,550
6	1,911	2,846	2,807	3,180
7	2,517	2,290	1,563	2,586
8	2,351	1,909	2,257	2,464
9	2,098	2,106	2,753	894
10	2,292	2,276	947	2,176
11	1,951	2,466	2,105	2,102
12	2,574	2,321	2,218	2,428
13	2,428	2,218	2,321	2,574
14	2,630	2,572	2,595	2,695
15	2,102	1,535	2,566	3,057

- Class 1 yield was not influenced by position
- What was the cause of the yield variability?
- Initial plant quality…

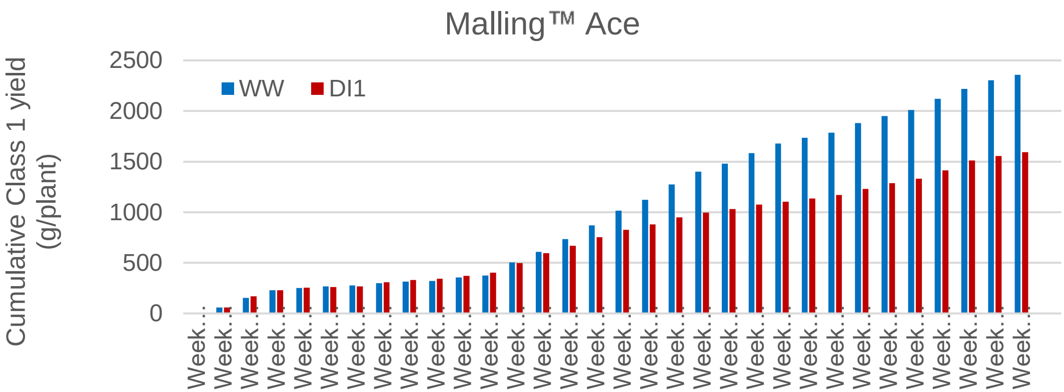
Optimising the propOptimising the propagation environment in TCEA systems to maximise strawberry yield potential in all production systems
agation environment in TCEA systems to maximise strawberry yield potential in all production systems

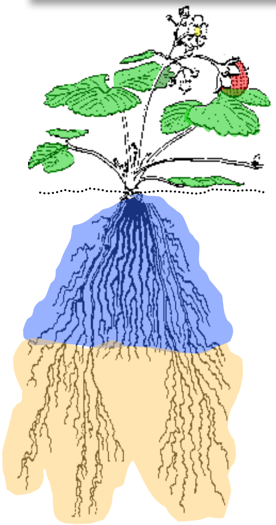
Optimising strawberry ramete quality using TCEA

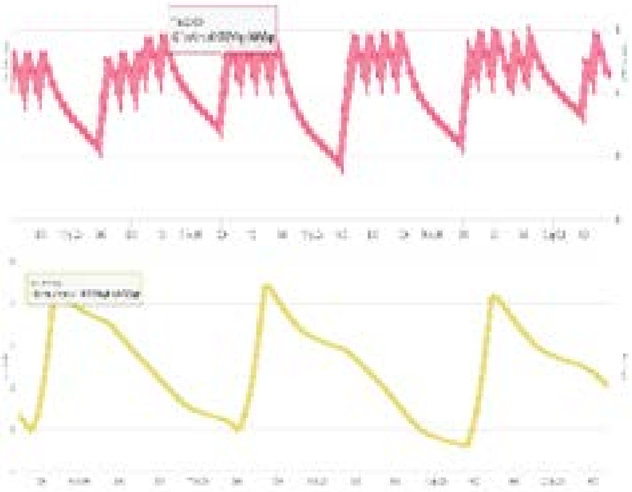


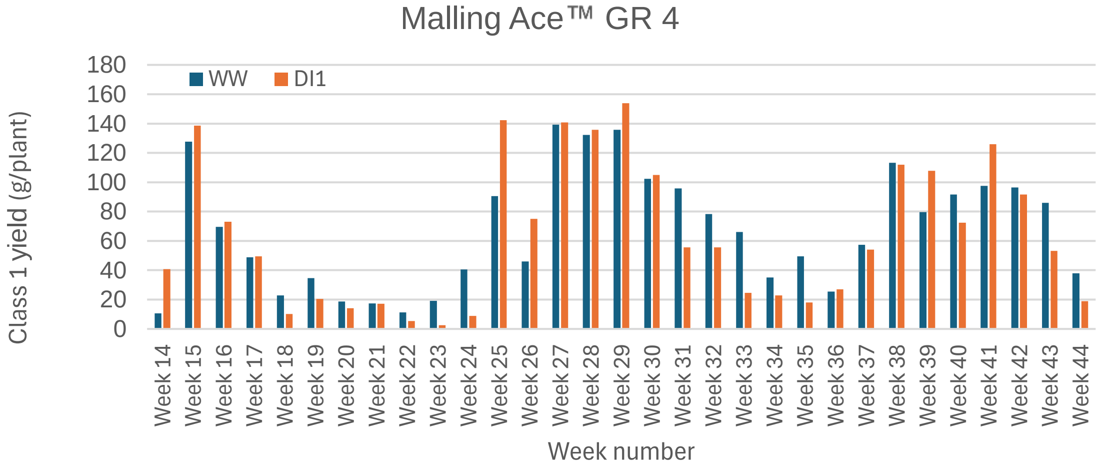
- Defra Small R&D Competition - £1.8M, 3-year project
- High health, high quality ramets programmed to achieve full cropping potential
- Test performance in TCEA, CEA, and polytunnel production systems

Deficit irrigation to improve resource use efficiency



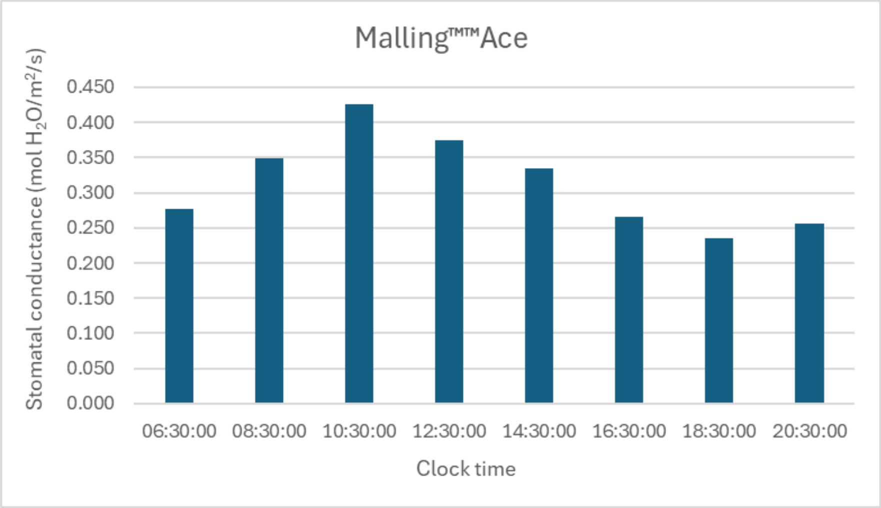


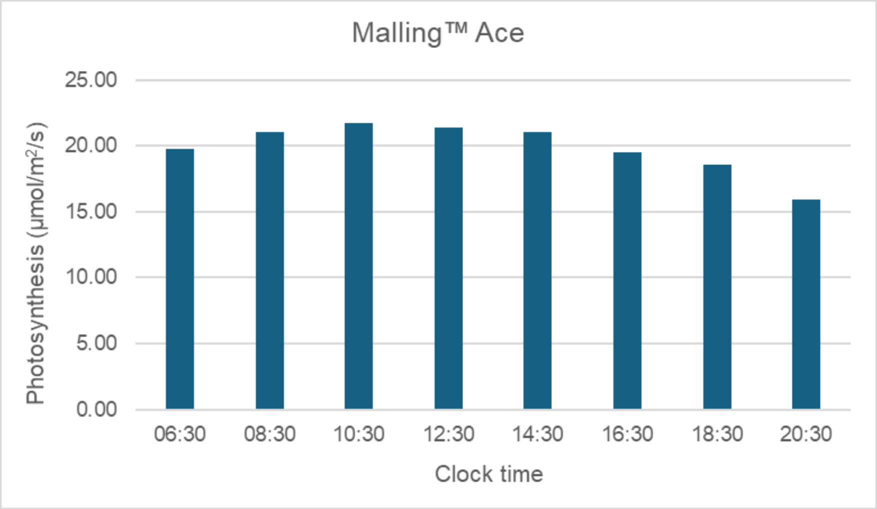




- KPIs - water and N use efficiency, Class 1 yield kg/m^2/kwh, berry quality

What's the ideal photoperiod and DLI for strawberry in TCEA?





- Consistent diurnal changes in stomatal conductance and photosynthesis in TCEA
- Currently investigating effects of different photoperiods on Class 1 yields…
- Must also consider secondary effects – *e.g.* pollination efficiency

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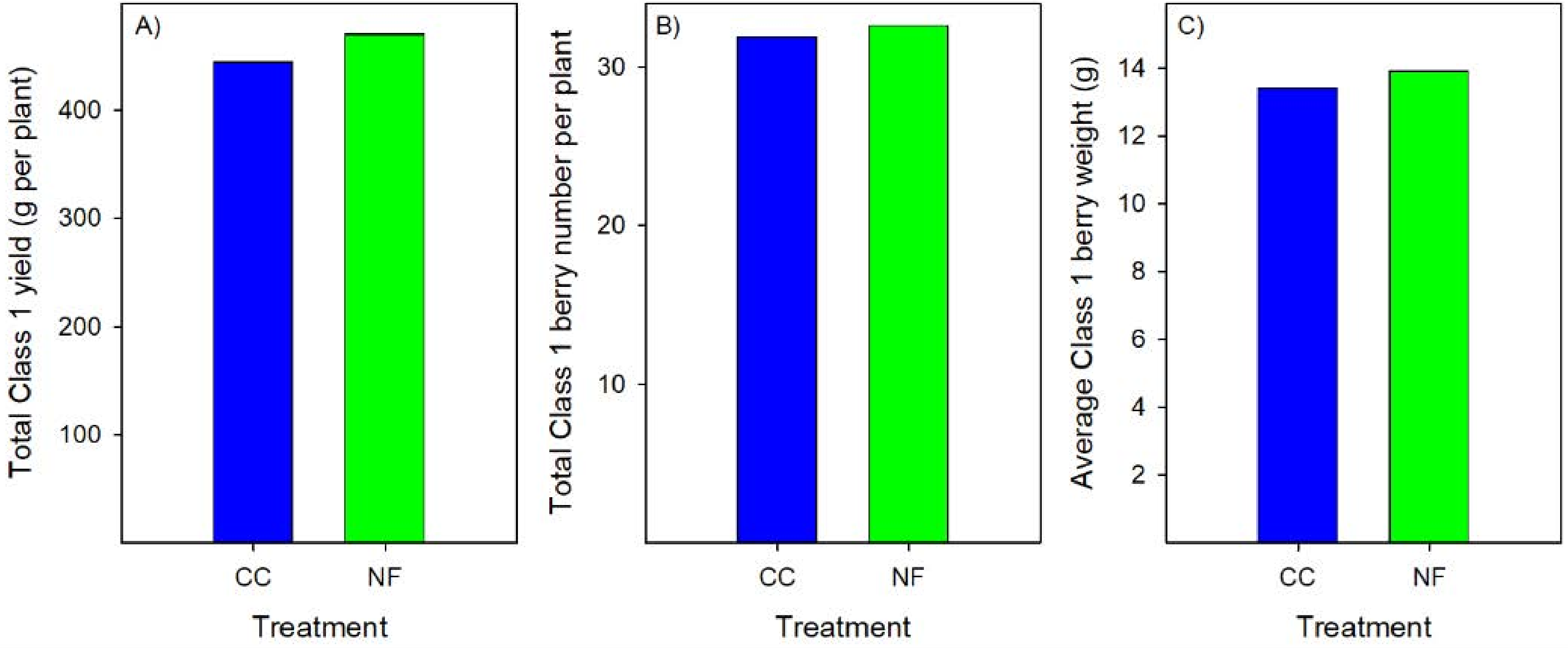
Variety-specific N-demand models



- 78% reduction in N inputs in the nitrogen forecasted (NF) treatment (Junebearer)
- Total plant biomass accumulation was not affected by the NF treatment (Junebearer)
- Continuing this work with an everbearer (Malling™ Ace)…
    - Class 1 yields very similar ca. 2 kg/plant in CC and low-N treatments

Thank you…

- Colleagues at NIAB
- CSPS team
- Farm & Glasshouse staff

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The Water Efficient Technologies Centre

What Have We Learned Since 2016?

Dr Trevor Wignall

Niab at East Malling

28th November 2024

Agenda

Overview & Objectives of the Water Efficient Technologies (WET) Centre

Precision Irrigation

Rainwater Harvesting

Nitrogen Nutrition Demand Modelling

The Importance of Light

Other Studies and Innovations

Double Truss Tape

Bag Colour

Polythene Colour

Biostimulants

The Water Efficient Technologies Centre

- **Putting plant and data science into practice**
  - The WET Centre Consortium was conceived in 2016 and draws on over a century of impactful R&D outputs from East Malling to support global fruit production.
  - Niab's world-class fruit science at East Malling aims to increase marketable yields, improve berry quality and consistency, and reduce costs whilst minimising emissions to land, air and water.

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WET Centre Objectives

- Create a **UK Centre of Excellence** at East Malling which brings together leading Irrigation Researchers and Equipment Suppliers to:
  - Develop and commercialise an **integrated portfolio of leading-edge technologies** for the horticultural sector
  - Demonstrate on a commercial scale how applying these technologies can enable growers to **improve their water use efficiency, yields and financial returns**
  - Provide growers with crop specific **workshops, training and 1:1 technical support** to enable them to successfully adopt these technologies

WET Centre Layout (Strawberry)

- Eight commercial-scale polytunnels (0.34 ha)
    - Commercial area
    - Advanced area
- Precision irrigation - high performance sensors, data loggers (Delta-T) and automated irrigation to ensure optimal coir moisture availability
- Improved coir water availability - tailored coir grades (Cocogreen)
- Netajet Octa nutrigation rig (Netafim)
- Stoller and Yara nutritional products
- Polytunnel rainwater harvesting and re-use
- Hydrogen peroxide water treatment (EndoSan)
- Automated polytunnels / environmental control
- Malling™ strawberry varieties: Champion & Ace

Hosting Innovate UK Soft Fruit Projects

IUK 105542

BerryPredictor: Improving harvest forecasts, yield predictions and crop productivity by monitoring and optimising zonal phytoclimates in covered strawberry production

ISCF TFP science and technology into practice: feasibility study

Integrating nutrient demand models and AI-based sensors with precision-dosing rigs to improve resource use and productivity, and reduce waste and emissions in commercial raspberry production

Precision Irrigation and Fertigation of Soft Fruit Crops

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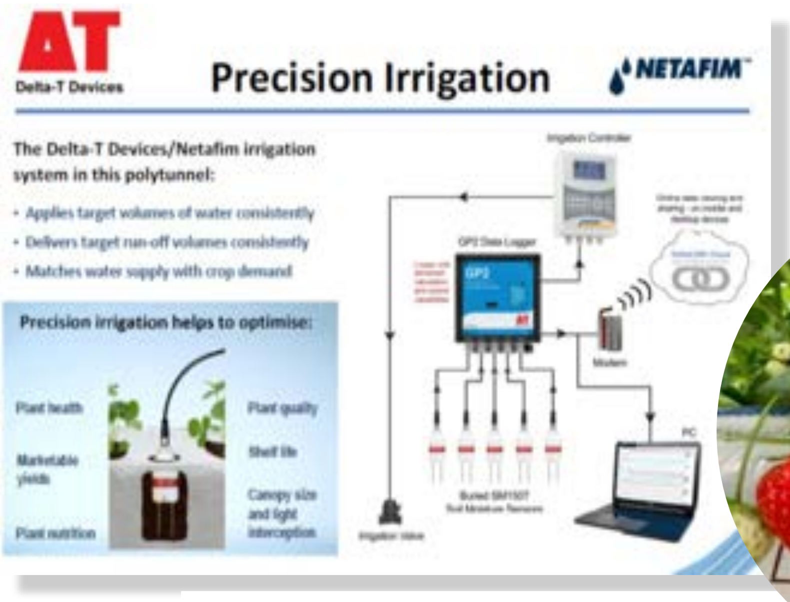
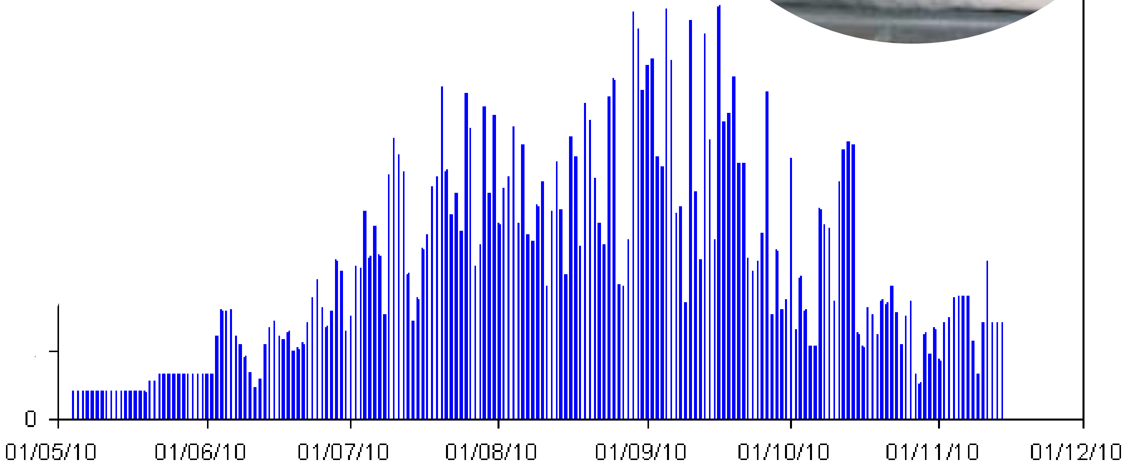
Evolution of UK Soft Fruit Production

- Strawberry production growth:
    - 127,000 tonnes (£629m) in 2018 to
    - 143,000 tonnes (£787m) in 2022 (Kantar; Berry Year Book 2023)
- 144,000 tonnes of berries were imported in 2023, worth ca. £762m (Defra)
- Transition from soil to substrate requires more accurate irrigation

What is Precision Irrigation?

- A system that applies the target volumes of water consistently
- A system that delivers target run-off volumes consistently
- A system that matches crop demand for water with supply
- Ensuring that irrigation is managed to optimise:
    - Plant health
    - Plant nutrition
    - Class 1 yields
    - Fruit quality
    - Canopy size and light interception





Industry Impact: Benchmarking Water Productivity

Crop and growing system	Cropping type	Source	Year	WP value (m^3 / tonne Class 1)	Comments
Strawberry - substrate	Everbearer	ERDF WATERR project	2011-2013	82	UK industry average value
Raspberry - substrate	Mixed	ERDF WATERR project	2011-2013	111	UK industry average value
Strawberry - substrate	June bearer	NIAB experiemnts	2022	58	Malling Fruit experiment
Strawberry - substrate	Everbearer	NIAB experiemnts	2022	43	Malling Fruit experiment
Raspberry - substrate	Primocane	NIAB experiemnts	2022	177	Malling Fruit experiment
Strawberry - substrate	Everbearer	NIAB WET Centre	2022	45	NIAB best practice
Raspberry - substrate	Primocane	NIAB WET Centre	2022	118	NIAB best practice
Strawberry - substrate	June bearer	BGG commercial grower A	2022	40	Industry best practice
Strawberry - substrate	Everbearer	BGG commercial grower A	2023	60	Industry best practice
Raspberry - substrate	Long cane	BGG commercial grower A	2022	71	Industry best practice
Strawberry - substrate	June bearer	BGG commercial grower B	2022	58	Industry better practice
Strawberry - substrate	Everbearer	BGG commercial grower B	2022	57	Industry better practice
Raspberry - substrate	Long cane	BGG commercial grower B	2022	105	Industry better practice
Raspberry - substrate	Primocane	BGG commercial grower B	2022	203	Industry better practice
Strawberry - soil	Everbearer	International berry conference	2022	150	Current practice in California
Raspberry - soil	Long cane	International berry conference	2022	200	Current practice in California

Benefits of Precision Irrigation

To Growers:

- Precision irrigation systems can reduce water use by up to 33% whilst maintaining consistent marketable yields and quality
- Average daily irrigation run-off volume can be reduced to 5% without a yield penalty
- Combining precision irrigation with rainwater harvesting and re-use enable us to achieve 90% self-sufficiency, even in very dry seasons
- Informed decision-making & improved time management for technical staff
- Less time spent on cane/canopy management & lower picking costs
- Significant fertiliser & cost savings

To Retailers:

- Improved consistency of supply of high quality, fresh fruit
- Fruit with an assured shelf-life leading to reduced wastage in store
- Innovative production methods to deliver sustainable intensification

To Consumers:

- High quality, phytonutritious, flavoursome fruit
- Improved availability of locally-sourced fresh produce

Rainwater Harvesting

More Efficient use of Resources


Climate change: Water shortages in England 'within 25 years'

3 hours ago

Share

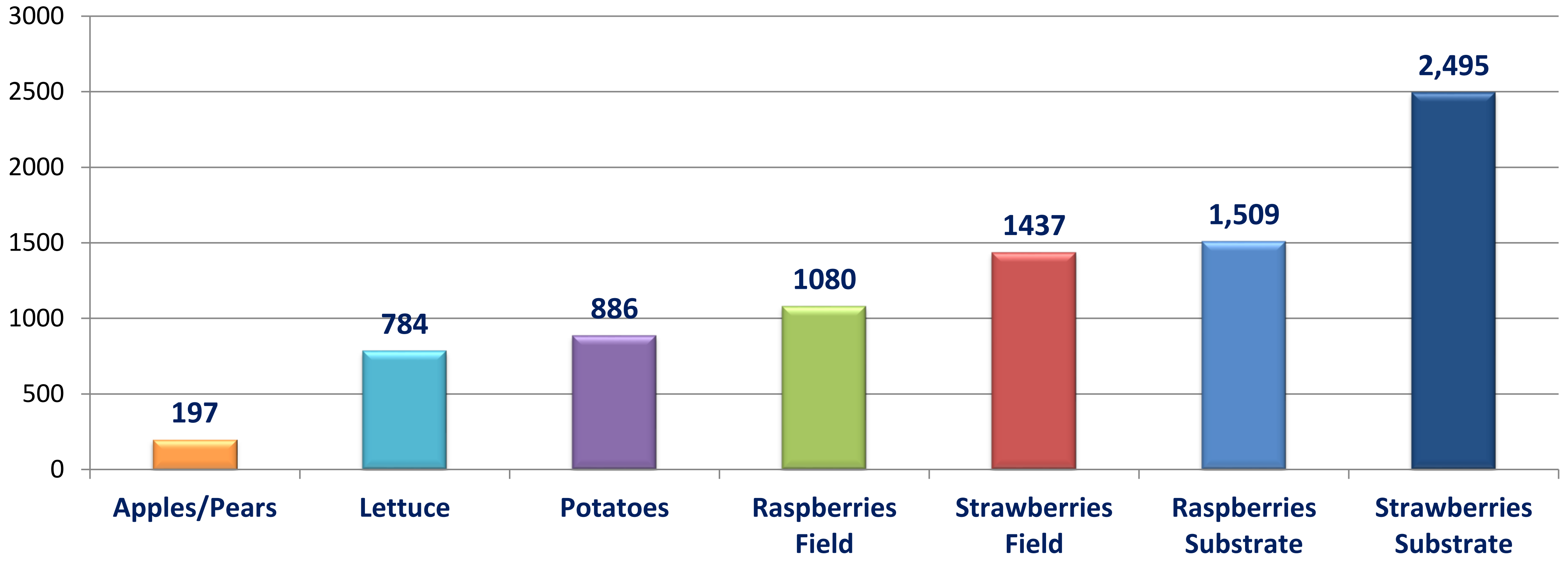
Low water levels at Wayoh Reservoir near Bolton in the UK heatwave in July 2018

PA

Within 25 years England will not have enough water to meet demand, the head of the Environment Agency is warning.

- Abstraction Licence Reform
- Shift from soil into soilless (substrate) soft fruit production in last 10-15 years
- Only 32% of water-bodies in England classified as being of ‘good status’ in 2022
- Requirement for us to double food production in next 30 years
- Food security, nutrition security, supply chain resilience, healthy eating

Water Applied per Hectare (2011-2013)



- Substrate soft fruit production under polytunnels is wholly reliant on irrigation

RWH – Our Objectives

To gather robust data on water savings

To provide a case study for the industry

To determine optimum system design

To identify opportunities for improvement

To understand the limitations of RWH

To develop a credible cost/benefit analysis

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Industry Impact - RWH Summary

- Combining precision irrigation with rainwater harvesting and re-use enable us to achieve 90% self-sufficiency, even in very dry seasons
- Improves local water security for production
- Automated venting focus optimised for rainwater collection vs for VPD control
- Additional benefits:
  - Less acid was needed to acidify RW than mains water
  - Better soil drainage between polytunnels
  - Improved humidity control within the polytunnels
  - Potentially reduces risk of soil erosion and compaction


Cranfield Water

Rainwater harvesting (RWH) tool for soft fruit production in polytunnels

User guidance manual

Jerry Knox, Niranjan Panigrahi, Tim Hess and Ian Holman

Cranfield Water Science Institute, Cranfield University

30 July 2021

Kent County Council

interreg

The Importance of Light

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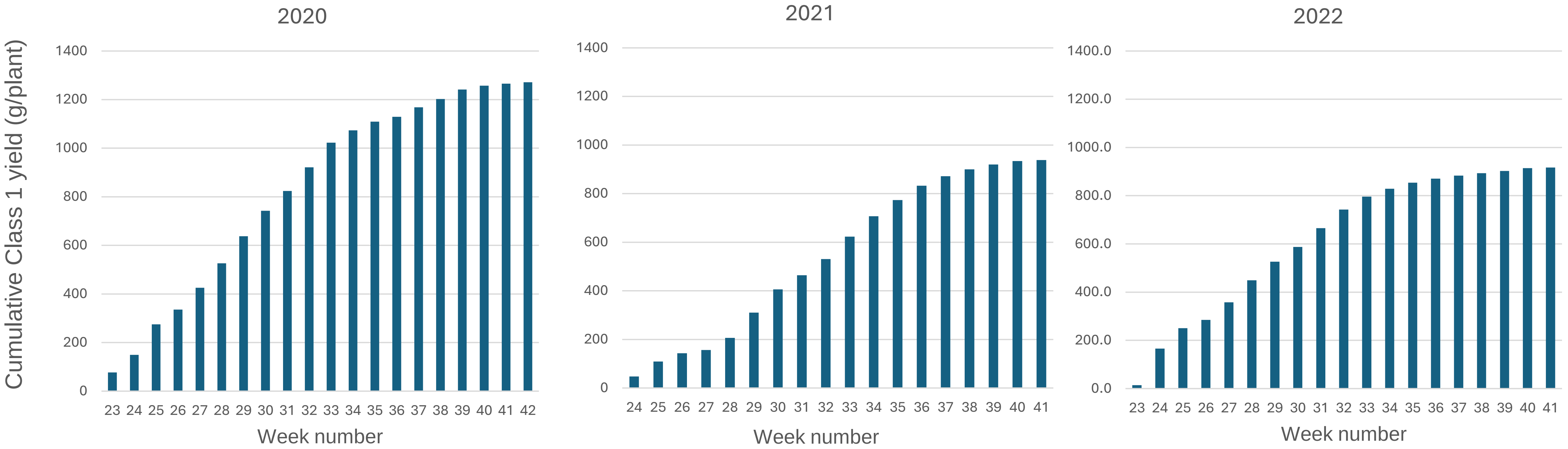
Malling™ Champion yield comparison, 2020 vs 2021 & 2022



- Same variety, same location, similar planting date, same planting density
- Average Class 1 yields of 1.25 kg per plant achieved in 2020
- Class 1 yields in first flush down by 50% in 2021
- Exceptionally high PAR throughout the 2020 growing season

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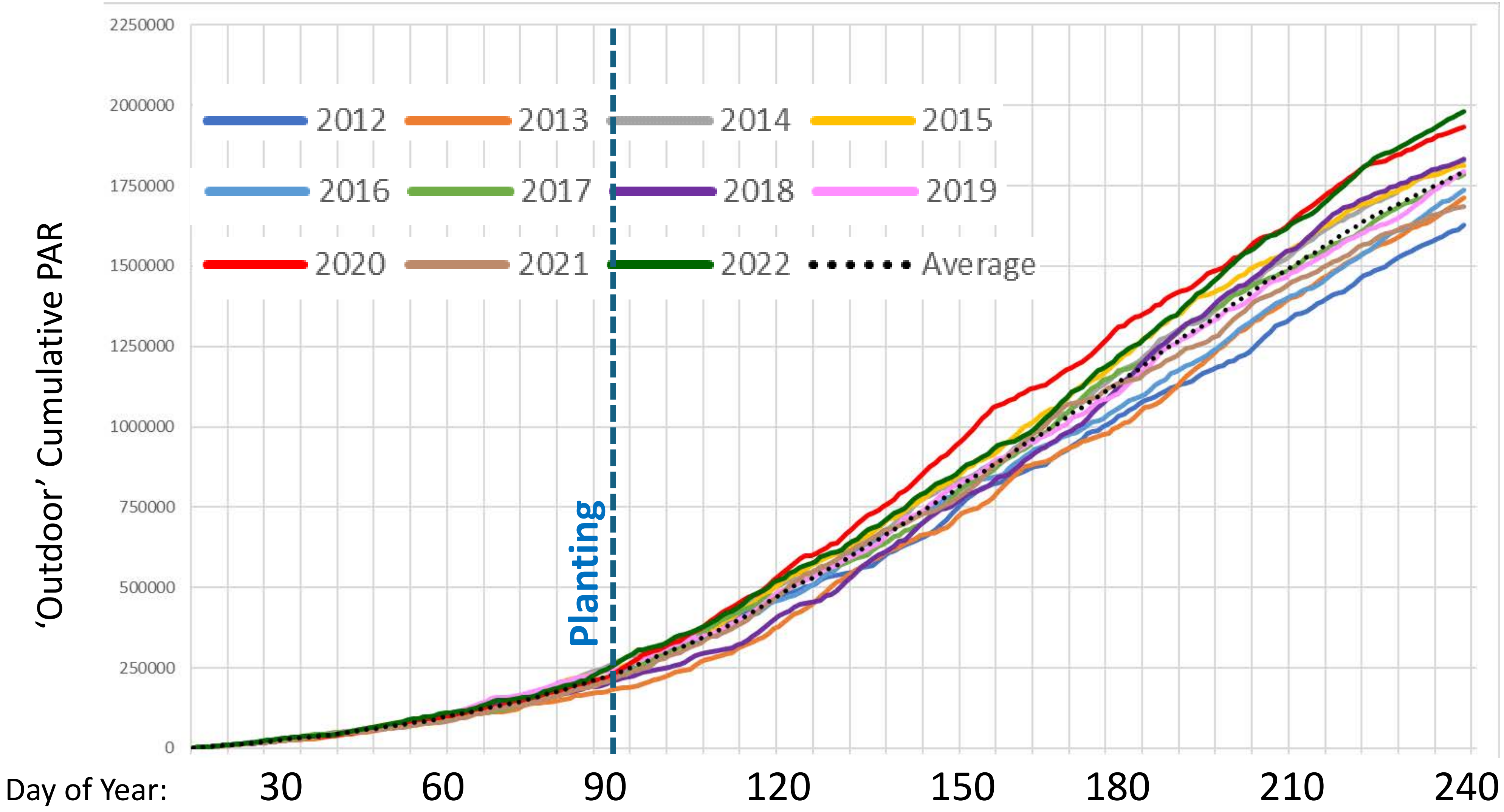
Outdoor Cumulative PAR 2012-2022



weatherquest ...an umbrella for your business

Rank Order

2022
2020
2018
2014
2015
2019
2017
2016
2013
2021
2012

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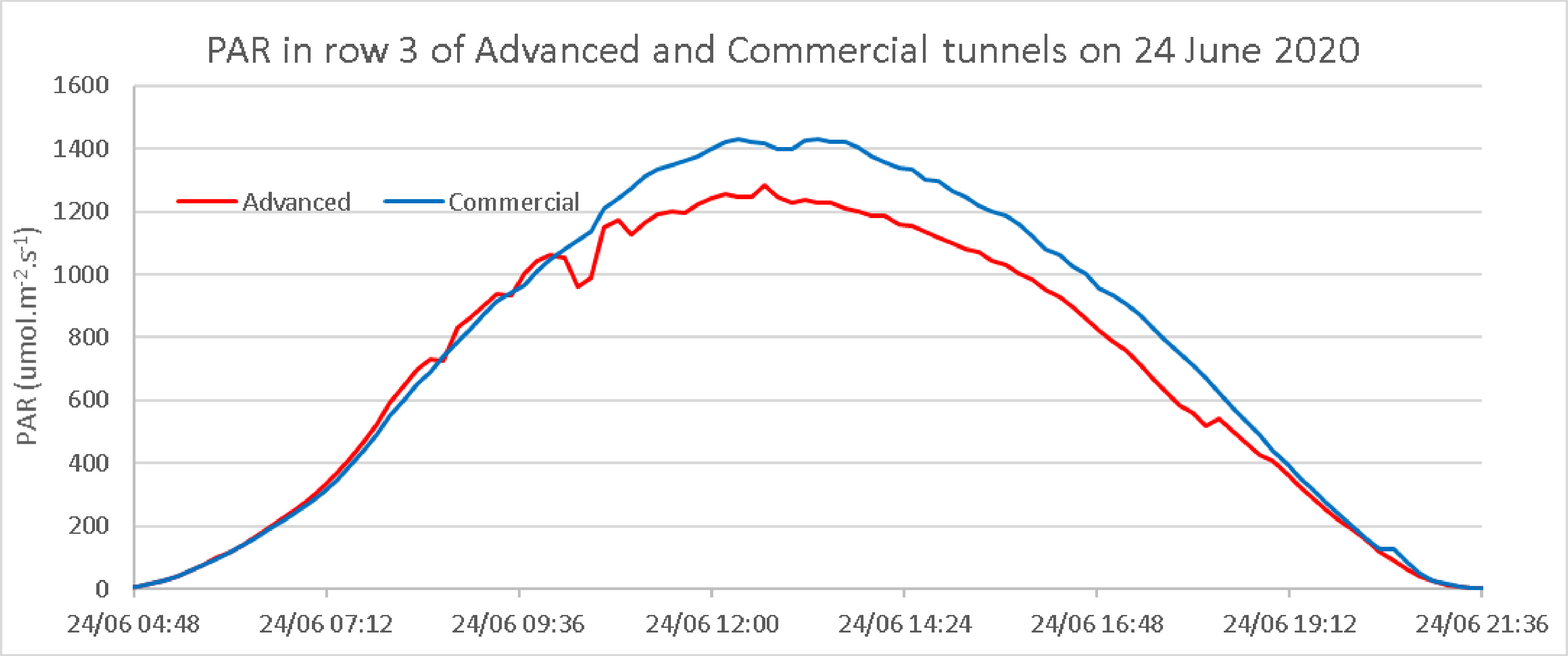
Commercial vs Advanced Areas Class 1 yields



- Photosynthetically active radiation (PAR) lowered by 3-7%
- Daily average air temperatures *ca.* 1 °C cooler in Advanced area in June and July
- On hotter days, Advanced area was cooler by up to 7 °C

PAR and Yield Correlations (2020)

Commercial area

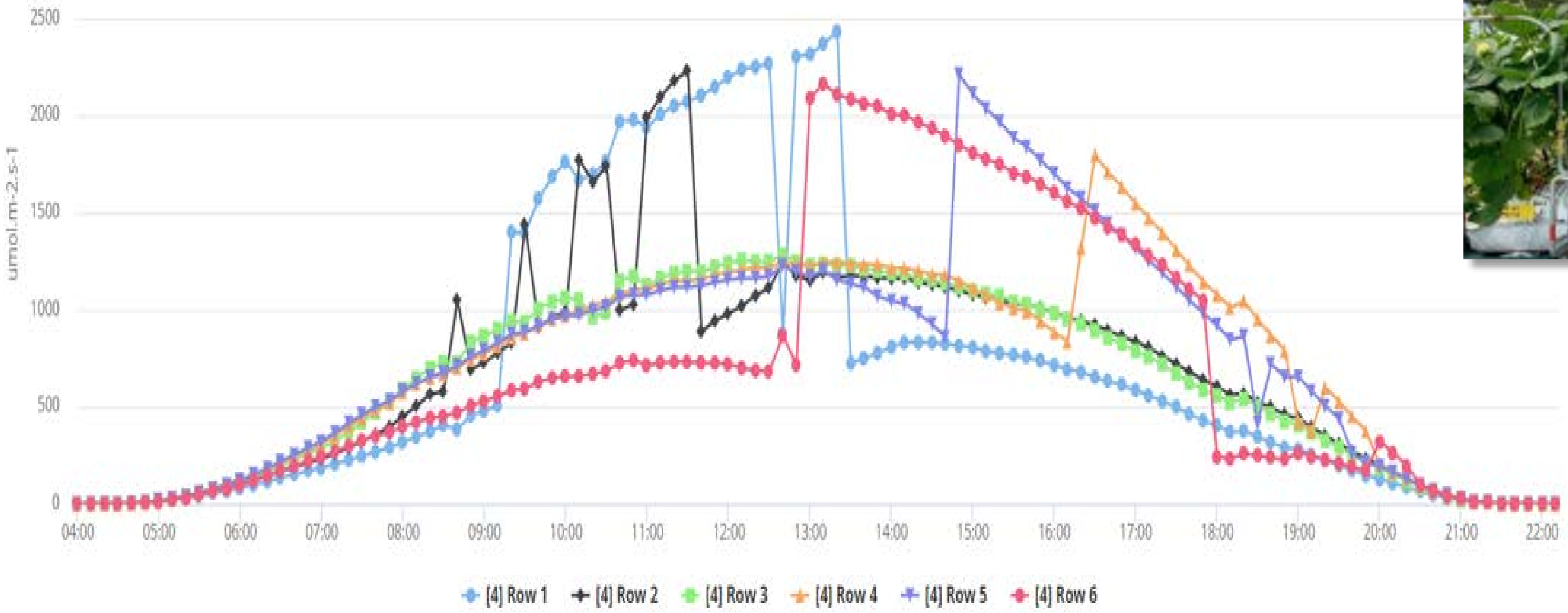
Tunnel Row #0	Class 1 (g / plant)	Total hourly PAR x 10^6	# hours PAR > 800 umol.m^{-2}.s^{-1}
1	1,269	5.5	359
2	1,252	**6.0**	**453**
3	1,281	**6.1**	**466**
4	1,323	**6.3**	**469**
5	1,269	**6.1**	**444**
6	1,177	5.8	387
Average	1,262	5.98	431

Advanced area

Class 1 (g / plant)	Total hourly PAR x10^6	# hours PAR > 800 umol.m^{-2}.s^{-1}
1,182	5.2	285
1,190	5.6	391
1,220	**5.8**	**417**
1,270	**5.9**	**439**
1,214	**6.0**	**439**
1,094	5.5	320
1,195	5.66	381

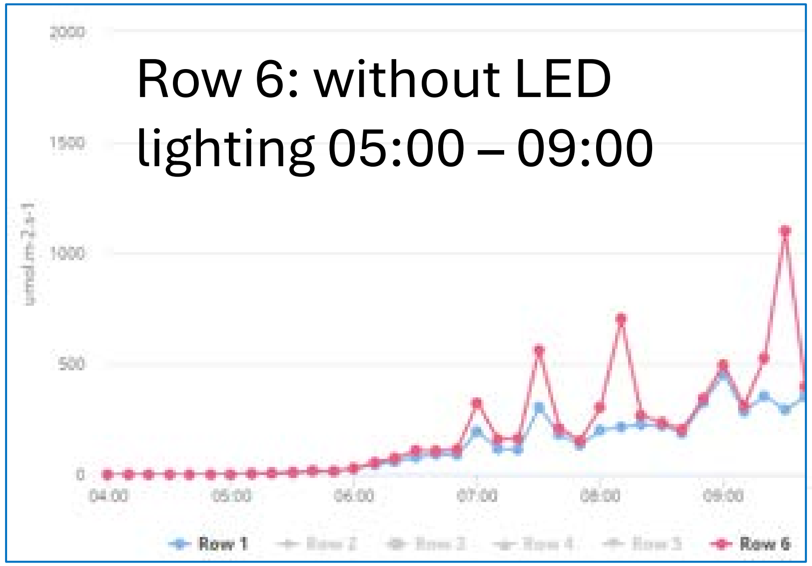
- Class 1 yields 5% higher in Commercial tunnels
- Cumulative PAR values at canopy height 5% higher in Commercial tunnels
- Correlation of 0.95* between Class 1 yields and PAR > 800 μmol m-2 s-1
- 11-14% difference between rows 4 and 6

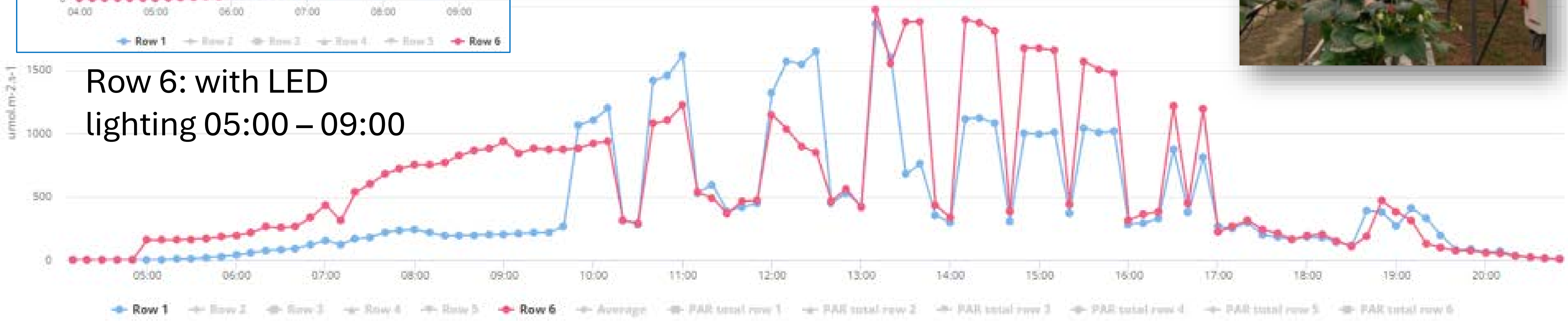
Ways to Increase Light Interception



- AI-driven “smart” venting control to optimise the phytoclimate
- Independent east and west tunnel roof venting
- Light reflective mulches in leg rows
- LED lighting in west rows

Effect of LED Lighting





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Industry Impact - Effect of PAR

- Informed projects in TCEA where we can control light intensity, quality and photoperiod
- Projects looking at photovoltaics to see if they can be used to capture energy and drive photosynthesis
- 1% loss of light ~ 1% loss of yield.
- How do we use this information in horticultural design?
  - Orchard planting N-S traditionally; yields higher on E side of crop. Change orientation of planting and inform future planting decisions.
  - Similar for soft fruit tunnels?

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Other Studies and Innovations

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Summary of Other Studies and Innovations…

- **Double Truss Tape**
  - Useful to prevent truss kinking and consequent uneven ripening when growth is vigorous
- **Bag Colour**
  - Class 1 yields 5% higher in white Cocogreen® bags vs black
  - Measured elevated rhizosphere temperatures, and root respiration rates during both day and night periods
- **Polythene Colour**
  - Class 1 yields 16% higher under clear polythene vs yellow
  - Average Pn and g_s 18% lower under yellow polythene
  - Aligns with findings on impact of light levels
- **Biostimulants**
  - No significant benefits under high health conditions of PI, IPM, vigilant plant husbandry

WET Centre Impact on UK Soft Fruit Research and Industry

- Reduction in average water use per tonne of fruit produced
- Generate benchmark data (KPIs) for realistic net zero targets
- Benchmarking for comparative performance of other growing environments: glasshouses, TCEA, etc
- Integrated package of PI, IPM, vigilant husbandry = high health
- Combination of PI with RWH improves local water security – need both for success
- The importance of light as a key consideration for TCEA productivity and horticultural design (orchards, polytunnels)

Thanks…

Crop Science & Production Systems & Farm Team

Niab at East Malling

BGG Agronomy Team

WET Centre Partners:

NETAFIM

Delta-T Devices

BERRY GARDENS GROWERS

Cocogreen

YARA

Stoller

HUTCHINSONS Crop Production Specialists

AHDB

weatherquest

LEAF

newleaf

Funding Organisations:

NIAB

Environment Agency

Kent County Council

UKRI Innovate UK

The effects of short-term water stress on raspberry

Ece Moustafa

CTP PhD Student

Water deficit stress

- Irrigation system failures/performance
- Applied to control cane vigour
- Climate change

Background

Moderate rootzone water deficit stress → Short-term restrictions in net photosynthesis → Caused by stomatal limitation (closure) → Triggered by hydraulic and/or chemical signaling

Stomata respond rapidly to optimise water use and CO_2 gain

Recovery of raspberry from water deficit stress is a longer and slower process (days-weeks) compared to strawberry (hours-days).

Fruiting raspberry canes

A strawberry plant

Drying Down Treatment

- Well-watered (WW) = The irrigation set point was adjusted to ensure ca. 15% average daily run-off.

- Dried down (DD) = Starting set point was 65%. This was dropped by 5% each day.

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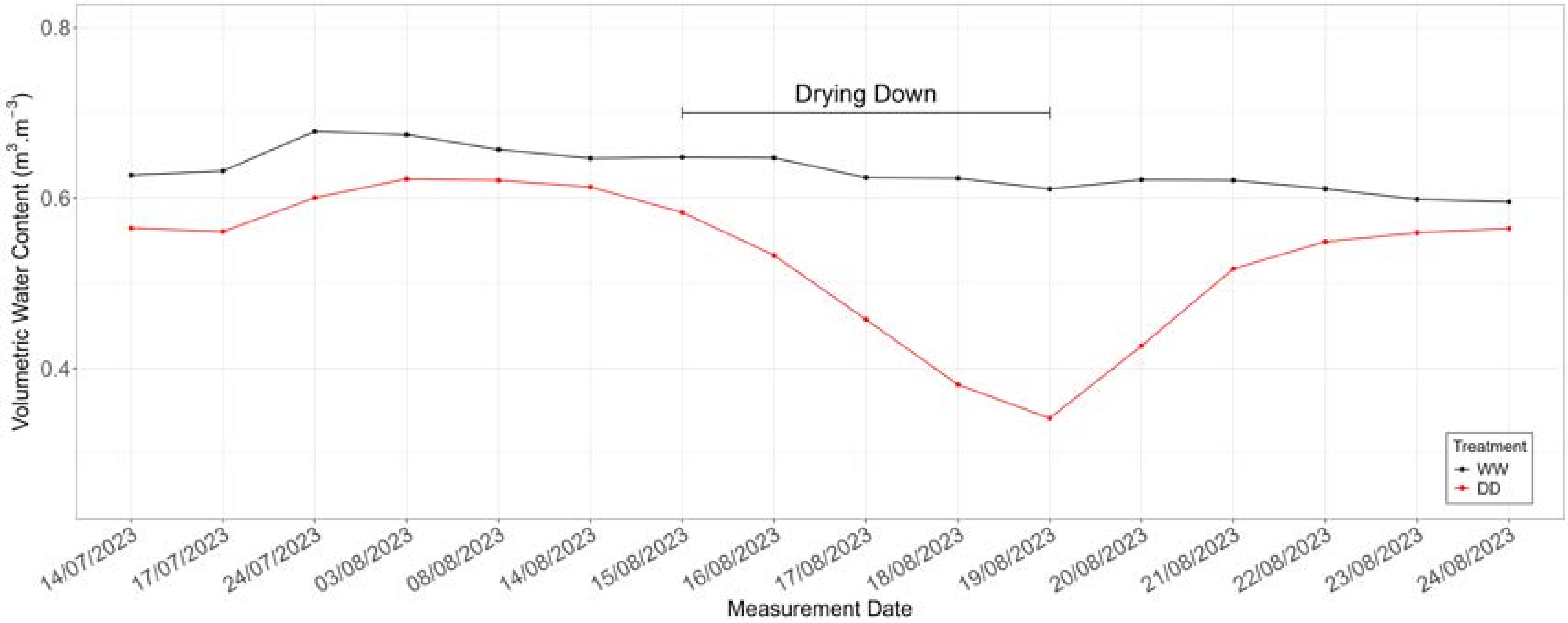
Coir volumetric water content

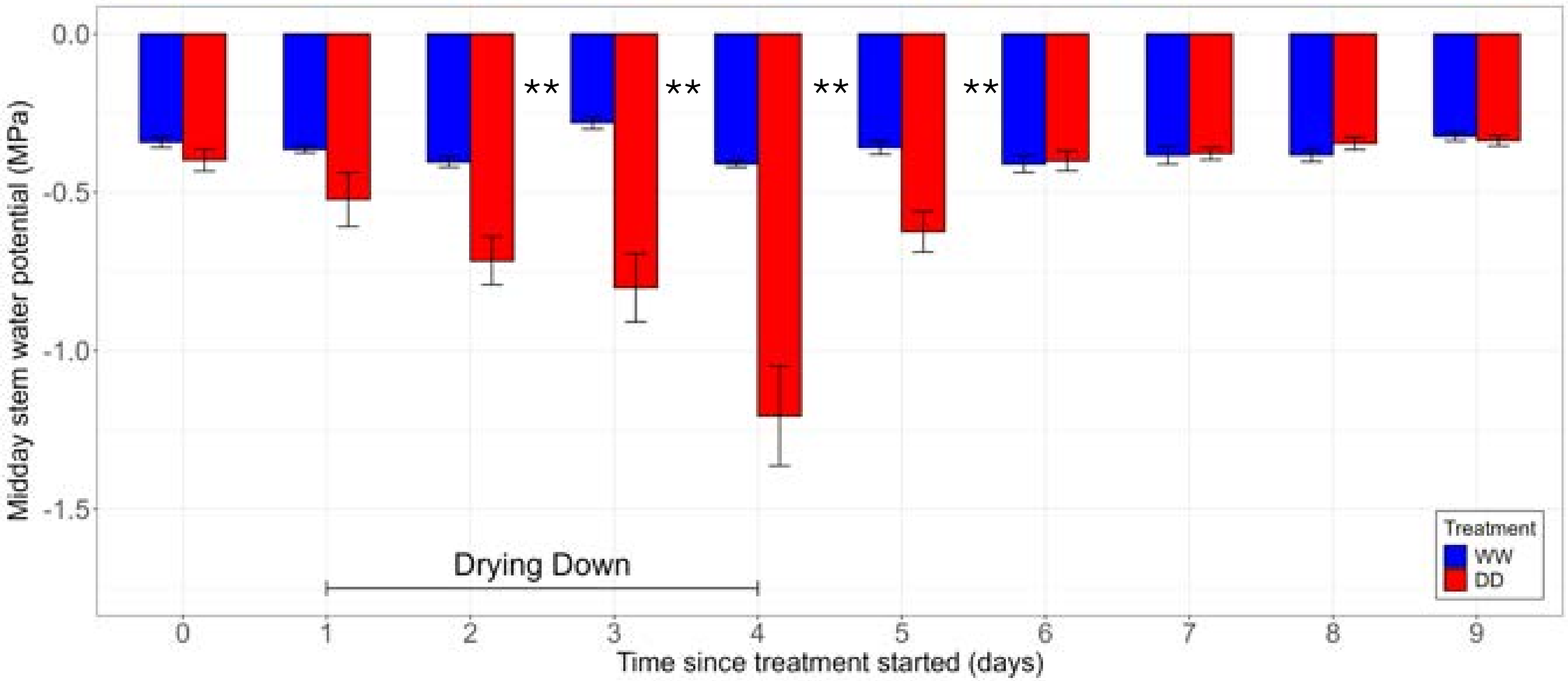


- Vital to keep WW values within a narrow range

Initial response: Midday Stem Water Potential

Day 2 = Response to the rootzone water deficit stress

Day 6 = Recovery of DD values back to pre-stress values.



Quick response and recovery of shoot water balance values

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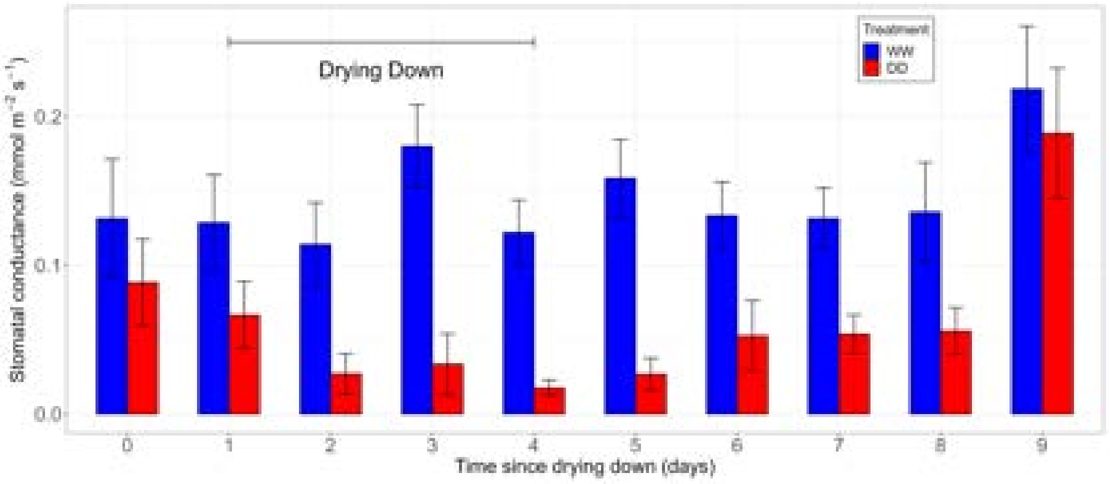
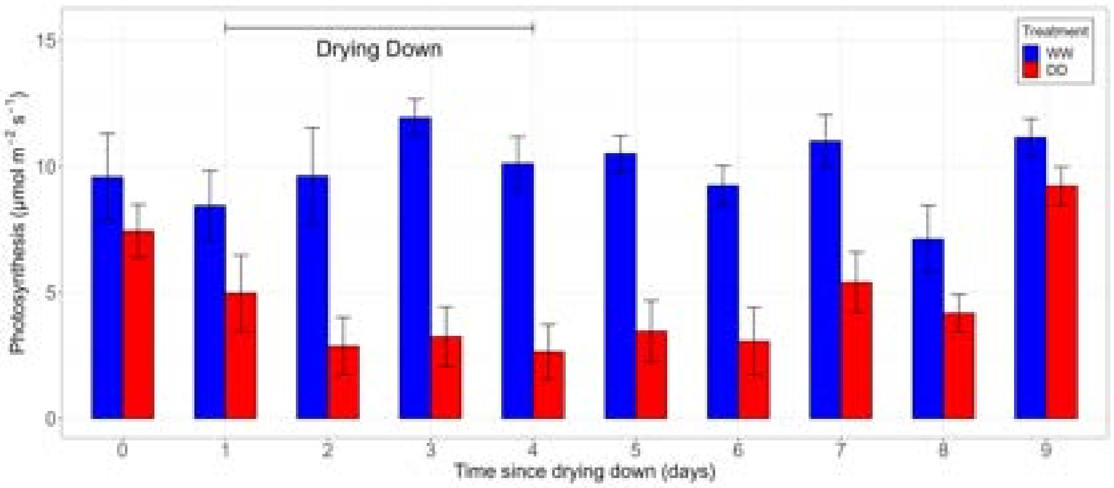
Midday stomatal conductance and photosynthetic rate changes





- Day 2 = Response to a rootzone water deficit stress
- Day 8 = Recovery (four days after rewetting)

- Day 2 = Response to a rootzone water deficit stress
- Day 8 = Recovery (four days after rewetting)

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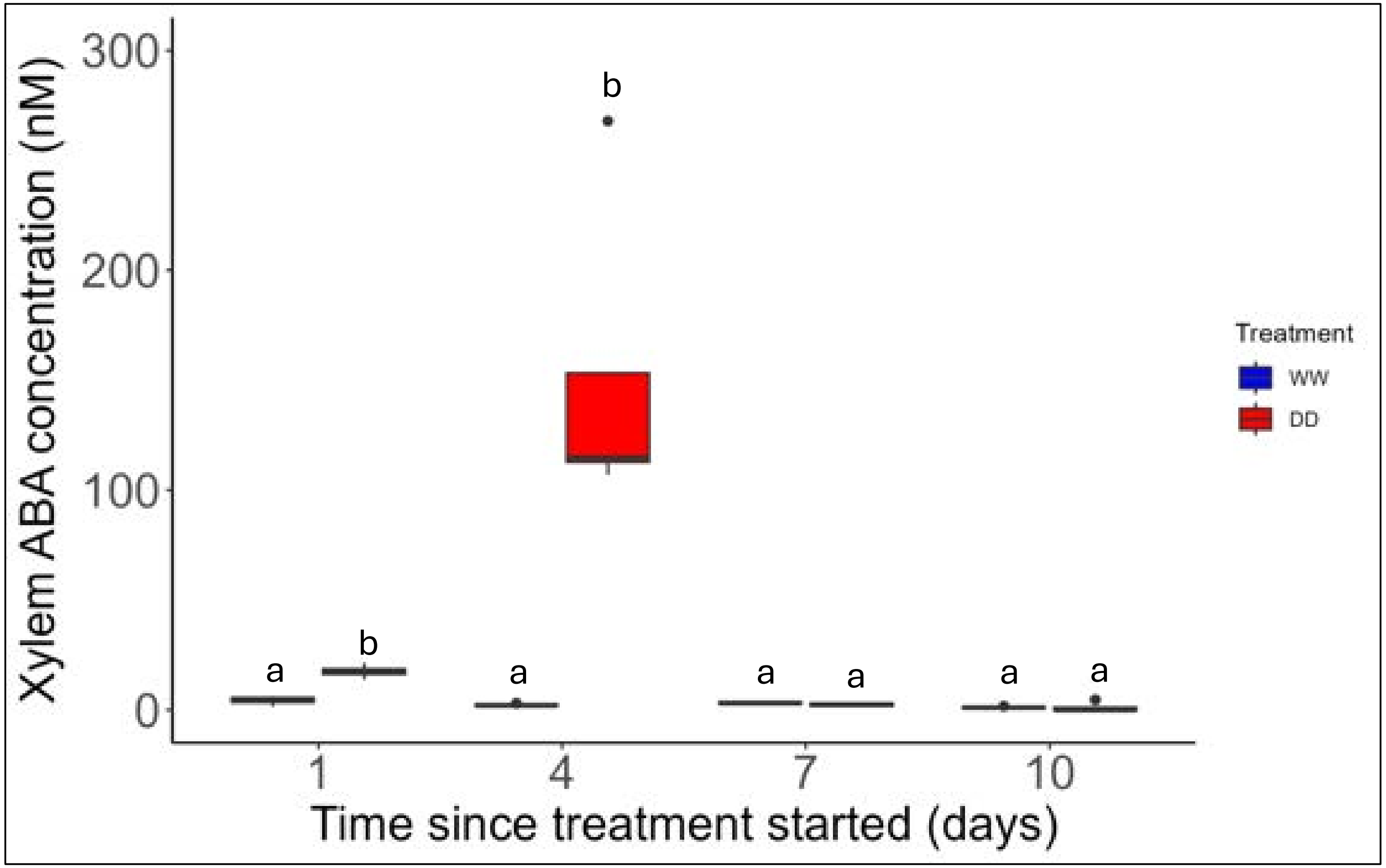
Xylem-borne abscisic acid (ABA) Concentrations



Xylem-borne ABA concentrations [ABA] increased during the drying-down phase, however, quick recovery to pre-stress values following rewetting of the coir.

What mechanisms may regulate the slow recovery rate from stress episodes in raspberries?

- Changes in xylem sap pH
- Foliar [ABA]
- Hydraulic signaling

Further experiments are being conducted to better understand the causal signals

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How is this research relevant?

There is a recent trend to grow commercial raspberry crops in 4.7 L pots rather than replanting them into 7.5 L pots.

- Growers are reluctant to repot raspberry canes received in small pots from the nursery into larger pots. Why?
  - Not repotting the smaller pots into larger pots reduces labour costs.
  - Smaller pots are less likely to be overwatered, hence, less likely for raspberry root rot.

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CTP Fruit Crop Research

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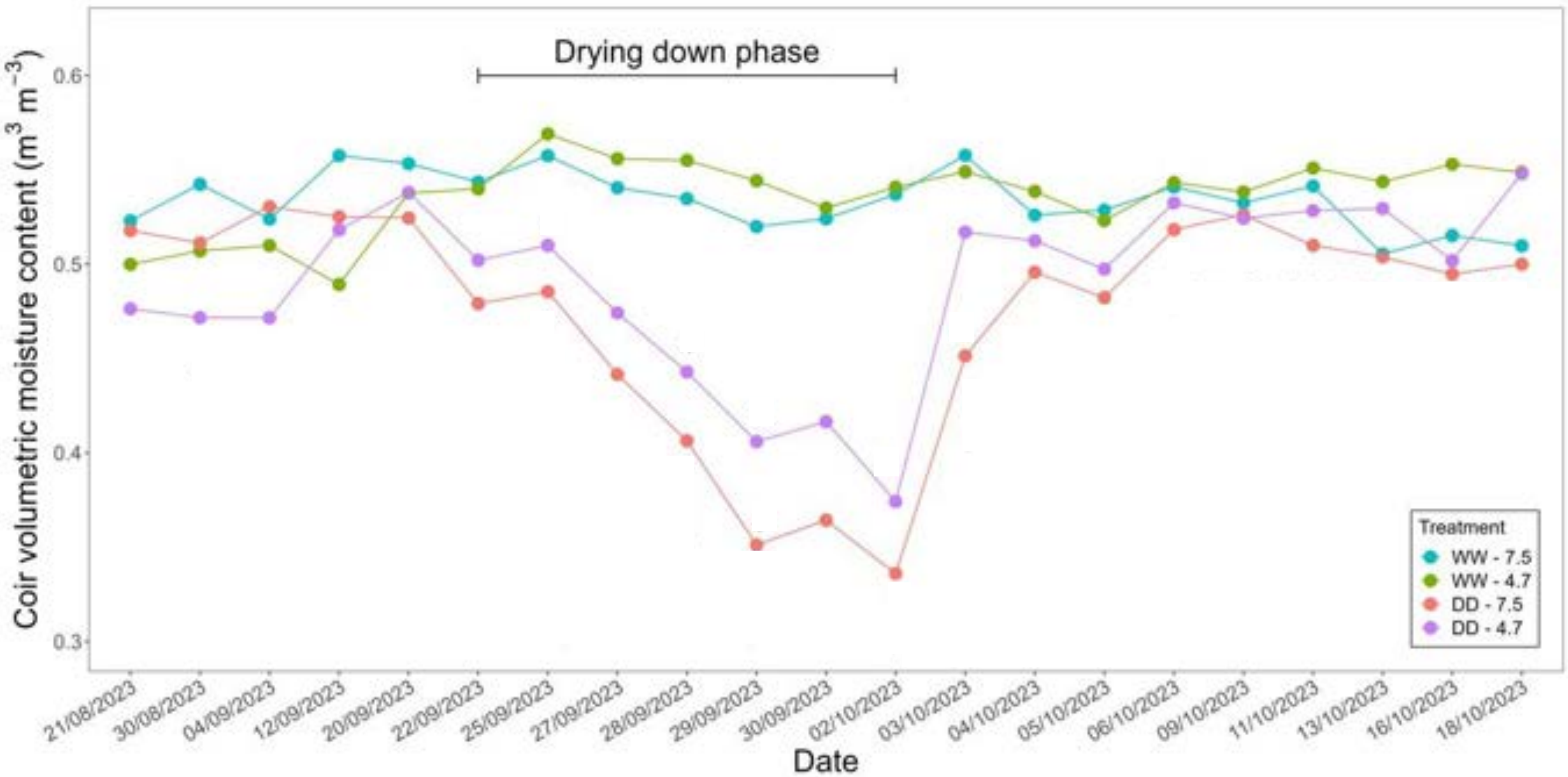
Why should we be replanting into larger pots?

WW 7.5	DD 7.5	WW 4.7	DD 4.7
Well-watered 7.5 L pots	Drying down 7.5 L pots	Well-watered 4.7 L pots	Drying down 4.7 L pots

Understanding the effects of water deficit stress when using smaller rooting volume pots.

Why should we be replanting into larger pots?



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- Vital to keep WW values within a narrow range

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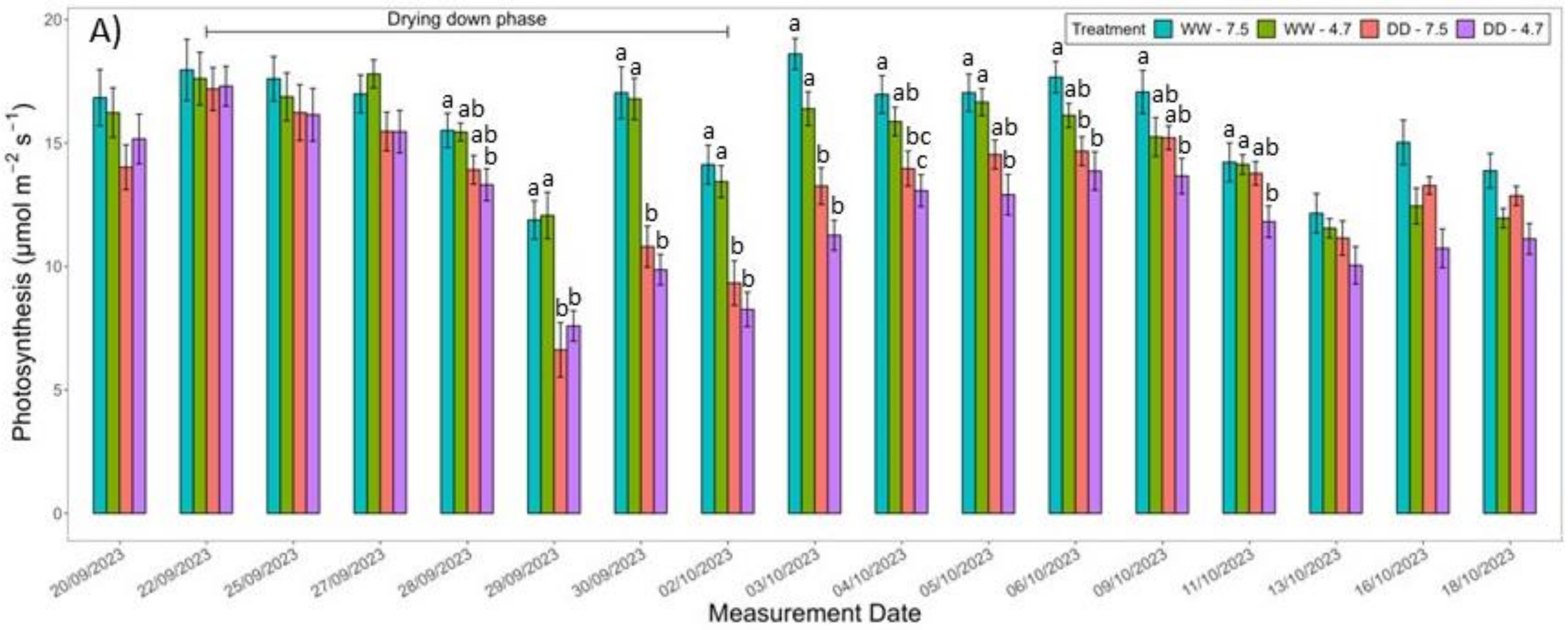
Changes in leaf gas exchange



- Day 5 = Differences between WW 4.7 and DD 4.7 & between WW 7.5 and DD 7.5
- **Day 13 = Recovery in DD 7.5**
- **Day 17 = Recovery in DD 4.7**

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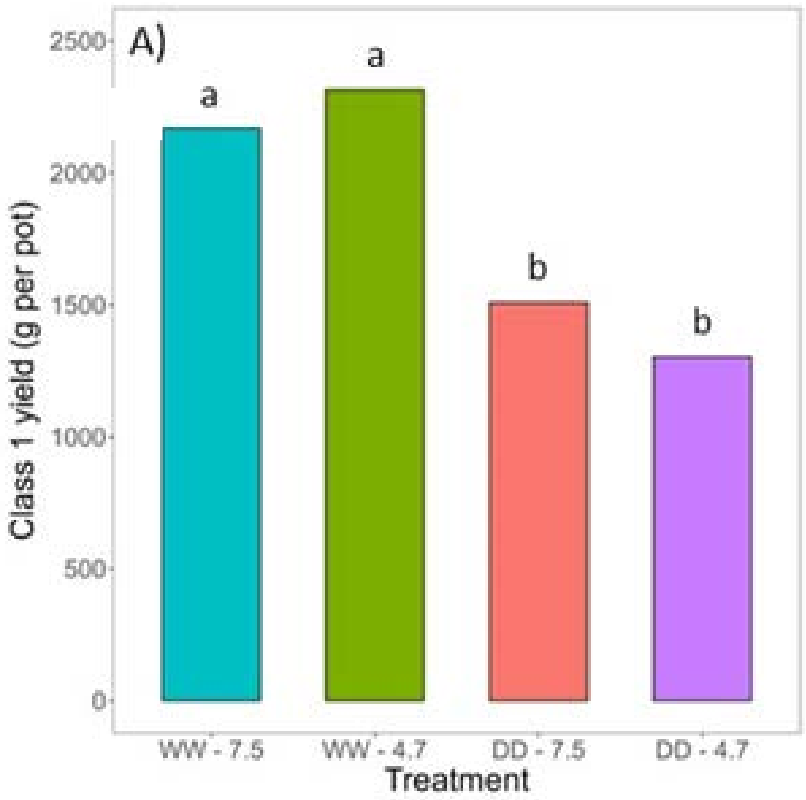
The effects of a drying down treatment on average Class 1 yield per pot



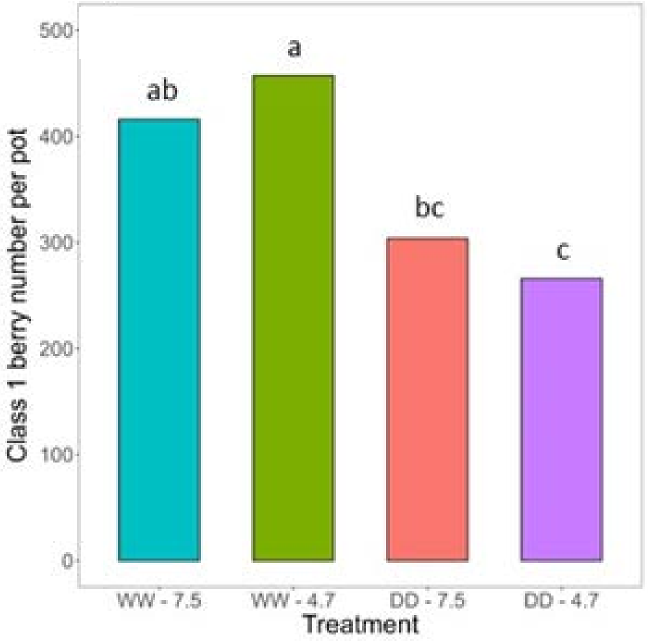
Average Class 1 yield:

- WW 7.5 = 2.2 kg/pot
- WW 4.7 = 2.4 kg/pot
- DD 7.5 = 1.5 kg/pot
- DD 4.7 = 1.3 kg/pot

A greater loss in average Class 1 yield per pot in the smaller pots despite the same duration of drying down treatment for both pots.

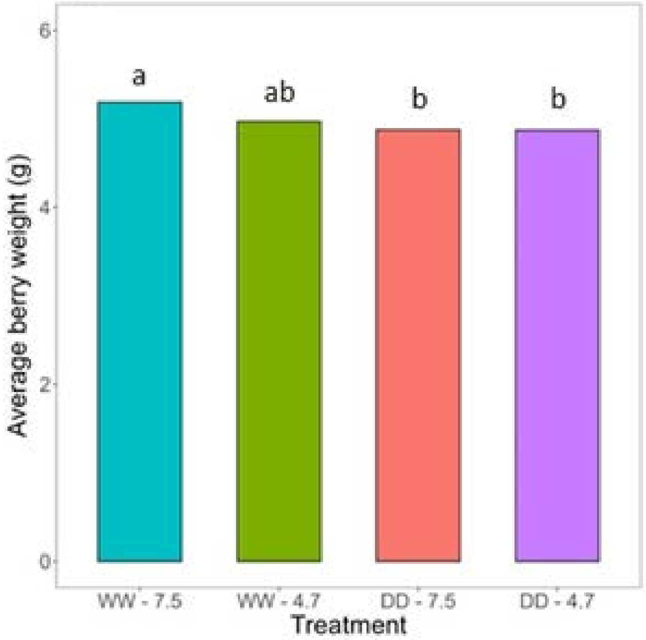
Treatment and pot size effects on berry number and weight

A greater reduction in total Class 1 berry numbers in the smaller pots despite the same duration of drying down.



Total Class 1 berry numbers:

- WW 7.5 = 416 berries per pot
- WW 4.7 = 473 berries per pot
- DD 7.5 = 304 berries per pot
- DD 4.7 = 266 berries per pot



Average berry weight:

- WW 7.5 = 5.1 g/berry
- WW 4.7 = 4.6 g/berry
- DD 7.5 = 4.8 g/berry
- DD 4.7 = 4.3 g/berry

There was a 10% reduction in the average berry weight in well-watered small pots compared to the larger pots. This was just outside of statistical significance.

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Summary

- A moderate rootzone water deficit stress caused stomatal closure and reduced photosynthesis.

- Recovery of shoot water balance occurs within two days; however, photosynthesis and stomatal conductance values take longer to recover.

- Xylem-borne ABA concentrations [ABA] increased during the drying-down phase.

- The use of smaller pots can lead to a detrimental reduction in berry yield and quality.

Thank you

Dr Mark Else

Prof. Tracy Lawson

Dr Amanda Cavanagh

Harriet Duncalfe

the CSPS Team at NIAB East Malling

the Lawson Lab members

ece.moustafa@niab.com

Optimising raspberry propagation for improved plant uniformity

Dr Louisa Robinson Boyer, Dr Matevz Papp-Rupar and Feli Fernández.

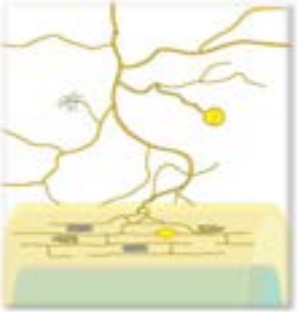
Challenges

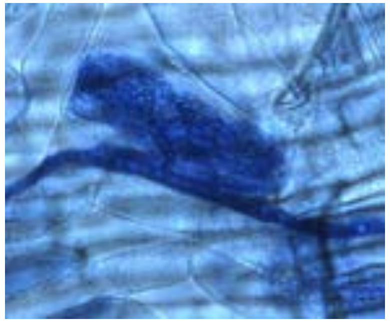
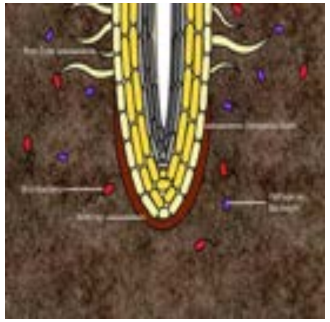
- Demand for high quality planting material for raspberry continuing to rise, especially of new varieties such as 'Malling Bella'
- High dependency on imports - cost/quality
- Inefficient raspberry propagation - variable survival and establishment
- High cost of production, reliance on chemical and resource input
- Production primarily depends on coir - long term sustainability and cost

Investigate the use of commercially available beneficial microorganisms to improve raspberry propagation and establishment

Coir substrate lacks beneficial soil microbes

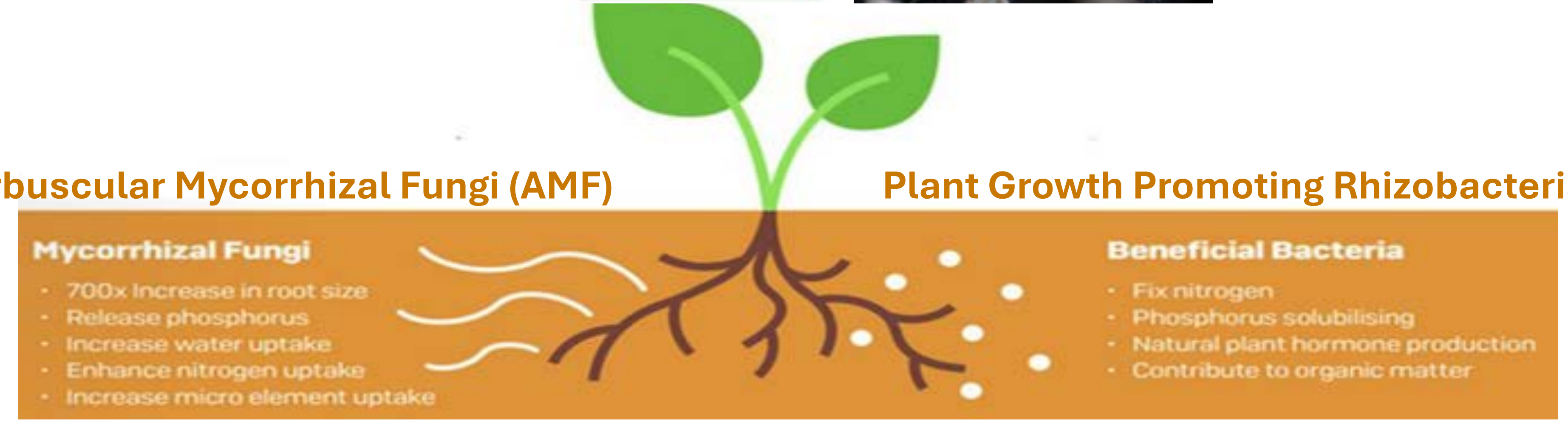
A healthy plant microbiome is....
A balance of beneficial microorganisms
Low levels of pathogenic organisms
Diverse populations



Arbuscular Mycorrhizal Fungi (AMF)

Plant Growth Promoting Rhizobacteria (PGPR)



Coir as a substrate

- Raspberry propagation and production both use coir as a substrate
- High costs of virgin coir
  - Increasing demand globally
  - Expensive to treat and source
- Environmental costs
  - Supply limited
  - Resource intensive
  - Shipping from Asia
- Farm waste
  - Circular economy
- AMF tends to give patchy/irregular colonisation in virgin coir
- Can coir from strawberry production be processed and recycled for raspberry

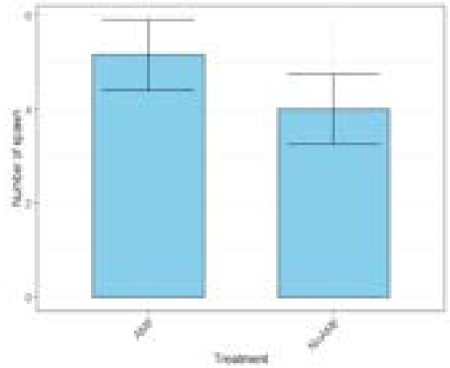
Aims:

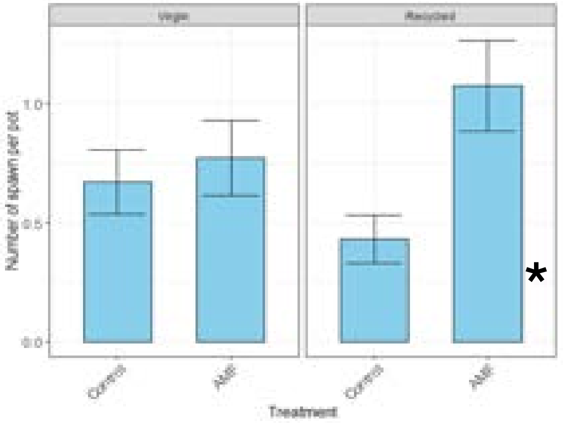
Promote and support the uptake of a Kent bred variety 'Malling Bella'

1. Improving tray plant production
    - Using microbial amendments for root blocks
    - Assessing tip production and establishment
2. Enhancing primocane production and cropping
    - Amendment in field planting
    - Establishment, growth and cropping
3. Improving long cane production and cropping
    - Amendment in field planting
    - Establishment, growth and cropping
4. Improving Production efficiency and sustainability
    - Using spent coir waste from strawberry (recycled coir) for raspberry production
    - Better understand the nutrient profile, water holding capacity, structure/porosity and disease pressure of recycled coir

Optimisation of Malling Bella tip propagation

- Evaluate the effects of amending root blocks with AMF.
  - Amended +/- AMF (commercial product) plants grown for root blocks
  - Evaluate the number of tips produced, survival/establishment and size





Year 1- Number of cuttings produced was slightly higher in the +AMF treatment. Also resulted in increased tip survival (not sig.)

Same trend seen in field plants for spawn, particularly in recycled coir.

Early results suggest AMF amendment may increase shoot production, and thus could improve propagation success

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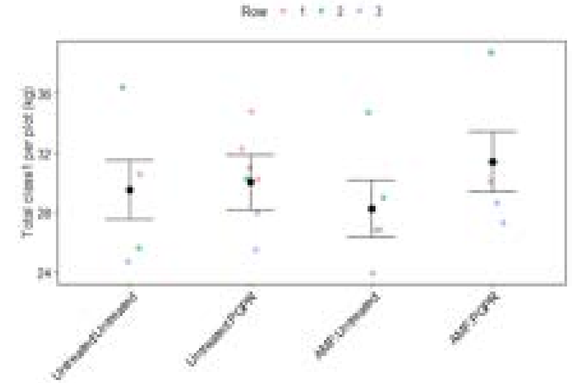
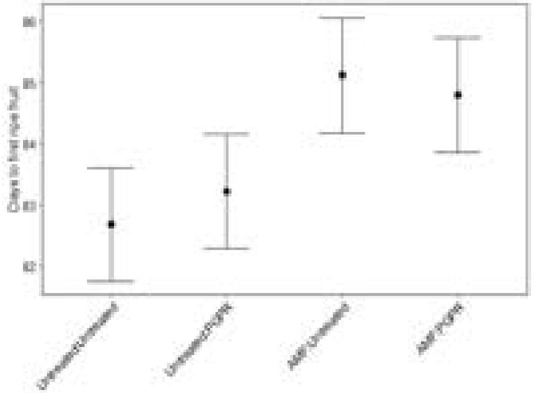
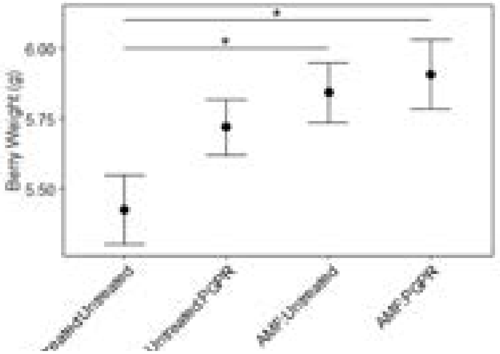
Effect of microbial amendment in **primocane** growth and cropping using **virgin coir**

- Planted late 2023; mowed down & cropped 2024
- Amendments (commercial products) were applied at planting: AMF, PGPR, Both and Unamended
- Plants were assessed for survival, girth, spawn production, height and yield

- No significant affect of amendment on yield or waste fruit, slight increase with PGPR treatment
- AMF **significantly** increased berry size, PGPR slightly increased berry size
- AMF slightly delayed time to first ripe fruit (approx. 3 days)



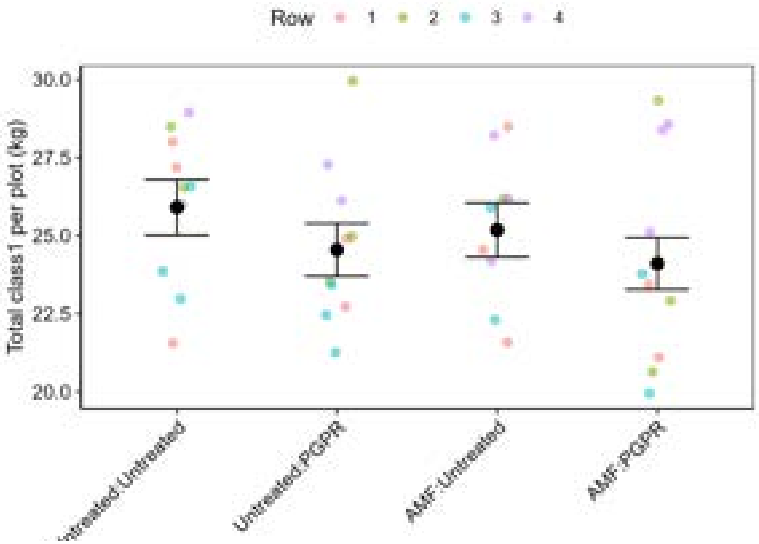




Effect of microbial amendment in **long cane** growth and cropping using **virgin coir**

- Amendments (commercial products) were applied at planting;
  - AMF, PGPR, Both and Unamended
- Plants were assessed for survival, girth, spawn production, height and yield

- No significant difference in yield between treatment, slight reduction in Class 1 fruit with amendment in 2023 planted



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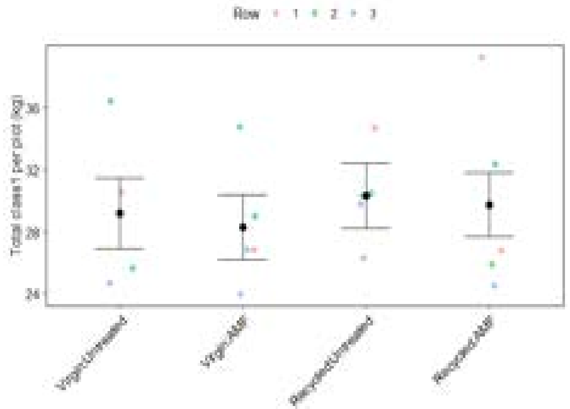
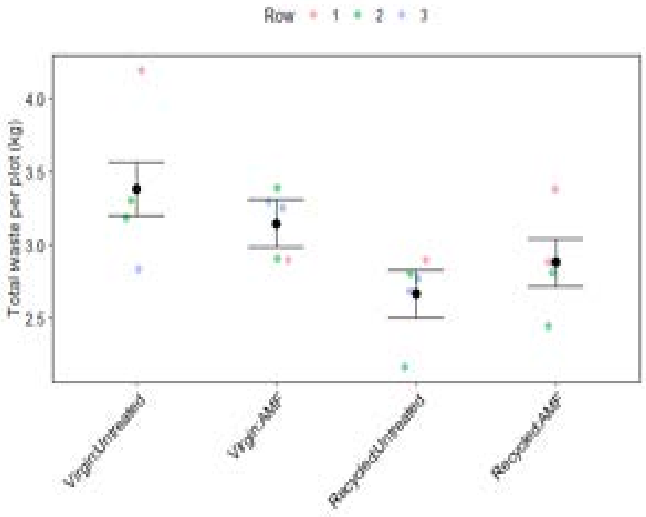
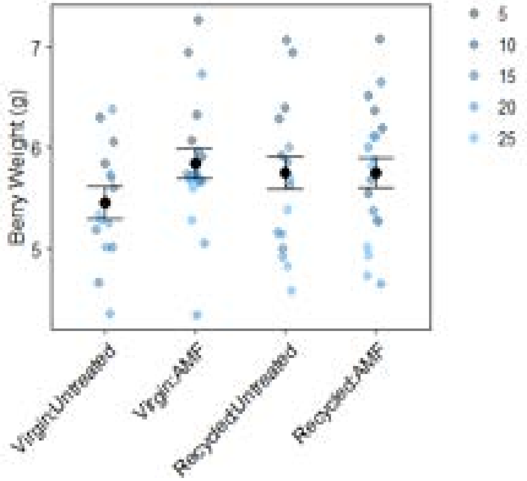
The effect of **recycled coir** and **AMF** in **primocane** production

- Planted 2023, mowed down, cropped 2024
- Treatments
    - Virgin coir +/- AMF amendment
    - Recycled +/- AMF amendment

- No significant difference between recycled and virgin coir, recycled coir slight increase in Class 1 yield and a significant reduction in waste fruit
- Berry size significantly increased with AMF
- AMF led to a slight delay of days to first fruit (Not shown)







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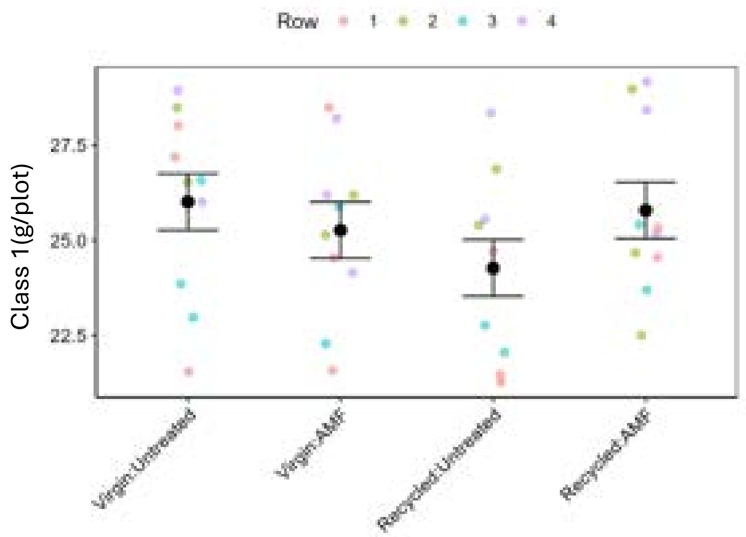
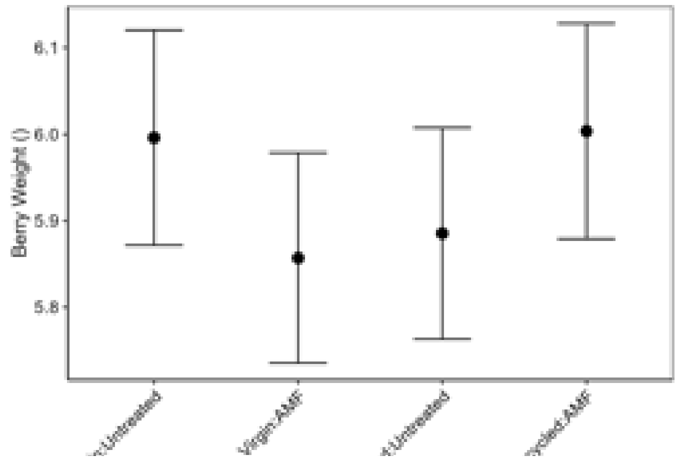
The effect of **recycled coir** and **AMF** in **Long cane** production

- Treatments
  - Virgin coir +/- AMF amendment
  - Recycled +/- AMF amendment
- No significant yield difference between treatments, however recycled coir has a slight reduction in Class 1 yield but also slight reduced waste
- AMF brings this slight reduction back to the same as virgin, likely due to berry size (AMF/coir interaction)





Conclusions

- Early data and better estimates will be obtained from 2024 planted primocane and long cane
- Very encouraging trends:
  - Recycled coir (from strawberry) good for growing raspberry
  - Addition of AMF recovers the slight reduction on Class 1 yield in recycled coir (long cane)
  - AMF addition (virgin and recycled) increases berry size
  - AMF/coir interaction. AMF has greater in recycled coir than virgin (long cane)
- Effect of Coir type and AMF inoculation on time to first fruit- important for production planning
  - AMF delay time to first fruit
  - Recycled coir decreased time to first fruit

Thank you..

Many thanks to

Charlie McLean - ReCoir

Tom Pearson - Blaise Plants

The Niab team, especially:

Tom Passey

Jen Kingsnorth

Georgina Fagg

Emily Murray

Maisie Bickerton

Sharon Halmkam

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Leigh Hammersley-Brunnarius

Lesley Brunnarius

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Blaise Plants

ReCoir

Innovate UK
Technology Strategy Board

Plant Works

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Plant Science into Practice

Recent developments in coir recycling and Phytophthora management

Dr Matevz Papp-Rupar

Thomas Passey, Jenifer Kingsnorth, Georgina Fagg, Xiangming Xu

Niab East Malling

Coir growing media in soft fruit production

UK soft fruit production is based on coir substrate / table-top / tunnel system

- Reduced impact of soilborne diseases
- Predictable high yield and quality, easier picking
  - Better input management / stress management.

Challenges of coir substrate system:

- Single use approach
  - Pest and pathogen build up during the growing season
  - Changes in coir chemistry and physical properties
- (Volatile) Price of material and shipping from SE Asia.
- Carbon footprint of shipping
- Large amount of waste produced

Project Aims

To develop a sustainable, circular recycled coir substrate for soft fruit production.

- **Overland** – producing recycled coir
  - Fast, automated removal of spent coir from commercial tunnels
  - Low labour
  - Removal of plastics, plant material
  - Inactivation of pest / weeds / pathogens
- **NIAB** – assessing recycled coir properties
  - **Pests** / **pathogens** / **weeds** / microbiome / biocontrol
  - **Chemical** and **physical** properties
    - Nutrient profile, water holding capacity, air filled porosity
  - **Sustainability** assessment
- **Commercial growers and advisors**:
  - Commercial trials
  - Recycling Quality Assurance

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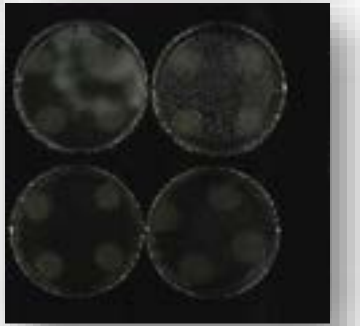
Pathogen / weed seed in recycled coir

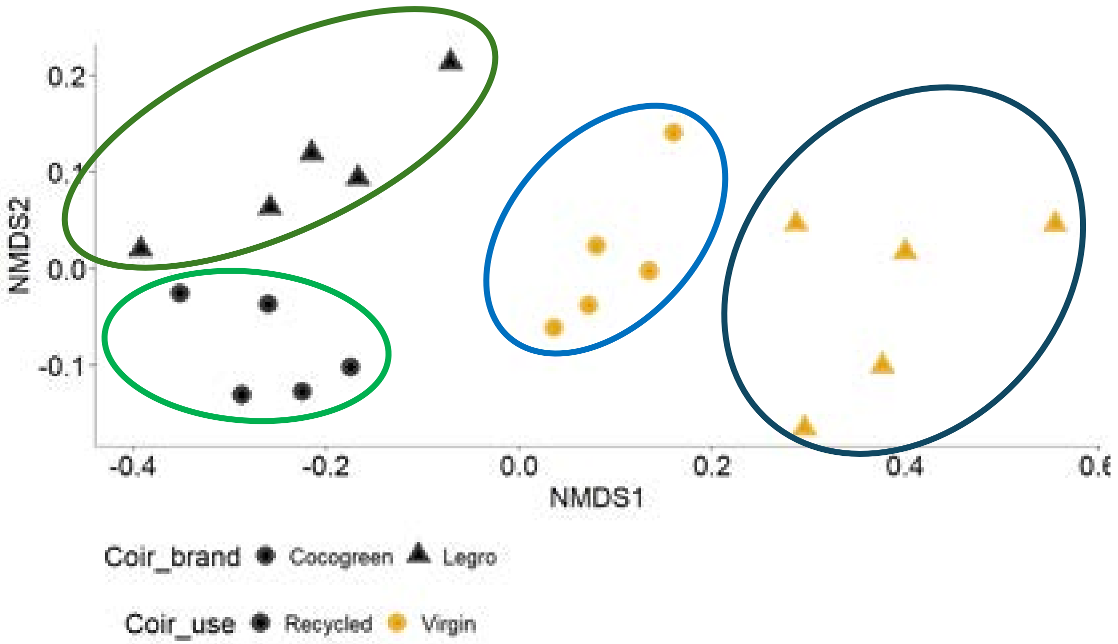
- **Overland processes tested** and **optimised** to ensure inactivation of:
  - **Root rots** caused by **Phytophthora** species, e.g. crown rot
  - **Weed seed** blown in during year 1 growing / recycling /coir storage
- **Phytophthora**
  - 7 strains from 3 species: *P. cactorum, P. cryptogea, P. citrophora* (all isolated from soft fruit)
  - Oospore inactivation tested – resilient resting spores
  - Known pathogens passed through recycling process in pouches
- **Weed seeds**
  - Most thermally stable seeds selected (thistles, tomato, night shade,...)
  - Seed pouches passed through recycling process



- **Outcomes – Overland processes benchmarked**
  - All **Phytophthora** strains **inactivated**
  - All **weed** seeds **inactivated**

Is microbiome different in recycled coir ?

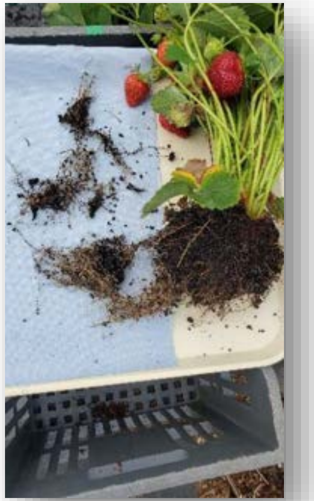
- Strawberry root associated microbes
- Metagenome sequencing of 2 trials:
  - **Commercial** trial, cv. Katrina
    - Virgin and recycled Legro coir
  - **Semi-commercial** trial, cv. Malling Supreme
    - Cocogreen/ Legro - virgin/recycled
- Distinct microbiomes of strawberry roots:
    - Bacteria / Fungi / Oomycete / Microbiome function
  - Between virgin brands
  - Between recycled brands
  - Between recycled and virgin



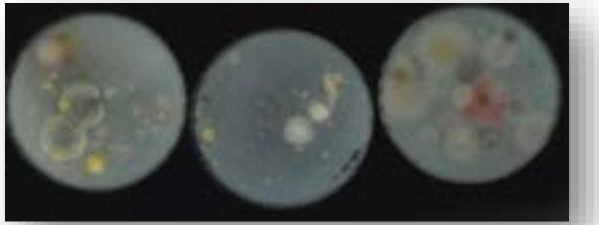
Implications / details of microbiome differences are being investigated and related to yield data

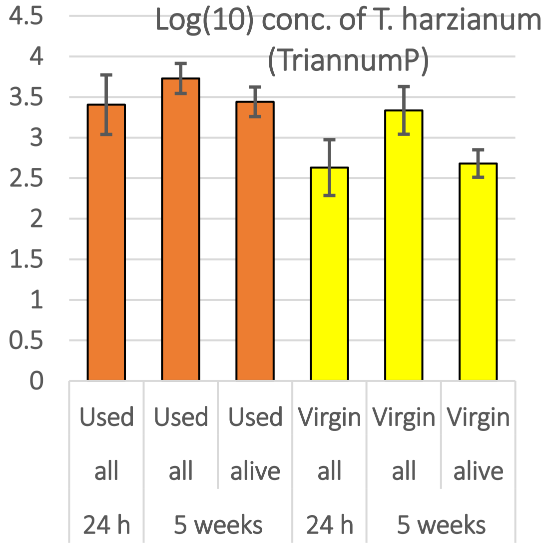
Other biological properties of recycled coir?

- **Does crown rot (*P. cactorum*) spread faster in recycled material?**
  - **Malling Centenary** plants **infected** with crown rot in **virgin** and **recycled** coir
  - Yield / crown rot symptoms observed
  - **No differences between the virgin and recycled**
    - Very low infection rates
    - Similar yields and crow rot incidence / severity in both materials.



- **Do biocontrol products establish better in virgin or recycled coir?**
  - **Arbuscular mycorrhizae** (PlantWorks), **Trichoderma** (T34/TrianumP), **Gliocladium** (Prestop), **Beauveria** (Naturallis)
  - Inoculated at planting (Malling Centenary) → biocontrol load measured at harvest (dilution plating, qPCR)
    - **No differences between virgin and recycled media**
    - Poor colonisation of biocontrols in both virgin and recycled coir





Chemical properties of virgin and recycled coir

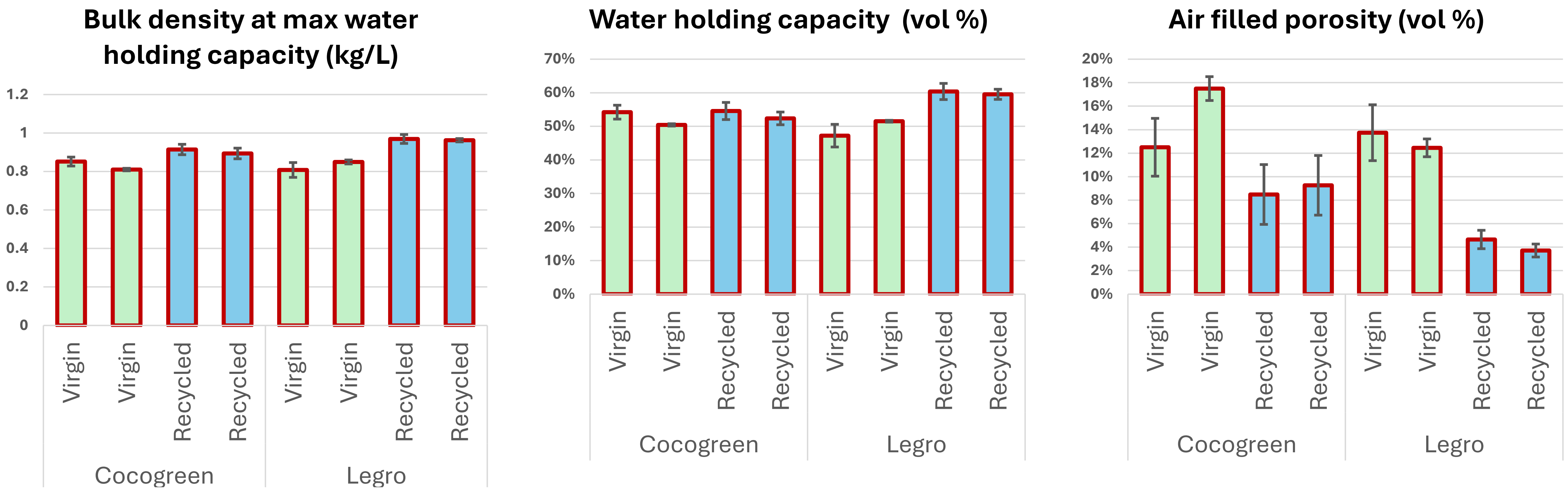
- **Recycled coir higher in nutrients** – but not beyond recommended levels
  - Commercial trial data

Farm-Year-Month	Coir	pH	Cond. uS/cm	Ammonia mg/l	Nitrate mg/l	Total N mg/l	Phosphorus mg/l	Potassium mg/l	Calcium mg/l
Kelsey-23-May	Virgin	5.8	39	0.6	1.5	2.1	6.1	5.9	10.6
SummerBerry-24-June		5.9	248	1.3	17.9	19.1	21.6	90.7	67.2
SummerBerry-24-May		5.4	220	2.6	46.5	49.2	31	101.1	54.7
Kelsey-23-May	Recycled	6.1	443	0.9	85.5	86.4	49.3	136.8	221.5
SummerBerry-24-June		6.5	475	1.8	101.4	103.2	43.7	204.3	175.9
SummerBerry-24-May		6.5	219	1	59.5	60.5	37.4	149.3	50.6

Farm-Year-Month	Coir	**Magnesium mg/l**	**Sulphate mg/l**	**Boron mg/l**	**Iron mg/l**	**Manganese mg/l**	**Zinc mg/l**	**Chloride mg/l**	**Sodium mg/l**
Kelsey-23-May	Virgin	1.2	16.4	0.19	1.15	0.01	0.05	13	20.1
SummerBerry-24-June		28.2	386.3	0.12	0.98	0.08	0.15	54.4	78.3
SummerBerry-24- May		25.1	256.4	0.23	2.95	0.22	0.43	28.5	50.7
Kelsey-23-May	Recycled	46.1	530	0.16	0.89	0.93	0.29	81.2	69
SummerBerry-24-June		42.1	481	0.23	1.87	0.85	0.63	112.2	88.7
SummerBerry-24- May		10.4	59.6	0.34	0.81	0.08	0.04	31.5	29.7

Physical properties of virgin and recycled coir

- **Higher bulk density** and **higher water holding capacity** in recycled
- Lower air-filled porosity in recycled
- Differences between brands – starting material matters
  - Can be mitigated by mixing during recycling and irrigation set up during growing.



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Commercial trials

2023: cv. Katrina @ Kelsey farm, Canterbury

- **3096 bags** of recycled coir (21,672 plants)
- Produced 29.221 tonnes = **1.34 kg class 1 per plant**
  - First pick 7 days earlier in recycled than virgin

- Excellent fruit size and quality
  - No complaints from the grower
- **Separate irrigation valve for recycled material**
  - Different irrigation schedule than virgin
  - **10% less fertigation used** (different demand)
    - Difference largest in the first 4 weeks and hot days
- No crown rot / mildew problem (compared to virgin)
- No weed problems (compared to virgin)
- No thrip / weevil problems (compared to virgin)

Commercial trials

2024: cv. Favori @ Summer Berry, Chichester

- Data analysis ongoing – yield data not ideal

- Preliminary conclusions:
  - No crown rot problems observed
  - No pest problems observed
  - Comparable yield and quality observed
    - Block with recycled vs block without
  - More dense and uniform rooting observed in recycled coir in early assessments
    - Similar rooting at the end of the season

Carbon emissions comparison (CO_2e) - preliminary

- Recycled:
    - Transport: farm to recycling location
    - Recycling: removing plastics / removing plants/ handling
    - Inactivation of weeds / pathogens
    - Bagging Transport to farm
- Virgin:
    - Shipping: to port in Sri Lanka / container ship Sri Lanka – UK / UK port to wholesale warehouse
    - Emissions of processing, drying, steaming in Sri Lanka <u>not included / known</u>

- Recycled coir production emitted 40% less CO_2e compared to Virgin
    - Additional water saving / and fertiliser saving during

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Recycled coir - Take home messages

Recycled coir produced comparable yields in commercial trials

Recycled coir required different agronomy than virgin coir

- Higher water holding capacity / Lower air porosity

Recycled coir had no issues with pests and diseases in any of our trials

Recycling process seem to release less carbon that shipping of virgin coir

Additional benefits for soft fruit sector from coir recycling:

- Labour savings - removal of spent coir bags
- Savings in water and fertiliser use
- Comparable pricing of virgin and recycled media
- Reduction of dependency on imports of virgin coir/ shipping costs
- Local infrastructure and jobs supporting soft fruit

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New crown rot biocontrol: From coir - To coir?

Current Crown Rot Control:

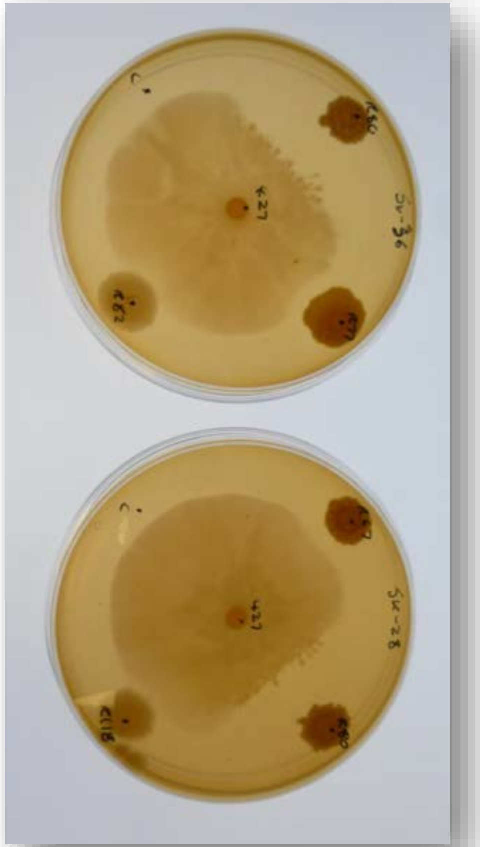
- Limited chemical control (Paraat)
- Low efficacy and survival of current biocontrol (BCA) alternatives
  - Most fungal, some new bacterial
- Challenges with application of fungal spores in irrigation

Considerations for new BCAs:

- Bacterial BCAs - in irrigation application
- Antagonist against many common strawberry pathogens
  - oomycete and fungal
- Adapted to coir environment

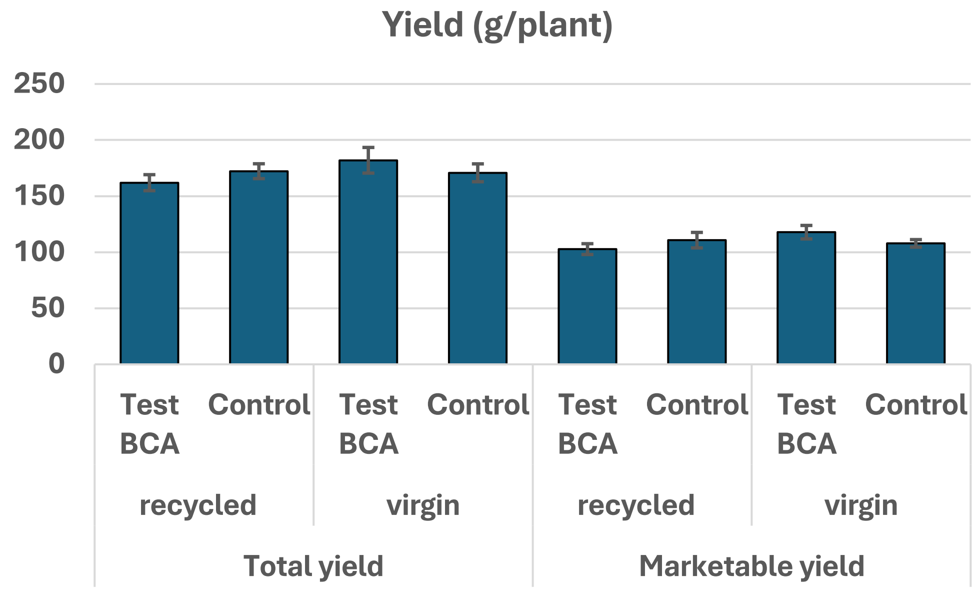
New BCA development - Methods:

- Isolation / purification of **300 strains** from spent coir
- Screening against crown rot (*P. cactorum)* → **top 30** strains
- Screening against **9 other soft fruit pathogens** → **top 10** strains
- Screening **for plant growth promotion** (Auxin, Phosphate, Siderophores)
- **Field trial: yield / plant health**



New BCA from coir - preliminary conclusions

- Four strains with broad *in vitro* antagonism and plant growth promotion tested
- Initial field trials not conclusive:
  - Very low crown rot in 2 consecutive trials
  - No negative impact on plant growth / yield
    - Survival/colonisation to be measured in future
- **Alternative trial methods are being developed**
  - **Inoculum, conditions, cultivars**



Pathogen	Phytophthora cactorum						Pytophthora fragariae		Phytophthora citrophthora		Phytophthora cryptogea		Phytopythium litorale		Phytopythium vexans		Macrophomina phaseolina				
Strain	P414		P421		P423		RH1-0178 (NOV5)		P427		P428		11/11/R/21		13/02/R/21		PC1/17				
Origin	Strawberry, Somerset, UK		Strawberry, Kent, UK		Strawberry, Kent, UK		Strawberry, Canada		Raspberry, Midlands, UK		Raspberry, Scotland		Raspberry, Scotland		Raspberry, Scotland		Strawberry, Egipt				
Test bacteria strain	% Red.	P-val	% Red.	P-val	% Red.	P-val	% Red.	P-val	% Red.	P-val	% Red.	P-val	% Red.	P-val	% Red.	P-val	% Red.	P-val	Phosphate solubilisation	Auxin production	Siderophore production (LB)
[redacted]	41.8	0.001	35.0	0.001	39.5	0.008	19.0	0.001	34.2	0.025	61.5	0.001	31.6	0.001	35.0	0.001	40.3	0.004	2.35	0.00	1.60
[redacted]	29.4	0.001	45.3	0.001	39.9	0.006	36.3	0.001	33.6	0.001	67.3	0.001	0		12.4	0.001	56.7	0.001	0.00	0.00	2.59
[redacted]	42.5	0.001	38.7	0.01	40.9	0.011	42.1	0.001	34.1	0.002	65.3	0.001	34.1	0.001	7.8	ns	54.9	0.001	0.00	nt	nt
[redacted]	40.1	0.001	34.0	0.02	46.5	0.001	38.5	0.001	29.6	0.001	29.3	0.001	5.0	ns	2.0	ns	56.3	0.013	0.11	0.77	nt
[redacted]	20.6	ns	37.4	0.002	44.8	0.005	39.3	0.001	36.2	0.001	61.5	0.001	31.8	0.002	4.7	ns	30.8	ns	2.10	0.04	2.14

Thank you for listening.

The funders and partner of the coir recycling research:

- Overland team for leading the project
- Claire Donkin for agronomy and quality assurance advice

- The funders of the coir biocontrol research:

Contact: John Longley, Overland Ltd. / John.Longley@over-land.co.uk / www.over-land.co.uk

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UKRI Biotechnology and Biological Sciences Research Council

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emt east malling trust

Improving pollinator management and precision pollination in soft fruit

Dr Sarah E J Arnold and the PPE team

Why is it important?

Results of **under**pollination

- Misshapen fruit

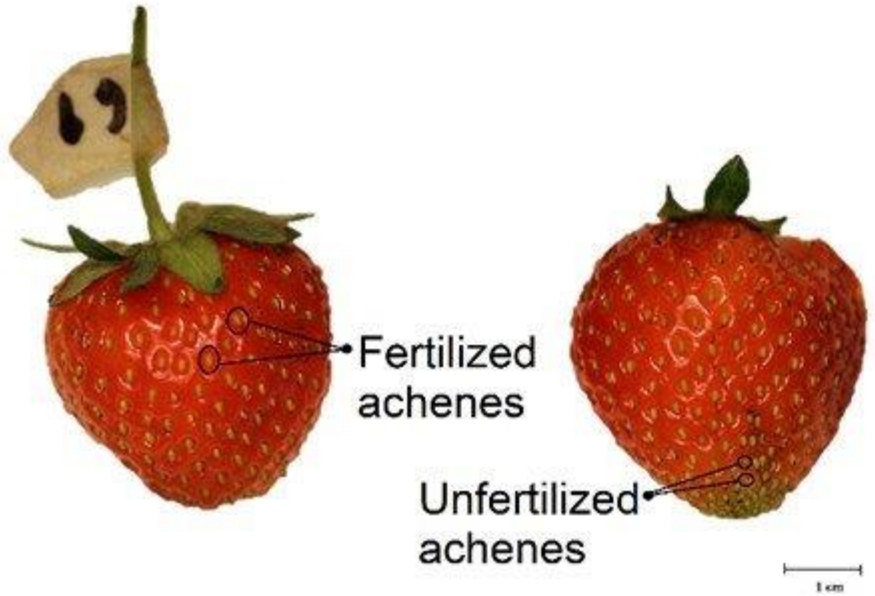
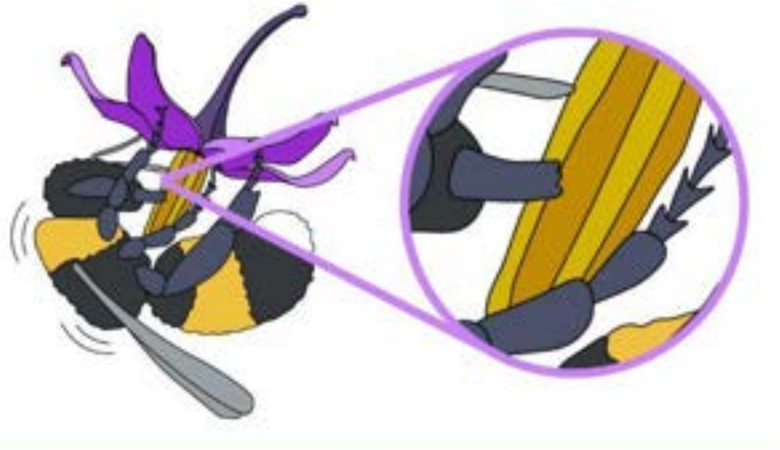


Image from: MacInnis, G., & Forrest, J. (2017). *Journal of Pollination Ecology*, *20*, 13-21.

- Bees chew stigmas
- Damage to flowers
- Also misshapen fruit



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Where is there a problem?

Polyhouses

- Patchy pollination effort
- High bee mortality
- Bees struggle with navigation, orientation

Polytunnels

- Poorer pollination in centre of tunnels
- Humidity/ temperature stress

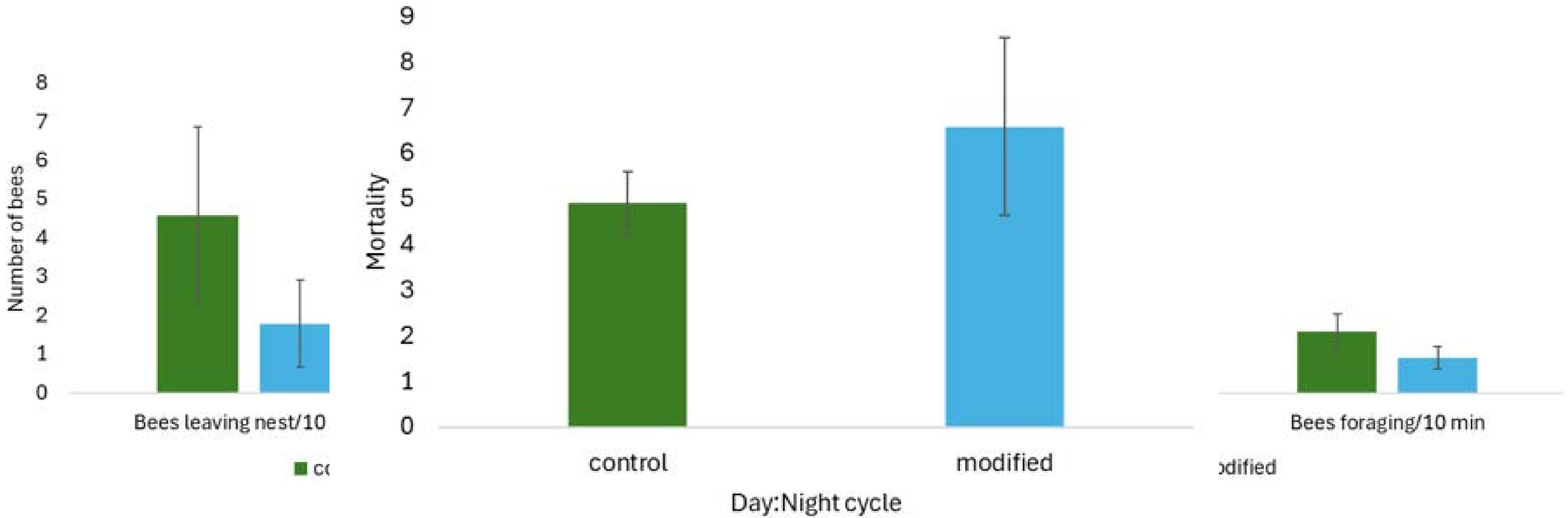
Vertical farms

- High mortality in bees
- Aggression
- Low pollination effort

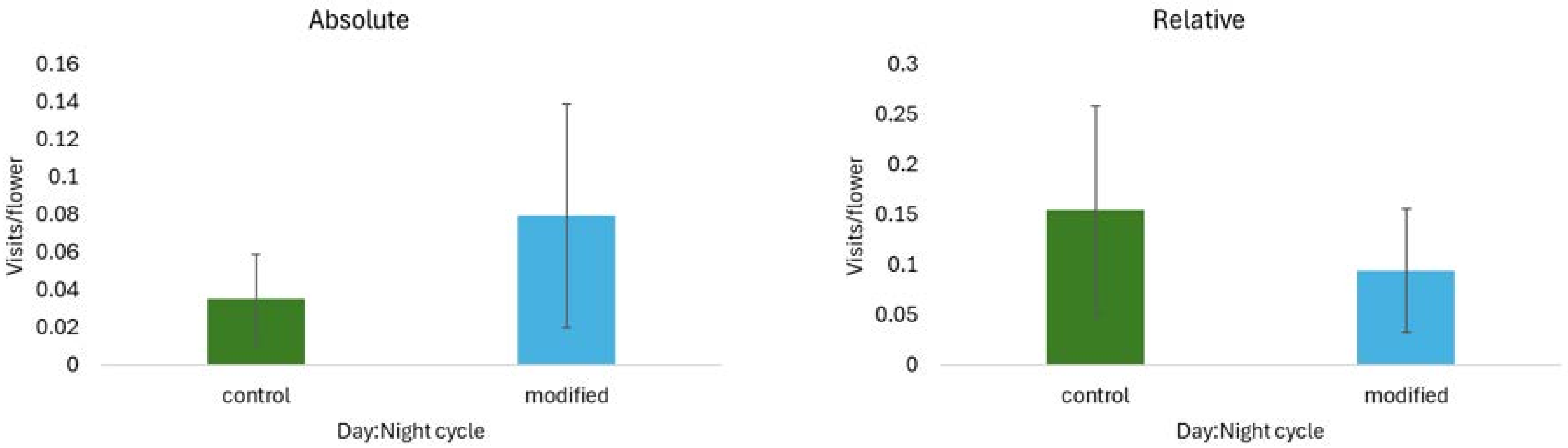
Causes?

- Light/visual/navigation environment
  - Cognitive stress
  - Bees disorientated
- Overheating
  - Physical stress
- Crop just not very attractive
  - Bees not motivated

Example: TCEA comparing bee activity in compartments with “normal” and “altered” circadian cycles



What this means for the actual pollination in TCEA?



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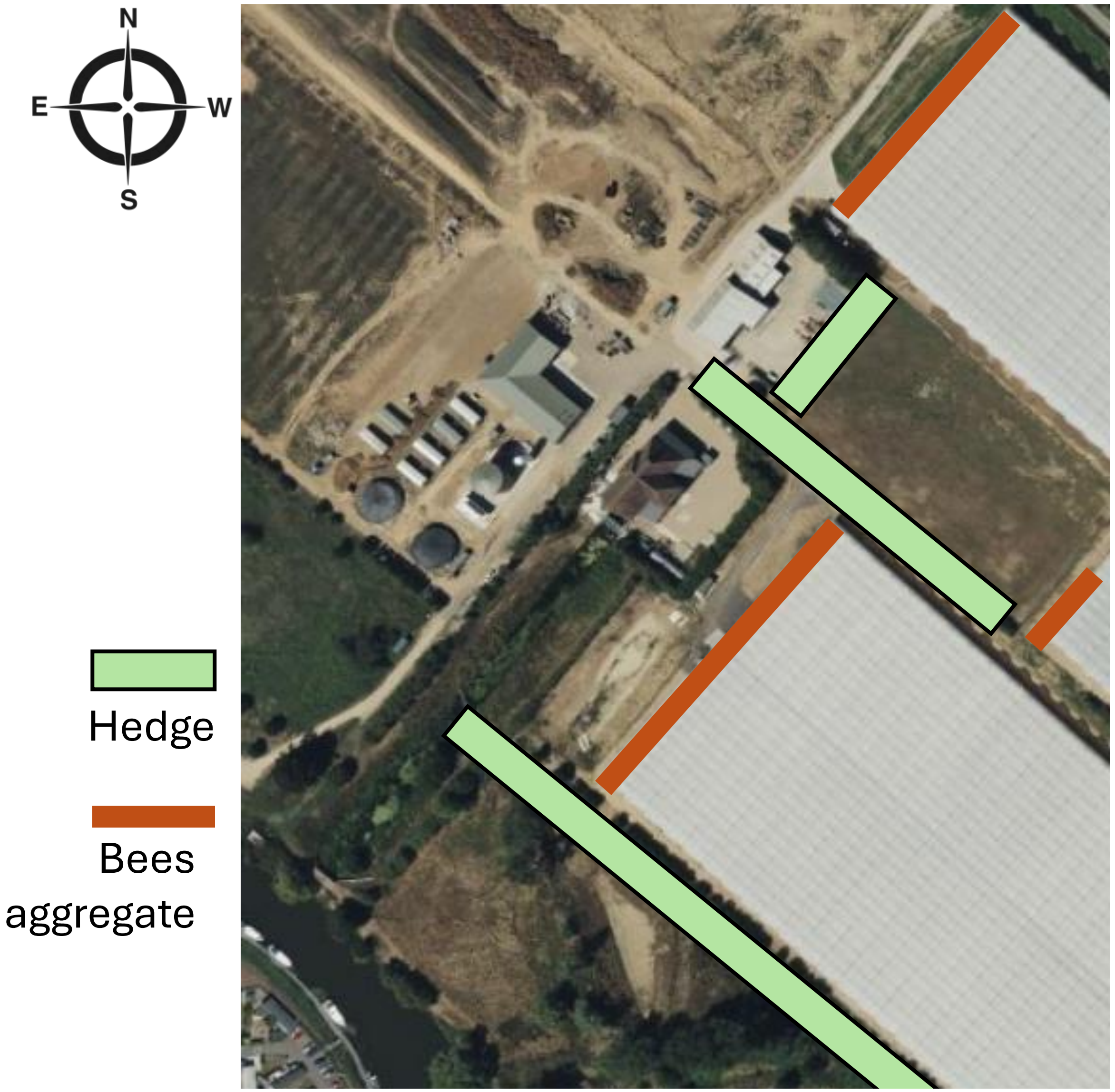
Solutions available

- Check light environment
  - Cladding – too much UV excluded?
  - Indoors – are light conditions affecting managed pollinators?
- Supplement with other pollinators – hoverflies?
- Better data – new technologies
- Lures?
- Temperature regulation via bee pits

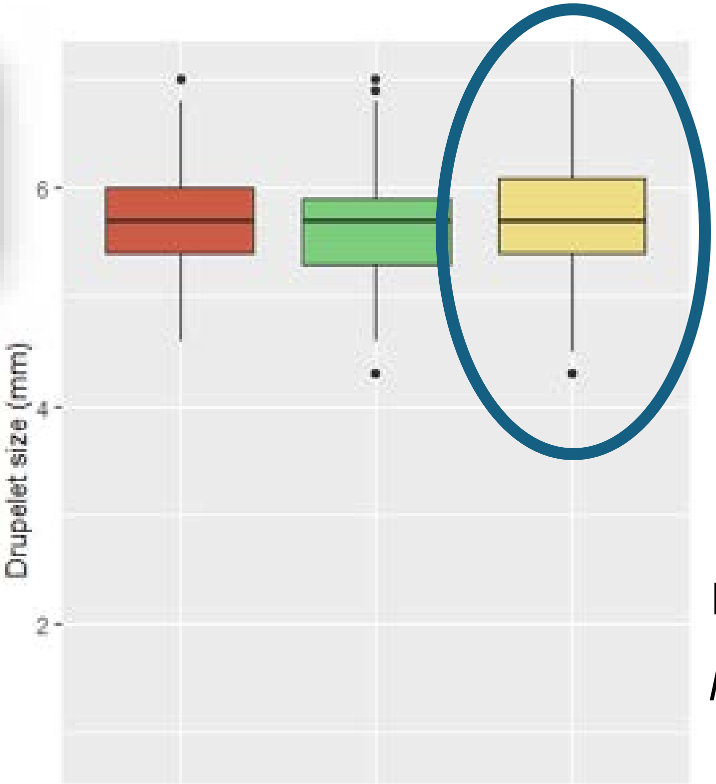
Light environment

- Bees see UV and use it to help navigate
  - Not that simple!
- Bees *can* operate without UV but behaviour is poorer – everything less efficient
- Often fly towards brighter areas (artificial lights, sunlit patches) especially if light environment is unusual
- Also prefer familiarity



Other options available

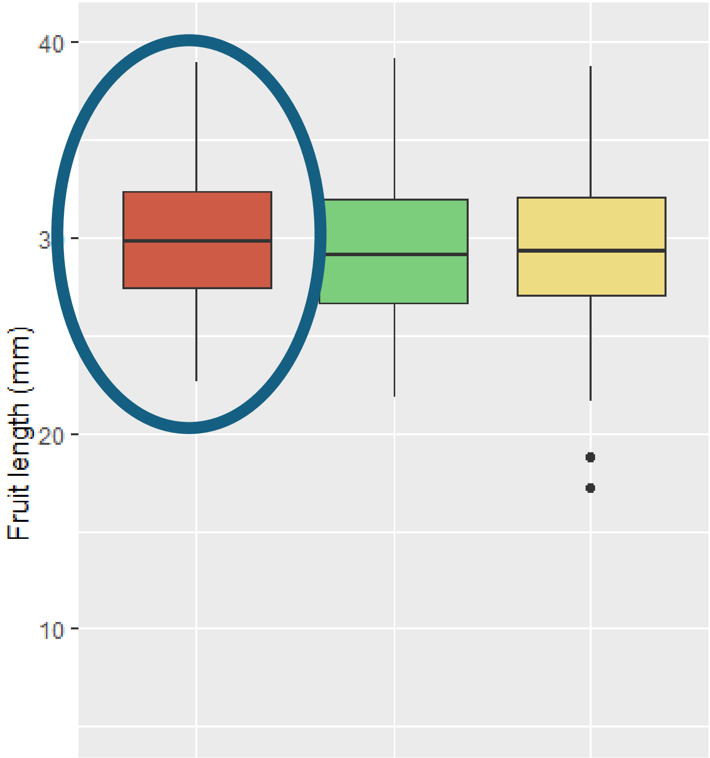
Hoverflies: disperse quickly, can be of limited effectiveness on their own, but complementary to bees



Drupelet size

p = 0.034

Air blowing: effective but time-consuming, especially in large facilities



Fruit size

p = 0.046

Better data

- Can’t fix a problem you don’t know about
- More companies entering the space of monitoring pollinators in crop

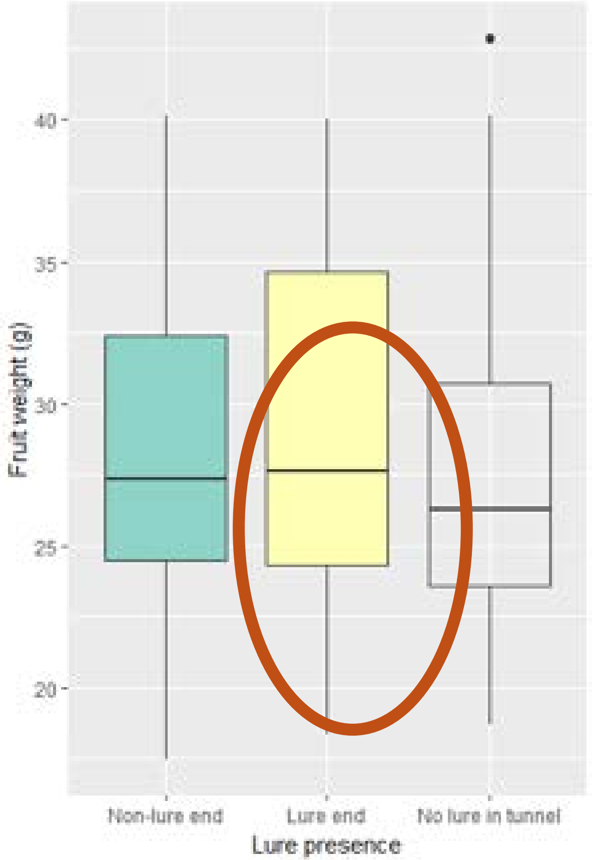
AgriSound™

bu[zz]up

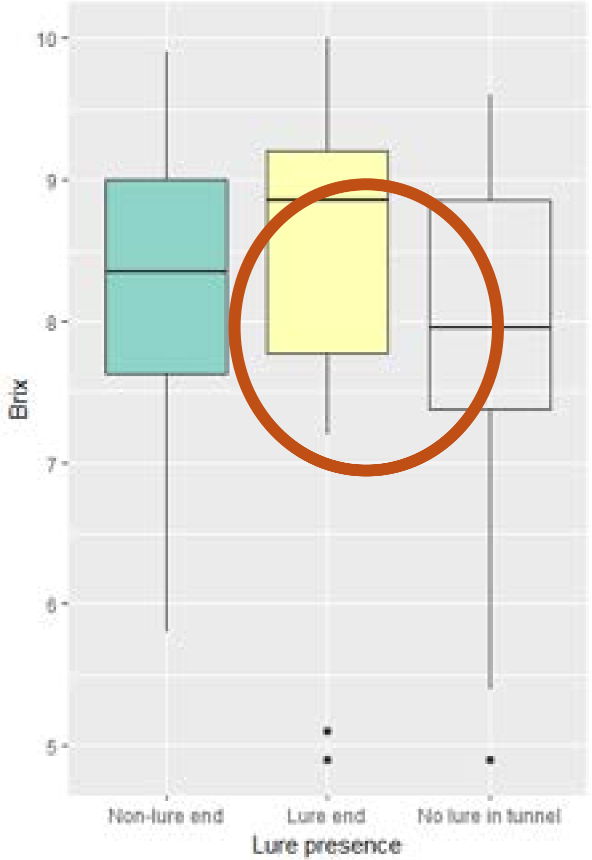
olombria

Can we manipulate the pollinators to go where they are needed?

Pilot studies of new lures



Fruit weight

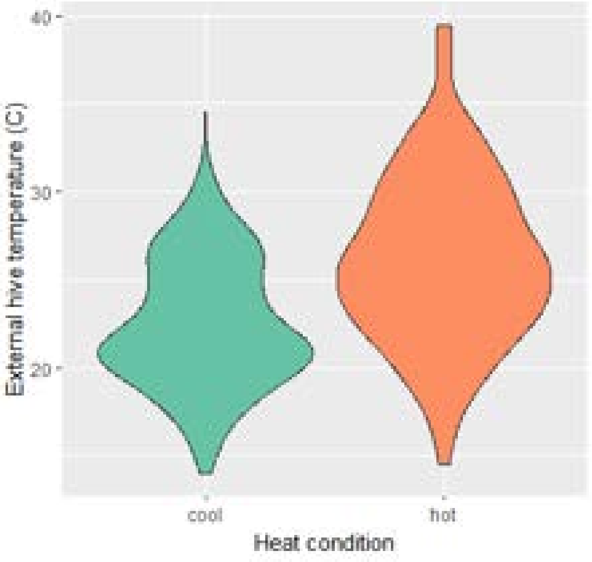


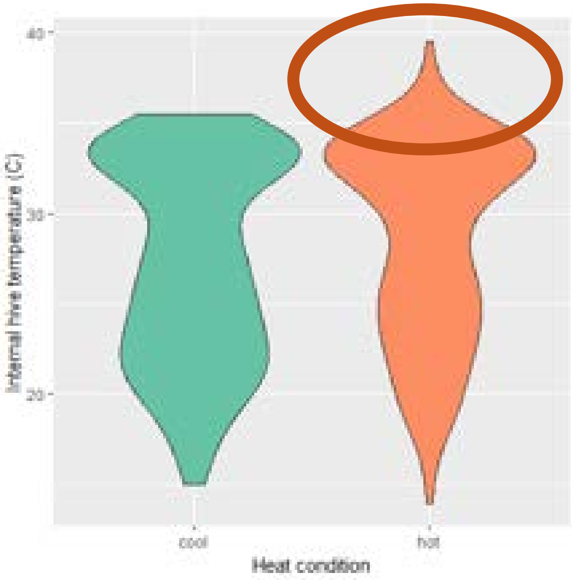
Fruit brix

Plants nearer lure produced 4.3 and 7.0% heavier fruits during the first 2 assessments.

Keeping bees warm, keeping bees cool

- Bumblebee colonies regulate their temperature (~32-33°C preferred)
- At higher temperatures they struggle
  - Hives in hot locations receive more dangerous temperature spikes
- Keeping them in less exposed places can help
  - Shaded spots
  - Just below the ground surface (“bee pits”)
  - These also often experience fewer extreme cold periods as well





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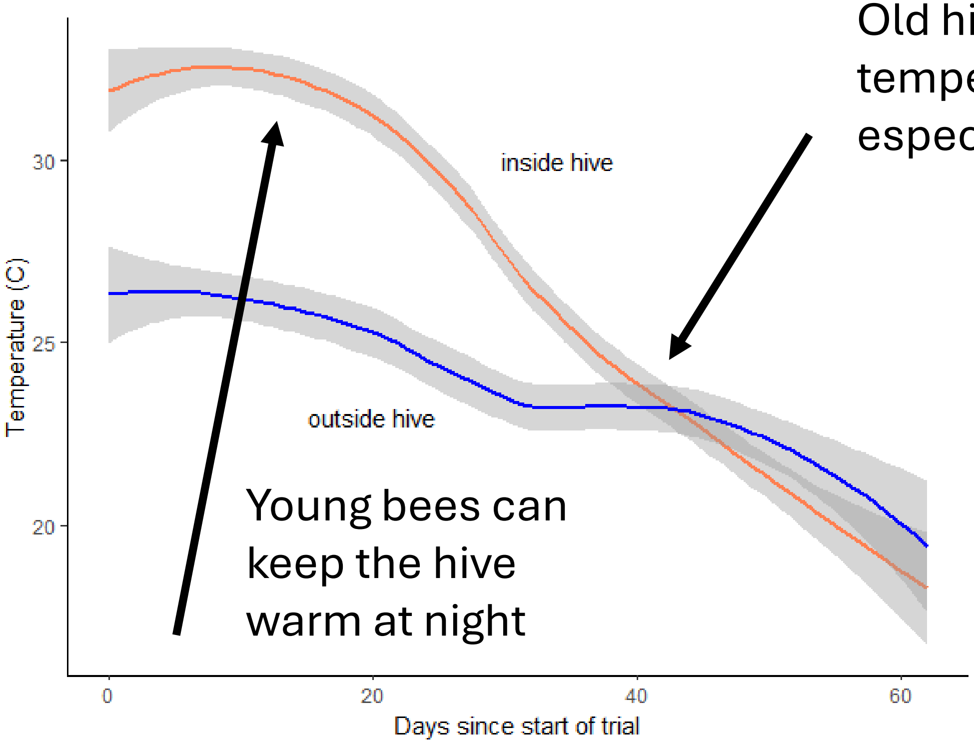
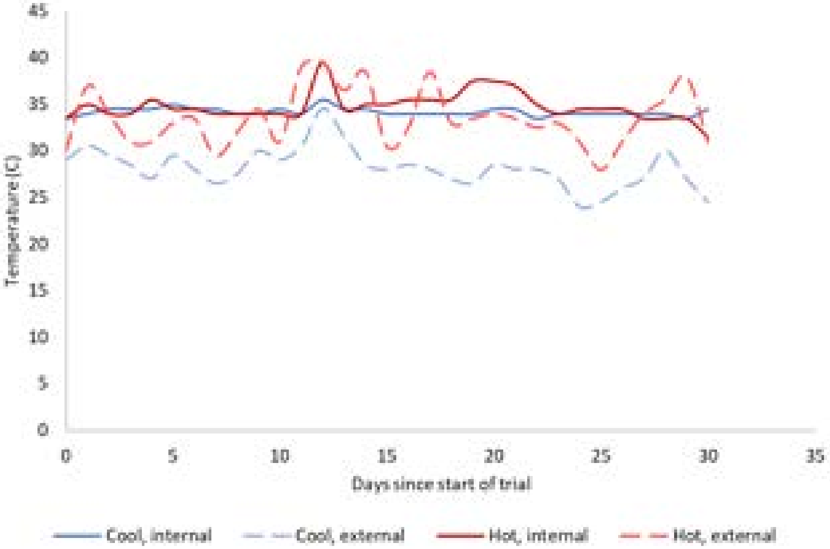
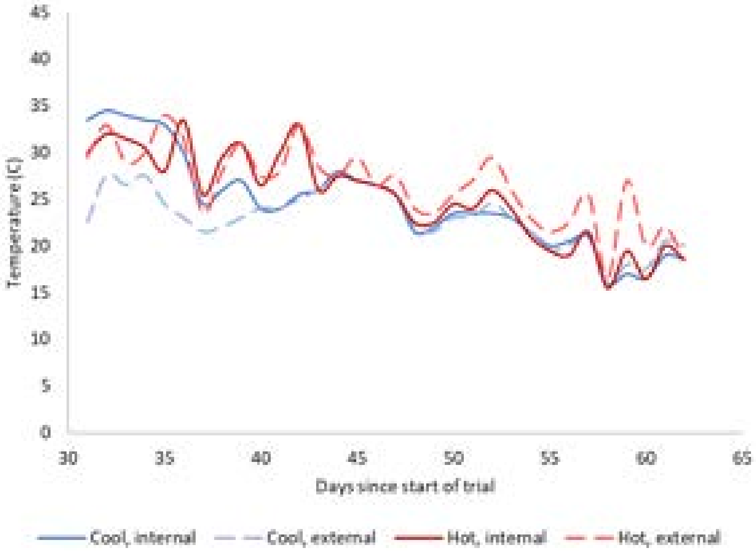
Keeping bees warm, keeping bees cool

Their ability to regulate this temperature declines over time

Old hives struggle and the temperature inside drops, especially at night







Interim recommendations

- Consider cladding with reasonable UV transmittance
  - More research coming
- Monitoring pollinator activity will highlight issues earlier
  - If activity low, options can include adding more hives, air blowing, and supplementing with other species
- Altered day:night light setups may not suit pollinators
  - Abrupt “lights off” settings can also be harmful
- Position hives to reduce heat stress (consider sub-surface pits)
- New innovations are coming to this area

Watch this space

More research to do:

- Films and cladding
- Lighting
- Heating
- Monitoring
- Dual-purpose pollinators – hoverflies for pollination and IPM

NIAB Plant Science into Practice

Acknowledgements

Funders and partners

- BBSRC
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Niab team

- Michelle Fountain
- Adam Walker
- Celine Silva
- Francesca Elliott
- Sam Fisher
- Maisie Bickerton
- Summer tech team

Insect ecosystem services in protected soft-fruit – influence of landscape composition

Celine X Silva, Sarah E J Arnold, Francis Wamonje, Marco Bascietto, Luigi Orru', Michelle T Fountain

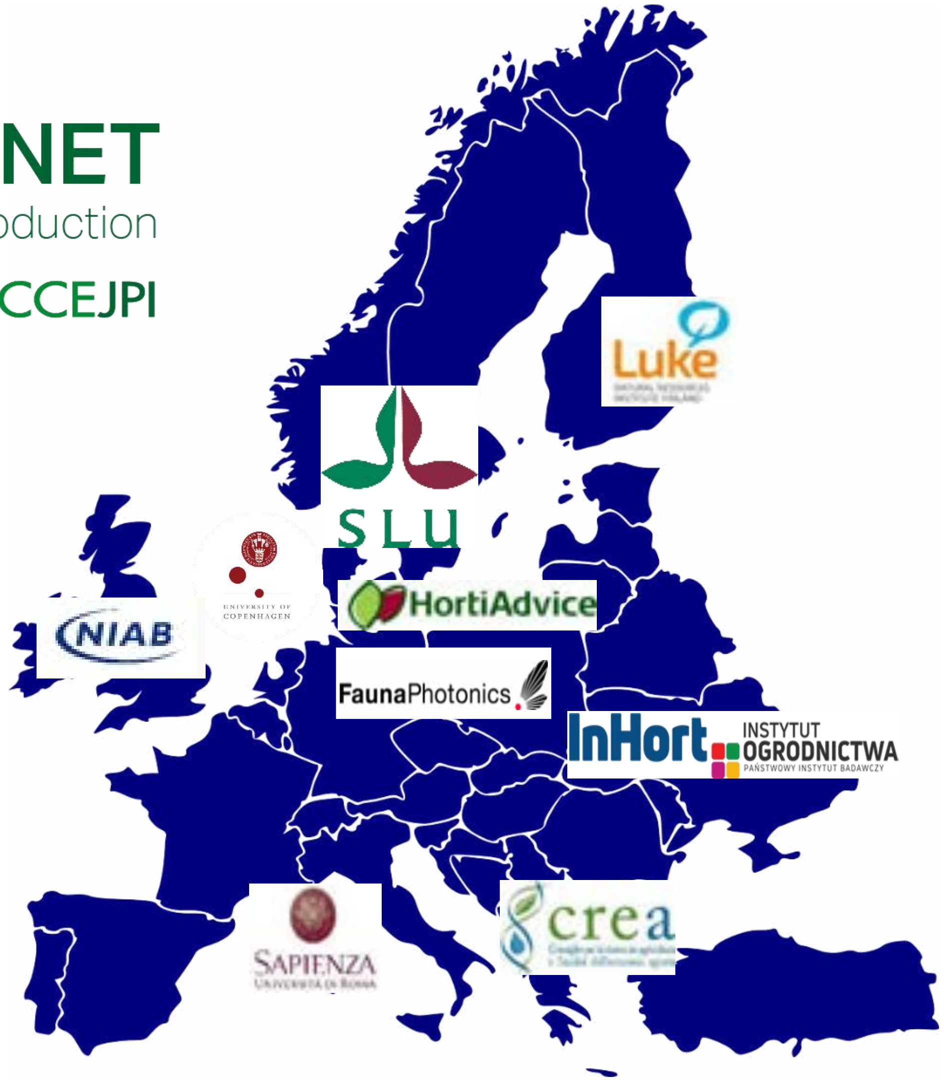
What we want to achieve:

Better understanding of how landscape dynamics affect ecosystem services over time in horticultural systems

- Are there ways to change on-farm management to take advantage of landscape benefits?
- Does the immediate or wider landscape play a larger role in influencing optimal pollination and pest management?
- Can you predict natural enemy activity based on landscape factors?

SusCrop – ERA-NET
Cofund on Sustainable Crop Production
FACCEJPI

defra Department for Environment Food and Rural Affairs



Also supported by the East Malling Trust

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Malgorzata Tartanus

Acknowledgement: Thanks to the growers who have given us permission to visit and sample

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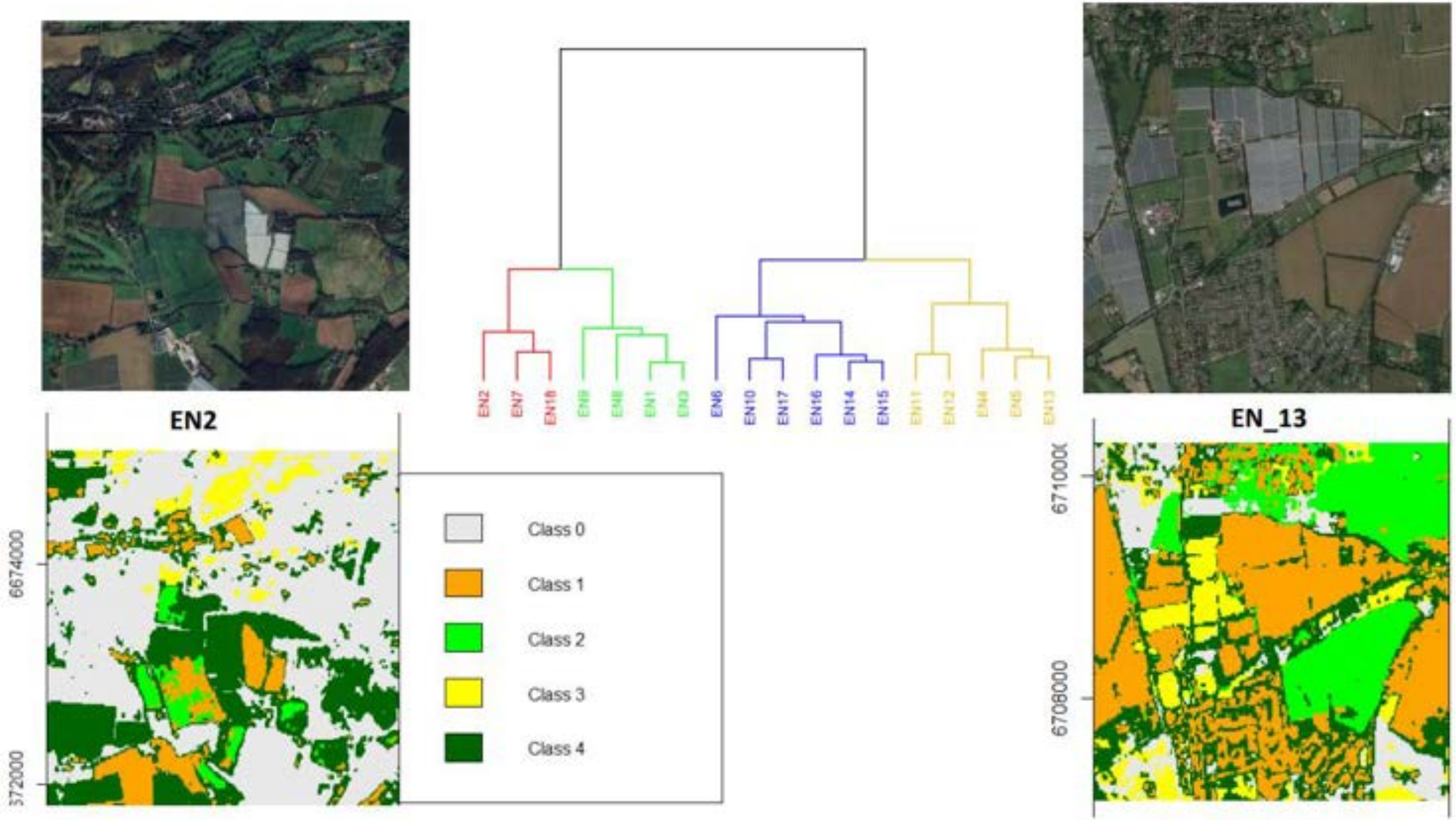
Analysing and classifying the landscape

Manually marked polytunnels and glasshouses on to maps



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On the ground...

Aphid parasitoids
Solitary bees

Creating additional in-house molecular barcoding references to verify identifications.

So far

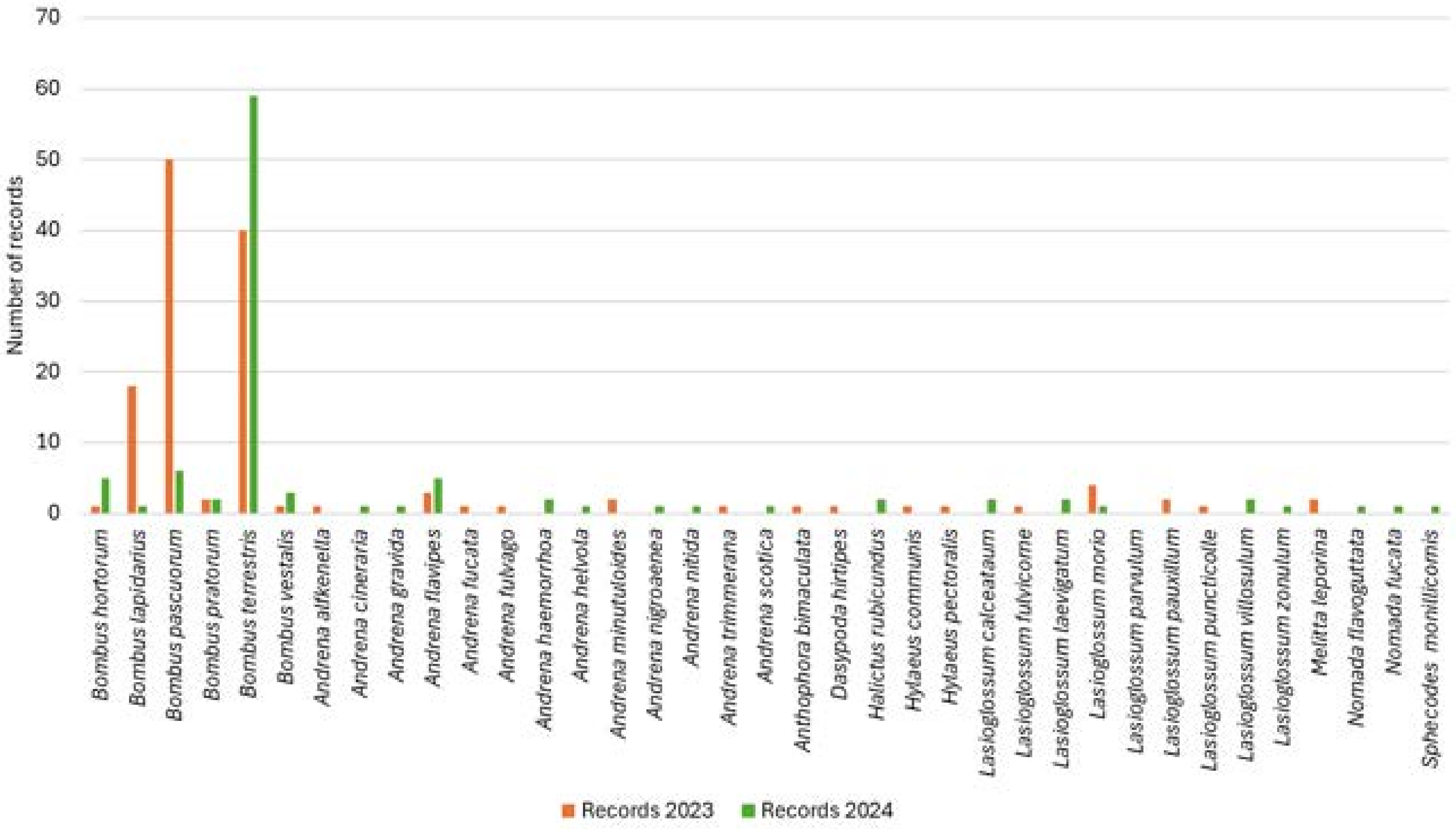
July/August 2023 ✓ → May/April 2024 ✓ → July/August 2024 ✓ → **May/April 2025**

Typical species so far:




Average of 2.7 wild bee species in margin and 0.9 in crop per visit
+ honeybees

Bees flying on farms – summer 2023 v spring 2024

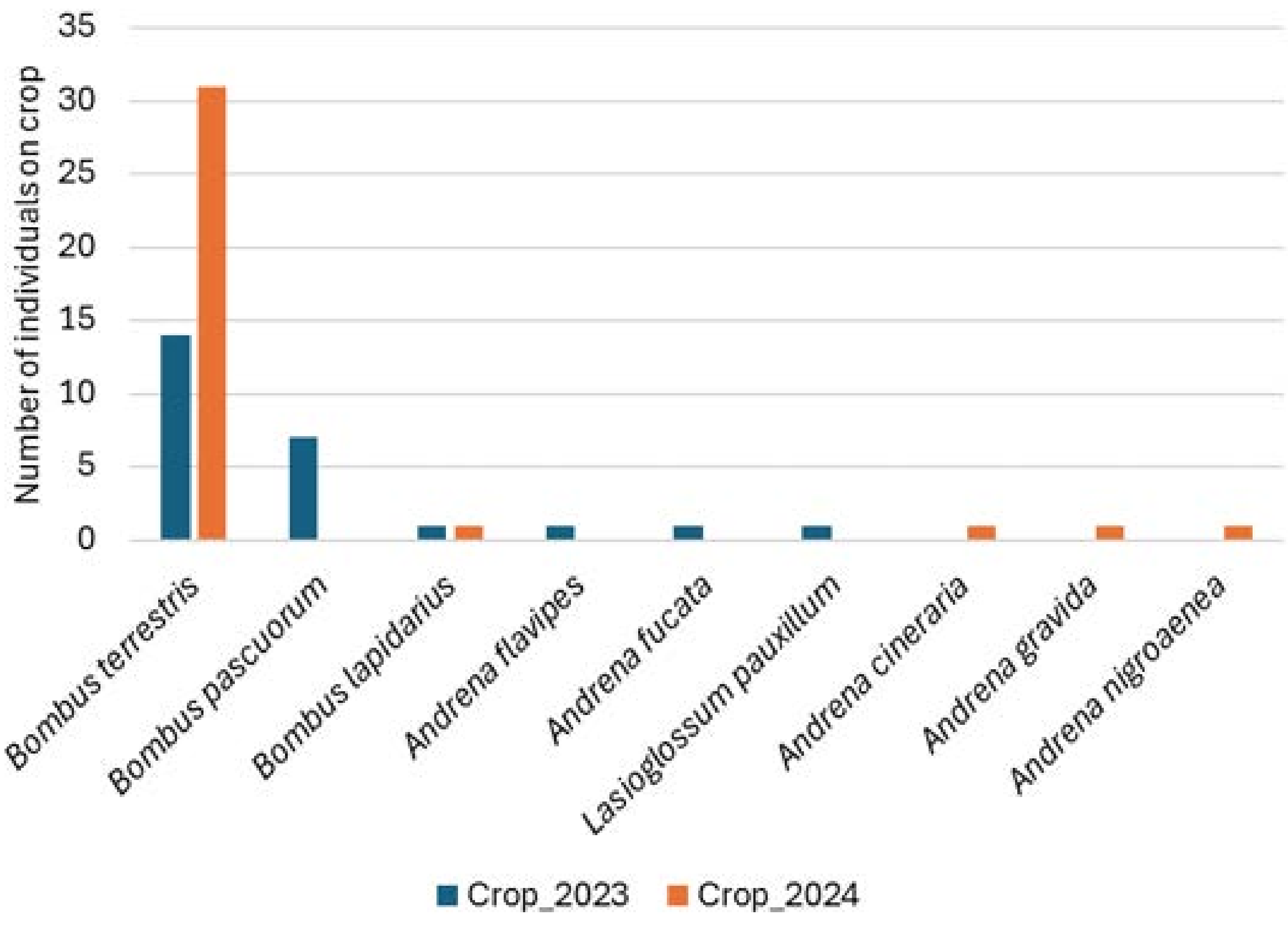


Weather can affect results!

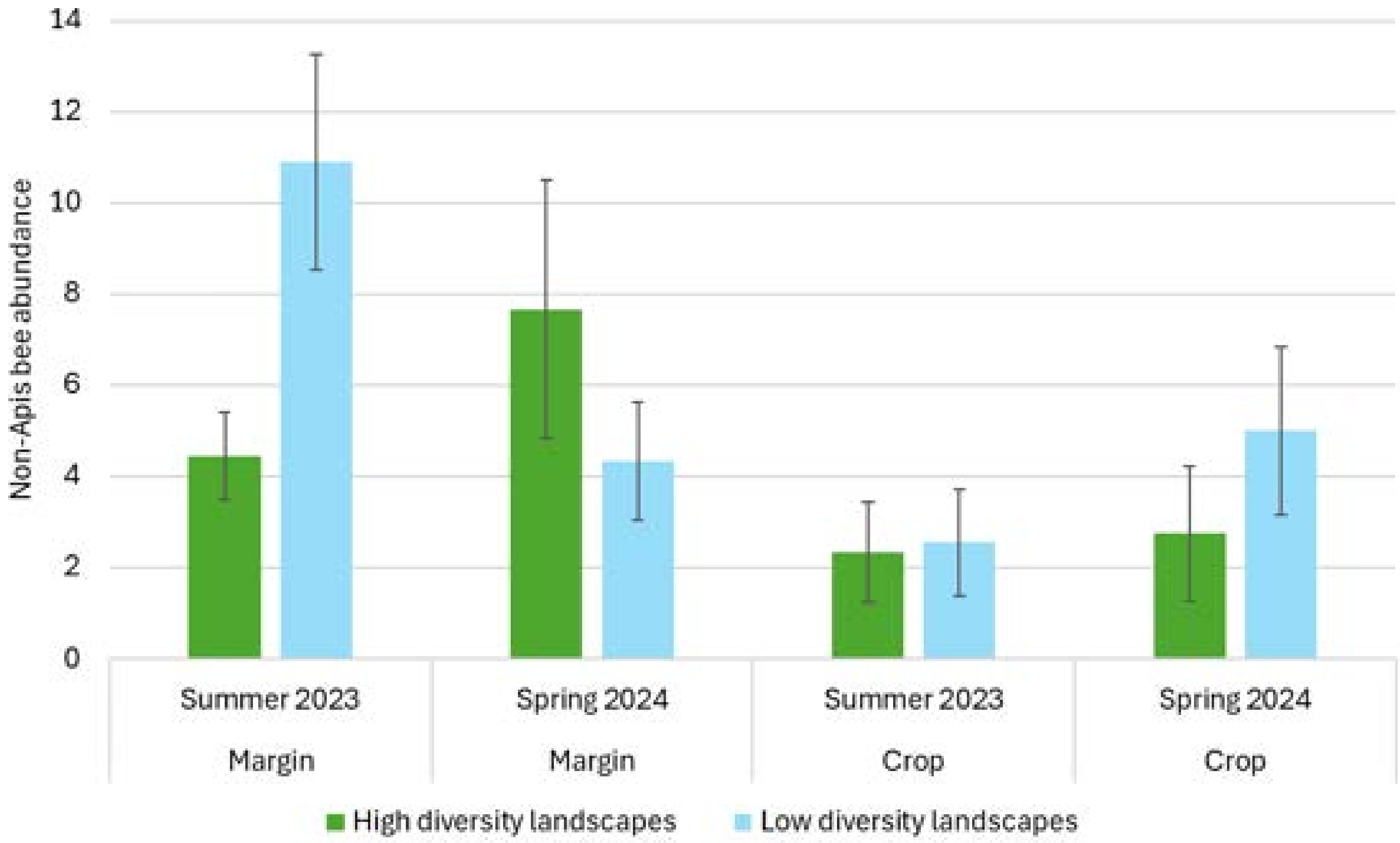
36 species (20 in summer 2023; 24 in spring 2024)

11 genera (including Apis mellifera)

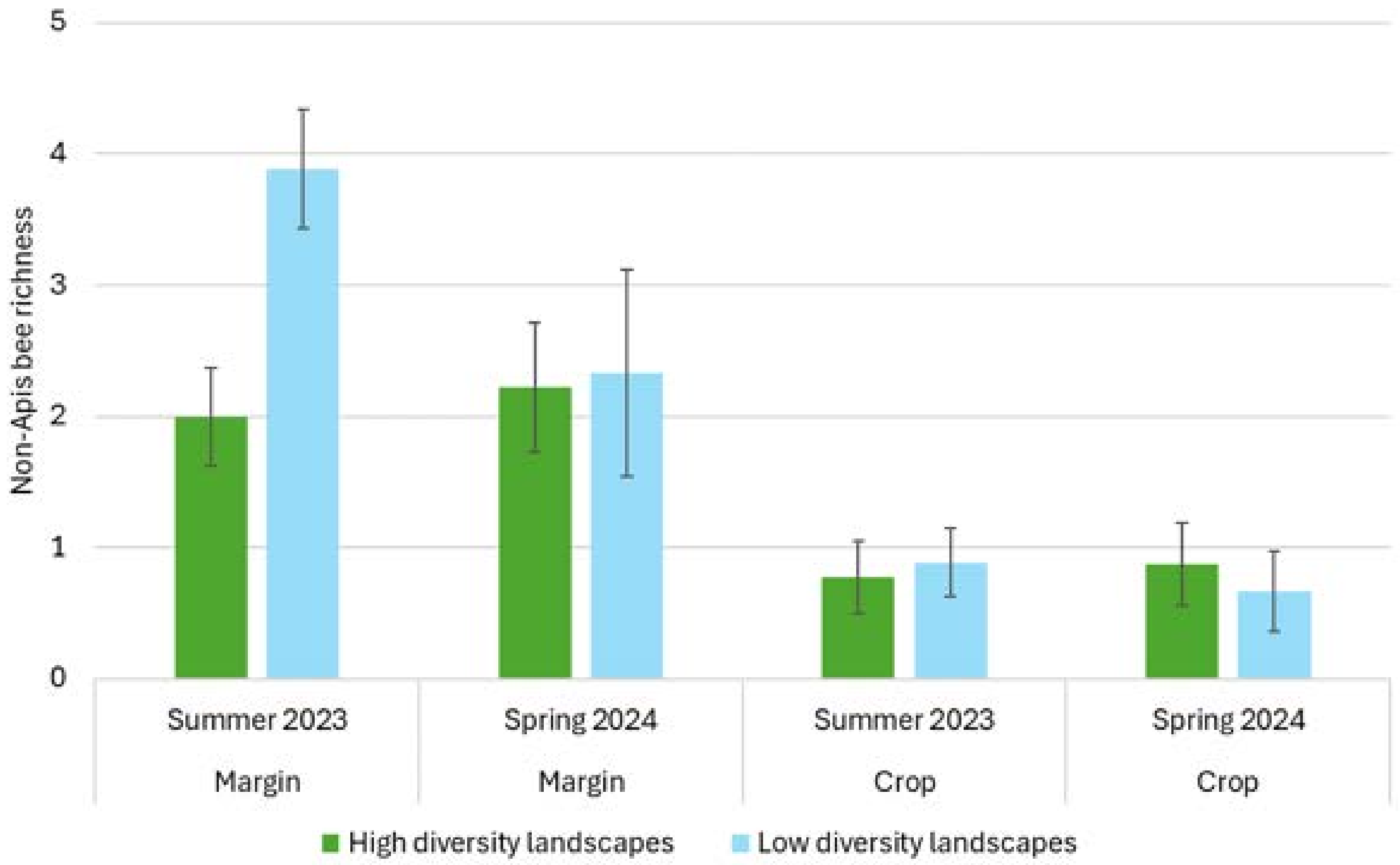
A smaller subset were recorded visiting the crop



Landscape diversity measures do not predict bee abundance



Landscape diversity measures do not predict bee species richness overall



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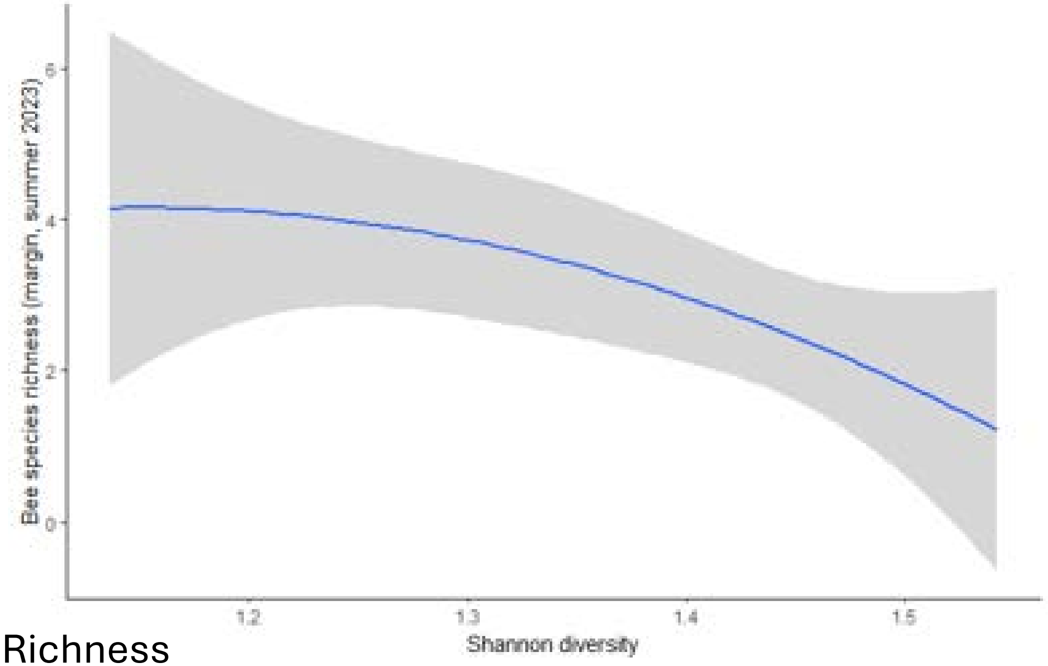
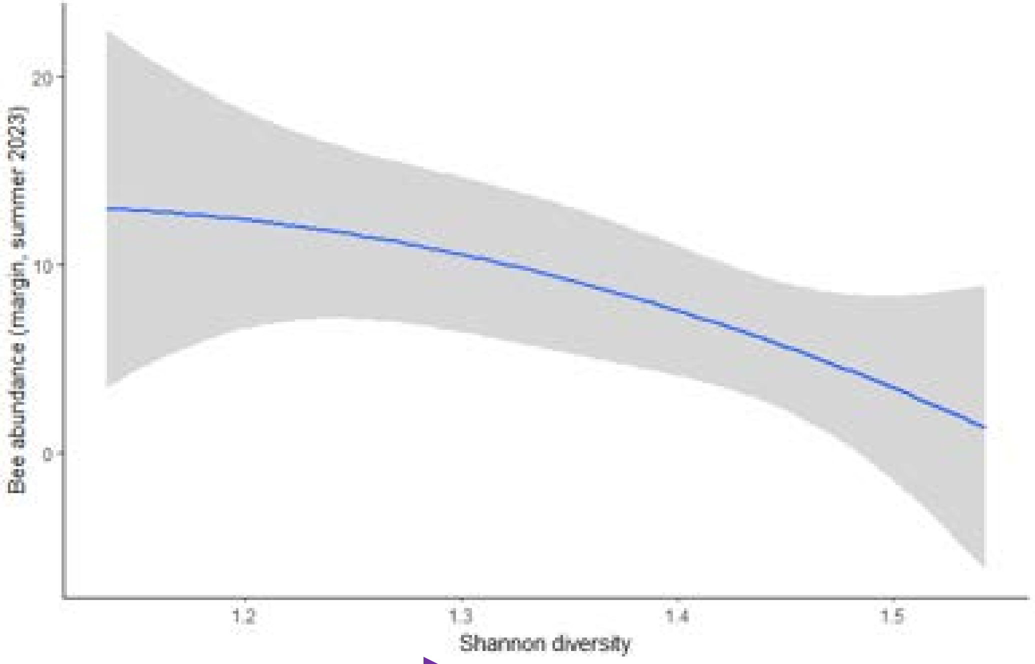
Some landscape diversity measures (weakly) predict bees in margin…but only in the summer data set



Richness
p = 0.02706

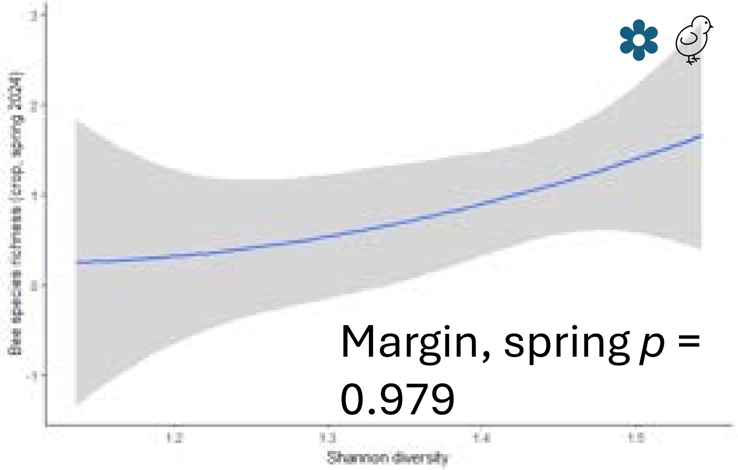
Abundance
p = 0.0294



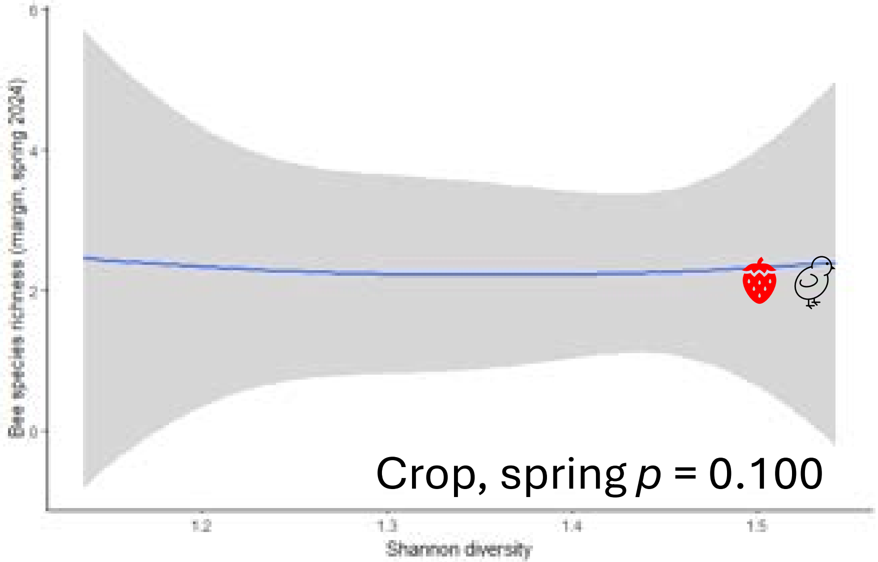
Shannon diversity - number of species in a community and relative abundance of each species in a community

More diverse and heterogeneous landscapes

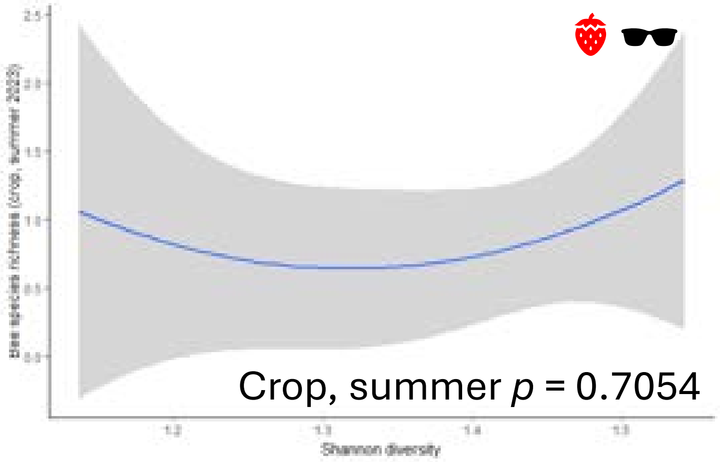
But so far no relationship between landscape and bees (a) within the crop and (b) in spring



Margin, spring p = 0.979



Crop, spring p = 0.100



Crop, summer p = 0.7054

More diverse and heterogeneous landscapes

Aphids and their parasitoids

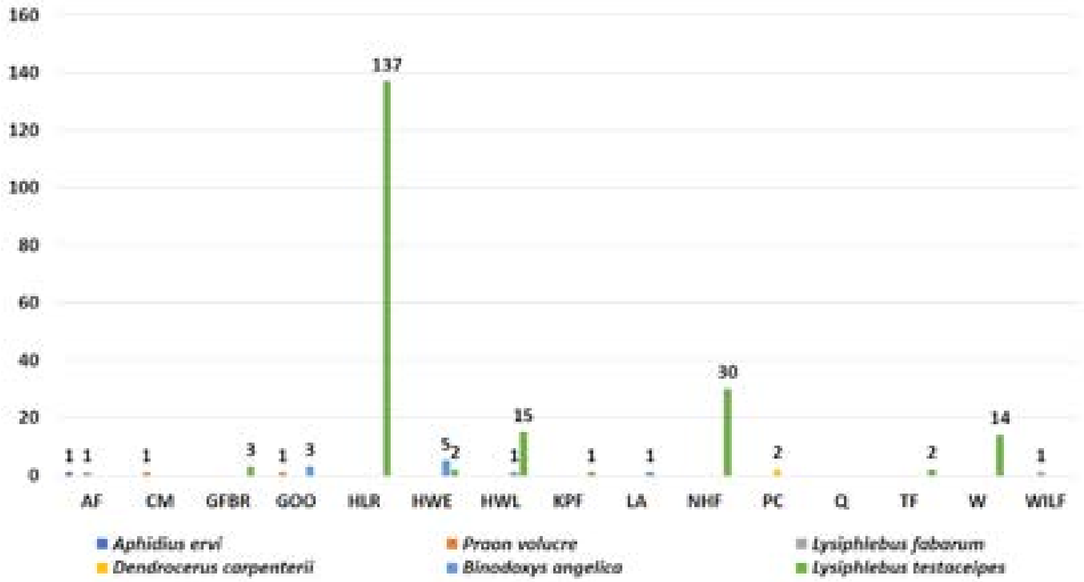
Aphid species

- *Black Bean Aphid* (majority)
- *Cotton Aphid*
- *Potato Aphid*
- *Staegeriella* sp.
- *Strawberry Aphid*
- Some unidentified

Parasitoid species

- Many specimens (>1000)

- ID manually, confirm some with DNA
- 4 primary/2 hyperparasitoids



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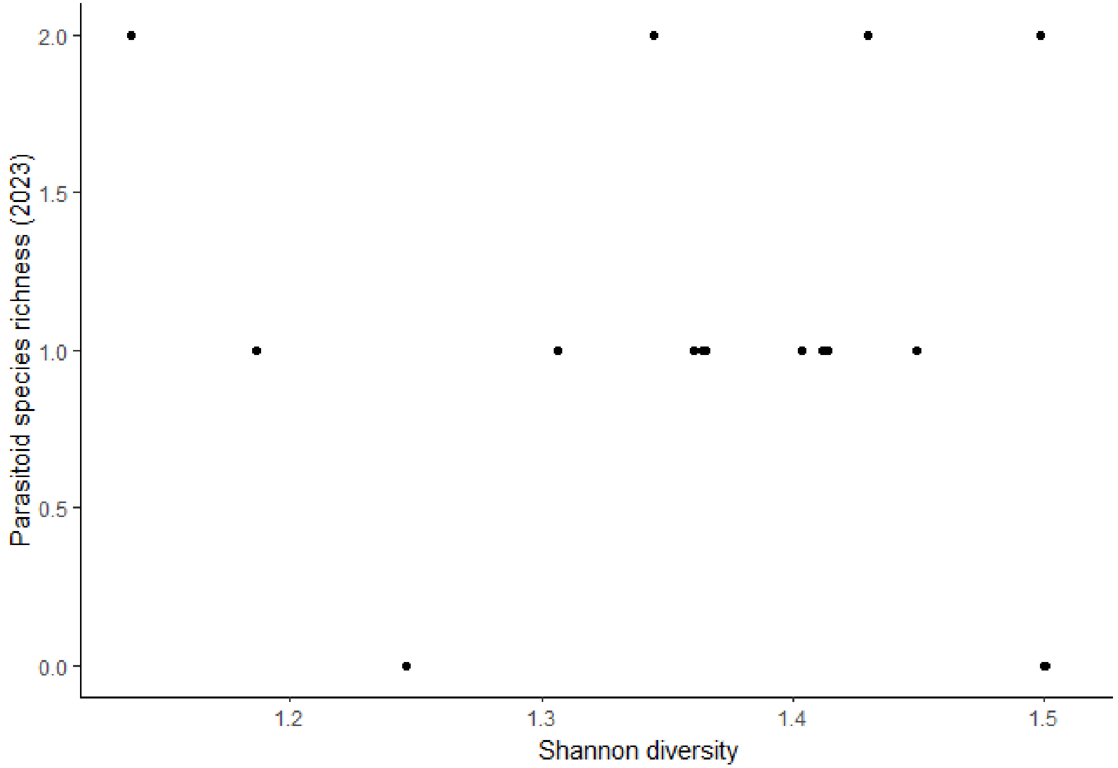
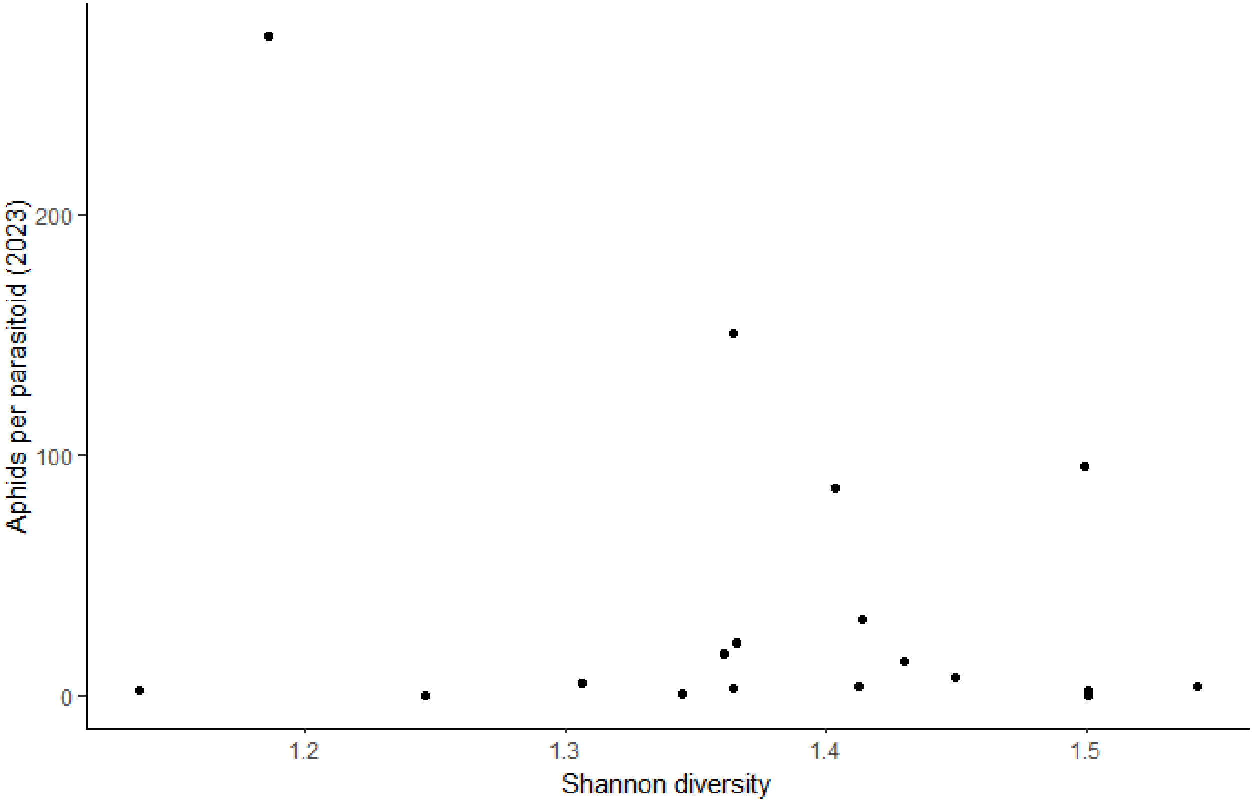
Landscape does not predict parasitoid richness or parasitism rate





$p = 0.227$

$p = 0.227$

Lysiphlebus testaceipes – new invader incoming!

- From Americas
- Introduced as biocontrol worldwide but spreads!
- Not known in UK until now
- We found it at about half the farms
- Likes *Aphis fabae* (one of the top strawberry aphid pests)
- Farms with *L. testaceipes* had no other primary parasitoids recorded

Conclusions

- For measures of pollinator and parasitoid diversity on strawberry farms, landscape may not be a major predictor
- Local factors likely to be important
  - Margin management – food, nesting sites
  - Presence of *Lysiphlebus testaceipes*
- A range of bee species visit the crop, including various solitary bees (but most visits are from human-managed species)
- Farms *can* host interesting solitary bee species
- Recommendations: support resources around/in polytunnels to encourage diverse beneficial communities

Useful resources: https://northsearegion.eu/beespoke/

PHENCONTROL: Integrated biological control of large raspberry aphid

F. Wamonje, C. Rose, S. Greenaway, L. Harvey, M. Fountain, C. Silva, F. Elliott and A. Walker

Niab Soft Fruit Day 28th November 2024

Impact of Large raspberry aphid (*Amphorophora idaei*) infestation

- Raspberry: popular and high-value soft fruit in UK

- About 15.7 T are produced in the UK ~ generate £147M in revenue

- Local production is only 30% of annual consumption in the UK

- Aphids, mainly the large raspberry aphid (Amphorophora idaei), are a significant impediments to raspberry production

- Between 10-20% of production is lost to aphids annually, which translates to at least £14-28M in lost revenue

Status of aphid control on raspberry

- Progressive withdrawal of pesticide has limited the options of most growers

- Genetic control for aphids is no longer widely existent in commercial varieties

- Effective use of biocontrol products (parasitoids and generalist natural enemies) is limited by deployments that are misaligned with aphid and plant seasonal variations

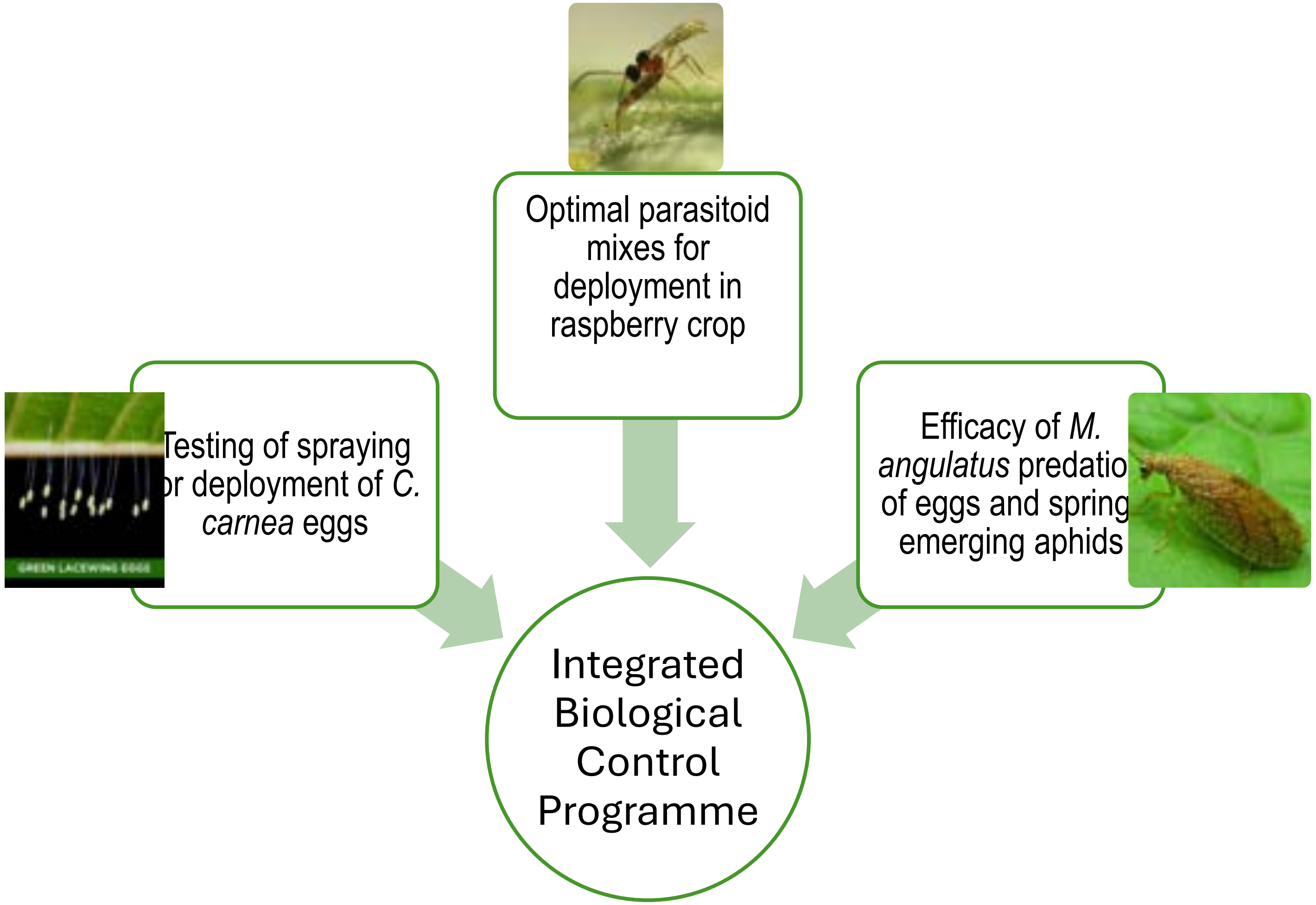
- Growers must contend with labour-intensive biocontrol deployment techniques for spot aphid outbreaks

Parasitoids (various species)

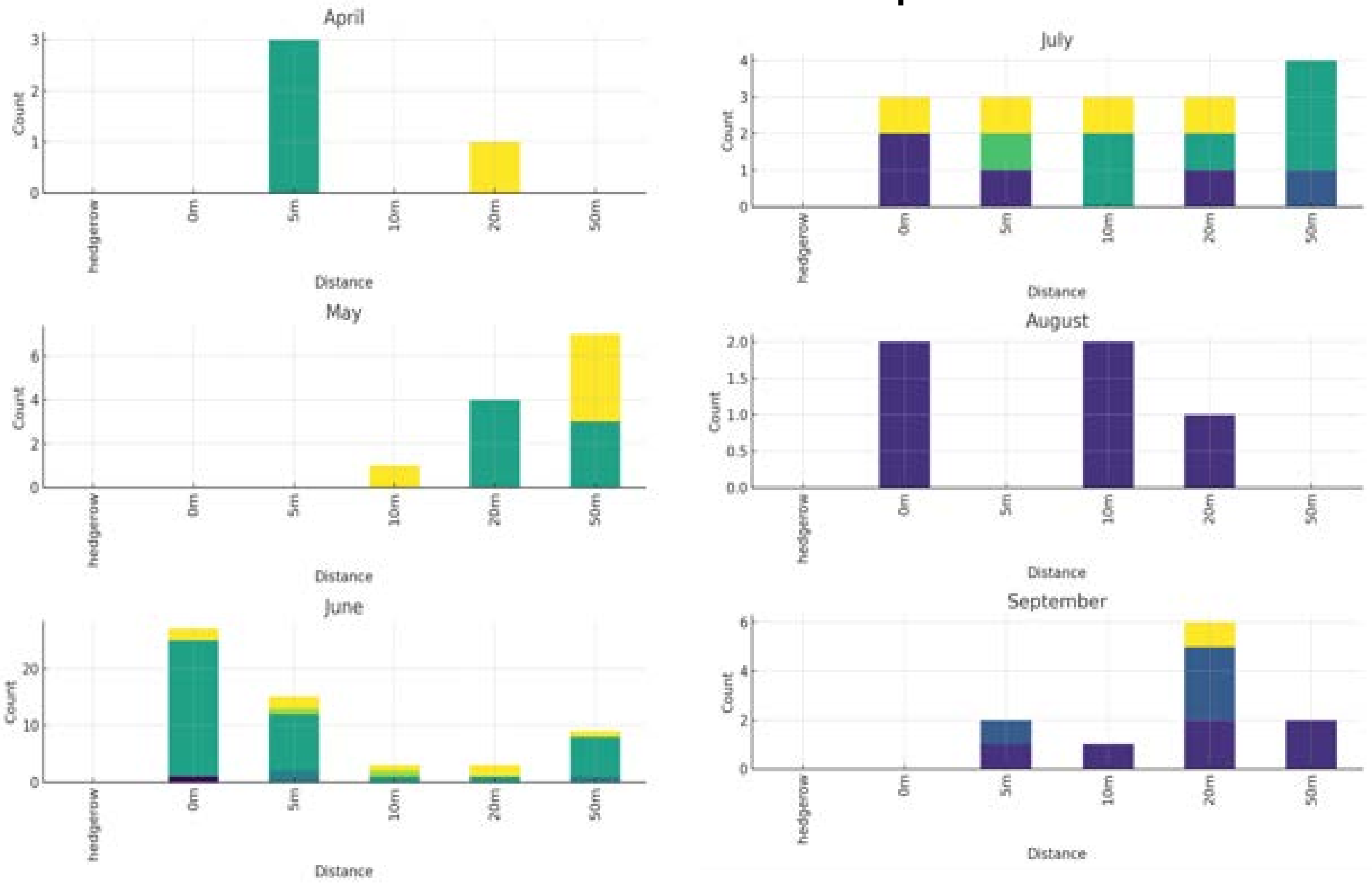
Green lacewing (*Chrysoperla carnea*)

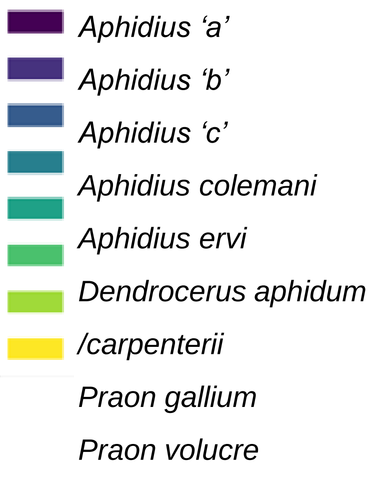
Brown lacewing (*Micromus angulatus*)

Project Goal: To develop an integrated biocontrol programme for raspberry that provides adequate protection against aphid herbivory and damage across all stages of aphid and raspberry phenology



Parasitoid spatio-temporal distribution reveals differences in species composition over time

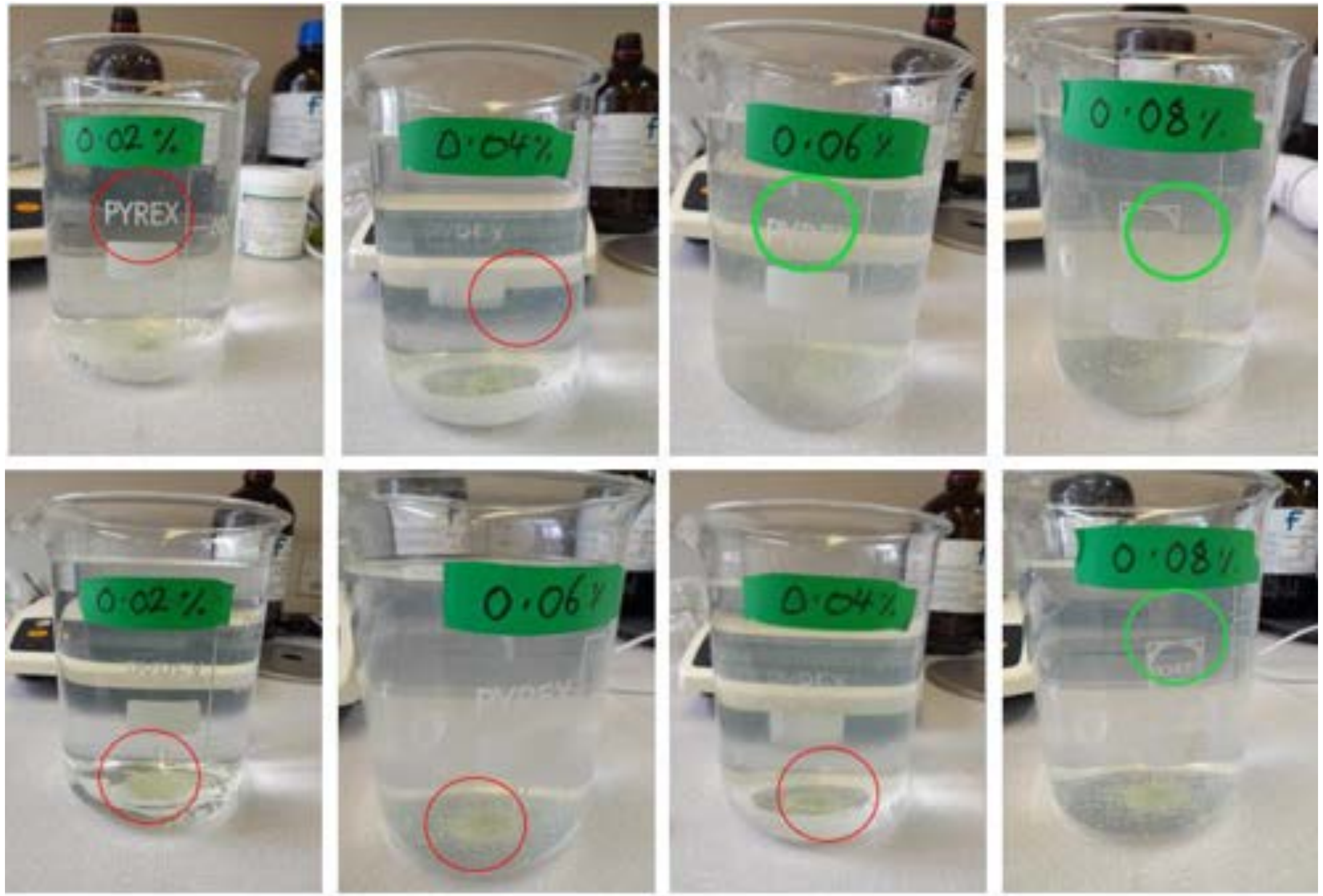




April-June months dominated by *A. ervi* however, July-September shows increase in other *Aphidius* species

Lacewing Sprays: Getting the eggs into suspension can get tricky!

Objective: Identify the most optimal concentration w/v to maintain eggs in suspension



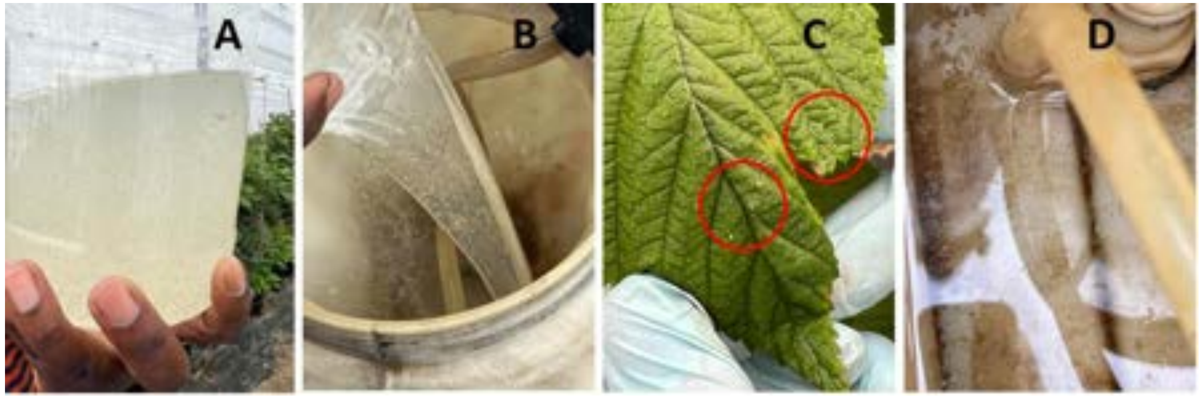
0.06 and 0.08 w/v Sticker C gave the best suspension of eggs

30 minutes post egg addition- only 0.08 w/v Sticker C maintained some eggs in suspension. Earlier experiments at 1%- 0.1% concentration found the mixtures too gloopy for spraying

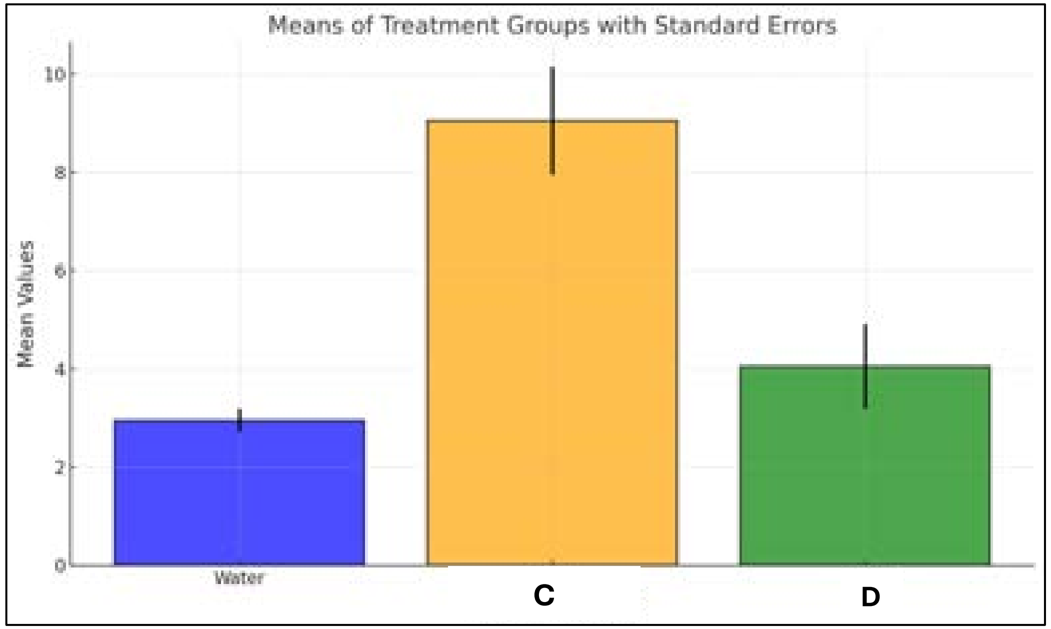
Lacewing Sprays- Eggs Adherence is best with Agent ‘C’

Agent ‘C’ Gives best Adhesion and Recovery from Leaves

Eggs in agent ‘D’ tends to sink to the bottom of the jar (A). There is no clogging while spraying (B) and eggs are visible on the raspberry leaves (C) though these tend to fall off. A substantial amount of eggs is present in the sprayer post-spray (D).



Eggs in agent ‘C’ are well suspended when mixing (A) and during pouring (B) and eggs are visible on the raspberry leaves (C) the eggs tend to adhere firmly. Some eggs are left in the sprayer but not in



ANOVA Test Results: F-statistic: 15.837; p-value: 3.39e-06 (significant)

Post-hoc Analysis with Tukey HSD Test

D vs Water: No significant (p-adj = 0.676); **D vs C :** Significant (p-adj = 0.0001); **Water vs. C:** Significant (p-adj = 0.0001)

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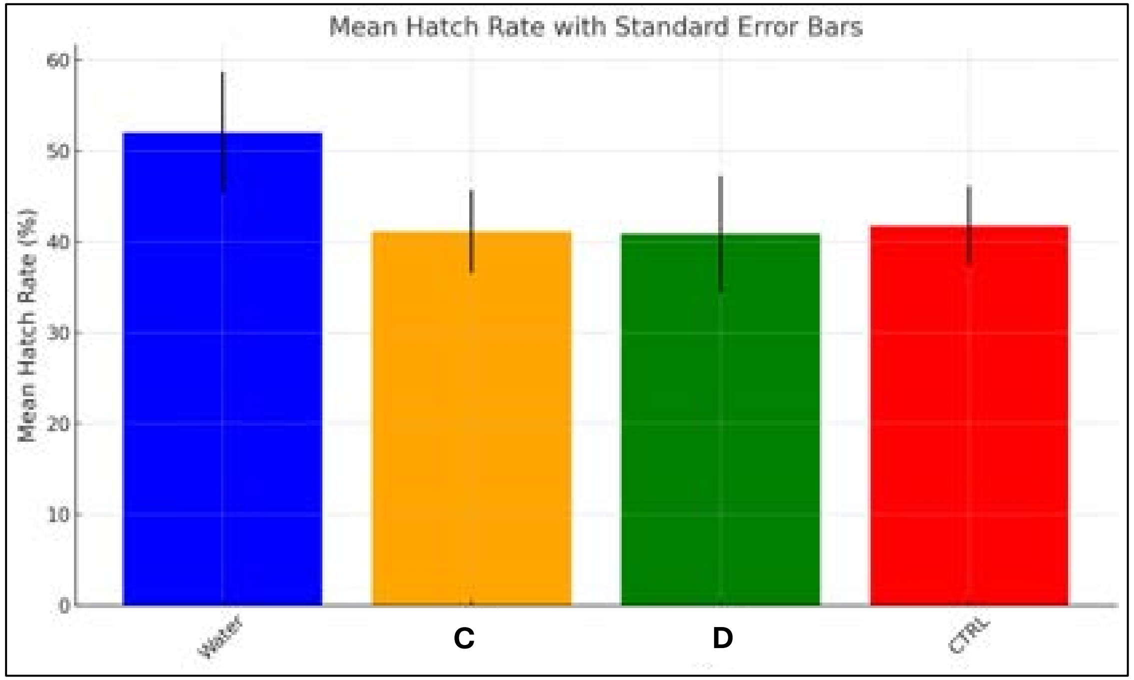
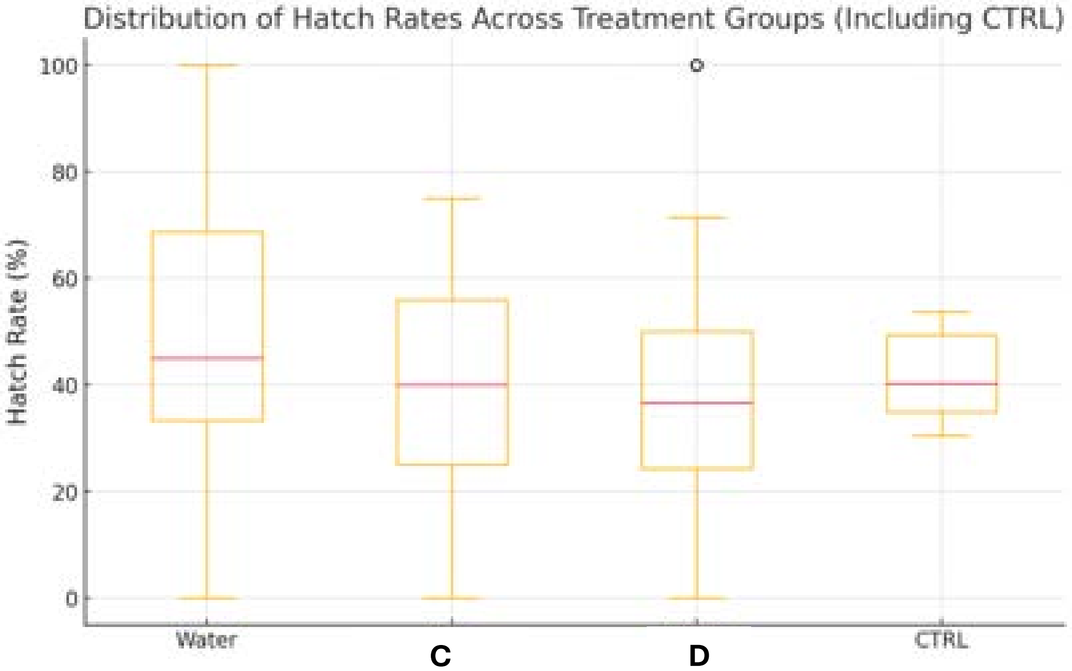
Hatch rate not dependent on treatment- therefore adherence of eggs on raspberry leaves is key



- **Water**: Mean = 52.00%, SE = 6.68%
- **C**: Mean = 41.11%, SE = 4.54%
- **D**: Mean = 40.85%, SE = 6.41%
- **CTRL**: Mean = 41.76%, SE = 4.34%

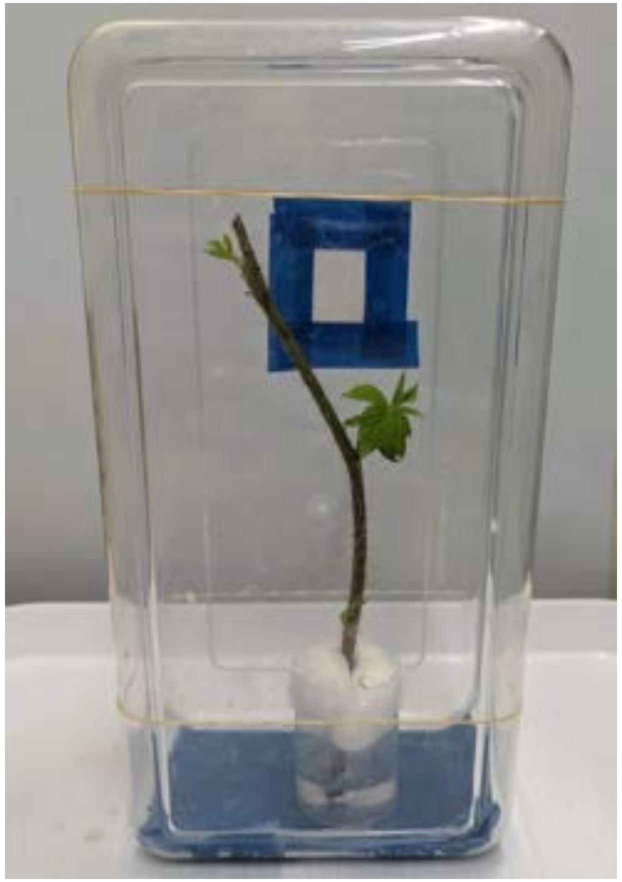


The one-way ANOVA (Water, C, and D)
F-statistic: 1.14 **p-value**: 0.326 (NS).
Tukey's: D vs C: p=0.9 (NS); D vs Water: p= 0.5266 (NS); C vs Water: p= 0.5358 (NS)

Brown lacewing predation

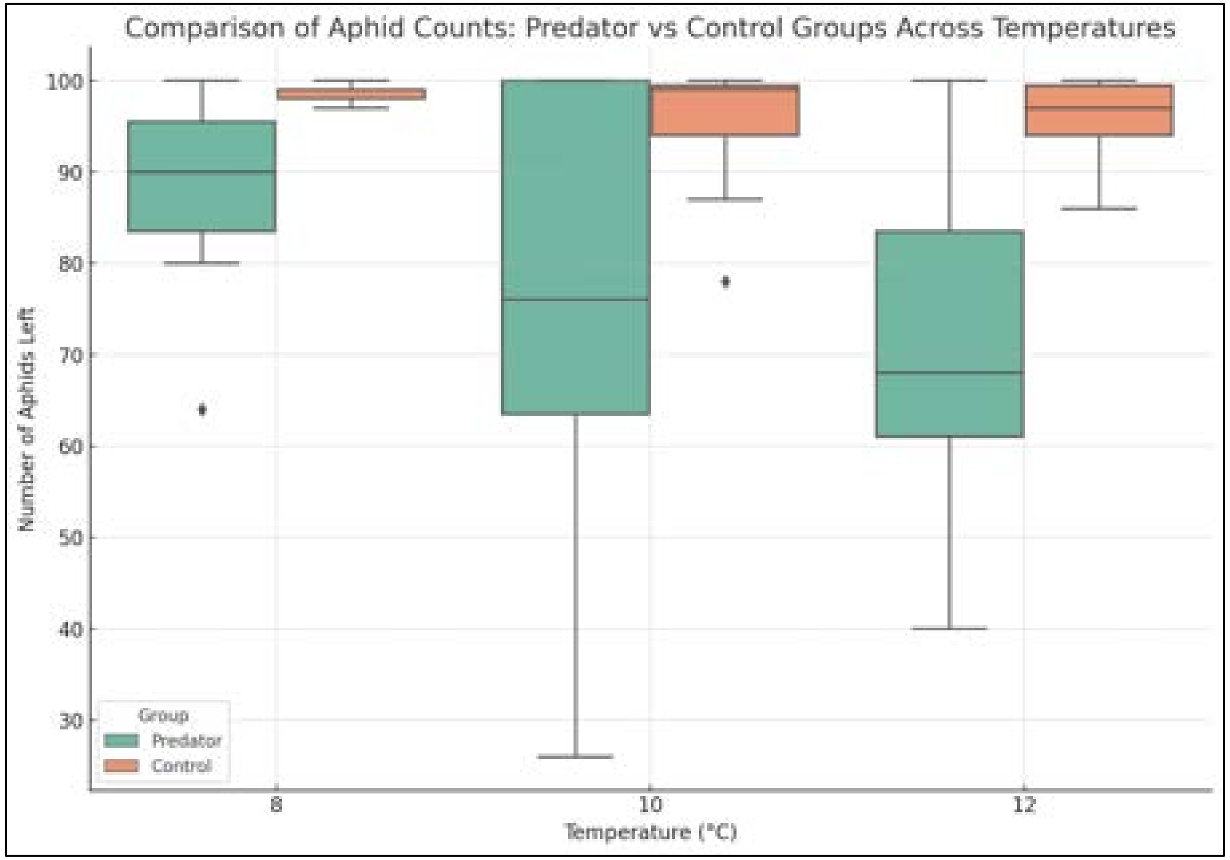
WP Objective: Investigate efficacy of *M. angulatus* (brown lacewing) predation of spring-emerging aphids for early season control in raspberry

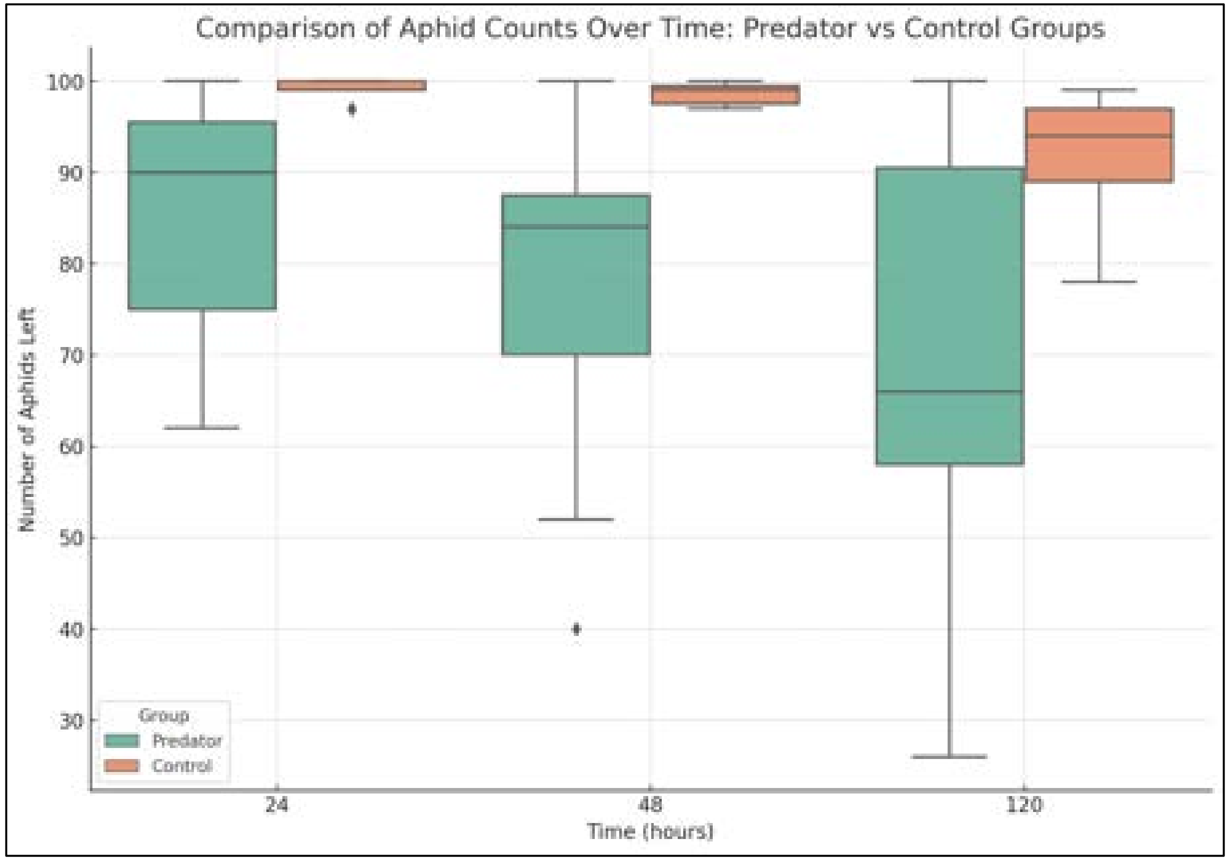
Amphorophora idaei eggs (circled in red) on raspberry stem



Bioassay setup in large Perspex box, with 2cm Ø fine-mesh vent in lid, raspberry cane section placed in 70ml plastic container holding 20ml of RO water, RO dampened cotton wool surrounding stem and RO dampened paper roll on base of box

Segregated comparisons indicate that predation is dependent on both temperature and time





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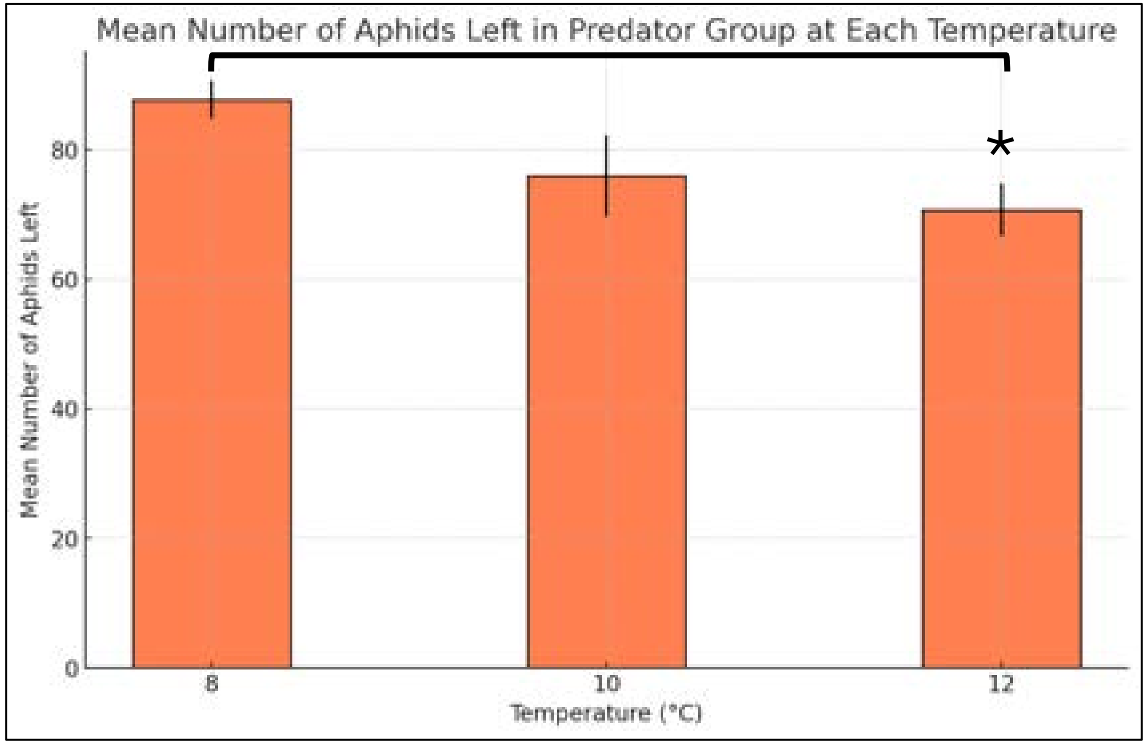
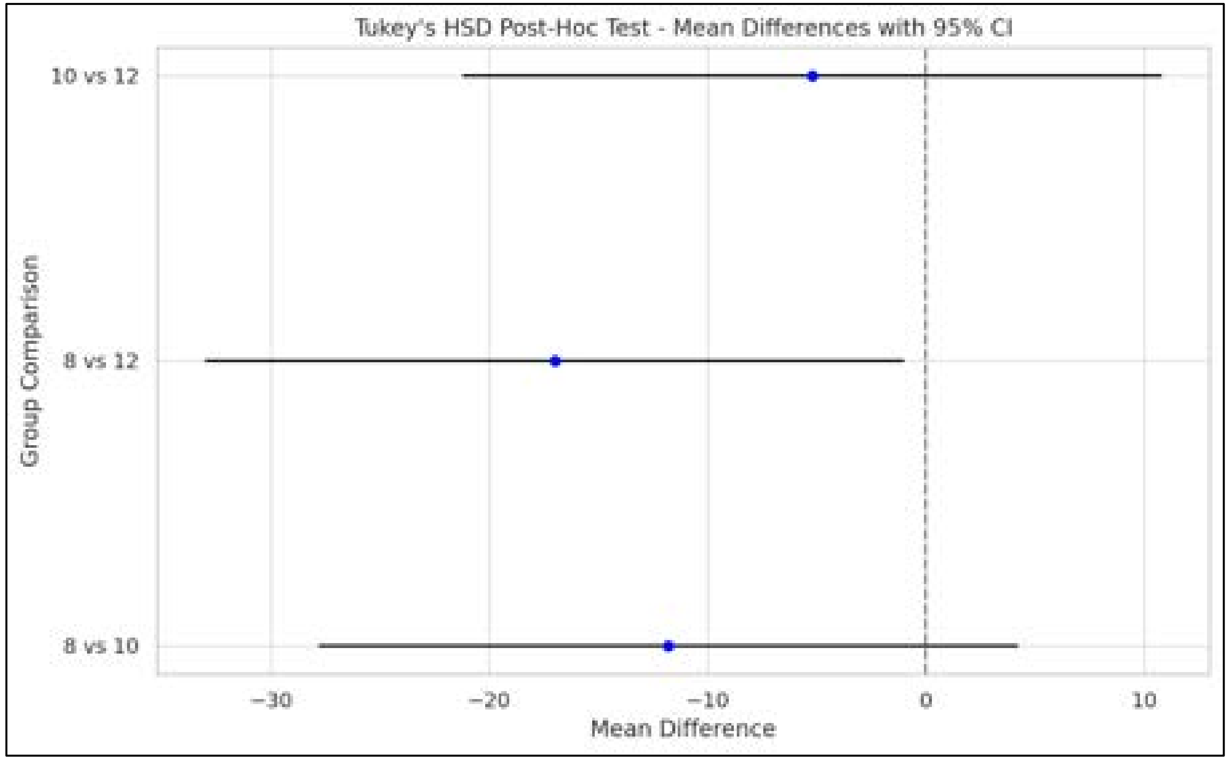
Brown lacewing predation: Analyses showed significant differences at 12 degrees

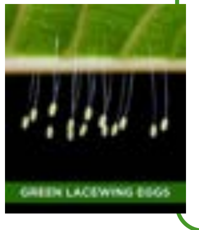




Source	F	p-value
Temperature (°C)	3.9712	0.0276
Time (hours)	2.8613	0.0703
Temperature × Time	1.4974	0.2235
Residual		

Ongoing Field Trial+ Data Analyses: Integrated Biological Control

Parasitoid mixes for deployment in raspberry crop



Deployment of *C. carnea* eggs

Efficacy of *M. angulatus* predation of eggs and spring-emerging aphids

Integrated Biological Control Programme

Lybolty

- Regular deployment of biocontrol
- Regular monitoring of occurrence of parasitoids, lacewing, capsids and aphid

Conclusions

- Opportunity for industry to diversify the number of aphid species in parasitoid mixes for better protection
- Egg adherence to leaves is critical to successful deployment of green lacewing eggs by spraying- good results from ‘Agent ‘C’’
- Early season deployment of brown lacewing is possible at relatively cool temperatures. Predation likely to increase with temperature (more research needed)

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Plant Science into Practice

THANK YOU FOR LISTENING

Russell IPM
INTEGRATED PEST MANAGEMENT

NIAB
Microbiotech Ltd
UKRI Innovate UK

Probandz bait spray adjuvant against **spotted wing drosophila** & Preventative and **monitoring** methods against **earwigs**

Presentation by Rachel Turner

Agenda

Part 1 – Russell IPM bait spray adjuvant **Probandz**

- Brief introduction to spotted wing drosophila
- An introduction to Probandz, recap of trials and new trail results
- How to mix and apply

Part 2 – earwig trapping in tabletop strawberry

- A brief introduction to earwigs
- Proposed solutions: **Shield B3**; traps and bait results
- Future research

Spotted Wing Drosophila, *Drosophila suzukii* (SWD)

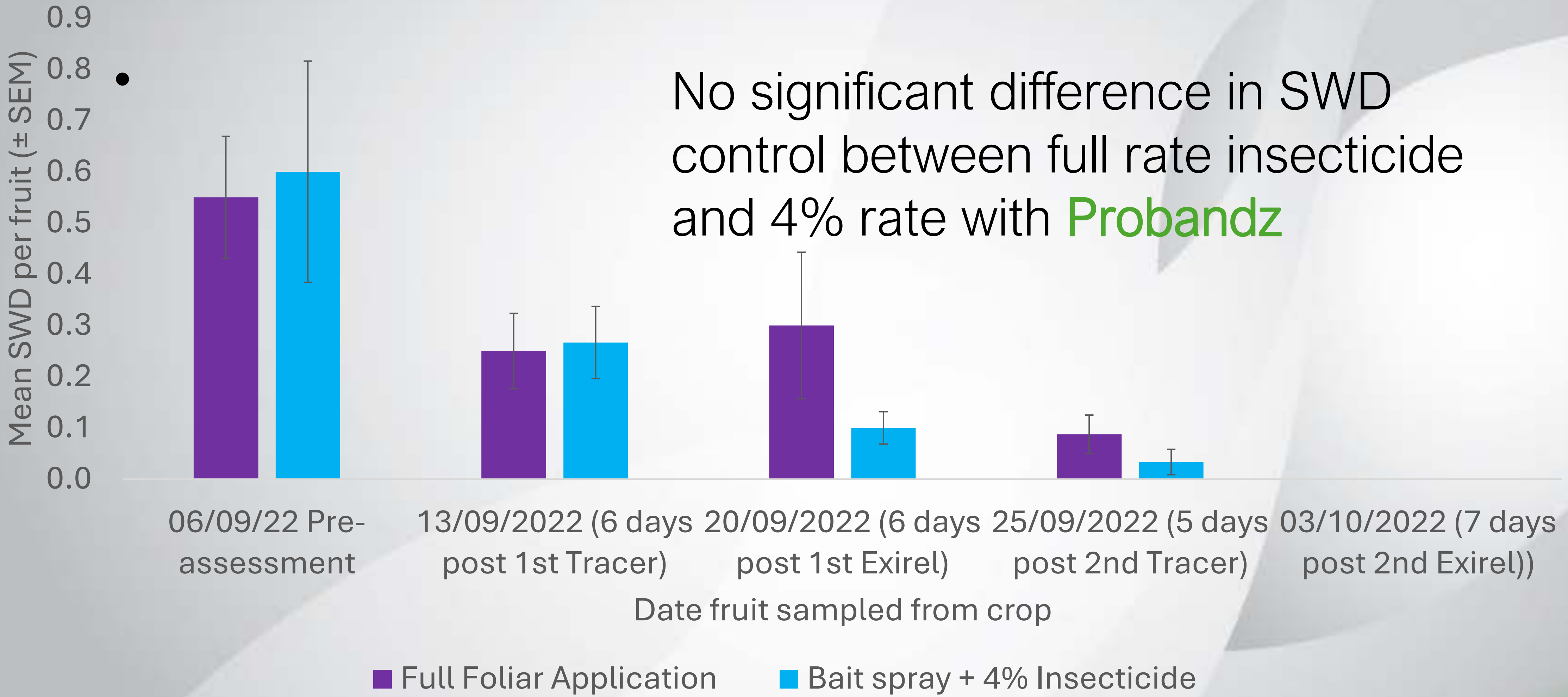
- A global economic pest of East Asian origin
- Females attack ripening and ripe fruit
- Capable of significantly diminishing yield prior to harvest
- The cost of damage to crops like cherries and berries can reach up to £20 million annually in the United Kingdom
- Capable of causing 100% crop loss under severe infestation conditions. 5-40% typical
- Overwinter as adults in dense hedgerows and woodlands

ProBandz®

- A natural, safe, food bait adjuvant containing 54-58% sugars
- Approved for use in the UK with all fully authorised and EAMU plant protection products on all edible and non-edible crops (ADJNo 0943)
- Not to be used with more than 50% of the maximum insecticide rate (4% recommended (8% Hallmark)
- Use as a band treatment to reduce costs and reduce the impact on beneficial species

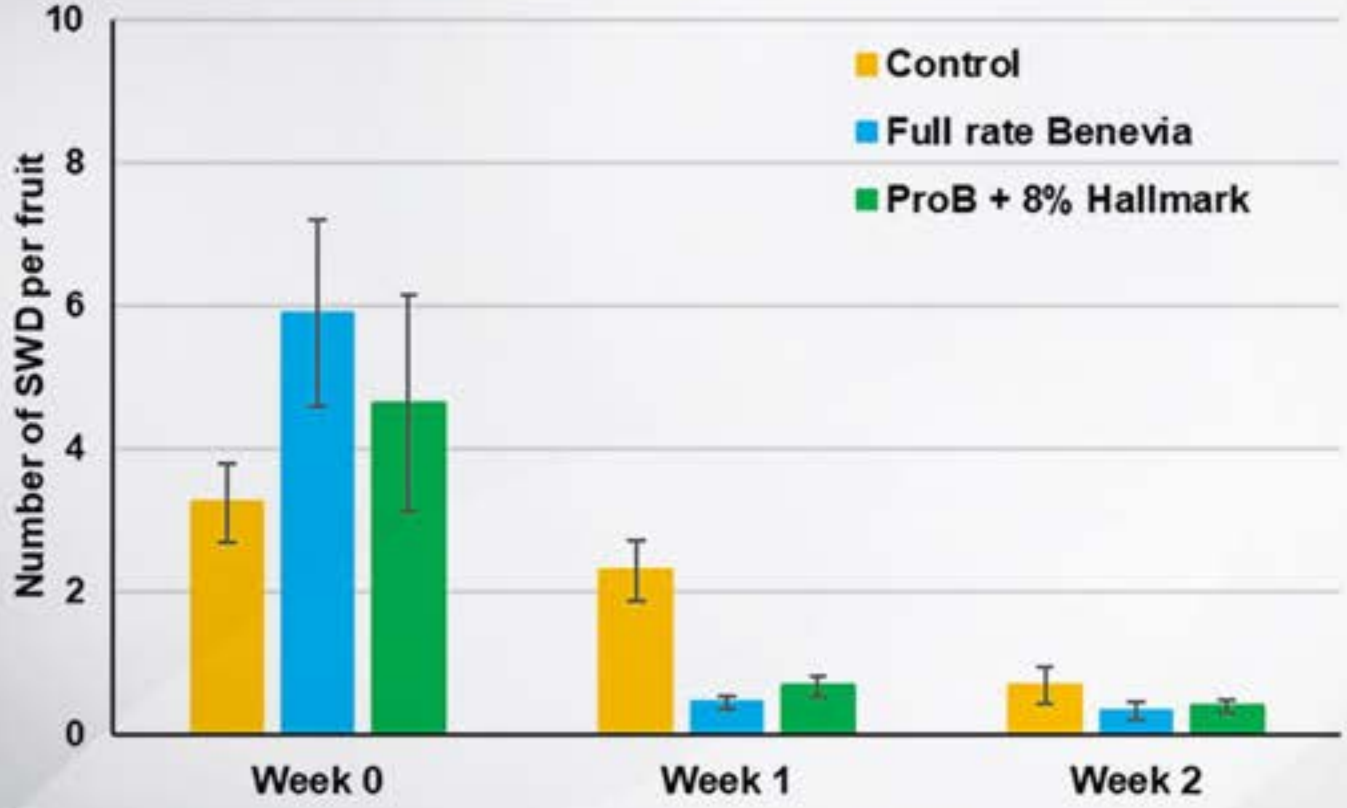
Field scale tunnel raspberry results, UK trial (2022)

- No significant difference in SWD control between full rate insecticide and 4% rate with Probandz



Trials supported by NIAB, Microbiotech, Berry Gardens, Russell IPM and Innovate UK

Field scale tunnel strawberry results, UK trial (2024)



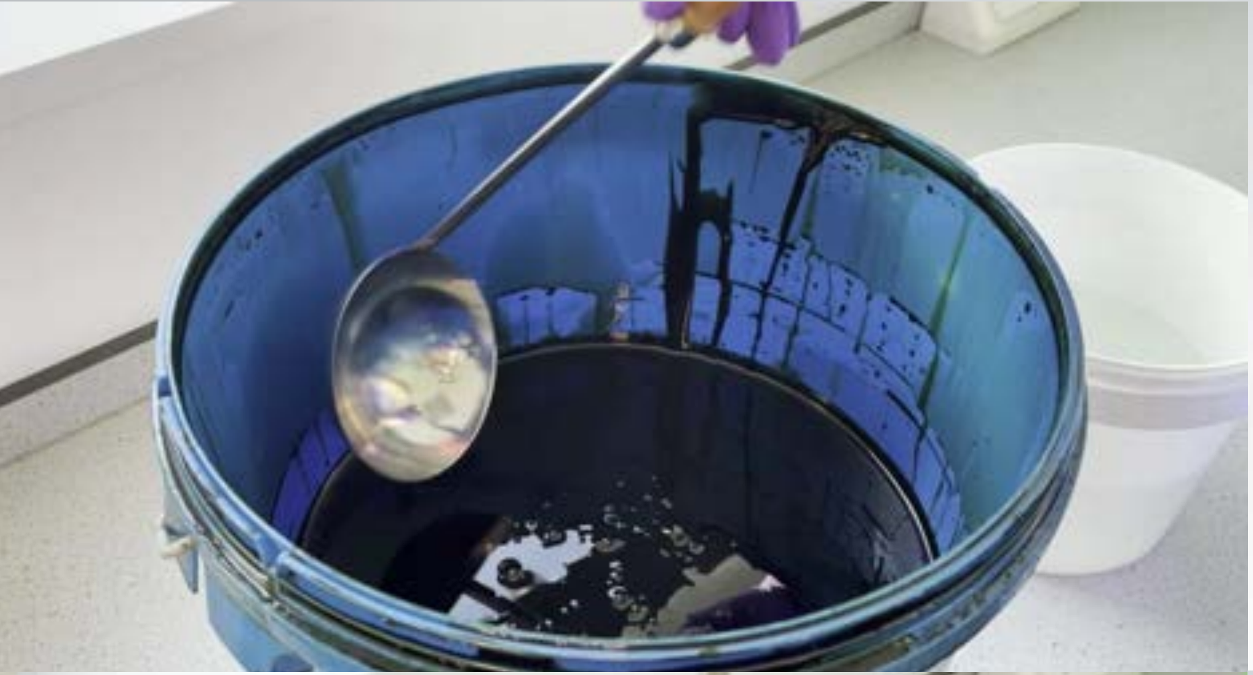
No significant difference in SWD control between full rate insecticide and 8% rate (Hallmark) with Probandz

*No detectable pesticide residues with ProBandz® bait sprays in 2024

Active ingredient & Probandz	Spray 1	Spray 2	Spray 3	Spray 4
	Tracer	Benevia	Tracer	Benevia
Spinosad with Probandz	Not detectable (ND)	ND	ND	ND
Cyantraniliprole with Probandz	ND	ND	ND	ND
	Hallmark	Decis	Hallmark	Decis
Lambda-cyhalothrin with Probandz	ND	ND	ND	ND
Deltamethrin with Probandz	ND	ND	ND	ND

Insecticide residues on fruit after full rate sprays, mg/kg

Active ingredient	Spray 1	Spray 2	Spray 3	Spray 4
	Tracer	Benevia	Tracer	Benevia
Spinosad	0.27	0.11	0.35	0.22
Cyantraniliprole	< 0.01	0.34	0.12	0.44
	Hallmark	Decis	Hallmark	Decis
Lambda-cyhalothrin	0.017	< 0.01	0.016	0.015
Deltamethrin	< 0.01	< 0.01	< 0.01	< 0.01



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How to mix ProBandz®

Practical application in raspberries

- Kobota Tractor with Claxton 400L tank front boom on tractor with two side discharge jets to base of the crop up to 0.5m high

- Forward speed 5km/hr

- Red bubble jets 1.5 bar

- 10L spray contains :
- 500ml (5%) Probandz (about 750g), predilute in 4L hot water and 1.9 ml Hallmark Zeon

- 40L spray per ha

- Use spray nozzles that result in a course droplet size: IDK DK 120-015 (Lechler); Airmix 110015 (Greenleaf); AVI/CVI 90-015 (Albuz); or equivalent

ProBandz® summary of benefits

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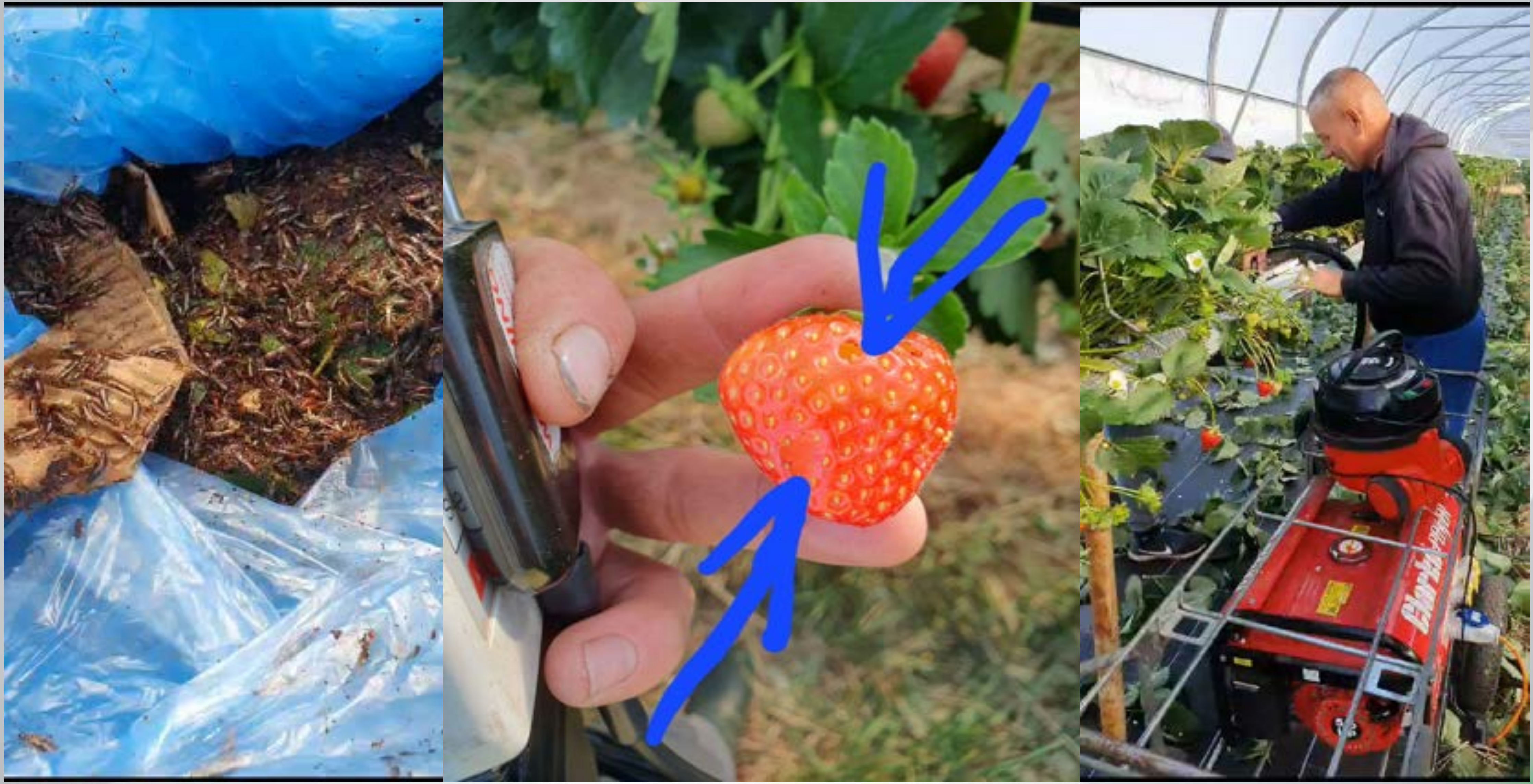
- Reduced grower costs and reduced environmental impact of pesticides using band treatments of Probandz bait sprays, yet equal or better SWD control
- Insecticide active ingredients reduced by 96% - 92%, grower costs reduced by >60%
- Time applying band treatment saved 85% compared to full-rate sprays, saving fuel & labour costs
- No detectable pesticide residues with baited sprays
- Hallmark - use as an end of crop cleanup spray
- Lasts 18 months plus in storage
- No reported issue with mildews or secondary pathogens, or scorch/ phytotoxicity
- No observed effects on bees
- Saves water – 8 times less spray applied

Earwigs – Friend and Foe

- Omnivorous – pest of some soft and stone fruit, beneficial in apple and pear orchards
- Prey on pests such as aphids, pear psylla, codling moth, and pear sucker
- Migrate into canopies at third to fourth instar from April/May depending on weather conditions and food availability
- Populations are normally highest in fruit crops from mid July-September
- Nocturnal



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Shield B3

A preventative measure to stop the earwigs and other crawling insects from migrating up into the crop

- Apply prior to earwig migration
- Apply a band round the top of each tabletop leg with robust disposable gloves

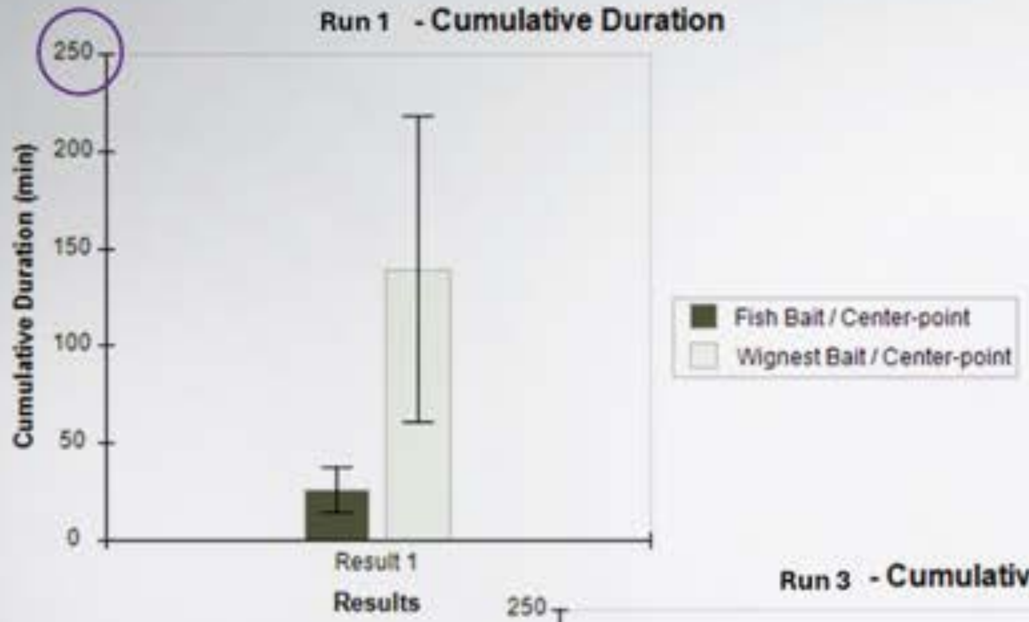
Ethovision Set Up – Wignest food Sachet vs Fish Pellet

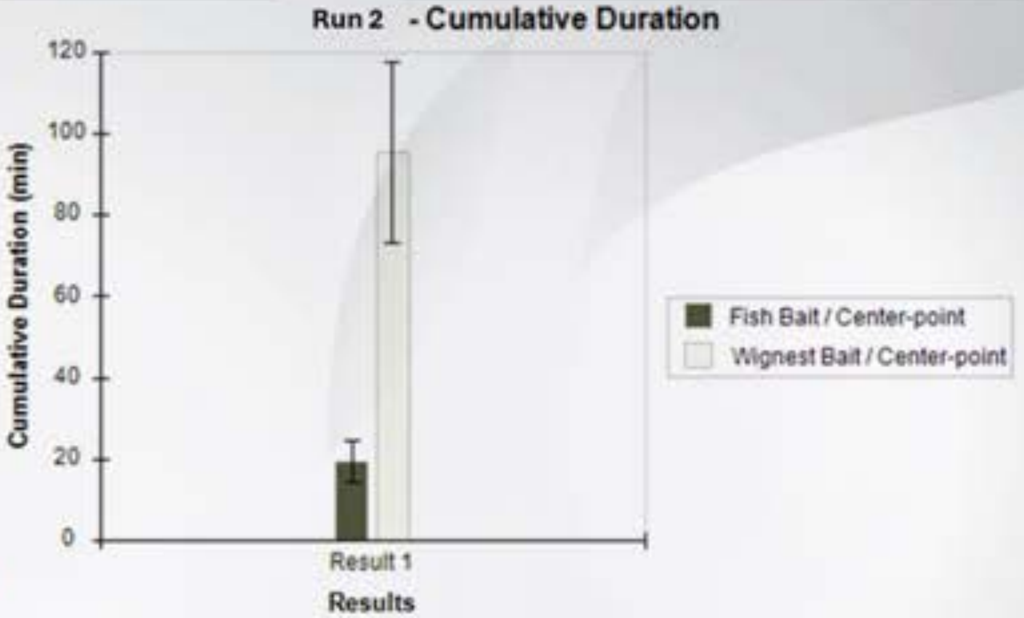
Areas of detection – 5 Earwigs per Assay

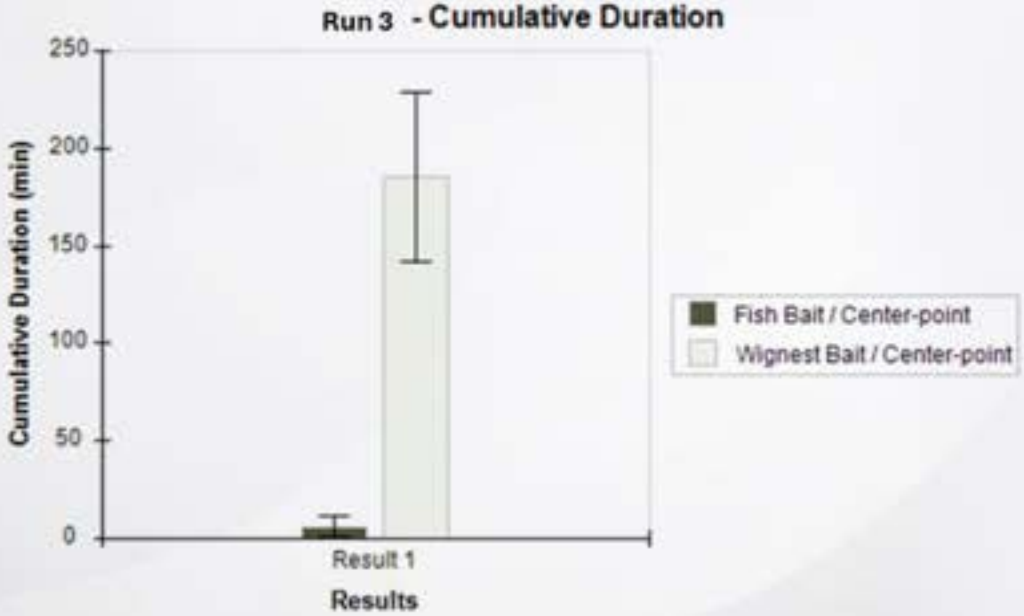
Wignest Food

Fish Pellets

Ethovision Repetitions



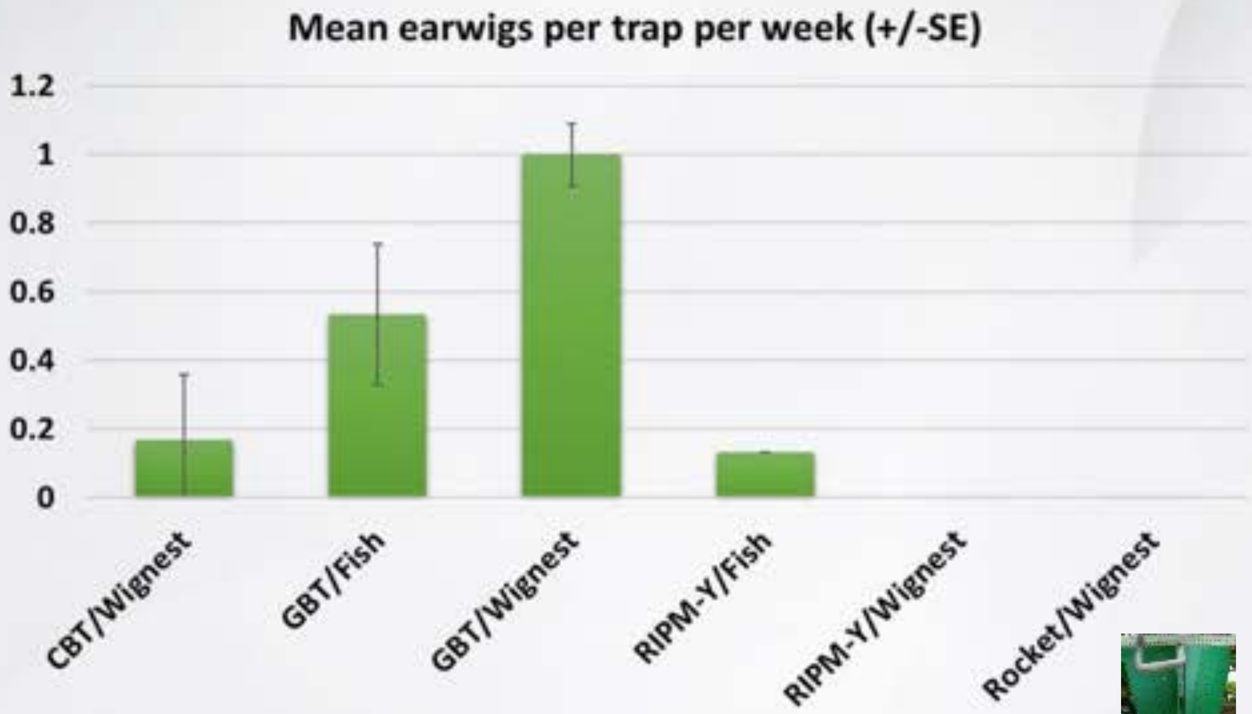




Wignest bait more attractive than Fish – used in other commercial baits

Timeline of trap deployment

19/09/2024 to 17/10/2024



Wignest Food Sachet

Fish Pellets

Questions

Email - rachelturner@russellipm.com

Sterile Insect Technique For SWD Control in Blackberry

Robert Moar, Acting Head of R&D

November 2024

BigSis Biological Control Solutions

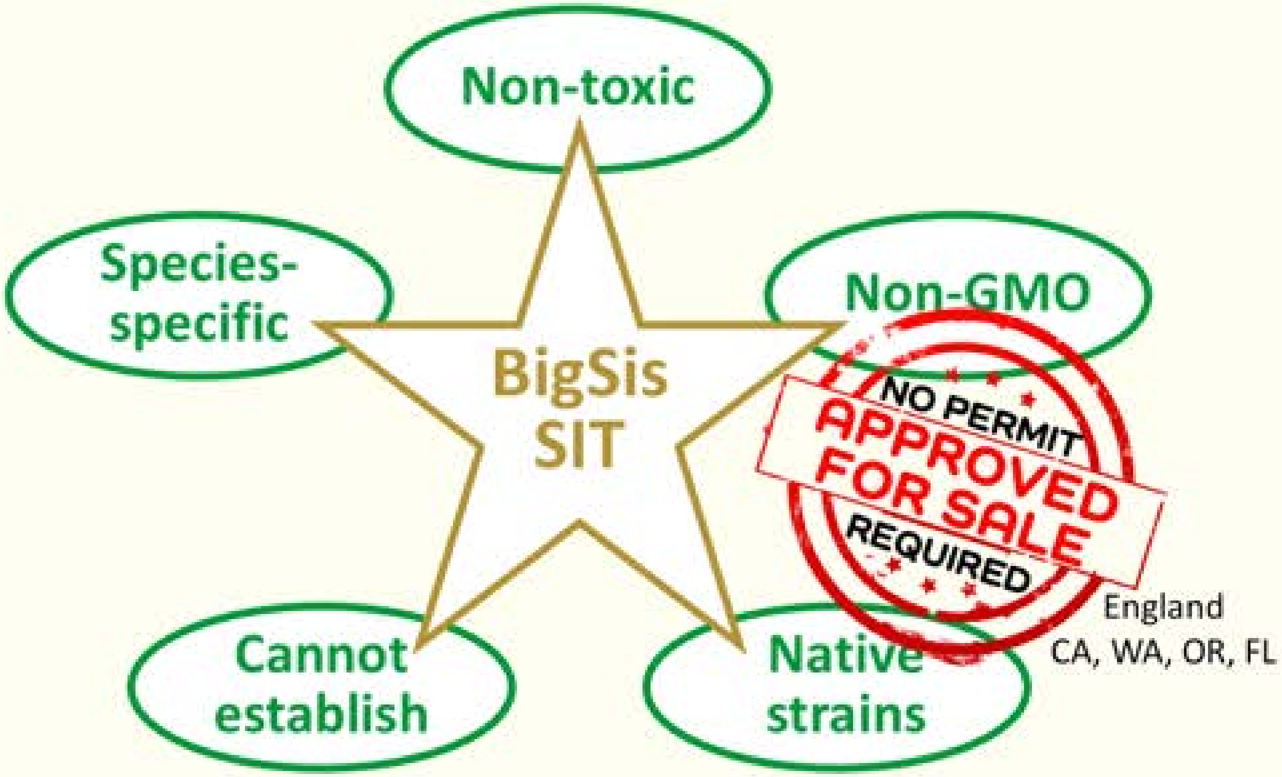
Based on Sterile Insect Technique (SIT)

Axiomatic Efficacy

How SIT Works

1. Produce sterile male insects
2. Release sterile males to mate with wild females
3. Females have no offspring

Ultra-Safe: Regulatory Light

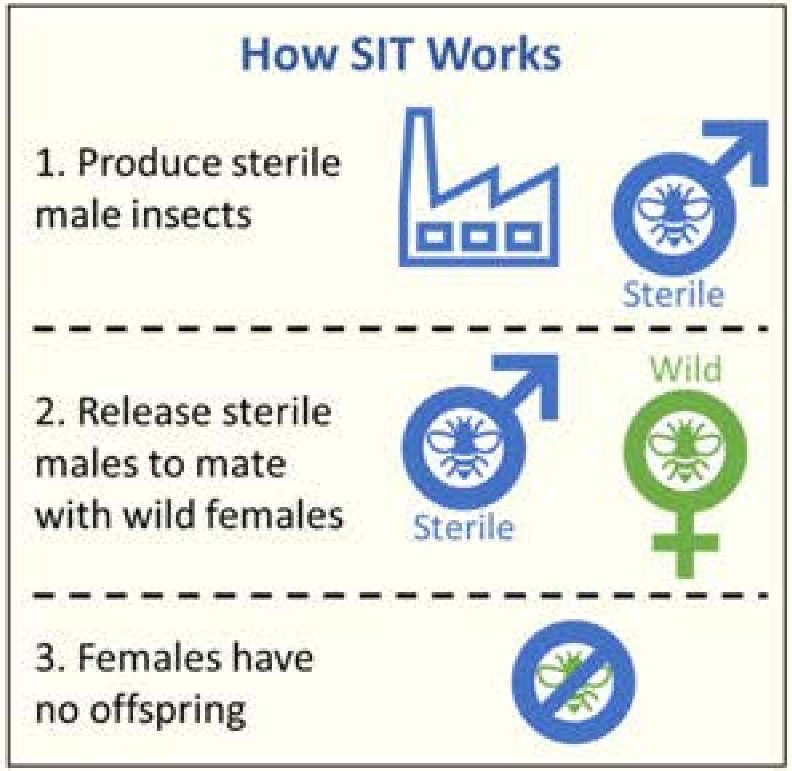


BigSis Biological Control Solutions

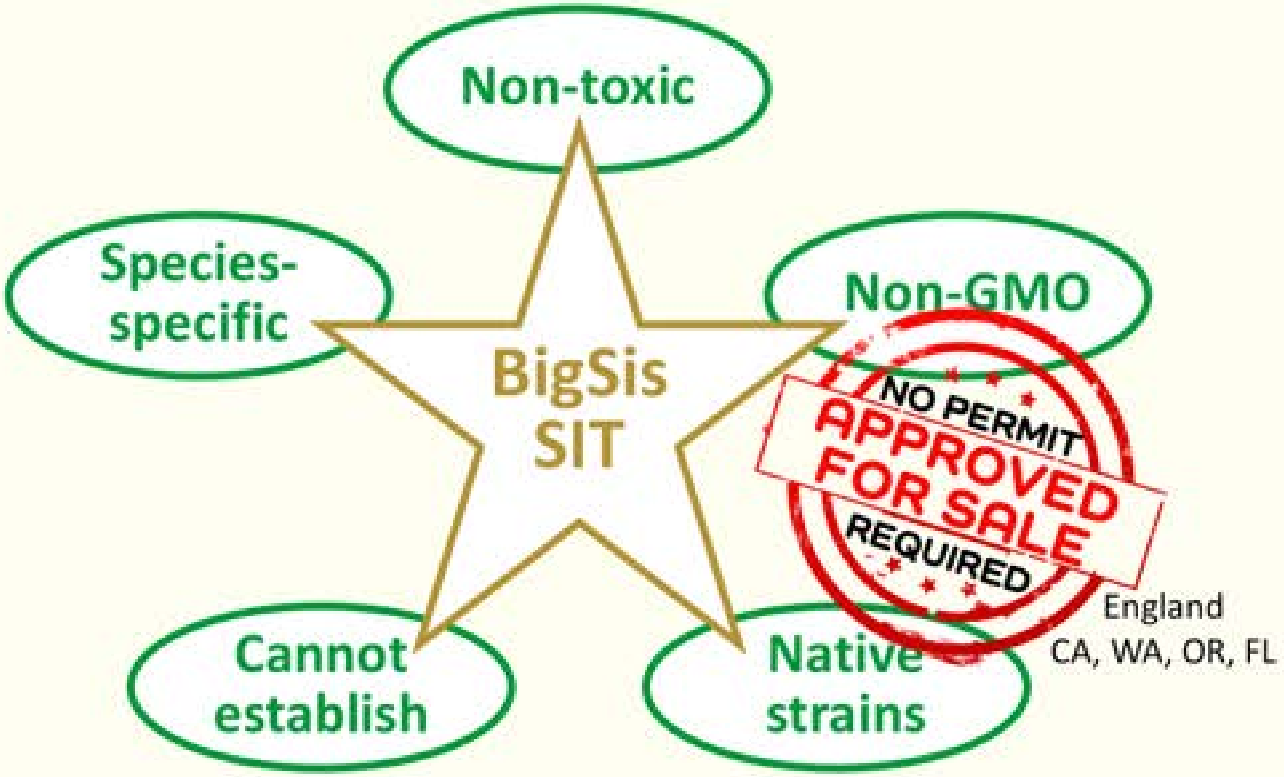
Based on Sterile Insect Technique (SIT)

BigSis™
WORKING WITH MOTHER NATURE

Axiomatic Efficacy



Ultra-Safe: Regulatory Light



BigSis First Solution Targets SWD

Achieved Season-Long Control and ≤91% Suppression

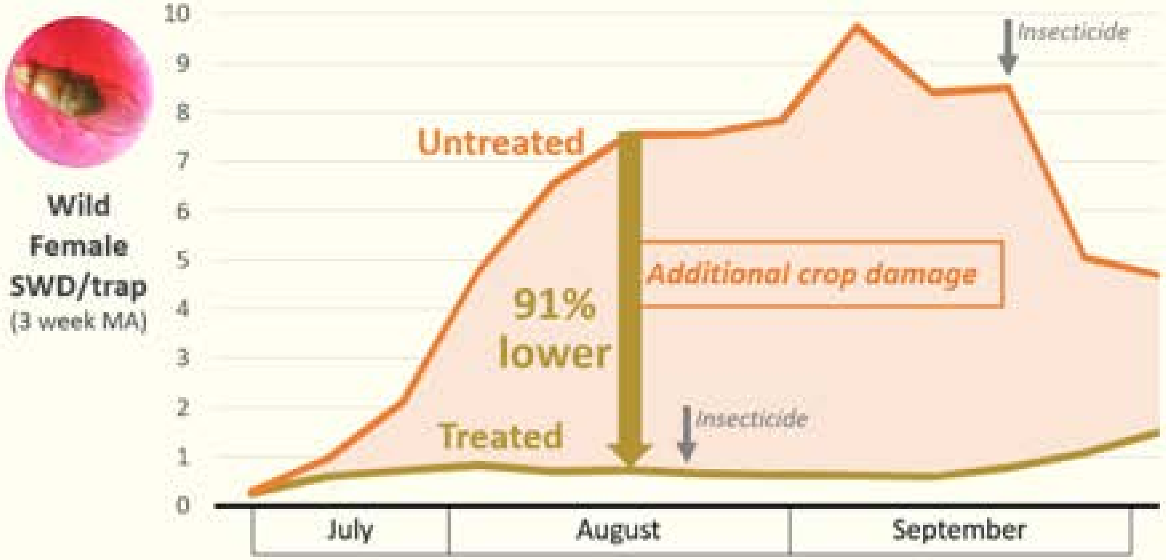
SWD

Spotted Wing Drosophila

SWD costs growers up to £11,000 per Ha plus rejected produce

2021 World-First Field Trial, Kent, UK

https://doi.org/10.3390/insects13040328



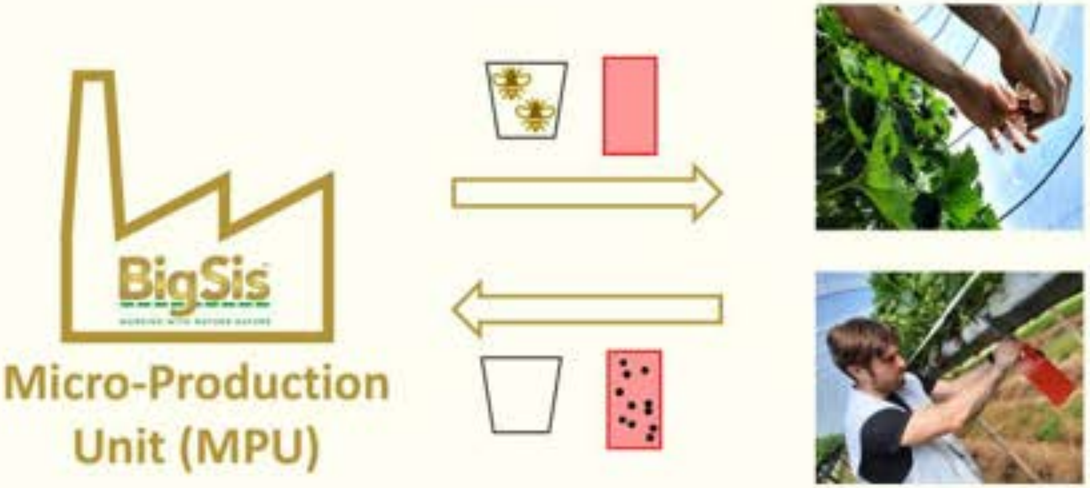
In partnership with

BERRY GARDENS

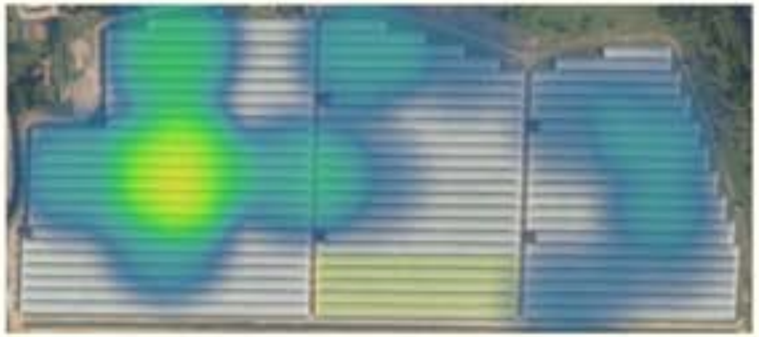
NIAB

Season-Long Control of SWD as a Service

BigSis
WORKING WITH MOTHER NATURE



- Zero hassle for grower
  - No learning curve
  - No labour requirement
- Ensures field work quality
  - Control release rate and location
  - Continuous learning
- Added-value SWD mapping

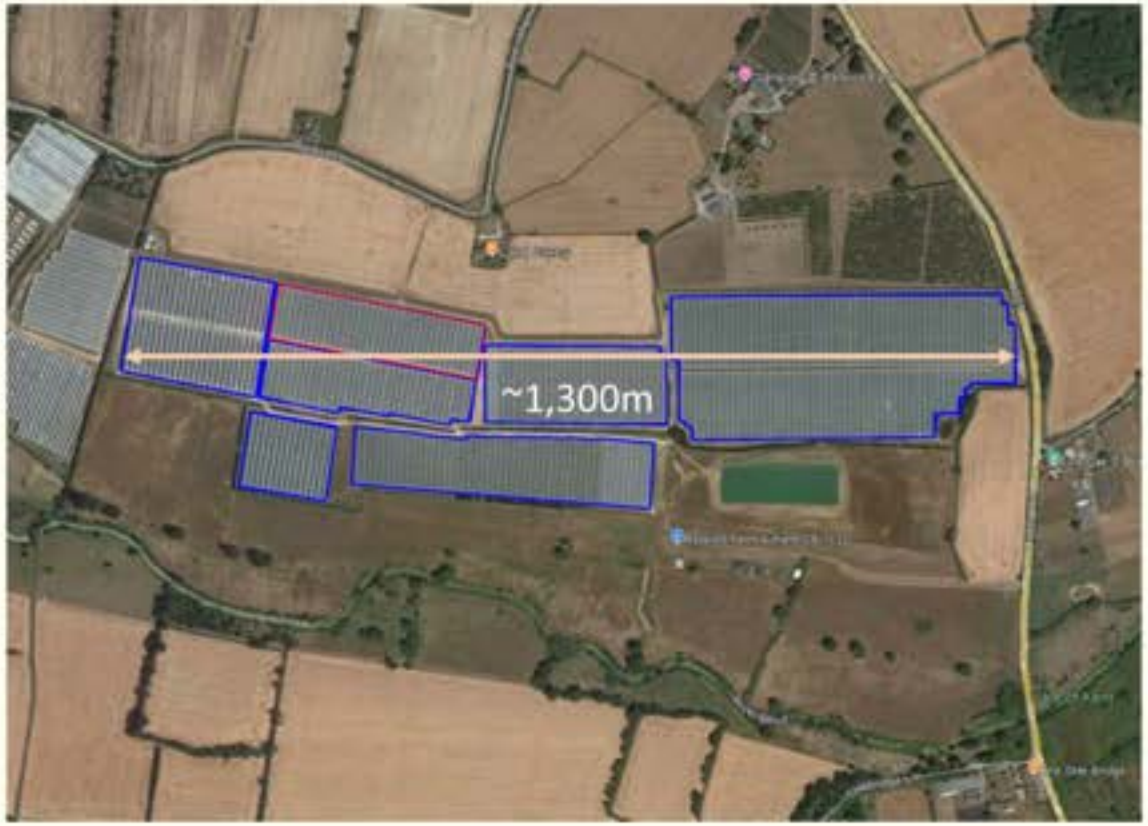


Innovate UK Funded Project With NIAB

- Optimising deployment of sterile insect technique to control spotted wing drosophila in blackberries: **BLACK-SPOT**
- February 2024 to January 2025
- Focused on blackberry crop
  - Highest SWD pressure
  - Highest value soft fruit crop
- Work packages included
  - Dispersal and longevity
  - Fruit vulnerability by stage
  - Develop predictive model (still in progress)

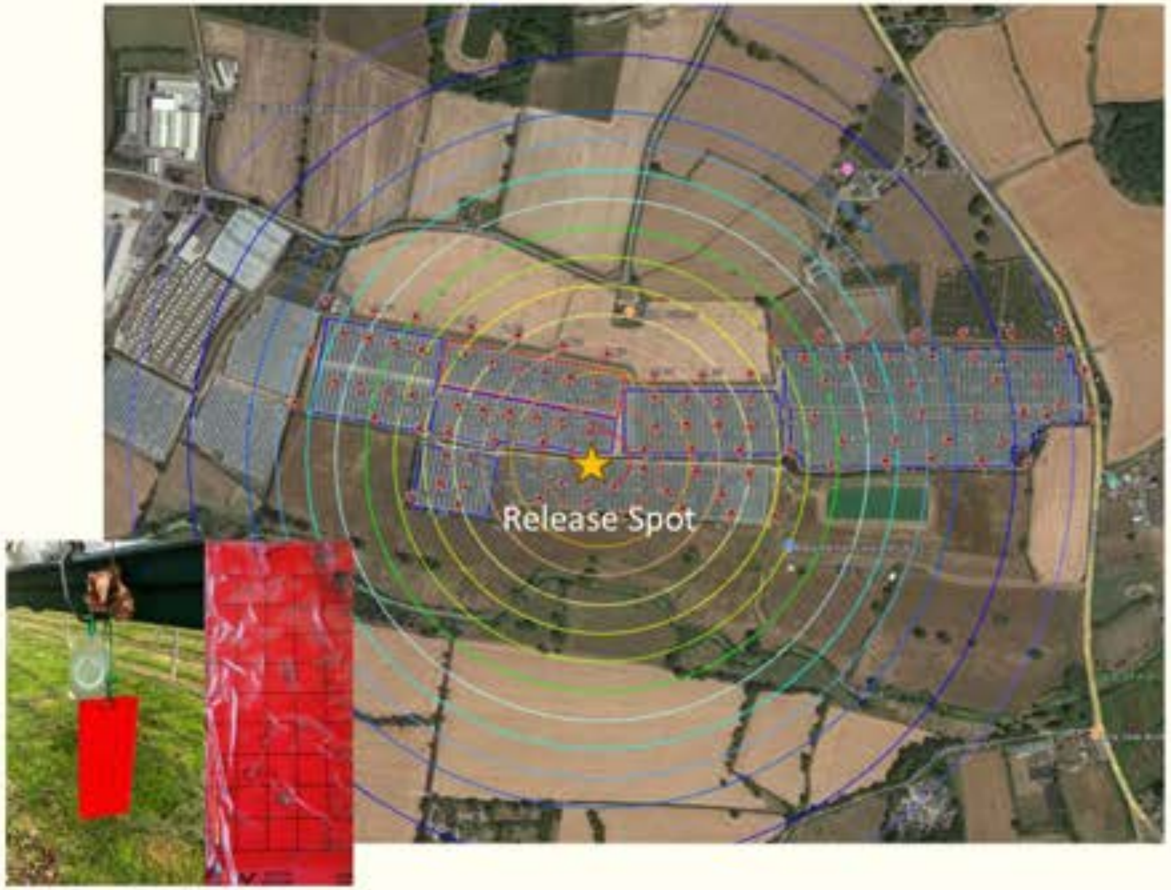
Dispersal and Longevity: Commercial Field

- Commercial farm in Kent
  - ~22ha across 5 fields of a long farm
  - ~1,300m from end-to-end
- Victoria variety blackberries
- Season ran from mid-June to early-November
  - Staggered planting meant different fields were harvested at different times



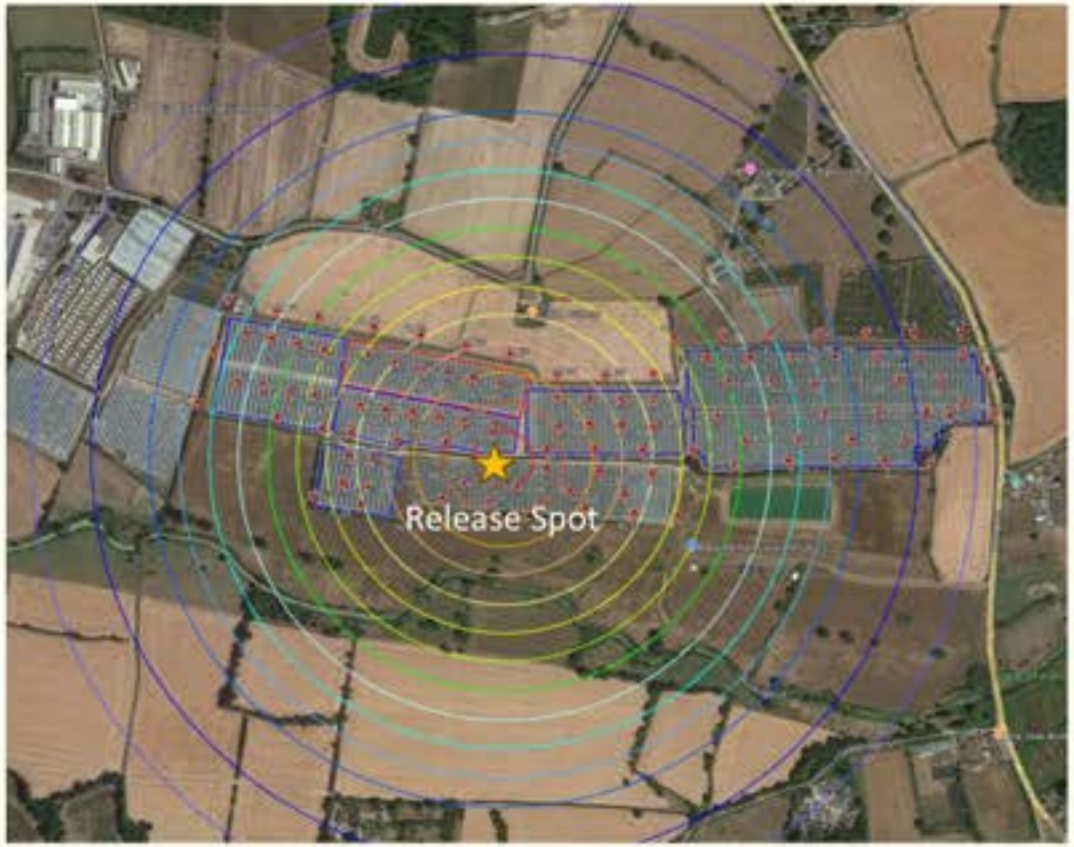
Dispersal and Longevity: MRR Study Design

- Mark Release Recapture (MRR) study carried out three times:
  - Pre-harvest (June)
  - Early Harvest (July)
  - Late-Harvest (September)
- Each MRR consisted of 4 releases of 5,000 sterile males
  - Each release was marked with a different colour to distinguish replicates
  - Files recaptured over 2 weeks
- Red sticky traps used as primary metric of scoring sterile males



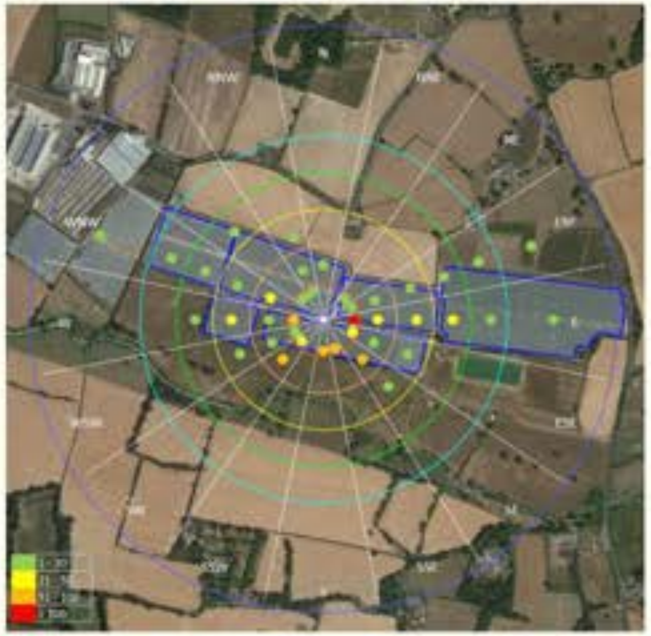
Dispersal and Longevity: MRR Metrics

- Parameters calculated:
  - Average Life Expectancy (ALE)
  - Probability of Daily Survival (PDS)
  - Population half-life (HL)
- Dispersal
  - Mean distance travelled
  - Flight range
    - Including the distance travelled by 50% and 95% of the population

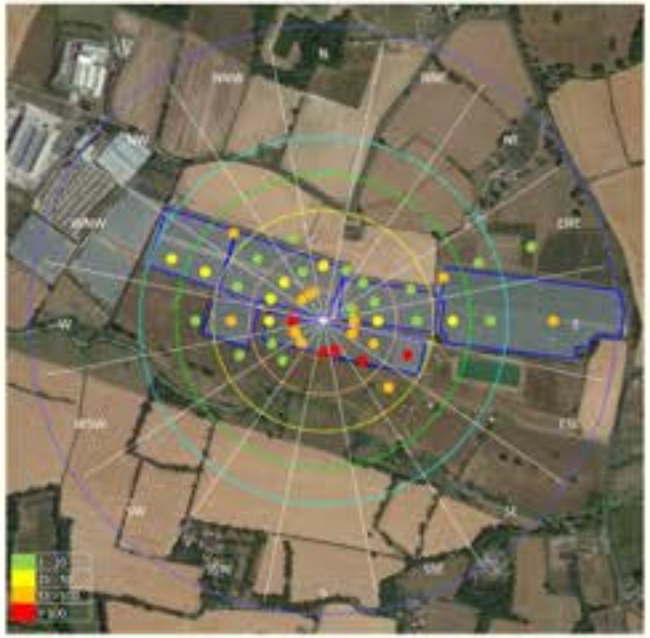


BigSis Sterile Males Are Active And Fit

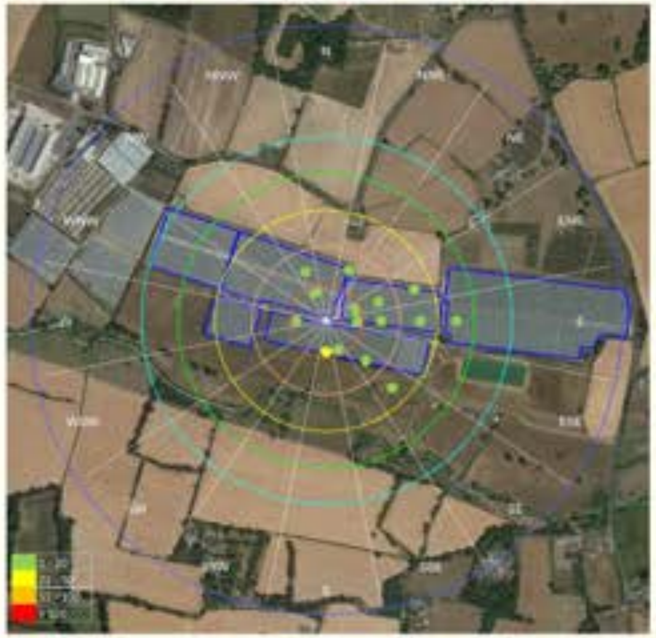
June	Early-Season
Population Half-Life	5.9 days
Mean Distance Travelled	272m



July	Mid-Season
Population Half-Life	3.1 days
Mean Distance Travelled	210m



October	Late-Season
Population Half-Life	5.3 days
Mean Distance Travelled	123m



Longevity and Dispersal Vary Across Season

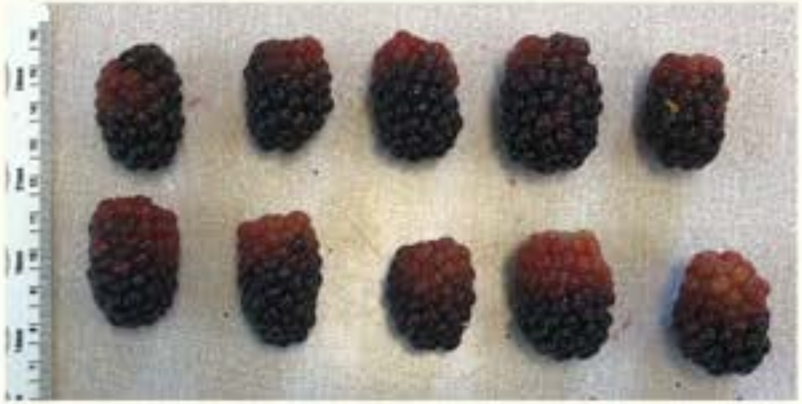
BigSis
WORKING WITH MOTHER NATURE

	Temperature	Humidity	Probability of Daily Survival	Average Life Expectancy	Population Half-Life	Distance Travelled	Flight Range of 50% of population	Flight range of 95% of population
Early	19.3	59	0.85	8.5	5.89	271.66	152.83	618.37
Mid	21.3	68.5	0.8	4.49	3.11	209.61	170.69	743.27
Late	12.6	81.2	0.88	7.64	5.3	122.7	91.78	338.67

- Temperature and humidity are more similar in early and mid crop periods
- Dispersal is less far in late-season, but daily survival metrics are lower in mid-season
- Temperature and humidity are not the only factors to consider; cropping stages, crop presence, picking schedule, wild-population presence all need to be considered – analysis ongoing

Blackberry Fruit Vulnerability

Fruit Quality Assessment
10 collected fruits assessed for:
- Weight (g)
- Colour
- Shade
- Brightness
- Cohesion
- Firmness (g/mm)
- Skin Firmness
- Sugar Content (Brix)
- Max Drupelet Size (mm)



Inoculated Emergence:
- 20 fruits incubated with 2 female SWD each for 48 hours.
- After the 48 hours, the 2 females are removed.
- Emergence checked 1 and 2 weeks after date of collection.

Natural Emergence:
- 40 fruits incubated in same conditions as inoculated fruits.
- No SWD added
- Emergence checked 1 and 2 weeks after date of collection.

x 600

(200 for Inoculated Emergence)

(400 for Natural Emergence)

Blackberry Fruit Vulnerability

Group	1	2	3	4	5
AVG Max Drupelet Size (mm)	4.22	4.70	5.43	5.66	6.44
AVG Weight (g)	3.32	4.62	6.14	9.30	13.1
AVG Sugar Content (Brix)	N/A	6.46	7.47	9.96	10.7

Automated Production: Scaling by Replication

Enabling Proprietary Technology: Individualised Insect Rearing

- Significant improvements made to automated production system during 2024
- Further progress and increased output expected ahead of 2025 season

Add diet

Collect egg

Add lid

Incubate

Select adults

Sort males

Sterilise

Thank You

Boosting Native parasitoids of spotted wing drosophila

Francesa Elliott & Michelle Fountain

Background

- *Drosophila suzukii* (SWD) – damages soft and stone fruit
- Female serrated ovipositor - eggs in underripe fruit
- Reproduces rapidly - many generations in the same year
- SWD overwinters in woodlands invading crops in the spring
- Current IPM strategies - require labour and cost inputs
- Encouraging existing parasitoids - could offer a lower-input control strategy
- SWD has ability to eclose parasitoid eggs

Photo credit: Martin Hauser

Boosting Native Biological Control

- Hymenopteran (wasp) parasitoids lay eggs on/inside hosts
- Hatched larvae feed on hosts - killing them
- *Trichopria drosophilae* commercially produced for release in Europe but not UK; non-native
- Native generalist parasitoids also attack SWD
- Can we exploit these native biological control agents?
- How?

Photo credit: Cherre S. Bezerra Da Silva, Briana E. Price, Alexander Soohoo-Hui, Vaughn M. Walton

> Parasitol Res. 2023 Nov;122(11):2585-2597. doi: 10.1007/s00436-023-07957-6. Epub 2023 Sep 14.

Preliminary evidence of Drosophila suzukii parasitism in Southeast England

Bethan Shaw [1], Adam Walker [2], Sebastian Hemer [2] [3], Madeliene F L Cannon [2], Benjamin Brown [2], Francesco M Rogai [2], Michelle T Fountain [2]

First to explore possible parasitoids of SWD in the British Isles

1. Identify parasitoids emerging from SWD pupae
2. Confirm ability to parasitise SWD by reinfesting lab cultures
3. Search for pupal parasitoid *Trichopria drosophilae*
4. Assess habitats to understand environmental conditions that encourage parasitism
5. Impact of parasitoids on SWD in the field

Sentinel Traps

Media exposed to 300 SWD females for 4 days

Parasitoid olfactory stimuli (inaccessible to SWD)

Petri dish and pot in Perspex box with damp tissue

1 mm mesh lid (allows parasitoids)/

0.2 mm mesh lid (no para)

Rodent-proof metal lid

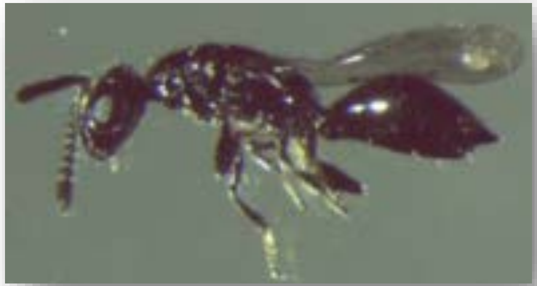
Box inside red delta trap

Boxes deployed in habitat

Identify parasitoids emerging from SWD pupae

- Six hymenopteran species
- 2017 2 pupal parasitoids;
  - *Pachycrepoideus vindemiae* (Pteromalidae)
  - *Spalangia erythromera* (Pteromalidae)

  2 larval parasitoids;
  - *Leptopilina heterotoma* (Figitidae)
  - *Asobara tabida* (Braconidae)
- 2018 additional pupal parasitoids
  - *Trichopria prema* (Diapriidae)
- 2020
  - *Trichopria modesta* (Diapriidae)



Confirm ability to parasitise SWD by reinfesting lab cultures

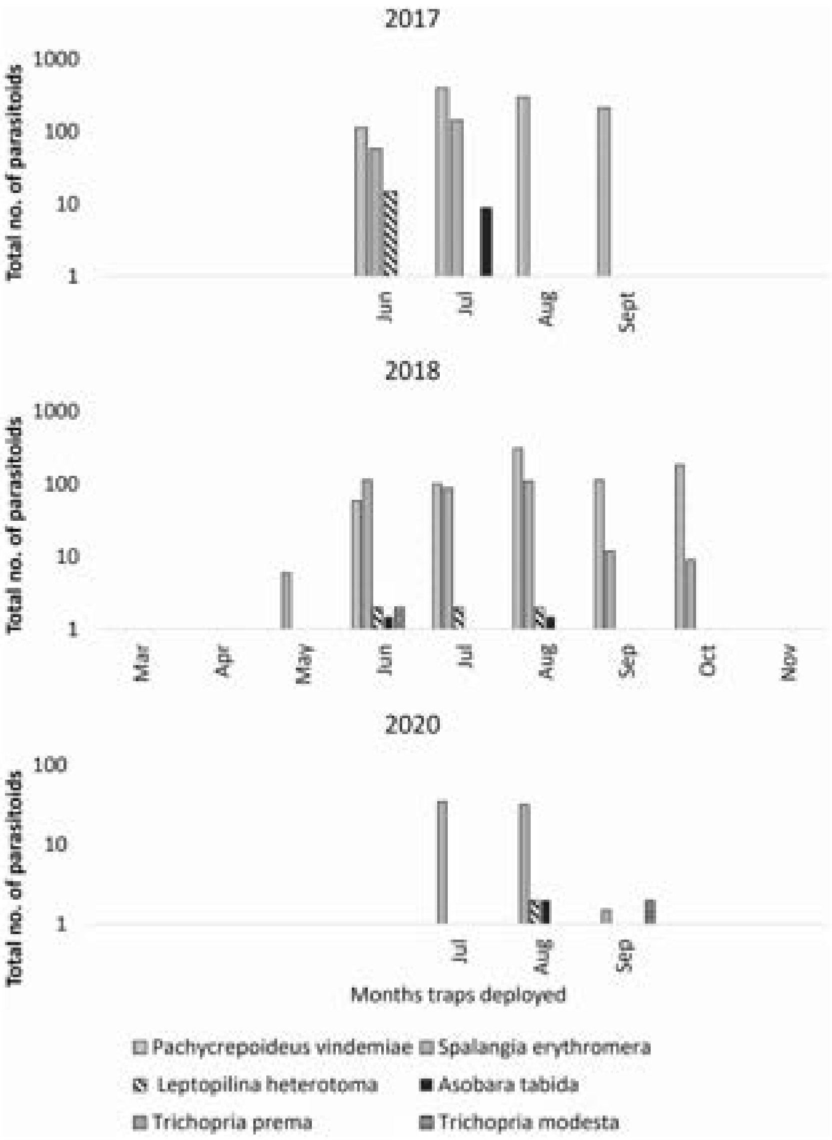
Replicate no	Species	Stage of *D. suzukii* host	No. adult parasitoids introduced	No. emerged offspring	No. offspring per adult
1	*Leptopilina heterotoma*	Larvae	10	1	0.1
1	*Asobara tabida*	Larvae	3	0	0.0
1	*Spalangia erythromera*	Pupae	11	3	0.3
2	*Spalangia erythromera*	Pupae	10	5	0.5
3	*Spalangia erythromera*	Pupae	12	2	0.2
4	*Spalangia erythromera*	Pupae	13	1	0.1
1	*Pachycrepoideus vindemiae*	Pupae	25	80	3.2
2	*Pachycrepoideus vindemiae*	Pupae	10	45	4.5
3	*Pachycrepoideus vindemiae*	Pupae	14	41	2.9
4	*Pachycrepoideus vindemiae*	Pupae	8	11	1.4
5	*Pachycrepoideus vindemiae*	Pupae	9	67	7.4
6	*Pachycrepoideus vindemiae*	Pupae	16	47	2.9

Pachycrepoideus vindemiae could increase its population size on SWD in the laboratory

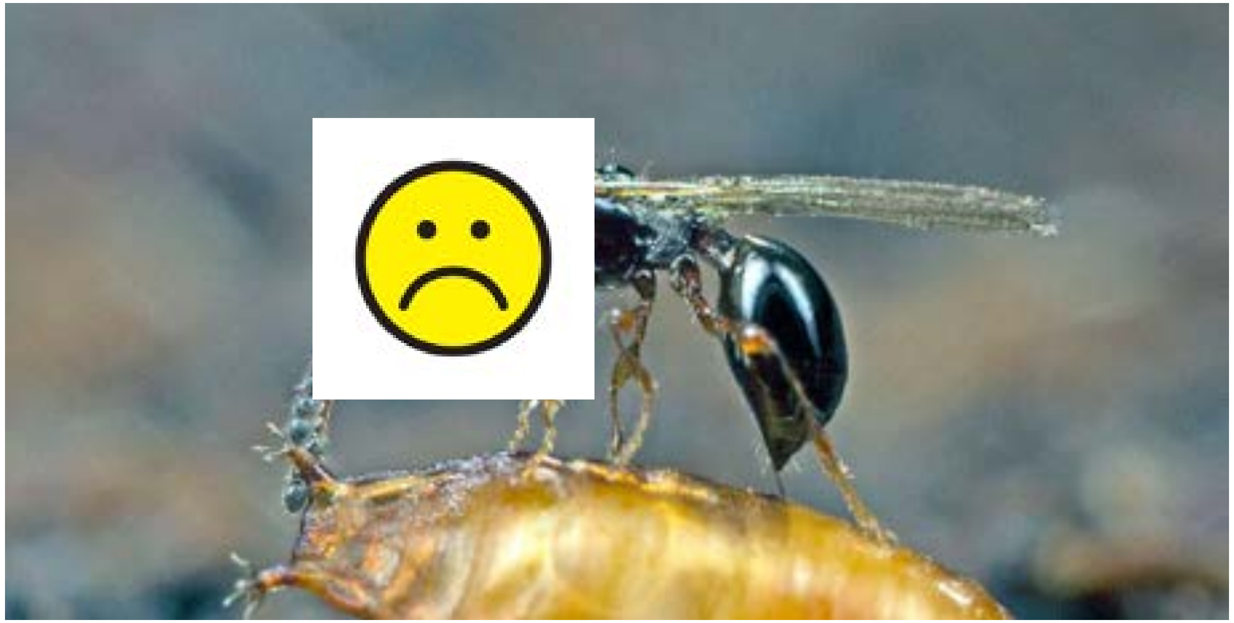
Assess site habitats to understand environmental conditions that encourage parasitism

Table 1 The total number of parasitoid species that emerged from *D. suzukii* inoculated replicate sentinel fruit traps in Southeast England in different habitats in 2017, 2018 and 2020. Data includes the number of sentinel traps deployed per habitat which yielded parasitoids, the total number of parasitoids per habitat, and the number of parasitoids per trap

Habitat	*Pachycrepoideus vindemiae*	*Spalangia erythromera*	*Leptopilina heterotoma*	*Asobara tabida*	*Trichopria prema*	*Trichopria modesta*	Total traps/habitat	Total individuals/habitat	Number of parasitoids/trap
2017									
Woodland centre	374	16	15	5	0	0	42	410	9.8
Strawberries edge	143	77	0	0	0	0	22	220	10.0
Raspberries edge	193	11	0	0	0	0	30	204	6.8
Hedgerow	108	89	0	0	0	0	40	197	4.9
Wild cherry orchard	95	3	0	0	0	0	38	98	2.6
Vineyard	86	0	0	0	0	0	20	86	4.3
Woodland edge	56	8	0	4	0	0	19	68	3.6
Parkhouse yard	39	0	0	0	0	0	3	39	13.0
Elderberry	32	0	0	0	0	0	1	32	32.0
Brambles	4	0	0	0	0	0	6	4	0.7
Total per sp.	1130	204	15	9	0	0	-	1358	-
2018									
Woodland centre	218	142	3	1	0	0	76	364	4.8
Strawberries edge	70	72	0	2	0	0	57	144	2.5
Raspberries edge	85	1	2	0	0	0	57	88	1.5
Hedgerow	161	8	0	0	2	0	57	171	3.0
Wild cherry orchard	258	102	1	0	0	0	38	361	9.5
Vineyard	0	37	0	0	0	0	19	37	1.9
Total per sp.	792	362	6	3	2	0	-	1165	-
2020									
Woodland centre	0	35	2	1	0	0	36	38	1.1
Wild cherry orchard	0	21	0	1	0	2	36	24	0.7
Total per sp.	0	56	2	2	0	2	-	62	-



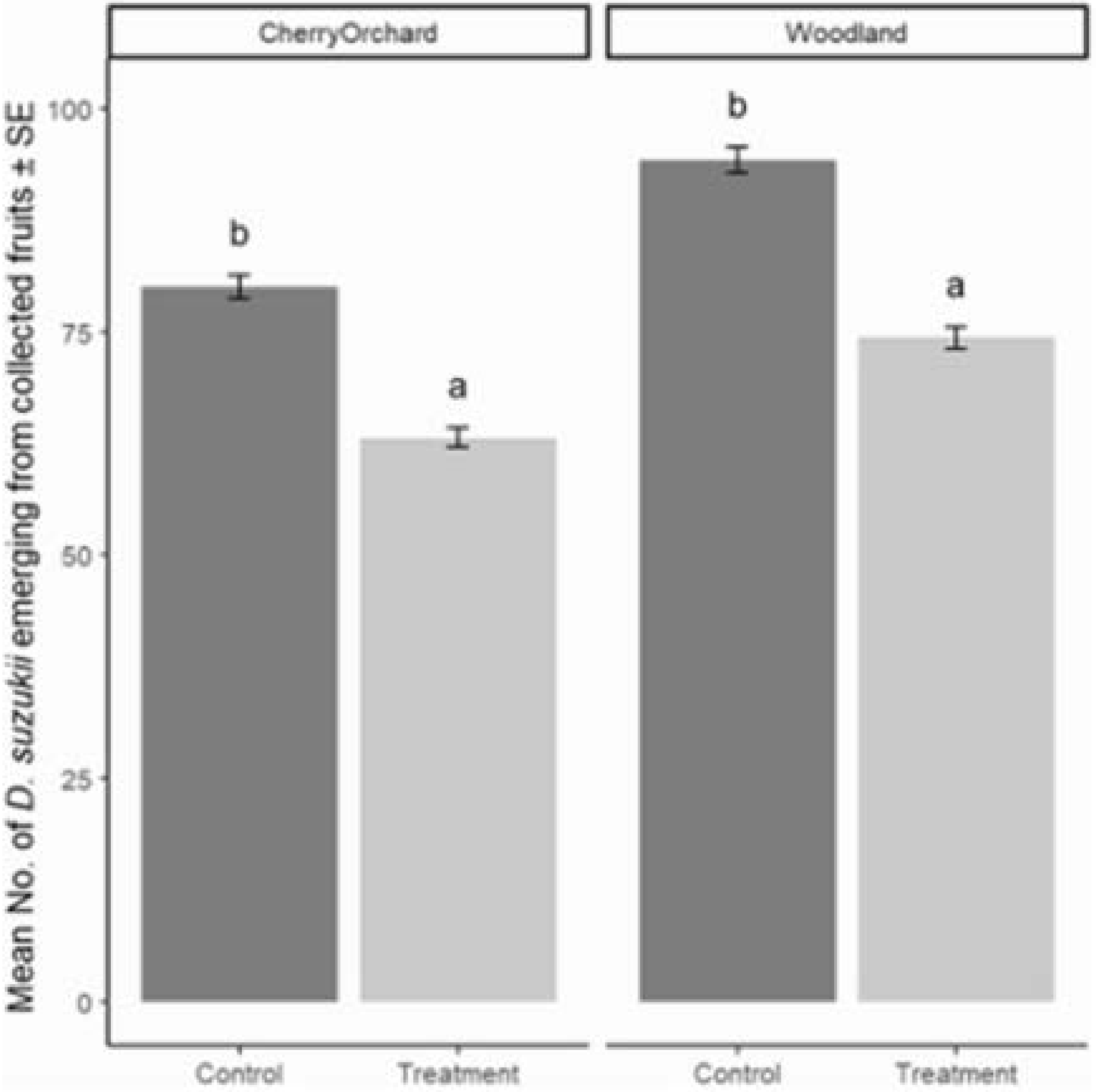
- Mainly between June-Oct
- No *Trichopria drosophilae*



Credit: Bioplanet.eu

Impact of parasitoids on SWD in the field

- SWD emergence was reduced **by ~ 21%** in field when wild parasitoids could access larvae and pupae



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Natural Enemy Augmentoria

- Growing interest in boosting local populations of natural enemies, on farm, using augmentoria
- Inoculated with pest or alternative host
- Allow NE out but not the pest
- Designed must be robust to be simple to use

Augmentorium: a sustainable technique for conservation biological control of *Drosophila suzukii*

Augmentorium: A Promising Pest Management Tool for Controlling the Olive Fruit Fly

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Pests Stay In, Parasitoids Fly Out: The Augmentorium for Biological Control in IPM

entomology today

Identifying an Optimal Screen Mesh to Enable Augmentorium-Based Enhanced Biological Control of the Olive Fruit Fly *Bactrocera oleae* (Diptera: Tephritidae) and the Mediterranean Fruit Fly *Ceratitis capitata* (Diptera: Tephritidae)

Extension of the use of augmentoria for sanitation in a cropping system susceptible to the alien Tephritid fruit flies (Diptera: Tephritidae) in Hawaii

Problems Inherent to Augmentation of Natural Enemies in Open Agriculture

Augmentoria to boost natural biological control – data being analysed

- For SWD; waste fruit repurposed to boost parasitoids numbers
- Woodlands are a particular source of native SWD parasitoids
- No commercially available Augmentoria for SWD parasitoids
- Project to develop robust and practical Augmentoria suitable for outdoor UK field conditions
- In 2024 we tested Augmentoria in woodlands next to commercial growing areas

Parasitoid in a 1 mm mesh box deployed 20 m from augmentorium

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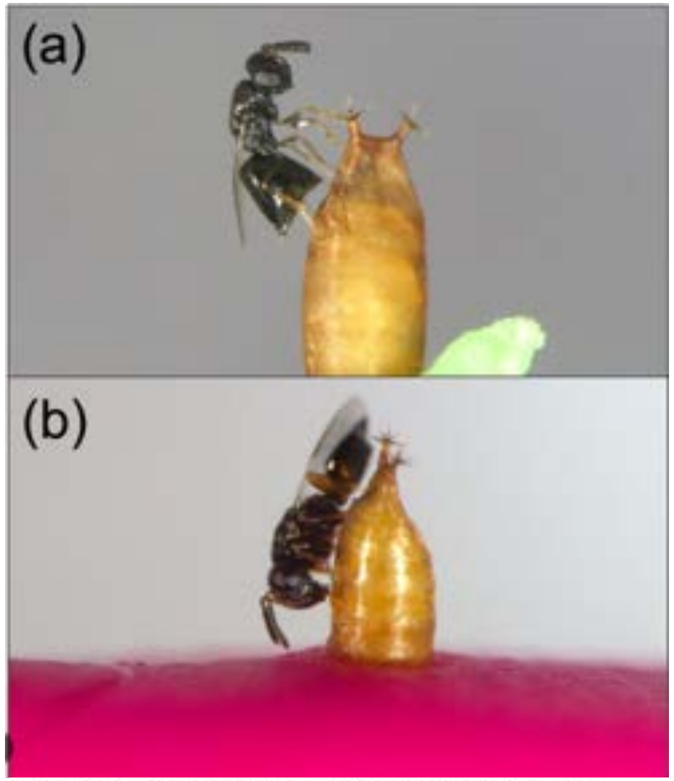
Future possibilities

Innundative releases

- *P. vindemmiae* successfully mass reared in lab (Garcez et al 2024)
- Generalist pupal ectoparasitoid
- Injects venom into host while laying eggs on the puparium
- Regulates host immunity and interrupts host development (Yang et al 2019)
- In 60 countries
- Hosts include species economic importance, Tephritidae and Drosophilidae
- Facultative hyperparasitoid - can survive as a primary or hyperparasitoid
- *P. vindemmiae* most likely overwinters as larva or pupa; wide range of habitats (Haner et al 2022)



Factors affecting the biology of Pachycrepoideus vindemmiae (Hymenoptera: Pteromalidae), a parasitoid of spotted-wing drosophila (Drosophila suzukii)

July 2019 · PLOS ONE 14(7)
DOI: 10.1371/journal.pone.0218301

Cherre Sade Bezerra Da Silva · Briana E. Price · Alexander Soohoo-Hui · Vaughn Walton

Future possibilities

Adventive establishment of non-native parasitoids

- 3 dominant parasitoids attacking SWD larvae: *Asobara japonica* (Hymenoptera, Braconidae), *Ganaspis cf. brasiliensis, Leptopilina japonica* (Hymenoptera, Figitidae)
- *L. japonica;* 5 locations in Southern and Western Germany 2021-2023 (Martin et al 2023)
- *L. japonica* and *G. brasiliensis* in Canada, Italy, Germany (Dudzic et al 2024)
- *L. japonica* in North America (Gariepy et al 2024)

https://www.waspweb.org/cynipoidea/figitidae/Eucoilinae/Leptopilina/Leptopilina_japonica.htm

Future possibilities

First described parasitoid wasp of adult Drosophila (Moore et al 2024)!!

- Eastern USA – *Syntretus perlmani*
- Mitochondrial DNA from melanogaster

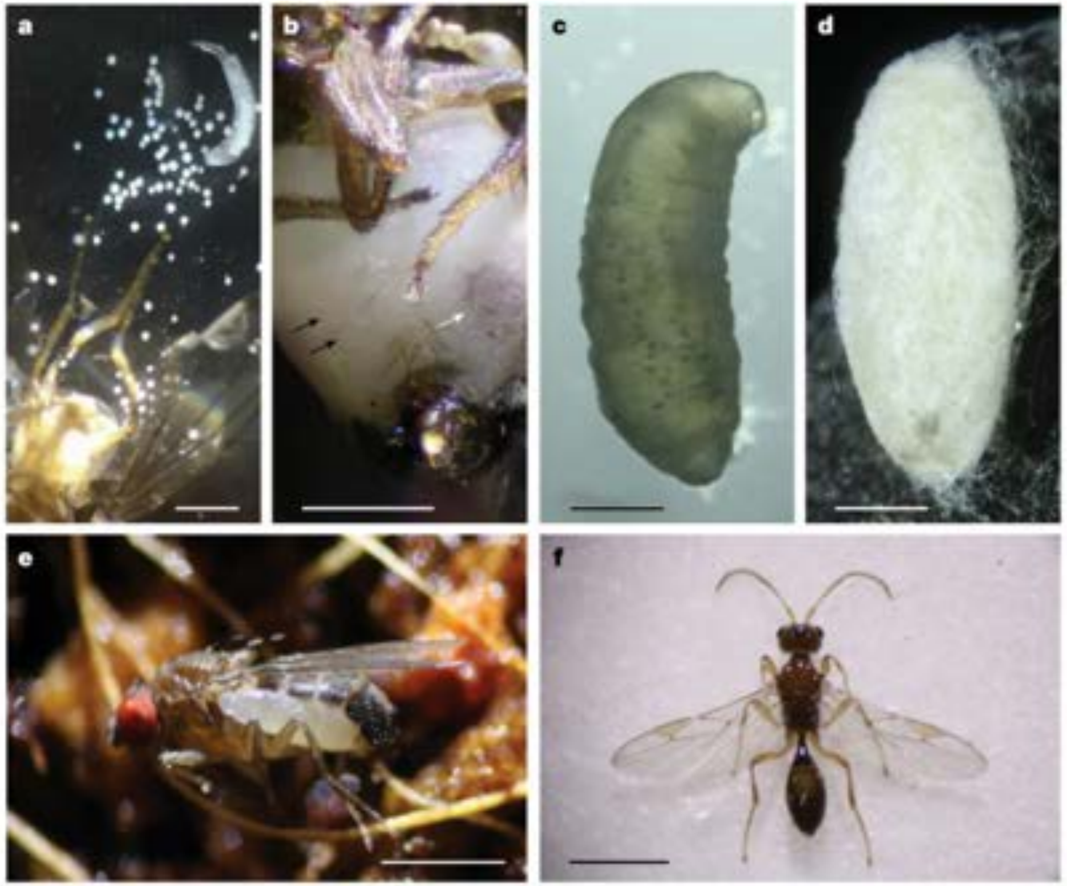


Fig. 2 | Life stages of *S. perlmani*. **a**,**b**, The development of wasp larvae inside host flies (**a**) is accompanied by growth of wasp teratocytes (**b**, black arrows), which can be seen through the host abdominal cuticle and obstruct the view of the testes (**b**, white arrow). **c**, The second and following larval instars lack a head capsule and tail spike, and the final instar grows to nearly the length of the host fly (see Supplementary Video 2). **d**, Pupal development takes place within a white silken cocoon as is typical of euphorine wasps. **e**, Larval emergence is always from the abdomen and has been observed to occur between the second and third tergites (dorsolaterally) or laterally through a tear in the abdominal cuticle. **f**, The adult wasp (male shown) is small, yellowish brown and approximately 1.5 mm in length. Scale bars, 0.5 mm (**a**–**d**) and 1 mm (**e**,**f**).

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AHDB HORTICULTURE

Berry Gardens

Topics

- SWD attractant – developing the pull
- SWD repellent trials – strawberry and raspberry
- SWD push-pull trial in commercial strawberry
- Improving the push
- Improving the pull

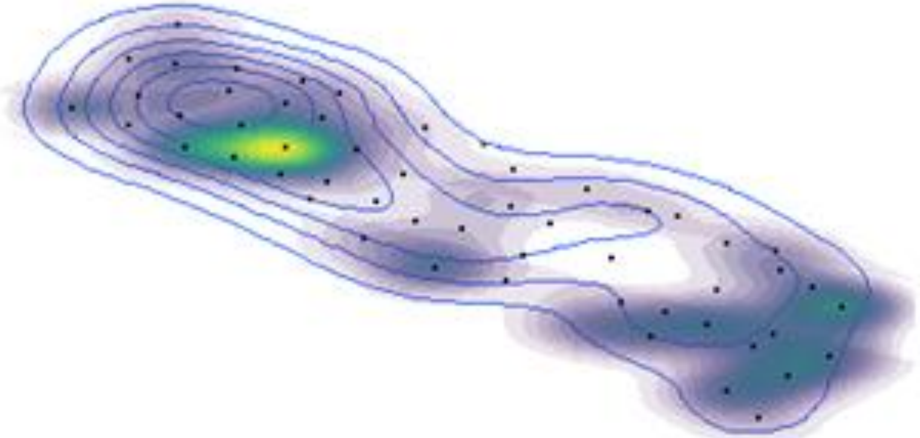
Topics

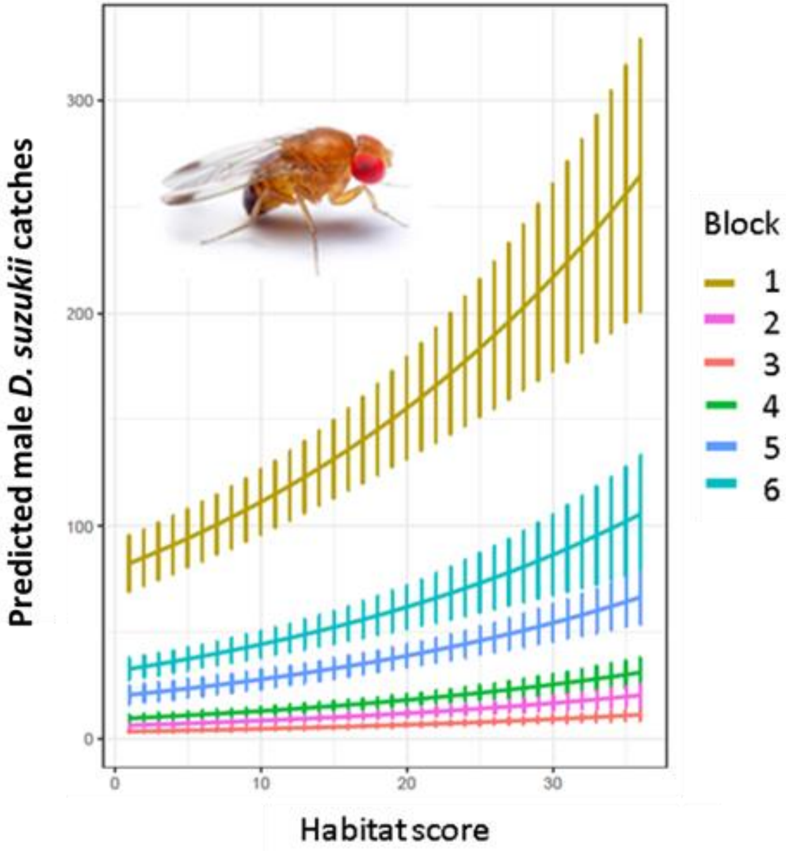
- SWD attractant – developing the pull
- SWD repellent trials – strawberry and raspberry
- SWD push-pull trial in commercial strawberry
- Improving the push
- Improving the pull

Previous work: pull strategy for SWD control

Winter pull in non-crop habitats, away from commercial crops.

Focus traps at SWD hotspots related to habitat.





Topics

- SWD attractant – developing the pull
- SWD repellent trials – strawberry and raspberry (semi field)
- SWD push-pull trial in commercial strawberry
- Improving the push
- Improving the pull

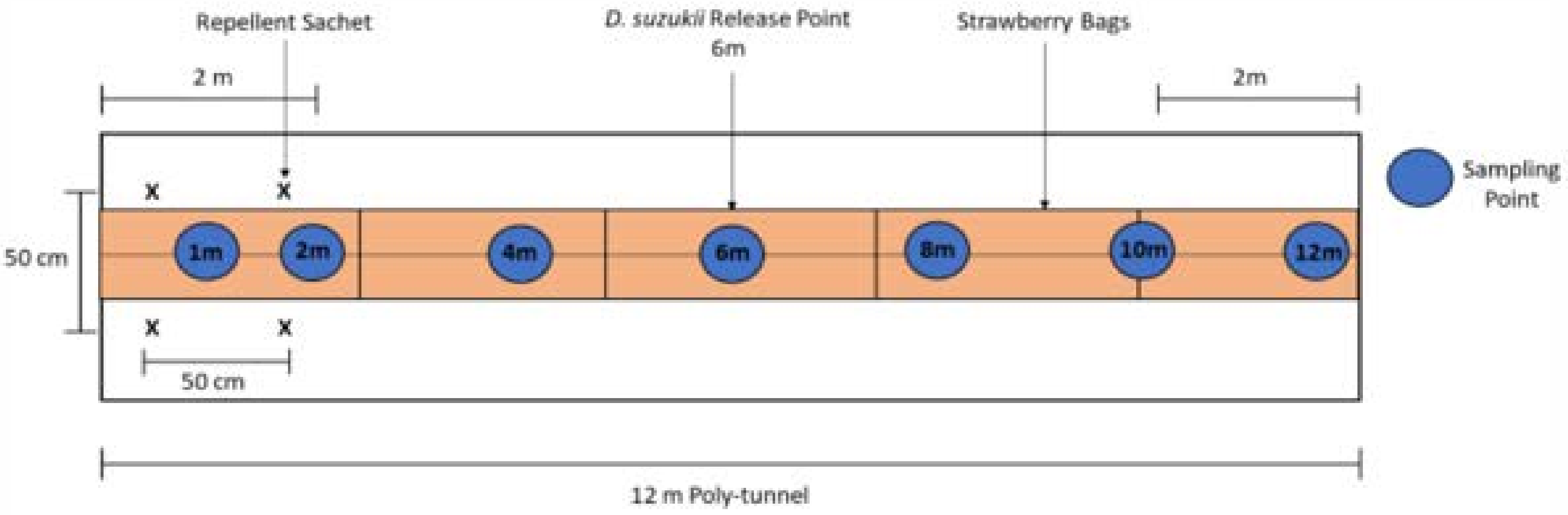
Christina Conroy PhD: Identify chemicals which act as repellents for SWD, summer and winter morphs


Research Article

Methyl *N,N*-dimethylanthranilate and ethyl propionate: repellents effective against spotted wing drosophila, *Drosophila suzukii*

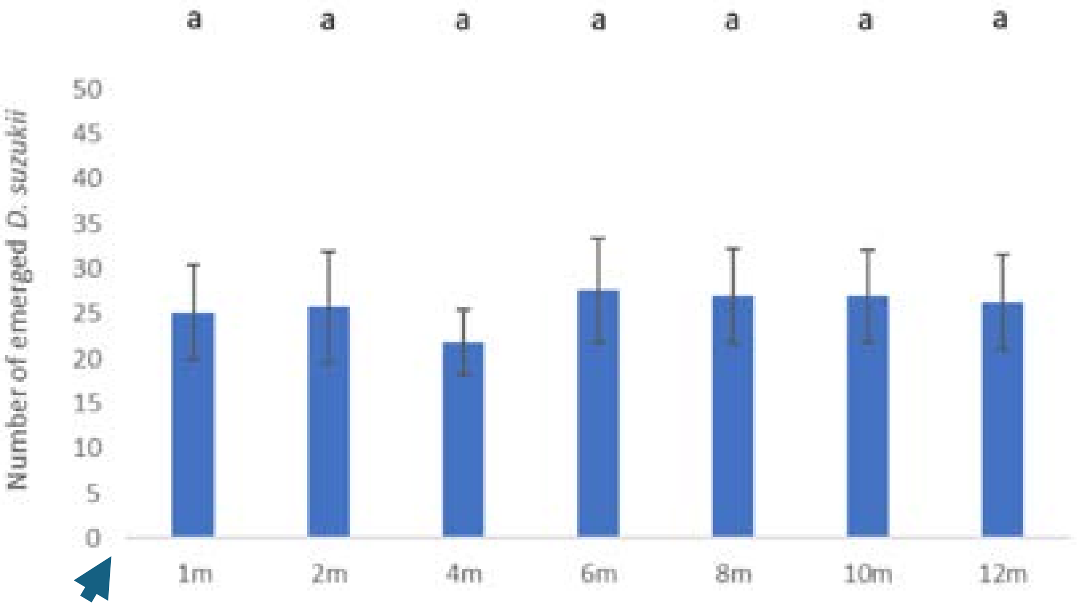
Christina Conroy,[a,b] Michelle T. Fountain,[a] E. Charles Whitfield,[a] David R. Hall,[b] Dudley Farman[b] and Daniel P. Bray[b*]

Count number of SWD emerging from fruits at distances from the repellent

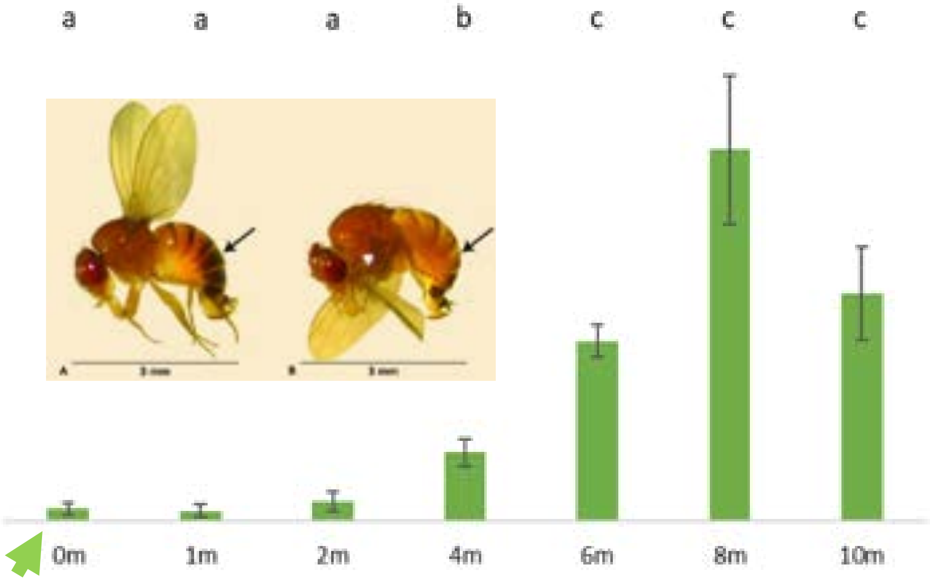


Evidence that repellents could be used as part of a push-pull strategy to protect fruit against SWD

No repellent



Repellent



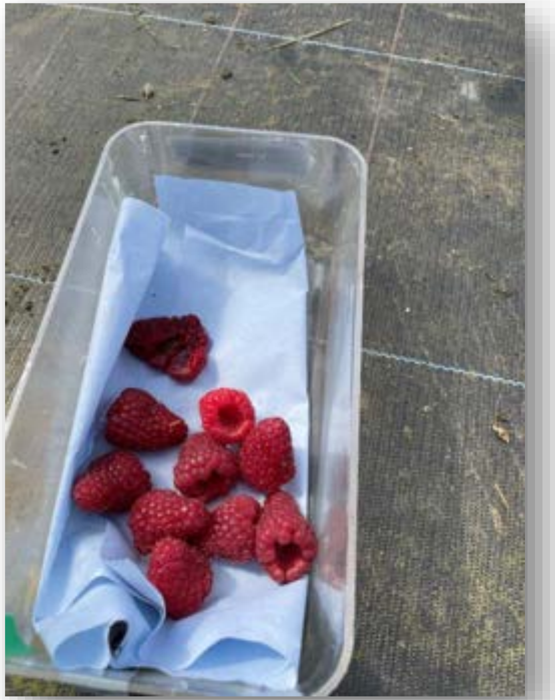
Control dispensers

Repellent dispensers

Assessing repellent in raspberry

Semi field trial

- No clear reduction in egg laying by prototype repellent
- Raspberry more vulnerable than strawberry



Topics

- SWD attractant – developing the pull
- SWD repellent trials – strawberry and raspberry
- SWD push-pull trial in commercial strawberry
- Improving the push
- Improving the pull

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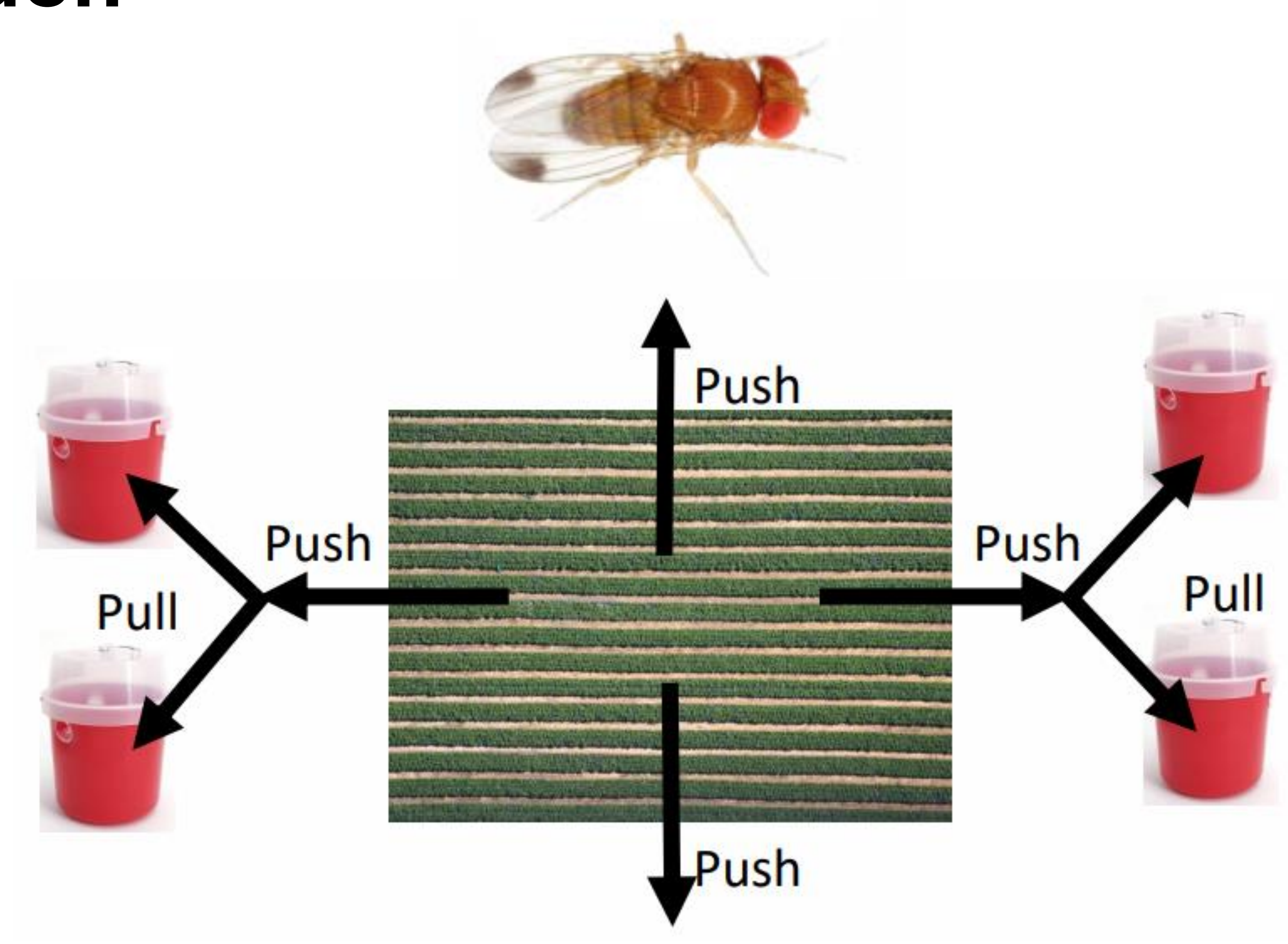
Push-pull approach

- Combine stimuli to
  - **Push** pest out of crop
  - **Pull** pest toward a trap
- Generally nontoxic
- Compatible with other control methods, preferably biological



Assessing push-pull in commercial strawberry: analyses of prototype repellent dispensers returned from field

Start Date	Sample Date	Days	Mean % remaining ± SE (N)
First deployment			
17-May-23	26-Jul-23	70	47.0 ± 2.2 (N=12)
17-May-23	02-Aug-23	77	46.4 ± 2.0 (N=8)
17-May-23	18-Aug-23	93	44.9 ± 7.0 (N=8)
Second deployment			
17/18-Jul-23	1/2-Aug-23	15	90.0 ± 1.0 (N=12)

- Prototype repellent dispensers found to last 6 months in the field

Assessing push-pull in commercial strawberry: flotation test results

SWD push-pull trial (commercial strawberry)

- No reduction in SWD egg laying
- Despite
  - 1) doubling prototype repellent dispensers,
  - 2) sampling fruit close to dispensers,
  - 3) dispenser deployment start of planting,
  - 4) switching to MagiPal dispensers

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Topics

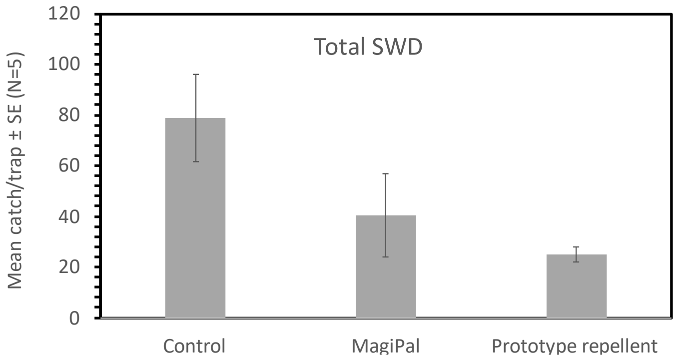
- SWD attractant – developing the pull
- SWD repellent trials – strawberry and raspberry
- SWD push-pull trial in commercial strawberry
- Improving the push
- Improving the pull

Optimise SWD repellent

In commercial strawberry, maybe prototype repellent and MagiPal dispensers reducing SWD feeding, but not egg laying

Field trial:

- Biobest Droso traps baited with Gasser attractant, with and without prototype repellent and MagiPal



- Catches reduced by both dispensers but only significant between prototype repellent and control (Gasser only)
- Dispenser mechanism? Masking / deterrent …?
- Currently repeating this experiment including prototype repellent and MagiPal combined

Topics

- SWD attractant – developing the pull
- SWD repellent trials – strawberry and raspberry
- SWD push-pull trial in commercial strawberry
- Improving the push
- Improving the pull

Optimise SWD attractants – monitoring and winter mass trapping

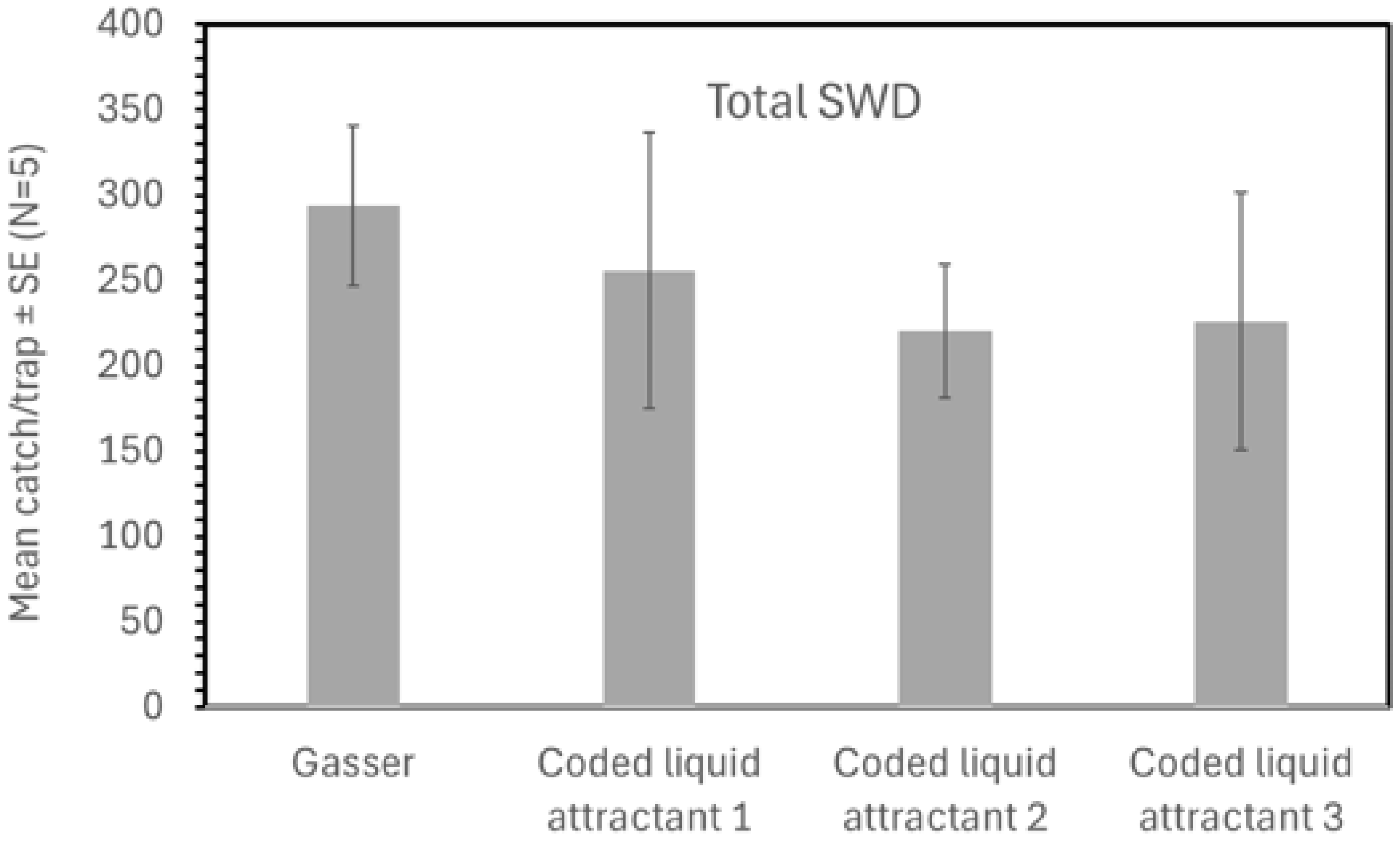
Gasser (industry standard)

Field trial at East Malling comparing:

- Gasser
- 3 coded liquid attractants (all blends)

Results:

- All coded blends as attractive as Gasser

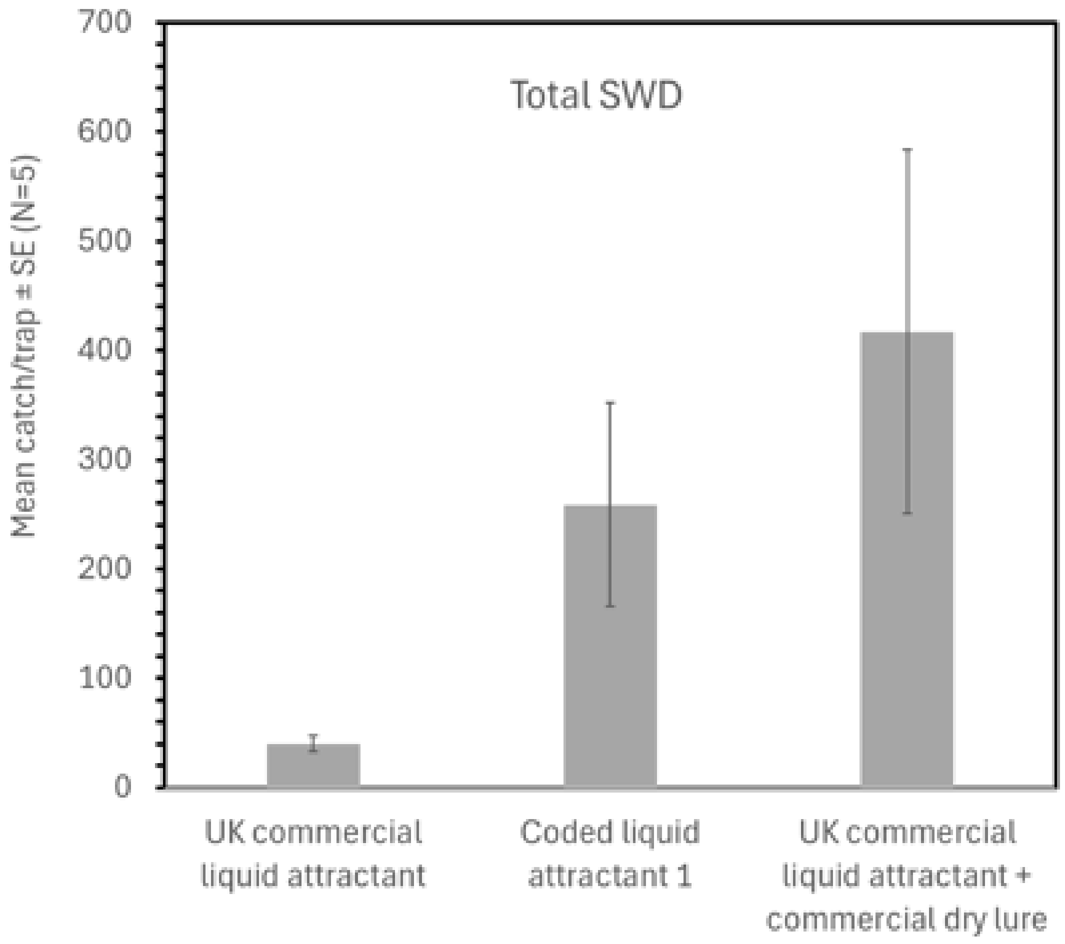


Optimise SWD attractants continued

Dry attractants are never as attractive as liquid attractant in bucket traps

Field trial at East Malling comparing:

- UK commercial liquid attractant
- Coded liquid attractant 1 (previous study)
- Commercial liquid attractant plus commercial dry attractant



Conclusions

- Although repellent works well on a small scale for strawberry – was not effective in raspberry
- When tested in commercial strawberry, push-pull system did not reduce egg laying
- Repellents reduce numbers of SWD in baited traps – but this is a food rather than egg laying attractant
- We have developed a commercial bait that is as attractive as Gasser and should be produced in the UK cutting down import costs