AHDB

Soft Fruit Review 2018

HORTICULTURE

Contents

Photography:
Page 5 – Yeast bottle – NIAB EMR
Page 6 – Melon and cotton aphid – Roger Umpelby
Page 8 – Strawberry picker – Chris Rose
Page 9 – Problem weed in rhubarb – ADAS
Page 10 – Blackcurrant sprayer – NIAB EMR
Page 11 – WFT in strawberry flower – NIAB EMR
Page 11 – WFT Adult – Nigel Cattlin/FLPA Images of Nature
Page 13 – Push/pull cage for SWD – NIAB EMR
Page 15 – SWD on raspberry – Washington State University
Page 15 – Bethan Shaw – NIAB EMR
Page 16 – SWD and Francesco Maria Rogai – Both NIAB EMR
Page 16 – Blueberries and *N. cucumeris* – Both NIAB EMR
Page 17 – *N. Cucumeris* – NIAB EMR
Page 18 – Aphids on strawberry – Roger Umpelby
Page 19 – Tarnished plant bug on strawberry fruit – Roger Umpelby
Page 19 – Capsid trap – NIAB EMR
Page 20 – Both images of fruit rots – NIAB EMR
Page 21 – Top left image of Verticillium wilt – ADAS
Page 22 – Two-spotted spider mite on strawberry leaf – ADAS
Page 23 – *Phytoseiulus persimilis*- NIAB EMR
Page 24 – *Phytophthora rubi* – ADAS and pots of roots – ADAS
Page 25 – Sawfly trap and sawflies – Both NIAB EMR
Page 26 – Botrytis in blackcurrants – ADAS
Page 30 – Laboratory shot – NIAB EMR
Page 31 – Both images NIAB EMR
Page 33 – Raspberry – the James Hutton Institute
Page 34 – Both images of raspberry – the James Hutton Institute
Page 35 – Strawberry – NIAB EMR

Meet the team

AHDB Horticulture contacts

Katja Maurer
AHDB Research Manager
T: 02476 478747
E: katja.maurer@ahdb.org.uk

Scott Raffle
AHDB Knowledge Exchange Manager
T: 01732 876671
E: scott.raffle@ahdb.org.uk

Vivian Powell
AHDB Crop Protection Manager
T: 07793 042335
E: vivian.powell@ahdb.org.uk

Elected members

Louise Sutherland (Chair), Freiston Associates, Lincolnshire
Sandy Booth, New Forest Fruits, Hampshire
Lindsay Hulme, E Oldroyd, Yorkshire
Andrey Ivanov, Wilkin & Sons Ltd, Essex
James Porter, WH Porter, Angus
Martin Skarp, Hall Hunter Partnership, Berkshire
James Waltham, Haygrove Growing, Herefordshire
James Wright, Whittern Farms Ltd, Herefordshire
Roger Vogels, S&A Produce, Herefordshire
Gerard Olivier, Edward Vinson Ltd, Kent
Trelawney Greaves, PJ Stirling, Angus

Foreword

Welcome to the Soft Fruit Review 2018.

I have been working closely with the grower members of our AHDB Soft Fruit Panel and others in the industry to ensure that we continue to fund research that is a high priority for you all. To aid us in this process, we have set up a 'Risk Register', which ranks your production problems. In the case of crop protection issues, it takes account of currently available control measures. When the AHDB Crop Protection team alerts us to pending withdrawals of current approvals, the ranking will change and this will highlight the need for further research.

On that note, spotted wing drosophila (SWD) remains a major challenge and we have increased the number of projects and experiments we fund on this pest. You can read about the progress being made in our main SWD project (SF/TF 145a), which includes interesting new work on the use of bait sprays and push/pull mechanisms to draw the pest away from the crop. This theme is being further developed in a new Collaborative Training Partnership studentship project, being undertaken by Christina Faulder at NIAB EMR and University of Greenwich.

We continue to part-fund the East Malling Strawberry Breeding Club, which is delivering a continuous stream of new and improved varieties following the success of Malling Centenary and also the Raspberry Breeding Programme at the James Hutton Institute.

In the past year, we have also set up a new dedicated GrowSave programme for soft fruit growers, designed to provide useful information for glasshouse and fixed tunnel growers to help them reduce energy costs.

I wish you a successful production season in 2019.

The reports that follow contain a snapshot of each project. Further detailed reports can be read at **horticulture.ahdb.org.uk/sector/soft-fruit**

Louise Sutherland
Soft Fruit Panel
Chair

GrowSave glasshouse

News and updates

A smarter way to work

SMARTHORT

AHDB has launched a campaign to help the industry address one of its biggest concerns: access to affordable labour as a result of rising wage costs and difficulties in recruiting and retaining seasonal staff.

The campaign, SmartHort, has two strands: improving management practices for the existing workforce and identifying new technologies, such as robotics and automation, which could reduce labour requirements in the long term.

An updated version of the film 'Creating Champion Employees' will be released early in 2019. To be used as part of an induction process, it shows new staff how to pick fruit quickly and efficiently to become a champion employee. The film will be translated into seven languages.

A series of workshops will take place in the New Year to introduce concepts of lean, Champion and Continuous Improvement, with practical recommendations about how to implement changes in your business to improve labour efficiencies.

The future of automation and robotics will be explored at SmartHort 2019, a two-day conference dedicated to driving innovation in horticulture. Guest speakers from around the world will share some of the most impressive and exciting technological developments that could change the way you grow. The conference takes place in Stratford-upon-Avon on 6 and 7 March 2019.

To book on to a SmartHort event or access our resources, visit **horticulture.ahdb.org.uk/smarthort**

Save your energy

GrowSave, an AHDB-funded project, has been helping the protected edible and ornamental industry to reduce its their energy costs and use for over 10 years. The project has now been extended to share this knowledge with soft fruit growers producing under glass and fixed tunnels.

The project specialises in sharing technical knowledge on glasshouse structures, ventilation, lighting, heating, storage and cooling, boilers, pumping and climate control.

Specialist information for the soft fruit industry will be shared through events, GrowSave News, The Grower and **growsave.co.uk**

AHDB set to fly flag at Fruit Logistica again

Following several successful years at Fruit Logistica, showcasing the best of British produce to the rest of the world, AHDB will be returning to the exhibition in 2019.

Over 78,000 trade visitors attend Fruit Logistica each year from every link in the supply chain. It is a great opportunity to meet new and existing customers and grow your exporting potential.

AHDB is offering growers the opportunity to network from our stand. For further details, please contact **amanda.morby@adhb.org.uk**

Fruit Logistica 2019 takes place in Berlin, Germany, from 6–9 February 2019.

New resources

A variety of useful videos, factsheets and guides are freely available on our website. Recently published factsheets include recommendations on controlling weeds in container-grown soft fruit, control options for vine weevil and precision irrigation methods. A video has also been released to provide guidance on how to easily calibrate proportional dilutors. Find them at **ahdb.org.uk/knowledge-library**

Keep in touch

If you're not currently receiving our emails, including Crop Protection News, Horticulture News, EAMU notifications, event alerts or our publications and would like to do so, simply fill in our form at **ahdb.org.uk/horticulture-subscriptions**

New projects

Discover some of the new projects that AHDB will be working on in the coming years.

AHDB project code: SF 171: Rhubarb: Enhancing the profitability of rhubarb using spectral modifications

Term: February 2018 to May 2019
Project leader: Emily Lawrence, ADAS

Traditional forcing of early rhubarb is labour-intensive and expensive. In recent years, there has been little research or development to find cheaper ways of forcing rhubarb. This project will investigate a novel system of field-forcing rhubarb with a quality approaching that of forced, but with significantly lower labour and energy costs. The work will review a variety of currently commercially available polythene films, used to cover the tunnels, in which the rhubarb would be forced. The films will allow the transmission of specific wavelengths of light to stimulate stem pigmentation, etiolation and sugar accumulation. The films will then be assessed in a commercial tunnel forcing trial, recording their effects on yield, crop quality and pest and disease control. Collateral effects, such as the reduced requirement for forcing conditions (cost of heating, dedicated forcing sheds) to produce a crop of high market value, will also be assessed. If successful, guidelines will be produced to help them implement similar systems.

AHDB project code: CP 170: Bioinspired vision systems for automated harvesting

AHDBSTUDENTSHIP

Term: August 2017 to July 2020
Project leader: Michael Mangan, University of Sheffield
PhD student: Zeke Hobbs

Robotic harvesting of strawberries is an aspiration that is still some way from becoming a commercial reality for the strawberry industry. However, this PhD studentship project at Lincoln University aims to develop the vision systems that are required by a robot to decide which strawberry fruits are ready to be picked. The work will take inspiration from insects such as bees and fruit flies, which use visual cues invisible to humans and which tend to be overlooked by engineers. The student will work closely with industry partners to collect a novel image database of fruits and flowers at various stages of development and in different weather, lighting and protected conditions. This will be done using a specially developed camera that mimics the vision system of insects. Subsequent analysis will allow the fundamental methods employed by these insects to be revealed. The results will provide a vision system that could be used to drive a robotic strawberry harvester.

AHDB project code: CP 171: The use of highly attractive yeast strains for controlling *Drosophila suzukii*

AHDBSTUDENTSHIP

Term: October 2017 to September 2020
Project leaders: Matthew Goddard, University of Lincoln and Michelle Fountain, NIAB EMR
PhD student: Rory Jones

AHDB has been funding research into spotted wing drosophila (SWD) since 2013 through the industry-funded project SF 145.

The work has identified that SWD populations reach a peak during the autumn and early winter months. It has also shown that ripening fruits tend to be more attractive to SWD adults than the baits currently used in commercial monitoring traps. In this project, a PhD student at the University of Lincoln, who has identified yeast attractant strains to other Drosophila species, will test and identify different species and strains of yeast as feeding attractants to *Drosophila suzukii*. Working in collaboration with the Entomology team at NIAB EMR, the student aims to use the best attractant strain of yeast in 'attract and kill' systems. The aim is to reduce reservoirs of overwintering adult flies after the main cropping period, which is when populations are highest and when no fruits are present to compete with the yeast bait.


Melon and cotton aphids

AHDB project code: CP 173: Towards a better understanding of the biology and genetics of *Phytophthora rubi* and *Phytophthora fragariae*

AHDBSTUDENTSHIP

Term: October 2017 to March 2021
Project leader: Eleanor Gilroy, the James Hutton Institute
PhD student: Aurélia Bézanger

The control of raspberry root rot and other Phytophthora diseases in soft fruit continues to be a major research priority for the UK soft fruit industry. Plant-based resistance is the only way forward, but this requires knowledge of the effector arsenal by which pathogens will be recognised by the plant.

This project aims to study in detail the unusual lifecycle and disease progression of *P. rubi* (the cause of raspberry root rot) and other closely related fruit crop-infecting Phytopthoras. The PhD student will develop *P. rubi* transformation protocols, generating transgenic strains to allow close monitoring of the infection process in real time, as well as to improve upon raspberry infection methods to allow better study of the roots during infection in resistant and susceptible cultivars. Using computational analysis, sequences of interest from genomic DNA of *P. rub*i will be identified and assessed to allow us to better understand the current diversity and population structure of *P. rubi* in the UK's fields and nurseries.

AHDB project code: CP 176: Selection and improvement of insect pathogenic fungi for the control of multi-resistant aphids

AHDBSTUDENTSHIP

Term: October 2018 to September 2021
Project leader: Ben Raymond, University of Exeter
PhD student: Zoltan Erdos

Several aphid species – in particular, *Myzus persicae* (peach-potato aphid) have evolved resistance to traditional chemical aphicides. Future control could be further compromised by the arrival of multiresistant clones from mainland Europe. Microbial biocontrol agents are widely used for other pests, but generalist pathogenic fungi used to control aphids tend to have only moderate killing power. This PhD Studentship project will investigate whether aphids that have developed resistance to traditional chemical control products are more susceptible to pathogenic fungi. It will also develop novel methods to select pathogens that are more effective at killing *Myzus persicae* and assess whether the pathogenic fungi have reduced impact on beneficial insects.

> “Future control could be further compromised by multi-resistant clones arriving from mainland Europe”

Collaborative Training Partnership (CTP) for fruit crop research

The CTP is a new research programme for UK Horticulture that is jointly funded by the Biotechnology and Biological Sciences Research Council (BBSRC), AHDB and innovative international businesses. The specific programme for fruit crop research is led by Berry Gardens Growers Ltd on behalf of an industry consortium collaborating with its principal academic partner, NIAB EMR. The programme aims to deliver high quality research projects, while concurrently training the next generation of researchers to support the UK horticultural industry. In 2017, three CTP projects with direct relevance to the soft fruit began.

Development and implementation of season long control strategies for Drosophila suzukii in soft and tree fruit

AHDBSTUDENTSHIP

Term: October 2017 to September 2021
Project leaders: Michelle Fountain, NIAB EMR and Daniel Bray, NRI University of Greenwich
PhD student: Christina Faulder

This project relates to project SF/TF 145a and will build upon a number of ongoing research projects at NIAB EMR and NRI investigating novel control methods for spotted wing drosophila (SWD). It will provide the basis for an IPM control strategy targeting *D. suzukii*, suitable for commercial growers of stone and soft fruit. The research will optimise attractants and repellents and their deployment. The integration of several control methods to form a push/pull system is a novel idea for this pest and will lead to a significant reduction in the use of traditional crop protection products. Improved understanding of the insects sense of smell and searching behaviour will provide the scientific basis for the development of the push/pull system.

Term: October 2017 to September 2021
Project leaders: Gerard Bishop, NIAB EMR, Simon Pearson, University of Lincoln and Paul Hadley, University of Reading
PhD student: Ben Chester

The UK strawberry market continues to grow but we are importing an increasing volume of fruit during the winter months. The UK has an opportunity to produce greater volumes of fruit during the winter, but this requires glasshouse technology combined with modern supplementary lighting systems. There is an on-going interest in the application of LED lighting systems in modern glasshouse as these provide an energy efficiency gain of approximately 30% over conventional high-pressure sodium systems. LEDs also offer opportunities to provide highly defined spectral outputs to maximise productivity. However, these opportunities have yet to be realised. We do not currently understand the optimal spectral qualities for strawberry or any other crop, how these change through production or how they affect the key agents (photosynthesis/radiation capture/ partitioning etc.) of yield and quality. This PhD project will examine these issues and develop optimal strategies for the use of LED lighting in soft fruit production.

Term: October 2017 to September 2021
Project leaders: Bo Li, NIAB EMR and Tom Duckett, University of Lincoln
PhD student: Jake Bird

This project relates to Project CP 170 in that the research will aid the development of a robotic strawberry harvester. The main objective is to deploy novel machine learning technologies to detect, locate and measure (size and colour) fruit. This will involve the use of advanced machine learning algorithms. Researchers from the University of Lincoln have previously developed similar systems for broccoli. This earlier work showed that 3D cameras could be deployed in field environments, but the alogrithms were highly complex with relatively slow processing speed. The new challenge for this PhD project will be to minimise processing requirements to identify fruit while maximising processing speed and recognition fidelity.

AHDB STUDENTSHIP

Term: October 2017 to September 2021
Project leader: Paul Baxter, University of Lincoln
PhD student: Alexander Garbriel

This PhD research aims to develop human behaviour recognition and interpretation capabilities for robots in outdoor situations. It forms part of the RASberry project which is developing robots for in-field transportation to support human fruit pickers. Within the RASberry project, this research is striving to improve the communication possibilities between humans and robots; a challenge that is made harder by a number of factors including distance, wind, changing lighting conditions and backgrounds and uneven ground. Current work is evaluating various sensors for suitability while building a first, prototypical solution.

AHDB STUDENTSHIP

Term: October 2017 to September 2021
Project leader: Grzegorz Cielniak, University of Lincoln
PhD student: Raymond Kirk

This project aims to progressively implement crucial components required for robust autonomous fruit harvesting and yield forecasting. The problem is comprised of five major milestones: fruit segmentation, detection/classification, maturity evaluation, quality grading and finally localisation and pose estimation. The new challenge will be to minimise computational requirements to identify fruit, while maximising processing speed and recognition fidelity. This project will complement Jake Bird's CTP studentship, which focuses mainly on shape analysis and localisation of fruit in 3D space.

SCEPTREplus programme to identify new crop protection products

Term: April 2017 to March 2021
Project leader: Jerry Cross, NIAB EMR

SCEPTREplus is an AHDB programme of research designed to assess the efficacy of new or emerging crop protection products at controlling pests, diseases or weeds in the full range of horticultural crops. It is a four year programme that will link with existing crop protection projects and, in particular, dovetails closely with the AMBER project on biopesticides. In terms of on soft fruit, the project will link closely with crop protection projects on spotted wing drosophila (SF 145a), strawberry pests (SF 156), strawberry diseases (SF 157) and cane fruit pests and diseases (SF 158), providing a forum to examine the efficacy of products for controlling some of the pests and diseases being researched in these other projects.

In the first year of the project, research was done to assess new oviposition deterrents for spotted wing drosophila to reduce its damaging effects in raspberry and blackberry. The results of this research can be read in the crop protection section on page 10.

Five new SCEPTREplus projects have begun in the last year, which have relevance to the soft fruit sector.

Weed control in rhubarb

Project leader: Angela Huckle, ADAS

Weed control is still one of the high research priorities for commercial rhubarb growers. This project is conducting two herbicide screening trials. The first has been assessing a variety of new contact-acting herbicide products, either alone or in combination, on commercial rhubarb production sites in Hampshire and Yorkshire. The products were applied in June and July. The second screening trial is assessing residual-acting herbicide products, alone or in combination on a trial in Yorkshire, where products were applied either to Timperley Early in February or to Victoria in March. Three or four useful products have been identified and these are being discussed further with AHDB and the manufacturers.

Identification of new acaricides for gall mite

Project leader: Adrian Harris, NIAB EMR

Control of blackcurrant gall mite continues to be a major challenge for the industry and control is proving difficult with the current products available. Fourteen treatments are being assessed for their efficacy at controlling blackcurrant gall mite. These treatments consist of products either alone or in combination. Additional work is being done in this project to assess the effect of climate change on the timing of migration of gall mites from blackcurrant buds. To this end, sticky traps are being used to monitor the movement of the mites over a period of weeks to find out if the mites are migrating for a longer period than they did in the past, making it more difficult to gain control.

Weed control in blackcurrants

Project leader: Sonia Newman, ADAS

Black nightshade and field bindweed are extremely difficult to control in commercial blackcurrant plantations. Black nightshade germinates very late in the season – often from May onwards – by which time, winter-applied residual herbicides are losing their activity. Bindweed is not controlled by currently approved herbicides. Screening trials are being carried out for both weed species to assess five or six treatments and compare them to untreated controls and standard blackcurrant herbicide programmes.

Integrated treatment strategies to control raspberry cane midge and blackberry leaf midge

Project leader: Charles Whitfield, NIAB EMR

Raspberry cane midge and blackberry leaf midge have been causing increasing levels of damage in recent seasons. Growers' ability to control both pests has been further compromised by the loss of chlorpyrifos containing products, so new control products are required. Initially, this project will undertake a review of available products and identify conventional and novel chemistry and other control strategies (biological products) that are compatible with an integrated pest management (IPM) programme, and could be used in the UK. At a later stage, any products with potential would be assessed in efficacy trials.

Integrated treatment strategies to control capsid bugs

Project leader: Glen Powell, NIAB EMR

Capsid control continues to be a major challenge for the soft fruit industry. As few biological control options are available, growers have had to rely on traditional control products. However, most of those that are effective against capsids, disrupt biocontrol programmes against other pests. A survey and review of all potential products with activity against capsids will be carried out and a list of promising new synthetic insecticides/biopesticides drawn up. Based on these findings, an experimental trial will be designed to test the most promising new leads for their efficacy in protecting strawberries from capsids.

Gall mite control

Crop protection

Growers have always considered crop protection research and the resulting delivery of new pest, disease and weed control measures as a principal function of AHDB. Both the research and the administration of securing new crop protection products are tasks that AHDB is structured to deal with effectively on behalf of the soft fruit industry.

AHDB Soft Fruit Research Panel Manager Katja Maurer, works with the Soft Fruit Panel Chair and grower members to identify the most pressing crop protection research needs and commissions projects to find solutions. She also works with our team of Crop Protection Research Managers Vivian Powell, Bolette Palle-Neve, Spencer Collins and Joe Martin, to identify pests, diseases and weeds where additional crop protection products are required by the industry to gain commercially acceptable control.

With approvals for so many products being lost on an annual basis, it is becoming increasingly difficult to help the industry maintain a sufficiently effective armoury of crop protection products. However, we have developed a system that we are confident will continue to deliver new and essential products to growers.

Each year, Katja works with the Soft Fruit Panel members to update a 'risk register' for pests, diseases or weeds that growers find most difficult to control and, from this, we produce a list of 'priorities' for new research projects.

Most of the 'priorities' are already being addressed in existing projects, such as spotted wing drosophila (SWD), western flower thrips and strawberry powdery mildew. However, new problems come to the fore each year and Katja seeks to address these when funds are made available to commission new projects.

Alongside this risk register, the Crop Protection team runs a system to track the changes that continually take place with product authorisations. This is done through liaison with the Government's Chemicals Regulation Division (CRD), the agrochemical manufacturers and a network of crop protection specialists in both EU member states and countries outside of the EU. Such networking allows the team to pre-empt problems for the soft fruit sector. Not only does this give us advance warning of a pending problem, it also links to our 'risk register' and adjusts our research priorities accordingly.

For example, a pest may have been rated as being of only moderate risk to a strawberry crop, because the industry had access to an effective control product, so it was of low priority for future research. However, when our Crop Protection team receives advance warning that the authorisation for this control product is to be lost, the risk rating on our register is amended and the pest becomes a high or urgent priority for further attention.

A high or urgent priority can be dealt with in three ways. Firstly, Katja can work with the Soft Fruit Panel to commission new research to develop alternative control measures. However, this can take time, so often more urgent action is required. A second course of action is to assess alternative control products in the SCEPTREplus programme. This is designed to assess the efficacy of new or emerging crop protection products at controlling pests, diseases and weeds. A third option for the most urgent situations is to submit applications to CRD for EAMUs or 120-day emergency authorisations.

The latter option often requires us to collaborate with agrochemical manufacturers, the EU Minor Uses Commodity Expert Group and other groups outside of the EU to gather safety and other data which is required by CRD before they can issue such EAMUs or emergency authorisations. A number of these have been secured by AHDB on your behalf in the last year (see the table on page 12).

Some of these products have been delivered by CRD for the emergency control of SWD. Harriet Duncalfe, Chair of the SWD industry working group, works closely with Scott Raffle and Vivian Powell to keep CRD fully informed of our ongoing research into SWD and the needs of the soft and stone fruit industry for emergency control products. CRD have been extremely helpful in seeking to issue these products at the most appropriate time of the season for each susceptible crop.

Growers and grower groups who have concerns about impending losses of crop protection products should contact the AHDB Horticulture crop protection team at **EAMU@ahdb.org.uk**

> "We are greatly indebted to staff at CRD for the help and co-operation we received in securing emergency authorisations for SWD control in 2018"

Vivian Powell, AHDB Horticulture Crop Protection Senior Scientist (Pesticide Regulation)

EAMUs secured in 2017/18

A list of the key products that have been delivered through AHDB activity in 2017/18 are found in the table below. Note that some of these approvals will have lapsed by the time of publication.

Product	Active ingredient	EAMU No.	Crops	Target pest/disease
Masai (13082)	tebufenpyrad	2262/17	Outdoor and protected blackcurrant, redcurrant, gooseberry and blueberry	Gall mite
Masai (13082)	tebufenpyrad	2263/17	Outdoor raspberry and blackberry	Two-spotted spider mire
Justice	proquinazid	2436/17	Protected strawberry	Powdery mildew
Toledo (14036)	tebuconazole	2503/17	Outdoor and protected raspberry and blackberry	Cane blight
Dynamec	abamectin	2532/17	Protected blackberry	Two-spotted spider mite and raspberry leaf and bud mite
Dynamec (13331)	abamectin	2658/17	Outdoor and protected strawberry	Two-spotted spider mite and tarsonemid mite
Centurion Max	clethodim	2726/17	Outdoor and protected soft fruit	Annual and perennial grass weeds
Amylo X WG	*Bacillus amyloliquefaciens*	0469/18	Outdoor and protected strawberry	Botrytis and powdery mildew
Apollo 50 SC	clofentezine	0620/18	Outdoor and protected strawberry, outdoor raspberry and blackberry	Two-spotted spider mite
Tracer	spinosad	1203/18	Outdoor raspberry and blackberry	Thrips
Tracer	spinosad	1207/18	Protected raspberry and blackberry	Thrips
Benevia 10OD	cyantraniliprole	1382/18*	Outdoor and protected strawberry	SWD
Exirel 10SE	cyantraniliprole	1383/18*	Outdoor and protected blueberry	SWD
Tracer	spinosad	1395/18*	Outdoor strawberry	SWD
Custo-Fume	chloropicrin	1432/18*	Outdoor and protected strawberry, raspberry and blackberry	Nematodes and soil borne diseases
Exirel 10SE	cyantraniliprole	1479/18*	Outdoor and protected raspberry and blackberry	SWD
Botanigard WP	*Beauveria bassiana*	1507/18	Outdoor and protected soft fruit	Two-spotted spider mite and whitefly
Plenum WG	pymetrozine	1629/18	Protected raspberry and blackberry	Aphids
Plenum WG	pymetrozine	1630/18	Protected strawberry	Aphids
Tracer	spinosad	1941/18	Protected strawberry	*Blastobasis lacticolella*
Chess WG	pymetrozine	2095/18	Protected raspberry, blackberry, redcurrant and gooseberry	Aphids
Chess WG	pymetrozine	2106/18	Protected strawberry	Aphids
Nimrod (13046)	bupirmiate	2110/18	Outdoor blackcurrant and redcurrant	General disease control
Serenade ASO	*Bacillus subtilis*	2336/18	Outdoor and protected raspberry and blackberry	Botrytis
Serenade ASO	*Bacillus subtilis*	2346/18	Outdoor and protected blueberry, blackcurrant, redcurrant and gooseberry	Botrytis

*denotes article 53 authorisation for 120 days.

Pests and diseases

Developing an SWD push/pull system

AHDB project code: SF/TF 145a
Term: April 2017 to March 2021
Project leader: Michelle Fountain, NIAB EMR

Since 2013, AHDB has been funding research into the management and control of spotted wing drosophila (SWD) in soft and stone fruit crops. The initial project (SF 145) was led by Michelle Fountain at NIAB EMR in association with the James Hutton Institute; this ended in March 2017. It greatly enhanced our knowledge and understanding of how SWD behaves in UK growing conditions and the best management and control options available to growers. However, SWD remains one of the greatest challenges for growers and further research is needed to develop measures that growers can employ to maintain control.

The project

This project aims to track the development of pest populations across the UK throughout the calendar year. It will develop and test a 'push/pull' system using repellents and 'attract and kill' strategies. Novel bait sprays will also be investigated, using them in combination with control products to see if they will enhance their efficacy. The opportunity to prolong spray intervals to maximise the effect of control products, while reducing the number of applications, will be assessed. Later in the project, work will be done to integrate the use of exclusion netting with other control options. The results of all of these lines of investigation will be compiled in a year-round SWD control strategy for growers.

National monitoring

The Entomology teams at NIAB EMR and the James Hutton Institute have continued to monitor populations of SWD across the UK with the help and collaboration of Berry Gardens. Fifty-seven traps have been deployed across nine farms in England (in Kent, Surrey, Herefordshire, Staffordshire, Northamptonshire, Yorkshire and Norfolk) and 40 traps deployed on four farms in Scotland.

Numbers and activity of SWD increased earlier in the spring (Mar-May) and late summer (Jul-Aug) of 2017 than in previous years. This earlier activity correlated with increases in reported damage to early forced June-bearer strawberries and resultant higher populations caused damage in later cane fruit. The first peak autumn catch was almost a month earlier and catches in the November/December period were almost double the number of the previous highest recording. These peaks coincided with mild weather and the Nov/Dec peak coincided with an absence of fruit and leaf defoliation in crops and wild areas, a time of year when SWD adults are more attracted

Assessing 'attract and kill' technology

> "Unlike mass traps, the 'attract and kill' device is open-ended and does not become saturated with dead flies"

to the lures contained within monitoring traps. Preliminary data from 2018 are showing spring trap catches very similar to 2016; this is likely due to the cooler spring in 2018. Numbers were similar to records from 2016, through the summer months, with the exception of July and August where catches were higher than 2016, but lower than 2017. It would appear that the cool spring and the hotter, dryer weather were detrimental to SWD population build-up early on, but numbers in late summer rose once there was rainfall and the temperatures were cooler. This monitoring work will continue throughout the life of the project to improve our understanding of population changes and habitat preferences.

Developing a push/pull system

The aim of this work is to combine the use of repellents and attractants, so that the pest can be pushed away from the crop using a repellent and attracted into a trap which would contain a distracting or fatal component.

Early experiments to assess the impact of several repellents, used either alone or in combination in an unsprayed cherry orchard, were disappointing as no statistically significant results were produced, partly because the numbers of SWD in the cherry orchard were too aggregated early in the season or too high later in the season. It is possible that the plot size was too small to be able to detect repellent effects. However, a blend that was used in the first experiment only resulted in one SWD egg being found in sentinel fruit. A larger scale experiment, which tested the repellent blend in 25 x 25m strawberry crop plots, was done in 2018 and data is currently being analysed.

An experimental 'attract and kill' prototype trap is being compared with one in commercial development, with both containing a control component enclosed within the inner surface of the device to minimise human exposure and environmental contamination. Unlike mass traps, the 'attract and kill' device is open-ended and does not become saturated with dead flies, which reduces labour costs. The experimental prototype Falcon tube device used Decis (deltamethrin) as a killing agent and was found to be as effective as the commercial trap in controlling SWD. The device achieved up to 30 per cent kill within 24 hours in semi-field cage trials. The devices with eight holes on the red sections of the tube were more effective than devices with four holes on the clear part of the trap. However, increasing the number of holes on the device from eight to sixteen did not increase the efficacy. The devices are currently being tested for their efficacy in the presence of competing fruits and an attempt will be made to see if it is unmated or fecund females that are more likely to enter the traps.

Further work was carried out to develop the Cha-Landolt SWD lure into a dry formulation contained within a sachet, which is more practical and easier for growers to use than a liquid equivalent. Such dry lures only require changing every six weeks compared with every week for liquid lures. Experiments were done to optimise the release rates of the different components of the dry lure in the sachet. The optimised lure caught greater numbers of SWD adults than the liquid Cha-Landolt lure or the Dros'Attract lure in some experiments but less in others. The reason for this is not yet clear. Further work is developing a 'Minilure' for use in the Falcon tube attract and kill device which will have a lifetime of six weeks or more.

Bait sprays

Using bait sprays in combination with spray control products should help to attract SWD adults to feed on the spray product, improving the likelihood of control. When compared to a spray control product on its own, it offers the potential to gain the same level of control with a lower rate of product. This would have the added benefit of reducing the risk of residues occurring and the development of resistance to the product.

Commercially available and novel baits were tested for their attractiveness to SWD, their toxicity to SWD when combined with a low dose of control product and their ability to prevent egg laying. In laboratory tests baits tested included a suspension of the yeast *Hanseniaspora uvarum* in sugar solution, fermented strawberry juice and Gasser bait. All of these significantly enhanced the efficacy of Tracer (spinosad) when used at 3.3 per cent of the recommended field rate for protected strawberries (at six per cent recommended field rate, 100 per cent mortality was observed in the laboratory). The yeast suspension (combined with a control product) was most effective in killing SWD, but all three were effective in reducing egg laying to a low level. Both the yeast plus sugar solution and the fermented strawberry juice improved the level of SWD mortality when mixed with Tracer, Hallmark (lambda-cyhalothrin) and Exirel (cyantraniliprole). In more recent work Calypso has been shown to be effective at reducing egg laying and increasing adult fly mortality if used in a bait. This is encouraging because Calypso has only moderate efficacy when used as a conventional spray; therefore, it would be helpful if it could be used in a bait as part of product rotation to prevent resistance. Additional experiments have shown no difference in toxicity when the baits are applied to leaves including cherry, raspberry, strawberry blueberry and blackberry leaves. To date there have been no phytotoxic effects of the baits on the plant material.

Prolonging spray intervals

To investigate spray intervals, trials were conducted in a commercial cherry crop under replicated tunnels and in a single tunnel at NIAB EMR in 2017. Either a weekly or fortnightly spray programme was employed on both sites, with fruits and leaves collected weekly, just before the next spray was applied. Fruits were collected from the commercial site and incubated to calculate the numbers of emerging SWD. Laboratory bioassays were performed on the leaves at the NIAB EMR site to test the mortality of SWD that came into contact with the leaves. At the commercial site, there were no differences in the numbers of SWD adults emerging from the fruits between the weekly and fortnightly sprays. In the NIAB EMR site, there was significantly more SWD mortality in the weekly and fortnightly spray programmes compared to the untreated control, but no difference between the two spray programmes. The study demonstrated that fortnightly sprays gave comparable efficacy to weekly sprays in cherry crops.

Disseminating results of SWD research

Factsheet 06/17 *Management and control of spotted wing drosophila* provides comprehensive guidance on the research results and management control measures that growers should implement. The latest information about SWD can be found on our website, horticulture.ahdb.org.uk/swd. If you're not already receiving our email alerts about SWD activity, sign up at ahdb.org.uk/horticulture-subscriptions.

The project integrates with several AHDB, CTP and other PhD studentships supervised by NIAB EMR and associated universities. The aim is to increase our knowledge subsequent control of SWD while ensuring a research base of experts on SWD into the future.

> "SWD females choose to lay fewer eggs in fruits containing other species of Drosophila"

Students get to grips with SWD

AHDB project code: CP 122
AHDBSTUDENTSHIP
Term: September 2014 to August 2017
Project leader: Darren Obbard, University of Edinburgh and Jerry Cross, NIAB EMR

AHDB project code: CP 142
AHDBSTUDENTSHIP
Term: October 2015 to September 2018
Project leader: Herman Wijnen, University of Southampton and Michelle Fountain, NIAB EMR

AHDB-funded research into spotted wing drosophila (SWD) has been extensive since the pest arrived in the UK in 2012 and many of the results have been presented in this publication over the years. In addition to the industry funded project (SF 145), two PhD studentships have been supported by AHDB, investigating alternative and novel topics.

The project

Bethan Shaw, who had previously worked with Michelle Fountain's Entomology group at NIAB EMR focusing on SWD research, is studying a PhD under the joint leadership of University of Southampton and NIAB EMR. The research project is examining the behavioural and physiological rhythms of *Drosophila suzukii*, as determined by its internal circadian clock and environmental cues. It is hoped that this will reveal the times of day when SWD is most active in the crop, allowing growers to time control sprays to coincide with this.

Nathan Medd has been working under the supervision of Edinburgh University and NIAB EMR to investigate viruses specific to SWD which might be used for the development of microbe-based biopesticides which would be compatible with all the other IPM programmes already used by soft fruit growers.

Results

The circadian rhythm work has already identified that the most active period for the female SWD to lay her eggs is during the daytime when the outside temperature reaches between 25-29.9°C. During the cropping months, female *D. suzukii* display a preference for egg laying in the warmest part of the day, typically early afternoon. However, when temperatures exceed 30°C egg laying is greatly reduced. Periods of activity appear to be in the morning and late afternoon with very little movement or egg laying at night. This work also investigated fruits that already contained eggs or larvae of other Drosophila species. SWD emergence from these fruits was reduced, with fewer eggs laid inside them. It is believed that SWD females choose to lay fewer eggs in fruits containing other species. Bethan Shaw has also been investigating the optimum laboratory parameters such as social housing and environmental conditions with the aim of producing a standard laboratory practice.

In the virus work, Nathan Medd has identified 18 new viruses from SWD alone. One virus identified called the 'Eccles Virus' (from the reovirus group) belongs to a family of viruses previously advocated for biological control in China and is a candidate for further investigation of its insecticidal activity. Further work has been to assess the effect of viral biocontrol candidates on SWD by injecting viral extracts from wild flies or isolated cultures of the best viral candidates. Sadly, this appeared to have no lethal effect on SWD. Nathan later explored SWD's susceptibility to two different viruses, by exploring its immune response. At the time of writing, the results are still be analysed, but he had identified a number of SWD genes that change expression significantly upon infection with virus.

Spotted wing drosophila (SWD)

Assessing dipped blueberries

Egg laying deterrents for SWD

AHDB project code: **SP 11 – SCEPTREplus**
Term: January 2018 to March 2018
Project leader: Jerry Cross, NIAB EMR

At present, there are only a few effective crop protection products available to growers and the numbers of permitted applications of these are very limited. Identifying products which can either deter SWD from laying eggs in developing fruits or reduce egg hatch, would aid sustainable control of the pest.

The project

AHDB's SCEPTREplus project tested seven different products to examine their insecticidal, repellent and oviposition deterrent effects on SWD. The products included three AHDB coded products - AHDB9919, AHDB9967 and AHDB9931 - along with Urtica, sodium hydrogen carbonate, calcium hydroxide and a mix of calcium hydroxide and AHDB9919. The tests were carried out using blueberry and blackberry fruits which were inoculated with SWD adults. Due to the delivery delay of Product AHDB9931, it could only be used in the blackberry trial. The fruits were dipped in an aqueous solution of each product at the standard recommended rate 48 hours after inoculation with SWD to test for detrimental effects on eggs. In addition, another batch of fruits were dipped 48 hours before being inoculated to determine if they had insecticidal, repellent or oviposition deterrent effects.

Results

The results for blueberry and blackberry differed. Urtica gave statistically significant reductions (~ 50 per cent) in numbers of emerging SWD adults on blueberry showing insecticidal effects probably of short persistence, and is a promising treatment worthy of further investigation.

> “Urtica gave statistically significant reductions in numbers of emerging SWD adults on blueberry”

AHDB9931 gave the greatest reductions in numbers of SWD emerged, in both the before and after inoculation tests on blackberry where it was included with calcium hydroxide or AHDB9919. However, the reductions were not statistically significant except in one case.

All of these treatments are worthy of further investigation, using greater numbers of fruits, greater replication, possibly a greater range of fruits and a wider spacing pre- and post-treatment.

If effective treatments could be found, it would be an important development as they could be used as a tool to extend the interval between sprays of conventional products in control programmes.

"With a very limited number of traditional products offering effective control of SWD, it is essential that AHDB continues to fund this type of study to find alternative control methods," said Roger Vogels, S&A Produce.

SWD released into dipped blueberries

Developing models to predict WFT fruit damage

AHDB project code: SF 156
Term: April 2015 to March 2020
Project leader: Michelle Fountain, NIAB EMR

Western flower thrips (WFT) continues to pose difficulties for strawberry growers and serious damage is still found in some crops. Following AHDB and Defra funded Horticulture LINK projects, which delivered helpful information, it was felt that growers needed more guidance on the levels of thrips populations that are likely to lead to fruit damage and how many predators are needed to keep them below injurious levels. Novel control methods to supplement the predatory mite *Neoseiulus cucumeris* are also required.

The project

Research in the third year of project SF 156 sought to further develop and refine a device for monitoring populations of WFT and N.*cucumeris*. It also set out to understand more about the distribution of *N. cucumeris* across the crop canopy after it has been introduced, and to find out the best plant part to sample when assessing populations.

Results

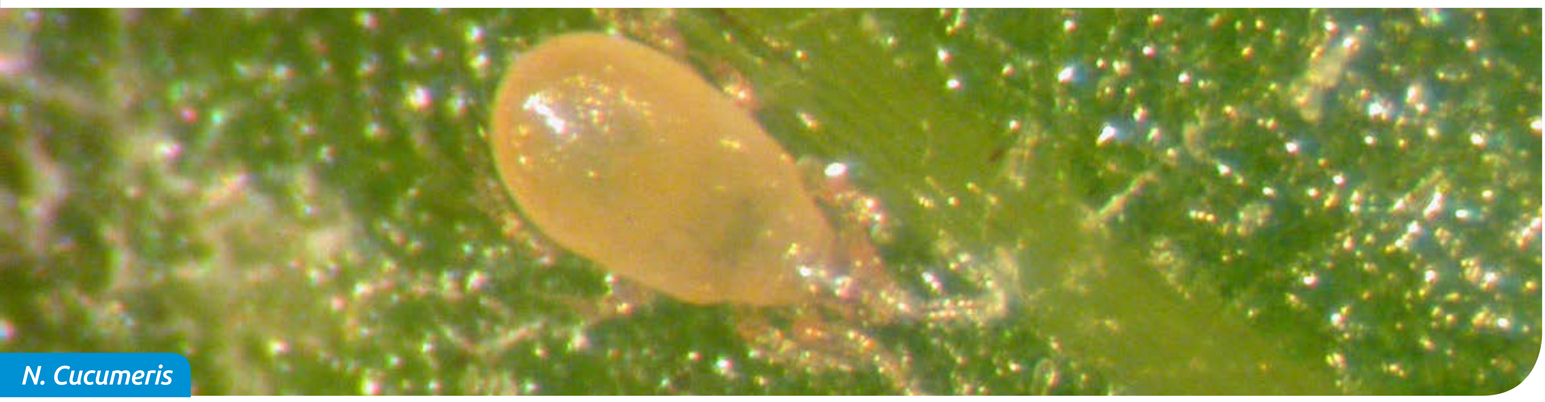
Previous work to develop a system to estimate populations of WFT and predatory mites had led to the construction of a clear plastic monitoring device using methyl isobutyl ketone (MIK) as a fumigant to extract the insects from flowers or button fruit (very early developing green fruits). The extraction device was constructed from two round food containers with a metal mesh screen in the middle. The small developing fruits are placed in the upper chamber and the thrips, Orius and predatory mites fall through a mesh onto a segmented counting surface. Both laboratory and field studies were done to assess the efficacy of the device. Laboratory tests using either individual or groups of fruits inoculated with known numbers of *N. cucumeris* revealed that the device could extract around 60 per cent of mites present on the fruit. In field tests, the device recovered 27 per cent of mites from button fruit and five per cent from flowers. This was compared to attempting to directly count *N. cucumeris* under the calyx of the fruits; direct counting yielded very few mites being detected.

For WFT, the device extracted 68 per cent from button fruits and 81 per cent from flowers.

Final calibration took place in 2018 to determine the field efficacy of the device and examine the number of times the MIK dispenser can be used. The latter currently gives over 60 field uses. The extraction device will be a useful tool for growers and agronomists to monitor their crops, in addition to scouting, and give confidence of *N. cucumeris* activity in strawberry flowers and fruits. Using the device can also give indication of the presence of Orius and predatory thrips (e.g. the black and white banded thrips (*Aeolothrips* spp)).

In the work to understand predator distribution on the plants, a trial was set up in two batches of plants in separate compartments of a glasshouse. To one batch WFT were released on the plants (about 20 mixed life stages per plant), and to the other no WFT were released. Five days after WFT release, about 200 *N. cucumeris* mites were introduced per plant to both batches. The numbers of mites and WFT on different plant parts were then counted one, four and seven days later. Most WFT were found on strawberry flowers and fruits. Of the *N. cucumeris*, around 50 per cent were not found or recorded on the plants, but those that were found were present on all plant parts, although numbers were lower on the leaf samples. It was interesting to find, in the plants treated with WFT, that significantly higher numbers of *N. cucumeris* were found in both flowers and fruits, confirming that button fruit are the most effective plant parts to assess *N. cucumeris* populations in the crop.

A further experiment was done to determine if numbers of *N. cucumeris*, WFT and the predatory bug Orius are affected by the time of day, light levels, temperature or humidity. The only variable that affected the numbers of these recorded in samples of flowers and button fruits was mean temperature in the hour prior to sampling. Numbers of *N. cucumeris* and WFT larvae declined as temperature increased, whereas WFT adults and Orius adults increased with rising mean temperature. In practice then, if very low numbers of *N. cucumeris* or WFT larvae are recorded when sampling, it is worth revisiting the plantation when temperatures have decreased. This work was repeated in 2018 to confirm these results and further test the efficacy of the extraction device at different temperatures.



N. Cucumeris

Improving the natural control of aphids in strawberry

AHDB project code: SF 156
Term: April 2015 to March 2020
Project leader: Michelle Fountain, NIAB EMR

Some commercial strawberry growers have been finding it extremely difficult to control aphids in recent years and in particular the potato aphid (*Macrosiphum euphorbiae*). Previous Defra Horticulture LINK research showed that aphicide sprays in autumn significantly reduce over-wintering populations. Earlier research in this project demonstrated that a number of aphicide spray products effectively control potato aphid in the spring months, if adequate coverage of the undersides of leaves and penetration of the crown tissue is achieved. However, the industry would benefit from improving natural and biological control of all aphid pests.

The project

We already know that the parasitoids *Aphidius ervi* and *Praon volucre* offer biological control of aphid species. They do occur naturally but can also be introduced in higher numbers. We also know that other naturally occurring predators will reduce aphid populations. However, we need to find out how reliable they are at different temperatures and different periods during the season. Two investigations have therefore been made, firstly to assess the effectiveness of the parasitoids *Aphidius ervi* and *Praon volucre* at controlling aphid populations in the spring, and secondly to understand at what time of year other naturally occurring predators can be relied upon for control of aphids.

Results

In the study on *A. ervi* and *P. volucre*, controlled experiments were done to assess the minimum temperatures at which both parasitoids would successfully parasitise potato aphid. The minimum temperature at which parasitism by *A. ervi* occurred under constant temperatures was 8°C. For *P. volucre*, the minimum temperature was 12°C. Development of both larvae inside the aphids and adult emergence was confirmed for each species of parasitoid at the lower temperature required for parasitism. In a similar trial when temperatures were fluctuated between 2°C and as little as two hours at 8°C for *A. ervi* and 13 °C for *P. volucre* parasitism was also recorded.


Potato aphid on a strawberry plant

The research demonstrated that early season releases of both parasitoids are likely to offer control but temperatures must exceed 8°C for at least part of the day for *A. ervi* and 12°C for *P. volucre*, which is currently only available as part of a mix of parasitoid species (including *A. ervi*). Such temperatures are commonly found in protected strawberry crops in February, March and April, although at low temperatures, the development of the aphid parasitoid will be very slow and may take several weeks to complete. This means that aphid mummies may not be seen within the crop for several weeks after release of the parasitoids or until temperatures start to increase.

> “Before June there are few natural enemies in strawberry crops, so other control measures should be employed”

In work to compare the timing, influx and appearance of natural predators compared to aphid pests, three crops of Junebearers and three crops of everbearers on two farms were monitored throughout the season from April until August. There was high variability in aphid species and numbers between farms and between sites. The main aphid pest was potato aphid, although some melon-cotton aphid was found. The main aphid predators were the green lacewing and hoverfly larvae. The main parasitoids found were Aphidius species and Praon species. Aphid numbers peaked in early June, while predator numbers peaked a month later in early July.

In both crop types, there were delays in the natural enemy’s population growth compared to the pest population growth. However, with the increase of natural enemies, the number of aphids declined. It is evident from this study, so far, that before June there are very few natural enemies in strawberry crops and therefore other control measures should be employed to suppress aphid populations until natural numbers build. Controls introduced by growers should be sensitive to the natural enemies likely to enter the crop later in the season.

“This research provides useful guidance for growers and gives us more confidence to rely on natural occurring predators to control aphids in strawberry crops,” explained Lindsay Hulme, E Oldroyd & Sons.

Developing a push-pull system for control of capsids in strawberry

AHDB project code: **SF 156**
Term: April 2015 to March 2020
Project leader: Michelle Fountain, NIAB EMR

Capsid bugs are very common pests of strawberry. The European tarnished plant bug (*Lygus rugulipennis*) and the common green capsid (*Lygocoris pabulinus*) are the most commonly occurring species. Both of them forage on developing flowers and fruitlets, leading to uneven fruit development and misshapen fruits, which are unmarketable. The practical problem for growers is working out how to control them without disrupting biocontrol programmes, which are adversely affected by the spray products typically required to eradicate capsids. The industry is in great need of new approaches for controlling the pests.

The project

The scientists leading this project decided to investigate a push-pull system for managing capsids. This system is set up to repel the pest from the crop (the push) and attract or lure the pest out of the crop (the pull). This project has focussed on three lines of investigation; can hexyl butyrate repel capsids from strawberry crops?; will the sex pheromone monitoring traps developed with previous AHDB funding, act in combination with the repellent to pull the pests out of the crop?; and will both systems help to reduce the levels of capsid damage when deployed in a commercial crop?

Results

A field experiment was set up using four tunnelled strawberry replicates where four treatments were compared:

1. Push treatment using hexyl butyrate (HB) sachets every two metres

2. Pull treatment using the Lygus sex pheromone plus phenylacetaldehyde (PAA), in green bucket traps, located every eight metres around the perimeter of the plot
3. The push-pull treatments combined
4. Control plot with no traps or repellents

There were significantly fewer adult and nymph *L. rugulipennis* where the 'push' was applied compared to where the 'push' was not applied. Differences were not statistically significant for *L. pabulinus* adults and nymphs, although overall numbers were lower where a treatment was applied. There was no significant effect of the 'pull' only treatment when used alone. There was also significantly less fruit damage where both the 'push' and 'pull' treatments were combined compared to no treatment. These results are very encouraging and current investigations are repeating this work using a combination of repellents and trying to improve the semiochemical attractant for female capsids in the 'pull' traps.

"Capsid control in strawberry is a particular challenge each year for growers and we are very keen to find a novel method of control which reduces our reliance on traditional spray products. I hope that this early research on a push-pull system may lead to a commercially viable control system," said Cristian Marmandiu, Haygrove.

> "There were significantly fewer *L. rugulipennis* where the 'push' was applied"

L. rugulipennis trap in a strawberry crop

Investigating the importance of *Pestalotiopsis* in strawberry

AHDB project code: **SF 157**
Term: April 2015 to March 2020
Project leader: Xiangming Xu, EMR

Botrytis cinerea has been the principal cause of fruit rot in UK grown strawberries for several decades and a great deal of research has been funded to find ways of improving the management and control of the disease. Research has shown that rapid cooling of harvested fruit to 2°C has significantly delayed the development of the disease, but this appears to have little effect on the development of other rots caused by Mucor and Rhizopus species, pathogens which have caused increasing damage in recent years. Earlier in this project, yet another pathogen (*Pestalotiopsis* spp.) was isolated from the crowns of wilting strawberry plants and this has been shown to cause fruit rot in Egypt.

> “*Pestalotiopsis* is a weak pathogen which is able to infect the plant when it is under other stresses”

The project

This project set out to determine the importance of *Pestalotiopsis* in UK grown strawberry crops. The aim was to find out if *Pestalotiopsis* is pathogenic against popular commercial strawberry cultivars and if it is a primary pathogen. We also wanted to determine how widespread the pathogen is in the UK industry.

Results

Using *Pestalotiopsis* isolates collected from strawberry plants of a low health status, pathologists at NIAB EMR used molecular techniques to identify that *Pestalotiopsis clavispora* is the species present in the UK. All of the isolates tested were shown to establish infection and colonise strawberry host tissue. The pathogen was also caused a post-harvest rot following inoculation during fruit development. However, it could not be proved that the isolates tested were able to cause a disease in the crown.

Based on the findings, it has been concluded that *Pestalotiopsis* is a weak pathogen which is able to infect the plant when it is under other stresses. To determine the presence of this disease in the UK industry, molecular primers are currently being validated for detecting this new pathogen and will be used to determine the incidence of *Pestalotiopsis* in the DNA samples collected from crown tissue of more than 2,000 nursery strawberry plants in the first two years of this project.

“Fruit rots other than Botrytis have become more of a problem for the industry in recent years so it is important to learn about all pathogens which might be implicated,” commented Lindsay Hulme, E Oldroyd & Sons.

Symptoms of Verticullium wilt

Assessing biocontrol methods for Verticillium wilt

AHDB project code: **SF 157**
Term: April 2015 to March 2020
Project leader: Xiangming Xu, EMR

Verticllium wilt in strawberry is caused by the soil dwelling pathogen *Verticillium dahliae* which infects strawberry roots and causes blockages in the water conducting vessels of the root tissue. This leads to plant wilting and gradual plant death. The severity of infection is dictated by the population levels of the pathogen in the soil and the susceptibility of the strawberry cultivar grown. Growers traditionally controlled the disease with chemical soil fumigation to reduce the levels of the pathogen to those which were safe for the proposed cultivar. With the withdrawal of the majority of chemical fumigants, AHDB and others have funded research projects to identify biological alternatives. Bio-Fence has shown promise and this is available in pellet form and composed of Brassica carinata meal. It is spread on the surface of the soil, turned into the surface, irrigated and covered with a polythene mulch to retain fumigation gases, which are released from the pellets.

The project

A trial has been set up in this project to compare the use of Bio-Fence pellets with other potential biocontrol products in a soil-grown crop of strawberry. The soil used had a history of Verticillium wilt and when tested for the presence of *V. dahliae*, scored between 2.6 and 5.6 propagules per gram of soil (depending on the area of the trial sampled). The cultivar Symphony was chosen as it is only moderately susceptible to Verticillium wilt and will display symptoms while still producing some fruit. More susceptible cultivars would die completely, providing less helpful results. Five treatments were compared which included the incorporation of Anaerobic digestate solids, incorporation of Bio-Fence granules and application of a plant drench of Serenade ASO. A further treatment combined the soil incorporation of Bio-Fence granules with a drench of Serenade ASO. All four treatments were compared to an untreated control.

Results

Planting and establishment took place in June during hot and dry conditions and throughout the trial plants displayed some symptoms of leaf scorch, although the incidence of this was greater in those plots treated with Bio-Fence or Anaerobic Digestate solids. It is possible that the incorporation of these products led to a more open soil structure resulting in more rapid soil drying. Alternatively, the high temperatures at planting time may have led to more rapid chemical release from these treatments resulting in plant scorch.

Verticillium wilt symptoms did appear in the plants following the stress of fruiting and these were recorded in assessments during September. There were no significant differences between treatments although a trend developed showing that treatments employing Bio-Fence had a lower proportion of wilting plants (5 per cent) compared with the other treatments (10 per cent). Further assessments were due at the time of writing which will be included in the annual report. These treatments are not expected to eliminate Verticillium in the soil like a chemical fumigant, but either reduce the level and infestation severity (in the case of Bio-Fence) or increase the resistance of the plants (in the case of anaerobic digestates or Serenade ASO).

Compatibility between SWD and spider mite control in raspberry

AHDB project code: **SF 158**
Term: April 2015 to March 2020
Project leader: Erika Wedgwood, ADAS

Over the past decade, raspberry growers have increasingly developed biocontrol programmes to control two-spotted spider mite. They have achieved this by relying on naturally occurring predatory mites such as *Amblyseius andersoni* and *Neoseiulus californicus*, whilst also making introductions of *Phytoseiulus persimilis*. For many growers, such biocontrol programmes are more successful than using acaricide sprays as the acaricide products are limited in number and achieving thorough coverage of the undersides of leaves can be difficult. However, with a recent increase in use of SWD sprays, which may be harmful to our predators, spider mite control could be compromised.

The project

The project aims to address the problem by first investigating the effects of SWD control strategies on two-spotted spider mite populations on commercial farms which are dealing with the pest and then developing compatibility strategies for controlling both pests together.

Results

In the first year's work, both canopy applications and overhead misting of a programme of sprays including deltamethrin (Decis), spinosad (Tracer) and chlorpyrifos (Equity – no longer approved) were applied to raspberries and their effects on two-spotted spider mite and naturally occurring predatory mites compared. The effect of both date and treatment were significant. By early August, the numbers of both SWD and predatory mites were lower in both types of spray application and there was a corresponding increase in two-spotted spider mite populations from mid-August onwards. This result confirmed that the sprays being applied for SWD control were having a detrimental effect on spider mite control.

In the second year, a programme of sprays of Decis and Tracer were applied to tunnel grown raspberries using overall canopy sprays and comparing these to overhead application. The effects on two-spotted spider mite, naturally occurring predators and *P. persimilis* (which had been introduced on two occasions) were assessed. Nozzles were used that gave a larger droplet size than in the first year, with the hope of creating less spray coverage on the undersides of the leaves and providing refuges for the predatory mites. Less spray coverage was found on the undersides of the leaves treated with overhead sprays. Two-spotted spider mite numbers were higher in the sprayed treatments, but less so when sprayed from above. Introduced *P. persimilis* were less affected by the sprays than anticipated.

Two-spotted spider mites on the back of a leaf

The second year's experiments were repeated in the third year. It was not possible to determine any treatment effects on the two-spotted spider mite or *P. persimilis* due to low numbers per leaf, but there were effects on the numbers of naturally occurring phytoseiid mites. The numbers of these mites were reduced, but the effect was mitigated where treatment plots were sprayed from above, as there was less spray deposition on the underside of the leaves.

Another experiment was carried out in Year 3 of the project on a primocane raspberry crop under tunnels, to assess the effects of control sprays made for SWD on the populations of two-spotted spider mite, *Phytoseiulus persimilis* and naturally occurring spider mite predators. Assessments were made throughout the season both before and after a chemical control product was applied to control SWD.

> With a recent increase in use of SWD sprays spider mite control could be compromised

The *Phytoseiulus* predators were introduced on 29 May and by 29 June, numbers of spider mites and their eggs were high and *Phytoseiulus* numbers still low. By 21 July, spider mite and egg numbers were significantly reduced due to *Phytoseiulus* numbers which had established well, but in addition, the naturally occurring predator mite *A.andersoni*, the predatory midge *Feltiella acarisuga*, the ladybird *Stethorus punctillum* and the predatory bug Orius had all appeared. By early August, before an SWD spray, spider mites and their eggs had declined further, due to predation by all predators and some of the floricane having been removed. However, in parallel, numbers of *P. persimilis* and *A. andersoni* had also declined.

By 9 August, following an application of deltamethrin (Decis) for SWD control and thiacloprid (Calypso) for blackberry leaf midge control, mean numbers of *P. persimilis* were significantly lower, partly due to the spray and also the reduced numbers of spider mites as prey. By the end of the season, numbers of both spider mites and predators were very low. Although the SWD control sprays are likely to have killed many of the spider mite predators, due to early good establishment of *P. persimilis,* the predators had controlled two-spotted spider mite before the sprays began and so no additional acaricide sprays were required.

Seeking alternative solutions to Phytophthora root rot

AHDB project code: SF 158
Term: April 2015 to March 2020
Project leader: Erika Wedgwood, ADAS

Phytophthora rubi is the most serious disease of raspberry causing root death and die-back of canes. It is a soil/substrate borne fungal pathogen which attacks the roots and spreads rapidly through soil water. Many growers reduce the risk of infection by planting in coir substrate that is sterile and devoid of Phytophthora spores. Control still relies on the application of a soil/substrate applied drench in spring and autumn.

The project

This project will focus on understanding the activity of non-conventional products that may improve root health and the production of propagation material that is more resistant to the disease. In the first three years of the project, the work investigated the effects of a range of novel plant treatments. In Year 3, investigation of root health in mature long cane raspberries and the use of biofungicides continued. It also assessed the effects of cold-storage on incidence and severity of *P. rubi* infection.

Results

Investigations on the effects of a range of novel plant treatments have been made for the first three years of this project. In Year 1, Tulameen plants were treated in growing media with biostimulants and growth promoters following propagation. In Year 2, these were potted up at a commercial site in Oxfordshire and ADAS Boxworth where the plants received various treatments including Prestop (*Gliocladium catenulatum*) and products approved for use in growing media in cane fruit. They were compared to a single drench of Paraat (dimethomorph). Full details of the treatments and product rates are provided in the SF 158 annual report.

At the Oxfordshire site, the ability of the products to improve crop performance and vigour was investigated, but no differences were found between any of the treatments and the untreated control. At the Boxworth site, plants were treated with preventive applications before inoculation with *P. rubi* and in some cases, curative applications were also made. No primocane death occurred as a result of inoculation. Interestingly however, Prestop and three coded products had statistically significantly increased the number of primocanes compared with the untreated control and Paraat treated plants.

> “Prestop and three coded products had statistically significantly increased the number of primocanes”

The trial continued in Year 3 when treatments were repeated at the Oxfordshire site and assessments made for plant phytotoxicity, cane vigour, fruit yield, berry weight and leaf nutrition. No foliar disease or cane wilting were observed in the trial, even in the untreated plots. No significant differences were found between treatments in plant vigour, fruit harvest or the number or strength of canes produced by the following January. Since no disease developed in the trial area, it was not possible to determine any benefit from the application of the products, but there were also no detrimental effects.

Work began on studying *P. rubi* zoospore behaviour at ADAS, to explore their attraction to root exudates using new video monitoring equipment. The work is now being continued by a PhD student at the James Hutton Institute.

Work is currently under way to assess disease infection on cold-stored long cane raspberry. There is a hypothesis that cold-stored canes are more susceptible to the disease as the pathogen can survive the low temperatures and on planting out the following spring or summer, the irrigation and warmer temperatures may trigger mass release of zoospores. A trial has been set up at a propagation site in Oxfordshire where pot grown long-cane Tulameen have been drenched with control products either in autumn or in spring. Half of each batch of canes were either cold-stored from December to March or left to stand in field conditions. Both batches of canes were transported to ADAS Boxworth in April, potted into five-litre pots and all pots from both experiments inoculated with *P. rubi*. Full assessments of cane height, vigour, disease incidence and root health were recorded throughout the trial. The results will become available in the annual project report.

“With raspberry root rot continuing to have such a destructive effect on UK raspberry crops, I think it is vital that we continue to fund research to improve its management and control,” commented Ross Mitchell, Castleton Fruit Ltd.

Developing traps and thresholds for blackcurrant sawfly

AHDB project code: **SF 162**
Term: March 2015 to March 2018
Project leader: Michelle Fountain NIAB EMR and David Hall, NRI

Blackcurrant sawfly is a serious, but sporadic, pest of blackcurrant. After laying eggs on the undersides of leaves in May, they hatch into larvae which can devour the leaves over a very short space of time in May or June, and a second generation can occur in July/August. The chemical components of the adult female sex pheromone were identified in Defra Horticulture LINK project HL01105 so that a monitoring trap could be developed to identify the need to implement control measures.

The project

This project is refining the pheromone blend, dispenser and trap that will be most effective and correlating catches of sawflies in the traps with field populations. The scientists hope to find out more about the factors affecting this relationship, such as the presence of predators and use of crop protection products.

Results

In the first year, the pheromone blend was refined to make it more attractive to adult male sawflies and it was found that a red delta trap caught most sawfly using this blend. The pheromone blend and trap are now commercially available to blackcurrant growers to allow them to monitor for the pest.

In the second year, the traps were used in a commercial plantation to assess if natural enemies may be having an effect on sawfly populations. Despite finding sawfly eggs and early stage larvae, only very low levels of foliar damage were detected, suggesting that predation could be occurring before significant damage could take place.

In the final year of the project, the second year study was repeated in a different crop and much higher numbers of male sawflies were caught in the pheromone traps.

Sex pheromone trap

However, no significant foliage damage was observed from larval feeding. It was also found that the numbers of adult sawfly in each location, within the field, did not correlate with the numbers of sawfly eggs or larvae. A large number and diversity of predatory species was found in the plantations studied and it is likely that these are reducing numbers of sawfly eggs and larvae. However, because of the low numbers of eggs and larvae, the pheromone trap, while useful to detect sawfly in blackcurrant crops, has not yet been calibrated to provide a spray threshold. The researchers recommend that growers monitor the number of predators, especially earwigs, across crops as well as using the pheromone traps to time sprays if natural enemies are scarce.

“We have made good progress in developing a pheromone monitoring trap for blackcurrant sawfly and it is interesting to learn that naturally occurring predators appear to be regulating populations of the pest,” said Rob Saunders, Hutchinsons.

> “The pheromone blend and trap are now commercially available to blackcurrant growers”

Investigating natural plant elicitors for Botrytis control in blackcurrants

AHDB project code: **SF 169**
Term: February 2017 to March 2019
Project leader: Angela Berrie, NIAB EMR

Botrytis fruit rot is an important disease of blackcurrants that currently relies on the use of routine fungicide sprays for control. The industry is increasingly seeking novel and biological control methods to reduce reliance on traditional fungicides. The use of biocontrol agents was explored in Defra Horticulture LINK project HL01105. However, in trials these were only effective in one of the three years and were prohibitively expensive compared to fungicides. The use of plant strengtheners or elicitors was also explored. Such products increase the resistance of the host to disease and some may have other beneficial effects on yield and crop growth. One plant strengthener product gave promising results in control of botrytis in one trial and was also a third of the cost of the standard fungicide programme.

The project

This project is evaluating the effect of three plant elicitors on botrytis incidence in flowers and fruit on the cultivars Ben Hope and Ben Tirran. In the first year of the project, they were compared to a standard fungicide programme and an untreated control in a blackcurrant plantation located at NIAB EMR. The biostimulants were coded AHDB9916, AHDB9915 and AHDB9957. AHDB9916 was applied both with and without the wetter Wetcit and applied from pre-flowering at three to four week intervals (total of three sprays). AHDB9915 was applied from pre-flowering at two week intervals (total of six sprays) and AHDB9957 was applied from pre-flowering at seven to 10 day intervals (total of six sprays). They were compared to a standard fungicide programme applied from first flower at seven to 10 day intervals (total of three sprays).

Results

Late frosts in April and May resulted in poor fruit set in Ben Hope and a mild winter led to poor bud break in Ben Tirran, so both cultivars performed poorly. There were no significant effects of treatments in Ben Hope. In Ben Tirran, there was significantly less botrytis recorded in the standard fungicide programme in green fruit tests and significantly less botrytis in the standard fungicide programme and the AHDB9916 treated fruit in post-harvest tests. However, as the incidence of botrytis in the post-harvest tests was very low, these results should be treated with caution. The trial will be repeated in the final year of the project.

Harriet Roberts, Lucozade Ribena Suntory, commented, “Growers are keen to find novel alternatives to their traditional fungicide programmes for disease control, so I am watching this project with interest to see if any products show potential for use in future.”

> “In Ben Tirran, there was significantly less botrytis recorded in the standard fungicide programme in green fruit tests”


AHDB
BROADEN YOUR HORIZONS
Join AHDB at Fruit Logistica and export around the globe
6-8 February 2019, Berlin
Reserve a networking table on our stand.
Contact amanda.morby@ahdb.org.uk
ahdb.org.uk
AHDB Horticulture TV
@AHDB_Hort

Soilless substrates

Designs on sustainably sourced growing media

AHDB project code: CP 095
Term: November 2012 to November 2017
Project leader: Paul Alexander, RHS Wisley
Fellowship trainee: Gracie Barrett, RHS Wisley

AHDB project code: CP 138
Term: January 2015 to December 2019
Project leader: Barry Mulholland, ADAS

Over the last 20 years, in response to both customer pressure and government policy, the horticulture industry has invested heavily in finding ways to source professional growing media responsibly and more sustainably while reducing peat usage. A huge range of materials considered as 'peat substitute' ingredients has been whittled down to just four: bark, coir, green compost and wood fibre. In the ornamentals sector, many nurseries use combinations of these to cut back the peat content of their growing media by between 10 and 50 per cent, depending on the crop. AHDB, along with Defra and the growing media industry, continues to fund research aimed at giving growers more confidence that specific blends of ingredients can be used commercially with predictable results.

The projects

A horticultural fellowship project, CP 095, was established in 2012, in which researcher Gracie Barrett reviewed the chemical, physical and biological properties of growing media materials and undertook trials investigating how nutrient management using organic and inorganic fertilisers was affected by varying the proportions of ingredients in media designed for nursery stock.

Her work dovetailed neatly with CP 138, a five-year project funded by Defra, AHDB and the horticulture industry. The project was commissioned in response to the Sustainable Growing Media Task Force's report in 2012 that highlighted the need for research to demonstrate the technical and commercial viability of new growing media blends and help growers overcome barriers to using them. It takes a different approach from past research by creating and using a model based on the physical characteristics of the raw materials to predict their performance in blends, followed by extensive trials on crops, including vegetable transplants, bedding plants, nursery stock and strawberries.

Results so far

Barrett used her review of ingredients to create 14 peat-reduced and peat-free experimental blends. She analysed their physical, chemical and biological characteristics and, in trials at RHS Wisley, assessed how well they performed with viburnum and hebe. While the properties of the blends varied widely, all but one proved capable of producing both crops to a good and uniform quality in the trial, demonstrating that a wide range of media could be used commercially.

In a subsequent trial on nutrient management, using only viburnum, the amount of nutrient leached from the different blends varied significantly, with up to five times more being lost from some compared with others – most of this occurred within the first 14 days after potting. The amount leached was not predictable and could not be related to any one physical property, such as water-holding capacity. Some of the blends proved to be 'over-fertilised' due to the inherent nutrient content of the materials, reinforcing the need to modify fertiliser rates when using them.

A trial looking at a possible alternative source of phosphorus tested biochar infused with phosphate from sewage sludge. Barrett found no significant differences, either beneficial or detrimental, between this and conventional phosphate fertiliser in the five growing media blends it was trialled with.

In the early stages of CP 138, air-filled porosity, available water and bulk density were identified as the three key physical parameters governing growing media performance. Accurate procedures to measure these attributes in growing media materials were then developed. The measurements were used as the basis for a model that could predict the materials' performance in varying proportions in blends.

> “The evidence suggested that similar yields could be achieved without using 100% coir”

As part of CP 138, specific trials on soft fruit crops have been running since 2016 to evaluate alternative substrates to the standard coir that is used for both fruit production and soft fruit propagation. Strawberry production was assessed on a commercial farm in Staffordshire where coir was compared to coir-reduced and coir-free products. Root development in all substrates was excellent, with no observable differences in root health. Fruit yields were variable over two years and across different substrates, but the evidence suggested that similar yields could be achieved without using 100 per cent coir. Similar trials have been done on a soft fruit propagation nursery in Berkshire on both strawberry and raspberry. In both cases, the growth of plants and their subsequent yield production have shown little difference between 100 per cent coir and coir-reduced substrates.


Root development has been excellent in coir-reduced substrates

Genetics

Sequencing the strawberry genome

AHDB project code: SF 166
Term: April 2016 to December 2018
Project leader: Richard Harrison, NIAB EMR

Since 2011 the complete genome sequence of the woodland strawberry has been available. This small fruited, wild strawberry is a relative of the cultivated strawberry, and has provided useful insights into its larger, more complex cousin. However, limitations of current DNA sequencing technology means we lack a complete genome for cultivated strawberry. Genomes must be read by first breaking them into many small fragments which are read by the sequencing machine individually, before being pieced back together by a software program, like a giant jigsaw puzzle. All commercially grown strawberries are octoploid, meaning they have eight versions of each chromosome in every cell (woodland strawberry has just two) and this causes the assembly software to get stuck as it often cannot tell the versions apart.

The project

SF 166 aims to use cutting edge DNA sequencing technologies to solve the assembly problem. New techniques allow special barcodes to be added to the DNA before it is broken down for sequencing, assisting in the process of assigning the jigsaw pieces back to the right chromosome. A complete genome sequence would facilitate a deeper understanding of the complex genetics underlying commercially important traits such as disease resistance and stress tolerance, and allow the development of cheaper genotyping techniques.

Results

Using a variety of techniques, NIAB EMR has sequenced the genome of the cultivar Redgauntlet, selected not for its agronomic value, but for the large array of genetic resources available to us for this cultivar. This is being assembled into a high quality reference to which the genomes of a further 200 varieties and breeding lines from the major European breeding programmes are being compared.

New strawberry breeds on the horizon

AHDB project code: SF 096a
Term: June 2013 to May 2023
Project leader: Adam Whitehouse, NIAB-EMR

The main objective of the East Malling Breeding Club is to develop improved strawberry varieties, both June-bearing and everbearing, with increased yield, larger fruit size, an extended season of production and greater resistance to fungal diseases.

Advanced selections of interest in growers' trials

Two new selections, one Junebearer and one everbearer have been chosen for commercialisation and release to the industry in 2019.

Assessing new selections in the East Malling Strawberry Breeding Club

The Junebearer is Malling™ Allure (EM2157), a late Malling Centenary-type selection which has a similar season to Florence, but with better fruit size, Brix scores, appearance and plant habit. First sales to industry are expected in 2018/19.

The everbearer is Malling™ Champion (EMR564), which has an early season of production with a high Class 1 yield and large fruit size. Fruit is glossy and attractive with uniform colour, firm skin and very firm flesh. Flavour has been judged to be pleasant with an average Brix score of 7.9. Fruit is displayed on long trusses. Initial assessments show resistance to crown rot and Verticillium wilt, with moderate resistance to powdery mildew. First commercial sales to the industry are expected in 2018/19.

In addition, EM2464 has been fast-tracked to large-scale growers' trials in 2018. It shows promise as an early (similar season to Vibrant), Malling™ Centenary-type selection, with very good fruit quality and yield potential. Preliminary tests at East Malling indicate it also has some useful resistance to crown rot.

Consideration will also be given to some other interesting everbearers that have been on growers' trials in 2018. One of these, EMR635, is a higher yielding everbearer with excellent fruit size and a high percentage of Class 1 fruit. The fruit is well displayed, with an attractive appearance and has a full, slightly aromatic flavour. Initial assessments indicate that EMR635 shows resistance to powdery mildew and crown rot. In a small scale growers' trial, EMR721 showed exceptionally high quality fruit in terms of size, flavour, appearance that has been well-liked in sampling sessions, and has also produced a high percentage of Class 1 fruit (greater than 80 per cent), with good resistance to powdery mildew. Two advanced lines, EMR693 and EMR704, will also progress to large-scale growers trials in 2019, the former being a sweet, attractive selection that has caught retailers' eyes, and the latter an early, high-yielding,
large-fruited selection that also has useful resistance to crown rot and mildew.

Promising selections in East Malling Trials

From the first stage trials at East Malling, nine (six June-bearers and three everbearers) new selections were put forward in 2017 for growers' trials in 2019, and another nine June-bearers were selected in August 2018 to go forward for offsite trials in 2020. For the June-bearers, this includes EM2434, a very-high yielding (2.5kg per plant Class 1 fruit in 2015) late selection that has excellent fruit size (78 per cent >35mm) and high average Brix score (9.4°).

For everbearers, EMR773 was the stand out new selection in 2017, having an exceptionally high Class 1 yield for the trial (1.7kg per plant) of which 80 per cent was >35mm. Flavour was judged as pleasant, with an average Brix score of 8.1°. This selection will be in growers' trials in 2019.

> “One Junebearer and one everbearer have been chosen for commercialisation and release to the industry in 2019”

Improving blueberry yield stability

AHDB project code: **SF 160**
(Innovate UK Project 102130)
Term: October 2015 to September 2020
Project leader: Julie Graham, the James Hutton Institute

Lack of yield stability is a major problem for UK soft fruit growers as it prevents accurate profit prediction and maximisation, and causing volatility of UK supply. The problem is now well recognised within the industry, though the causes of significant season-to-season yield variation are unknown.

The project

This project aims to identify the physiological, biochemical and genetic processes underlying yield limitations in blueberry, thereby identifying causes of the yield volatility phenotype. An examination of the impact of the growing environment and management on yield will be undertaken to allow development of predictive yield maps and models that provide frameworks for yield optimisation in the short- to medium-term. This underpinning knowledge will be transferred to growers and also used to develop molecular markers for yield stability allowing long-term solutions to the problem, thereby future-proofing the UK soft fruit industry, particularly blueberry crops, with application to other fruit crops.

Results so far

Work has now been conducted across three complete growing seasons to identify the mechanisms underlying the yield instability trait. Data gathered indicates that fruit is lost progressively across the entire developmental period and is not associated with catastrophic environmental events such as frost damage to flowers. This indicates that more subtle environmental variation must be associated with yield instability and highlights the need for the development of predictive yield maps and models that can support crop management.

A detailed examination of other potential mechanisms underlying the yield instability trait has consistently indicated that at moderate light levels, equivalent to a mildly overcast day, photosynthetic activity of blueberry bushes becomes saturated. Furthermore, the rate of photosynthesis at saturation is highly temperature dependent within the range of temperatures encountered during the UK growing season. For example, saturated photosynthetic rates were approximately 25 per cent lower at 15°C than they were at 25°C. On heavily overcast or cooler days the plant is not able to achieve its full photosynthetic potential, however it is also unable to compensate by photosynthesising more on sunny days. This means that even if interspersed with strong sunshine, too many heavily overcast days are likely to have a negative impact on yield. This problem is exacerbated by the observation that, unlike some other berry crops, blueberries do not accumulate a starch reserve that can be utilised to provide sugars and energy for fruit growth and maturation if the later part of the season is not ideal.

These findings are being used to build a model that, in conjunction with a user focused interface, can be used by growers to aid yield prediction. The work is also relevant to soft fruit breeding programmes, providing insights on gene markers which could be deployed to improve yield stability in future.

> “Even if interspersed with strong sunshine, too many heavily overcast days are likely to have a negative impact on yield”

On the trail to an improved raspberry

AHDB project code: SF 035c
Term: April 2014 to March 2024
Project leader: Nikki Jennings, the James Hutton Institute

The Soft Fruit Panel has been funding two projects to breed and develop new and improved raspberry varieties for growers. The UK raspberry breeding programme (SF 035c) was set up in 2009 at the James Hutton Institute to breed new summer fruiting and primocane varieties suitable for either machine harvesting for processing or to extend the season of fresh-market fruit grown under protection.

In its first five-year tranche of funding for the UK raspberry breeding programme, three new summer fruiting varieties have been produced which performed well in previous AHDB funded raspberry variety trials. Glen Fyne offers a suitable replacement for Glen Ample and Tulameen, producing higher yields and presenting its fruit well to pickers. It breaks its buds evenly down the length of the canes which lends itself to early production under tunnels. It is also suited to machine harvesting, but is susceptible to *P.rubi*. Glen Ericht is an early/mid-season variety well suited to machine harvesting and the processing/freezing market. It regularly out yields Glen Ample and exhibits strong field tolerance to *P.rubi*.

Glen Dee was released in 2014 as a mid-late season variety with a long cropping season. The fruit quality is excellent, and the size is consistently larger than Glen Ample, making it very suitable for the fresh market. Spawn growth is good too, and although it has no resistance to *P.rubi,* root vigour is high. Feedback from commercial growers report that Glen Dee has large fruit which is easily picked off the plug, reducing picking costs by up to 20 per cent compared with current commercial varieties.

The current programmes

The current tranche of funding for the breeding programme runs from 2014 until 2019. Breeder Nikki Jennings is routinely employing technology, developed at the James Hutton Institute in three research projects part-funded by growers through AHDB and also through the Defra Horticulture LINK scheme and Innovate UK. The first (SF 063) identified molecular markers and genes on the raspberry genetic map that are linked to resistance to *P. rubi*. The second (SF 076) achieved the same, but for quality traits such as colour and flavour. A recent Innovate UK project (SF 138) developed this research further to find markers for combinations of traits controlled by more complex genetic relationships to help breeding for fruit flavour and pest and disease resistance at the same time.

Recent results

Glen Carron was named in 2018 as a new floricane variety. In trials, this variety was known as selection 0485K-1 and has consistently proved popular for its excellent eating quality and attractive, shiny appearance. The flavour has been described as sweet and sherbet with low acidity and has consistently outperformed other genotypes for eating quality in blind tastings at events over several seasons. Glen Carron produces a high proportion of Class I fruit and confers resistance to cane botrytis and spur blight from the presence of the phenotypic marker, *Gene H*.

Phytophthora resistance

Since 2014, marker-assisted selection work has identified several selections with root rot marker genes that have been used to breed varieties resistant to Phytophthora root rot. Selection RBC16F6 has displayed robust field resistance after six years in infested plots without showing symptoms despite repeated flooding. It combines resistance with a high yield and significant fruit size and plants were cropping in growers' trials for the first time in 2018. Feedback from triallists confirmed a high productivity, competitive fruit size and good fruit quality. RBC16F6 is the result of a cross between a floricane x primocane, and crops on the primocane only on the top buds. It performs well as an early floricane in the breeding plots in Scotland.

Variety RBC16F6

> "Glen Carron has consistently proved popular for its excellent eating quality and attractive, shiny appearance"

Glen Dee 2016

Primocane trials

Breeding for primocane varieties began in 2009 and focuses on the early autumn season with high fruit quality. Significant improvements have been seen in the JHI primocane germplasm since 2015. Since the start of the project, more than 20 first stage primocane selections have been planted in commercial trials in England to give an early assessment of seasonality and yield. Two of these selections, RBC16P4 and RBC16P5, stand out with superior fruit quality and have been fast-tracked into commercial trials after showing outstanding results in the breeding plots in 2016:

- RBC16P4 is generating interest in growers' trials around the UK. Picking in early autumn, between Kweli and Kwanza, this selection produces a high yield of flavoursome fruit with a high potential to double crop
- RBC16P5 produces an early crop, with a start date similar to Imara, in mid-late summer. Large fruit picks easily, filling punnets quickly, and produces a consistent sweet flavour with vanilla notes

Plans to commercialise selections RBC16P4, RBC16P5 and RBC16F6 have been initiated by the James Hutton Institute in 2018.

The breeding plots at the Jame Hutton Institute have minimal inputs to help identify robust new varieties which are economical to grow. Selections are grown in soil with a basic feed programme and few or no chemicals. In order to showcase the most promising selections to their optimum ability, a new Raspberry Demonstration Plot was established at the James Hutton Institute in 2018 to grow raspberries in conditions closer to a commercial plantation. A floricane and a primocane tunnel each have 11 replicated genotypes, including commercial cultivars for each habit, established in coir substrate and will be cropping in summer at the James Hutton Institute in 2019. Plots of Glen Dee, Glen Carron, RBC16P4, RBC16P5 and RBC16F6 are included.

Understanding the causes of crumbly fruit in raspberry

AHDB project code: SF 167

AHDBSTUDENTSHIP

Term: October 2016 to September 2019

Project leader: Julie Graham, the James Hutton Institute

A condition known as crumbly fruit occurs to differing degrees in different raspberry cultivars and indicates a partial failure in the physiological processes in fruit development. Raspberry fruits are formed from an aggregation of multiple fertilised ovaries, each of which is referred to as a 'drupelet' as they become fleshy. Two causes of crumbly fruit have been proposed: either each individual ovule is not fertilised due to a physical obstacle that impedes the process or ovule fertilisation does occur but something hinders the ovary development into a drupelet. In practice, if the number of ovaries is greatly reduced, drupelets may be greatly enlarged. If there is only a small reduction in ovary number, the drupelets cohere imperfectly so fruit readily crumbles when picked.

Project SF 167 aims to understand what triggers the condition and how the crumbly fruit arises. Such knowledge may help in future to identify genetic markers, allowing breeders to eradicate the condition. It may also lead to an improved test in the production of nuclear stock plants for entry into the UK certification scheme. Ideally, we could also identify treatments that can be applied at the onset of the crumbly fruit to help the affected plants recover from the condition.

"For some years, raspberry growers have encountered this condition in their fruit without fully knowing the reason. This fundamental genetic research is vital if we are to find the cause," explained Louise Sutherland, Freiston Associates Ltd.

Results so far

A set of experiments have been set up in an attempt to produce the crumbly fruit phenotype under controlled conditions. To date it has been possible to induce crumbly fruit by mechanical damaging, removal of style and stigma, and by damage to the receptacle. Material has been collected and the control of the crumbly phenotype will be examined at the gene and hormone level.

> "Such knowledge may help to identify genetic markers, allowing breeders to eradicate the condition"

It has also become clear that there is a varied opinion on what constitutes the crumbly fruit condition, so a clear and universally accepted definition is required. The definitions below have been suggested as part of the project progress (one is a genetic determinant and the other an environmental determinant):

1. Crumbly Fruit Condition (CFC) – all fruits are misshapen and the plants display the symptoms year after year (genetically determined)
2. Malformed Fruit Disorder (MFD) – uneven fruits are displayed mainly at the beginning of the fruiting season and only on the top laterals. Alternatively, plants exhibit malformed fruits on all or most of the laterals throughout the fruiting season, but the symptoms are not expressed every year (environmentally determined)

Significant progress has been made to develop a hormone profiling system to look at the development and possible control of the crumbly phenotype and a microarray has been conducted to look at the difference in gene expression across fruit development between normal and crumbly fruits.

> “Such improvements would hasten the delivery of new and improved strawberry cultivars to the UK strawberry industry”

Developing genome selection to aid strawberry breeding

AHDB project code: **CP 163**
Term: October 2016 to March 2020
Project leader: Richard Harrison, NIAB EMR

Traditional strawberry breeding has involved crossing programmes that are based on the identification of desirable traits in the parent material. The subsequent offspring are assessed visually over a period of years in trials to determine their yield, habit, pest and disease susceptibility and fruit quality characteristics. The time taken from making crosses to release of a new cultivar can be between seven and 20 years. Genomic selection is an advanced breeding technique that allows breeders to more accurately select desired traits from parents when making crosses, thus ensuring that the progeny contain these traits. It also allows the progeny to be assessed more quickly to detect whether or not they contain the traits. This speeds up the whole breeding cycle allowing cultivars to be released more quickly.

The project

The aim of this project is to improve the deployment of genomic selection in commercial strawberry, a particularly difficult subject as it is octoploid, which means that it contains eight versions of each chromosome in every cell, rather than the two versions present in woodland strawberry. Such improvements would benefit the East Malling Strawberry Breeding Club, helping to hasten the delivery of new and improved strawberry cultivars to the UK strawberry industry.

Results

An imaging platform was developed using a camera and computational algorithms to capture data in 3D and quantify seven external fruit quality traits such as berry shape and colour. This allows the physical characteristics of the progeny (the phenotype) in the breeding programme to be assessed rapidly and objectively – a process known as ‘phenotyping’. The genetic material contained within the progeny is known as the genotype and the assessment of this material is called ‘genotyping’. This project is investigating technology to speed up the genotyping process, so the breeder can rapidly assess the genetic composition of the progeny. Breeders have a variety of genomic selection models available to them, but there is no consensus on the optimum model for octoploid strawberry.

“I am pleased that AHDB is funding a project which will benefit the precision and speed of strawberry breeding to ensure that new and improved cultivars are delivered more quickly to the industry,” said Tom Rogers, CPM Retail Ltd.

Produced for you by:

AHDB Horticulture
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

T 024 7669 2051
E comms@ahdb.org.uk
W horticulture.ahdb.org.uk
@AHDB_Hort

If you no longer wish to receive this information, please email us on **comms@ahdb.org.uk**