Niab

Fruit

Annual Review 2026

Mario Caccamo, Chief Executive Officer, Niab

Welcome to the Niab Fruit Annual Review 2026

This Review magazine demonstrates how Niab is supporting the UK and wider fruit industry through our current fruit research portfolio. We feature the results of some of our ongoing and recently completed fruit projects in short summary format, explaining how the research is relevant to the industry. Also included are snippets about new projects that have recently begun, along with details of some of the other services that Niab offers to help the wider horticulture sector.

A large proportion of our fruit research is funded through government programmes like Innovate UK that require matched funding from the industry. A significant number of our projects are also now directly funded by industry bodies. Industry input ensures that all the work we carry out is of direct relevance to fruit growers as we seek to develop solutions to some of their most pressing production problems.

To this end, we continue to work closely with British Apples and Pears Ltd (BAPL), British Stone Fruits Ltd (BSFL) and British Berry Growers (BBG), monitoring and surveying the presence of invasive pests and diseases and supporting the respective industry working groups on spotted wing drosophila and brown marmorated stink bug.

In this year's Review, read about BAPL funded research carried out by Niab entomologists and pathologists to find novel solutions to rosy apple aphid, woolly apple aphid, apple blossom weevil and apple canker. You will learn about our work to support the soft fruit sector by developing modern technology to correctly identify thrips that damage strawberry, developing biocontrol approaches to control the large raspberry aphid, and investigating better ways of managing bees and other soft fruit pollinating insects.

There are feature articles on the work our crop scientists are doing to improve precision irrigation and nutrition in plum and cherry crops, the development of technology to identify an early warning of stress in apple trees, and matching nitrogen supply to demand in strawberry. Niab is also investigating a system of strawberry propagation that could provide planting material that is consistently capable of producing 3 kg per plant. In the words of an agronomist who attended our Niab Fruit Agronomist Day in 2025, "if successful, this could be a real game changer for the strawberry industry".

Niab is leading a Defra funded project called the 'Soft Fruit Genetic Improvement Network'. This is pre-breeding research that seeks to develop the genetics behind fruit quality and nutrition, yield

Sharing results at the Niab Fruit Agronomists Day 2025

enhancement, improved sustainability, pest and disease resistance, and resource use efficiency. It aims to support both private and publicly funded soft fruit breeding programmes and has the involvement and support of a number of current UK programmes. The latest progress is included in this publication.

And finally, there is a comprehensive round-up of the output from the Growing Kent & Medway programme that began in 2021. We explain how it has supported the food, drink and horticulture sectors in the Kent and Medway region over the past five years, how its R&D funding has helped to develop solutions to fruit production problems, and how fruit businesses have benefited from the programme in other ways.

I have recently announced that, after a remarkable ten years at Niab, I will be leaving the organisation by the summer of 2026. I would like to take this opportunity to express my gratitude to all our industry and academic partners, and Niab staff. In particular, I would like to thank the East Malling Trust for their continuous support and partnership during a period that has been marked by change. Together we have achieved a great deal, and I am incredibly proud of what we have built.

Kevin Attwood, Chairman, East Malling Trust

Cultivating change: investment and innovation at East Malling

With spring comes renewed growth and optimism, at a time when the UK—alongside the rest of the world—is experiencing unprecedented social, economic and environmental change. Against this backdrop, the importance of food security has never been greater. Developing a resilient food system that can sustainably supply a growing population with nutritious, healthy food is a critical priority. The East Malling Trust recognises its role in supporting this challenge. As we continue to evolve, our focus remains firmly on delivering our vision for a thriving and resilient UK horticulture sector.

The Trust itself is entering an exciting new phase. We extend our sincere thanks to our long standing Chair, Oliver Doubleday, whose leadership has been instrumental in shaping the organisation we see today. We are delighted to welcome Kevin Attwood as our new Chair, alongside two new Vice Chairs, Louise Manning and Gary Walters. They join a growing board of new trustees, introduced through our ongoing LinkedIn series Meet the Trustees, and together bring fresh energy as we build momentum following our strategy launch in July 2025.

Our ambitions for supporting UK horticulture research and innovation are bold. We are committed to significant investment at East Malling, alongside the development of a vibrant horticulture research and commerce ecosystem on site. Central to this is our close partnership with one of our key tenants, Niab.

The Trust is pleased to announce that Niab will again receive the Directors' Award, increased this year to £1.25 million over 5 years. This investment will directly support research in three core areas:

- Integrated pest management,
- Orchard management,
- Resource efficiency and sustainable inputs

delivering benefits for the UK horticulture economy, sustainability, and healthy diets.

The Trust will soon be issuing a programme of events, to support our East Malling community and generate a nexus point for the horticulture sector.

Aerial view of the GreenTech Hub for Advanced Horticulture at East Malling

Niab services for the horticulture sector

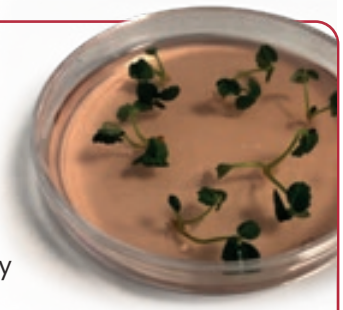
Niab's work at East Malling has gained recognition around the world through its employment of enthusiastic staff from a wide range of disciplines who have become experts in their field. Together, they have engaged directly with fruit growers to develop solutions to their problems and help to increase yields and fruit quality, allowing local growers to remain profitable and compete on the world stage. In addition to our traditional fruit research, Niab provides a range of other services to the horticultural sector.

Adrian Harris, Horticultural Trials Co-ordinator • adrian.l.harris@niab.com

Horticultural trials services

Whilst much of the science carried out by Niab examines basic principles, technology and proof of concepts, the results of such research often require further development and validation before they can be deployed commercially and adopted by growers. Many commercial companies are seeking to develop and validate primary research results to allow them to innovate and deliver new products and services to the horticultural industry. Niab has an experienced horticultural trials team working from our East Malling site who can trial a range of new products to test their market readiness.

The team offers a range of technical support through bespoke trials services, technical innovation, independent evaluation and commercial demonstration, all of which is accredited by ORETO, ISO and GEP. Specifically in horticulture, we offer help in crop protection, crop production systems, variety and novel crop trialling, soil amendments, growing media trials, irrigation and nutrition, biostimulants, predator delivery systems, frost protection, horticultural robotics, artificial intelligence, devices, and application method technology. Crucially, the work is independent, authoritative, comprehensive and impartial.



Tissue culture laboratory services

Niab uses its state-of-the-art tissue culture laboratories to offer a range of services to the horticulture industry, particularly supporting research and breeding programmes. Our work can be tailored to individual requirements, is quality controlled, confidential and APHA accredited. Our services encompass meristeming, micropropagation, clonal propagation, maintenance of collections, embryo rescue, flower mapping, and high-health material initiation and maintenance. Weaning, bulking and supply of plants is also available. For further information, contact: TC-Propagation@niab.com or call 07511 873178.

Emma Easton, Head of Glasshouse Services • emma.easton@niab.com

Glasshouse services

Niab has a full range of glasshouse and growth room facilities that are used at both our Park Farm (Cambridge) and East Malling (Kent) sites. The facilities at East Malling were constructed in 2021/22 with funding from Growing Kent & Medway, The East Malling Trust and Kent County Council. They include some state-of-the art glass, allowing staff to replicate the very best glasshouses that are used by the industry, making our research relevant to current commercial practice.

Niab works collaboratively with industry partners to develop projects designed to find solutions to crop production problems commonly faced by the commercial fruit sector. The glass is equipped with a full range of irrigation facilities, lighting design and screens for night break lighting or sun-shading. We also have climate-controlled compartments with heating and cooling facilities, which are also fitted with black out blinds. The growth rooms have independently controlled environmental conditions and range in size.

We currently use some of the glasshouse units in research on tomatoes and peppers to utilise the latest diagnostic technology and agronomic knowledge to co-develop a crop scouting service, informed by spectral diagnostics (wearable and mounted diagnostic hardware) that can detect the early establishment of any event which adversely affects yield, and which can be integrated within crop management systems. The growth rooms allow research into Total Controlled Environment Agriculture (TCEA) systems enabling us to study the full yield potential of fruit plants under optimum growing conditions.

BCPC UK Pesticide Guide

Niab manages the production of the BCPC UK Pesticide Guide, producing the traditional printed 'Green Book', whilst maintaining the continuous stream of updates on the online database. A UK Pesticide Guide Package provides both the hard copy and essential online version, and also includes a monthly notification of new products, approvals, EAMUs and product withdrawals. From innovative herbicide and fungicide mixtures to newly extended expiry dates and fresh GB-only registrations – the UKPG remains the only place where all updates are captured clearly, promptly, and in full.

Consider BCPC's package offer of the Online UK Pesticide Guide with a 50% discount on the Green Book. The package also offers 12 NRoSO and 4 BASIS points. For further information, visit www.bcpc.org or contact: publications@bcpc.org or call 01223 342495.

Exploring Niab's fruit research

Niab Fruit is an outreach programme designed to keep the industry fully informed of our recent and current fruit research projects and the results that they are delivering to growers. In 2025, we presented results and shared our work at a series of events, most notably at trade shows such as Fruit Focus and the National Fruit Show, our apple and pear technical day presented in partnership with BAPL at East Malling, and our soft fruit technical day at East Malling. Both technical days were live streamed and recorded.

Niab presented results at the Controlled Environment Users' Group Conference, the Growing Kent & Medway Showcase Day and the Niab Fruit Agronomist Day, all hosted at the East Malling site in September 2025. In addition, we actively engaged with the East Kent Fruit Society, providing short research updates at their seasonal fruit walks in 2025.

Every year, we arrange and organise a range of activities to maintain the flow of information through Niab Fruit including:

- **Annual Review** – digital and printed versions
- **Electronic factsheets** – providing guidance to the industry on crop management and crop protection issues
- **International research updates** – offering summaries of overseas research visits and international conferences and symposia
- **Web archive of information** – including the Apple Best Practice Guide and relevant research information at niab.com
- **Technical webinars** – providing presentations on the latest research results
- **On-site events** – short events to appraise the industry of research and demonstration work
- **Growing Kent & Medway information** – updates and events from the Growing Kent & Medway Innovation Cluster

Anyone wishing to receive information from Niab Fruit should register at horticulture@niab.com

For further information, contact:
Scott Raffle, Niab Knowledge Exchange manager
Email: scott.raffle@niab.com
Tel: 07712 131769

Niab presentation at the 2026 BAPL/Niab Apple and Pear Technical Day

Sharing results with the Controlled Environment Users' Group

New projects 2025/26

Niab has begun work on a series of fruit research projects this year which seek to make fruit production more sustainable. Whether developing more sustainable methods for improving crop health and crop protection, producing plants in a more sustainable way with reduced inputs, or improving soil health and crop productivity, the overall aim is to increase efficiency of production in ways that are sympathetic to the environmental problems growers face today.

Eleftheria Stavridou, Senior Specialist in Plant Nutrition

Title: Using novel nutrition in apple orchards to work towards net-zero emissions

Funder: Innovate UK

Partners: British Apples and Pears Ltd, Clockhouse Farm Ltd and W. Stewart Wood

Term: November 2025 to October 2027

Apple growers employ inorganic nitrogen fertilisers which can be converted to environmentally harmful nitrous oxides. Niab is working with BAPL and commercial apple growers to assess two innovative nitrogen products. The first (R-Leaf) is a daylight-activated foliar spray that converts atmospheric nitrogen oxides into plant-available nitrate directly on the leaf surface. The second (Vixeran) is a microbial biostimulant that supports nitrogen fixation at the root level. Both will be compared to standard nitrogen programmes with the hope of improving nitrogen use efficiency, maintaining yields and lowering environmental impact.

Two new nitrogen products will be compared to standard nitrogen application in apple

Eleftheria Stavridou, Senior Specialist in Plant Nutrition

Title: SNAP: Sustainable nitrogen application project

Funder: Innovate UK

Partners: Hutchinsons, Orion Future Technology and Outfield

Term: January 2025 to December 2026

Developing precision nitrogen application in apple orchards

Niab has been a research partner in previous Innovate UK projects to develop a prototype variable rate orchard sprayer and further develop techniques to precisely manage orchards using resources more efficiently, benefiting the local environment. In this project, our crop science team will work with industry partners to develop precise application of nitrogen in commercial apple orchards. Variable use of nitrogen rather than broadcast application will provide more even crop growth leading to increased yields whilst reducing both waste fertiliser and environmental damage.

Eleftheria Stavridou, Senior Specialist in Plant Nutrition

Title: Resilience in agrifood systems: supply chain configuration analytics lab (RASCAL)

Funder: UKRI

Partners: Queen's University Belfast, University of Cambridge and University of Plymouth

Term: January 2025 to December 2027

This project will study the balance between UK food production and imports, especially in light of disruptions caused by economic, political or climate factors. An interactive digital lab will be created that enables exploration of multiple scenarios involving cascade risks, and potential mitigation interventions. To ensure that the UK is better prepared for unexpected challenges, this project is part of a wider UKRI funding programme to ensure the robustness of UK supply chains and to help secure essential resources and food supplies for the future.

This project will examine the robustness of UK supply chains

Francis Wamonje, Entomology Research Leader

Title: Screening UK habitat for the presence of forest bug (*Pentatoma rufipes*) and brown marmorated stink bug (BMSB; *Halyomorpha halys*) parasitoids

Funder: The Worshipful Company of Fruiterers

Term: April 2025 to March 2027

Forest bug dorm set up to identify if parasitoids of the pest can be identified

The loss of broad-spectrum pest control products from the crop protection armoury available to fruit growers has led to an increased incidence of new pests such as the forest bug (*Pentatoma rufipes*) which is causing increasing levels of damage to apples and pears. The invasive pest brown marmorated stink bug (*Halyomorpha halys*) is also a new threat and growers have insufficient control measures available for either of these pests. This project will investigate if UK native parasitoids exist and if they could be used as a sustainable control measure.

Francis Wamonje, Entomology Research Leader

Title: POLLEN: Pollinator observations linked to environmental DNA in mango and avocado agroecosystems

Funder: Cambridge – Africa ALBORADA Research

Partners: Kenyatta University and The National Museums of Kenya

Term: January 2025 to December 2025

Mango and avocado production contributes significantly to the agricultural economy in Kenya but current monoculture practices are harmful to natural ecosystems and knowledge of the impact of pollinator diversity on crop productivity is limited. Niab will work with its research partners to develop innovative eDNA monitoring methods for bee diversity and establish the connection between diverse pollinator presence and productivity in mango and avocado cropping systems.

Niab is connecting bee activity to mango productivity

Matevz Papp-Rupar, Plant Pathology Research Leader

Title: Soil amendments to improve apple establishment

Funder: Innovate UK

Partners: A.C. Hulme and Sons (Lead), British Apples and Pears Ltd, Ian Overy Farms, Skylark Carbon Ltd

Term: September 2025 to September 2027

Amending the soil at planting time to hasten tree establishment

Planting and establishing new apple orchards incurs significant costs and it can take four years to reach full production before these costs can start to be recouped. Trees from redundant orchards that are grubbed have been traditionally burned, but there is increasing interest in converting grubbed trees to biochar to retain the carbon that has been sequestered by an orchard. In this project, biochar, Trichoderma species and arbuscular mycorrhizal fungi (AMF) will be used as soil amendments at planting time to assess if they might hasten establishment and production, whilst improving orchard sustainability and reducing the carbon footprint of orchards.

Michelle Fountain, Head of Pest and Pathogen Ecology

Title: ABC: Adopting Biologicals for the Control of spotted wing drosophila in soft fruit

Funder: Innovate UK

Partners: W.B. Chambers Farms Ltd (Lead), British Berry Growers Ltd, Hall Hunter Partnership (Farming) and Hugh Lowe Farms Ltd

Term: November 2025 to October 2027

Although growers have adopted various management practices to reduce populations of spotted wing drosophila (SWD), they still have to rely on conventional spray products for complete control. Previous Niab work identified that resident generalist native parasitoids were contributing to SWD control and in 2025, Defra Plant Health issued permission for commercial release of one such parasitoid (*Pachycrepoideus vindemmiae*). In this project, Niab will work with three commercial growers to deploy *P. vindemmiae* and measure and optimise its efficacy in controlling SWD.

Niab will deploy the native parasitoid Pachycrepoideus vindemmiae to assess its efficacy in controlling SWD

Sarah Arnold, Entomology Research Leader

Title: FLYTHRIVE: Hoverflies for aphid control in soft fruit

Funder: Innovate UK

Partners: Olombria (Lead), Asplins, The Summer Berry Company and The Natural Resources Institute

Term: June 2024 to May 2026

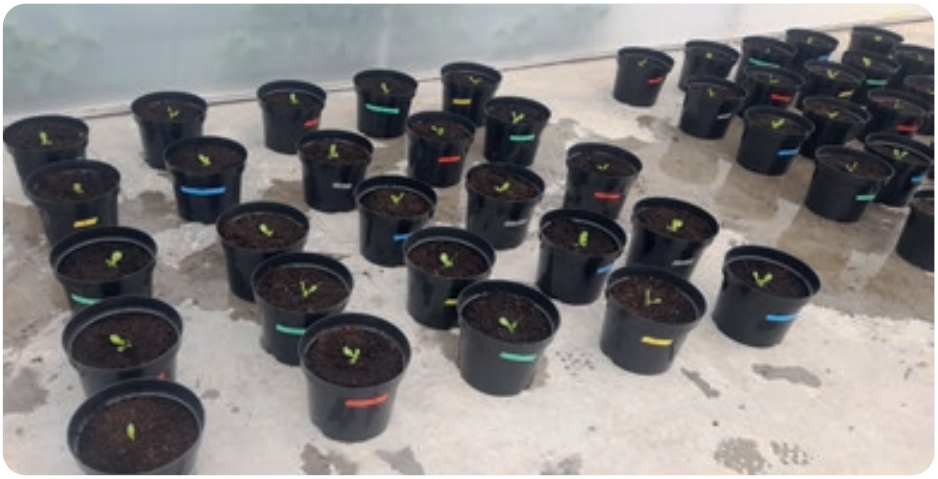
Testing native hoverfly species blends to control aphids in protected soft fruit

Control of aphids in soft fruit crops is becoming increasingly difficult with very few effective conventional chemical aphicides authorised for use. Previous studies have shown that hoverflies can contribute significantly to aphid control in protected crops as adults released into the crop can seek out aphid colonies even in dense foliage, where they lay their eggs. Emerging larvae are voracious predators of the aphids with a single larva able to consume hundreds of aphids. This project will test and develop bespoke native hoverfly species blends to control key aphid pests of soft fruit crops under protection.

Xiangming Xu, Director of Research

Title: Soil health: Developing agronomic practices to improve soil health and crop productivity
Funder: Horizon Europe
Partners: A total of 19 other partners from EU countries will collaborate with Niab
Term: June 2024 to November 2027

Several EU-funded projects have investigated methods of improving soil management practices and creating viable and sustainable alternatives to peat as a soilless substrate. The data and outcomes of one of these projects 'EXCALIBUR' will now be exploited by transforming agri-food by-products either into soil fertilising products or sustainable alternatives to peat substrates. Within the project, Niab is working with ReCoir Ltd to recycle and repurpose spent coir for fruit and vegetable production.



Assessing lettuce growth in recycled coir

Xiangming Xu, Director of Research

Title: Sustainable management of apple replant disease
Funder: Biotechnology and Biological Sciences Research Council
Term: October 2024 to September 2026

Evaluating an integrated approach to controlling apple replant disease

It is now generally accepted that apple replant disease (ARD) is a disease-complex primarily caused by microbial pathogens. Recent research at Niab funded by BBSRC and the EU has shown that disease severity is reduced where newly planted trees are planted on a rootstock genetically distinct from the previous one and the trees are in the previous grass alley. Amending soils with specific biopesticides and microbes or organic composts further reduced the problem. In this project, Niab will evaluate an integrated approach to control using all these treatments in combination.

Graham Dow, Ecophysiology Group Leader

Detecting early signals of tree stress

Title: Arboricrop: Next generation agriculture using real-time information from tree crops

Funder: Innovate UK

Partners: Benchmark Control Ltd (Lead), Adrian Scripps Ltd and H.L. Hutchinson Ltd

Term: February 2024 to July 2026

Research interests are increasingly focused on developing technologies that can detect early signs of plant stress in various crops. Niab is currently engaged in an Innovate UK project that is focused on glasshouse tomatoes and peppers (DCM: Digital Crop Management for glasshouse pests and diseases). Traditionally, plant stress caused by water and nutrient deficiency or pest and disease attack, has been detected by visual crop inspection. Often by the time interventions have corrected the problem, the short-term stress has given rise to some level of yield penalty. The development of technology that detects plant stress at earlier stages would allow changes in crop management to be implemented quickly and reduce yield penalties that might be incurred. To date, very little research has been carried out to develop early warnings of stress in woody tree fruit crops.

The project

Niab has been working under a Swiss – UK bilateral R&D programme funded by Innosuisse and Innovate UK. The UK consortium is led by Benchmark Control Ltd and the Swiss Consortium is led by Vivent Biosignals, with a specific goal to develop sensors that record tree electrophysiology and indicate stress before visible symptoms appear (Figure 1). The Niab research contribution has been carried out in a Gala apple orchard grown by consortium partner Adrian Scripps Ltd. The sensor hardware produced by Benchmark and Vivent is about the size of a deck of cards, which has a transmitting device attached at the top and miniature environmental sensors at the bottom (Figure 2). Two electrodes from the device are inserted directly into the tree, one into the branch vascular system (Figure 3) and the second into the main trunk. The device measures the electrical difference between electrode locations in real-time and machine learning algorithms can interpret these electrical signals as changes in biological activity.

Figure 1. Next generation electro-physiological sensor being set up in an orchard

The resulting data is sent to a centralised 5G router in the orchard which transmits data via the cellular network, allowing information to be continually relayed to a farm manager's computer.

In this project, a trial was set up to impose different levels of water stress on Gala apple trees and compare the data output from the electrophysiological sensors with traditional ground-truth measurements of plant water stress. If the electrophysiological sensors are found to correlate with the other measurement approaches, it provides confidence the electrophysiological data can be used to accurately measure water stress without relying on more time-consuming and labour-dependent measurements.

Results so far

Within the trial Gala orchard, sensors were set up in four different plots. Two plots were positioned in the north end of the orchard where sandy soils are fast-draining and two plots in the south end where clay soils are slow-draining. In each plot, water stress was imposed during

Figure 2. The hardware erected in the tree

July and August by withholding drip irrigation in one 'treatment' row and maintaining irrigation in one 'control' row. This combination of soil type and irrigation input created four experimental groups to analyse.

The Niab research team wanted to determine if the data collected from the electrophysiological sensors would correlate with three different ground-truth measurements of plant water relations: stomatal conductance (a measure of leaf transpiration); stem water potential (a measure of water stress); and soil matric potential (a measure of soil water availability). Ground-truth measurements were taken once or twice weekly from June through to September, while electrophysiological data was produced on a continual daily basis throughout the season.

In July, when the first irrigation treatment was imposed, wet and cool weather conditions prevented the development of water stress and data from the ground-truth measurements were similar across the four groups. In August, hotter and drier weather conditions started to impose water stress across the groups and differences were recorded in the ground-truth measurements. During this period, the data collected from the electrophysiological sensors significantly correlated with both stomatal conductance and soil matric potential. Surprisingly, stem water potential showed no correlation with the electrophysiological data. Stem water potential is often considered the first indicator of plant water stress, which highlights a need to further understand the timescale(s) at which electrophysiological data can indicate water stress.

These results provide encouraging progress that electrophysiological sensors can deliver useful measurements of water stress in real-time and without labour-intensive approaches. With additional refinement, electrophysiological sensors can hopefully be deployed in an orchard-wide layout for automated irrigation based on tree water status, where irrigation is actuated when the sensors indicate water stress is dropping below a predetermined level, of say 50%. In effect, the sensors provide a system where the tree is telling producers when it needs water rather than relying on proxies derived from soil moisture levels or environmental conditions.

In the future, Vivent plans to use the technology to measure other parameters, such as nutritional content (N, P, K, Mn, Ca), to identify when nutrient deficiencies are occurring in the tree. The digital dashboard provided to producers that relays sensor information is also being integrated with existing agronomic and forecasting tools, such as Omnia Digital Farming, which is led by project partner Hutchinsons.

This project has successfully demonstrated the use of an automated stress detection system that employs reliable sensor hardware and communication software for continual real-time assessment of plant electrophysiology in orchard systems. Niab has validated a model that predicts water status and plant health based on electrophysiology data by using ground-truth plant physiology measurements. There is now potential to exploit this system in digital farming systems management.

Figure 3. Sensors are inserted in the branch vascular system

Flora O'Brien, Root and Soil Biologist

Developing a test for the biological health of soils

Title: Developing a holistic biological soil health assessment
Funder: Innovate UK
Partner: Verdant Carbon Ltd
Term: August 2024 to January 2026

Healthy soils are vital if they are to supply fruit crops with the correct environment for optimum root growth and facilitate the uptake of water and nutrients required to produce high yields of top-quality fruit. Chemical, physical and biological soil properties all contribute to a healthy soil, and growers need to be able to measure these to understand and manage their soils to maintain optimum soil health (Figure 1). Soil scientists can already measure chemical properties such as pH, nutrient content, soil organic matter, cation exchange capacity and organic carbon. They can also measure physical properties such as soil texture, structure, porosity, infiltration, aggregate stability, bulk density and compaction. Biological soil properties have been more difficult to measure. Earthworm counts are relatively easy to carry out but are only one small component of soil biology.

Ideally, it would be helpful if we could develop a way of measuring soil microbial communities as these are essential in delivering ecosystem services. Microbial communities are very important in supporting nutrient cycling such as nitrifying bacteria that convert ammonium to nitrate nitrogen, a form that is more readily available to plants. They also aid organic matter decomposition and carbon storage in the soil, whilst providing sticky compounds essential for maintaining soil structure. Plant growth promoting bacteria help to stimulate plant growth while other microbes can enhance plant defences against pathogen attack. Some microbes can even help to absorb heavy metals or other contaminants, making the soil safer for plant growth, a process known as 'bioremediation'.

Soil microbiology can be assessed by measuring the microbial biomass of a soil, but this fails to identify specific functional groups of the microbiome. DNA extracts from the soil can be sequenced in the laboratory to measure the microbial community composition. This provides a large quantity of data at great expense, but it does not necessarily reveal how healthy a soil is, or what impact different management practices are having on soil health.

The project

This project set about developing a better system of measuring the microbial functioning of a soil, so that growers and agronomists can better understand the status of their soil biology in relation to its ability to support crop productivity. Such a system would allow us to monitor the impact that our management practices are having on the biological health of the soil. In this Innovate UK project, Niab collaborated with industry partner Verdant Carbon, a company that already provides various soil testing services including the total carbon and nitrogen content of a soil, but who are keen to extend their offering to provide a more meaningful test for the biological health of a soil.

Results so far

The project focused on the use of two distinct approches to analysing soil microbial communities. In each, the scientists sought to identify key markers or predictors that would correlate best with crop health and productivity. For example, would a test indicating high levels of microbial organisms involved in nitrogen cycling correlate with the biomass production of a crop. The first of these is Phospholipid Fatty Acid (PLFA) analysis while the second is quantitative Polymerase Chain Reaction (qPCR).

Figure 1. Growers need to measure the health of a soil

PLFAs are present in the membranes of all microbial cells,

Figure 2. Soils were assessed in a pot experiment

but their profiles differ according to different groups of microbes. They degrade rapidly following cell death, so analysis using PLFA provides a measure of living organisms only. PLFAs are sensitive to management practices so a change in management will provide a quick response using this type of measurement. Analysis using qPCR provides a measure of both living and dead DNA, so this does not give quite as accurate a picture of active soil microbial activity at a particular time. However, it can provide measurement of very specific groups of microbes and is more targeted than the PLFA analysis.

At the start of the project, Verdant Carbon collected 236 soil samples from sites with varying soil characteristics and management histories, from the south and east of England, with varied previous cropping, current cropping and soil type. The samples were largely collected from arable farms and farms with mixed cropping and livestock. Using these samples, the team set about optimising the two biological soil profiling tests, then complemented these analyses with checmial and physical analysis,

Figure 3. Above and below ground crop biomass was measured

measuring total carbon and nitrogen content, soil pH, soil texture and nutrient content.

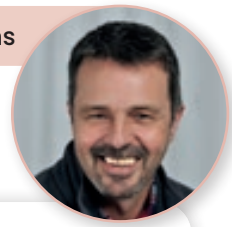
Using a subset of 88 of these samples, a pot experiment was set up in a polytunnel (Figure 2), growing lettuce, cabbage, leek and perennial rye grass, with each crop harvested following between seven and nine weeks of growth. Both above and below ground biomass (Figure 3) produced from each crop were measured, as well as analysing the soils collected from each pot. Niab examined the data and measurements collected to identify any correlations that appeared between the biomass of the harvested crops, the measurements of soil health recorded by the PLFA and qPCR tests, and the results of the chemical and physical soil analyses that were carried out.

From the soil chemical analysis, levels of phosphorus, potassium and pH showed strong correlations with the crop biomass measured in the pot experiments. From the biological soil health analyses, two genes from the qPCR test which are involved in the denitrification stage of the nitrogen cycle, and the bacterial:fungal ratio measured from the PLFA test, also both showed a strong correlation with crop biomass.

Although excellent progress has been made from this short-term project in identifying markers from these tests that might be used as a proxy for biological soil health, further field trials will need to be carried out over a longer period of time using more field soils and different crops. This will help to build up more data and experience, increasing scientists' knowledge and confidence when interpreting the results of the tests and offering improved guidance to farmers and growers.

To this end, Verdant Carbon are now offering the PLFA analysis as part of their soil assessment services and are encouraging other researchers to bolt on biological soil health analysis to their physical and chemical analyses in future research projects.

Mark Else, Head of Crop Science and Production Systems



Precision fertigation of stone fruit

Title: Sensor-based precision fertigation of stone fruit to improve nutrient use efficiency, yields, and quality whilst lowering emissions

Funder: Defra Farming Innovation Programme

Partners: The Orchard Fruit Company (Lead), A.C. Hulme, Domum Agrum, Delta-T Devices, Driemtech, EDT directION, Fotenix, Soil Moisture Sense and Torry Hill Farm

Term: January 2025 to December 2027

Niab's research at East Malling on optimising production efficiency in plum was funded first by Innovate UK and then by the AHDB between 2016 and 2022. Early work compared the cropping potential of Victoria on a range of different rootstock/tree architecture combinations along with a variety trial which aimed to extend the production season from July until September. The Plum Demonstration Centre (PDC) was then established, a three-year project funded by an industry consortium of growers and marketing agents who took an active role ensuring that the work was of direct relevance to the sector. The PDC consortium took more of an interest in tree management and nutrition and some of the consortium secured funding from Innovate UK for this new three-year project to investigate how irrigation and fertilser strategies could be optimised in commercial stone fruit orchards whilst maintaining or improving marketable yields and lowering inputs and losses.

The project

The project seeks to match supply of water, nitrogen, phosphorus and potassium to changing tree demands over the growing season. The aim is to develop, test, and de-risk low-N growing strategies to help to raise grower confidence and uptake. Novel technologies are being developed to measure nitrogen, phosphorus and potassium concentrations in soil solutions at different rooting depths (Figure 1) and in real-time to help growers to make more informed fertigation decisions. Alongside tried-and-tested soil moisture sensing, vision systems are being developed which are capable of identifying if and when fruit growth and leaf physiology become impacted by the lower-input water and fertiliser strategies. In addition to reducing losses of water and nutrients from the rooting zone (Figure 2), these treatments are also expected to lower greenhouse gas emissions from orchard soils.

Figure 1. Measuring N, P and K at different rooting depths

Results so far

In the first year of the project, the work focused on two objectives: the first aims to develop data-driven precision fertiliser strategies

to lower inputs and emissions, and the second seeks to manipulate canopy and root system architecture to improve nutrient acquisition and partitioning. Experiments were initiated early in 2025 using established Victoria plum trees grown in a hedgerow system supported by posts and wires.

In the precision fertiliser work, a replicated experiment was set up to compare three fertigation strategies in Victoria plum. This included a typical commercial control programme, a Niab programme using the same commercial control fertiliser formulation but applied more frequently using lower volumes to limit losses of water and nutrients beyond the rooting zone of the trees, and a reduced nitrogen input treatment. There were no significant treatment differences in marketable yields or grade-out of fruit, but the low N treatment did lower fruit weight in the 40+ mm size category. Together with changes in foliar N status, these results indicate that the amount of N applied in the low N treatment was becoming limiting at the season progressed. As expected, both water use efficiency and nitrogen use efficiency were higher in the Niab and reduced nitrogen programmes, with the latter showing highest water and nitrogen efficiencies. Irrigation volumes will be further reduced in 2026 across all treatments whilst keeping the same three N programmes.

In the canopy and root system architecture work, experiments were set up in separate areas of the orchard where visual comparisons of root pruning versus no root pruning and hand pruning versus mechanical hedge pruning had been made in 2024. Records were collected in 2025 of marketable yields, grade-out and fruit size categories for each treatment. No significant treatment differences were noted. Data will be collected again in 2026 to identify any legacy effects. Similarly there were no significant treatment differences in the pruning comparison, but legacy effects will be assessed again in 2026.

The ongoing work in 2026 will focus on quantifying N, P, and K inputs and losses in commercial orchards (Figure 3), and developing the combined sensor technology package to detect when lower N and water inputs begin to alter tree physiology and marketable yields.

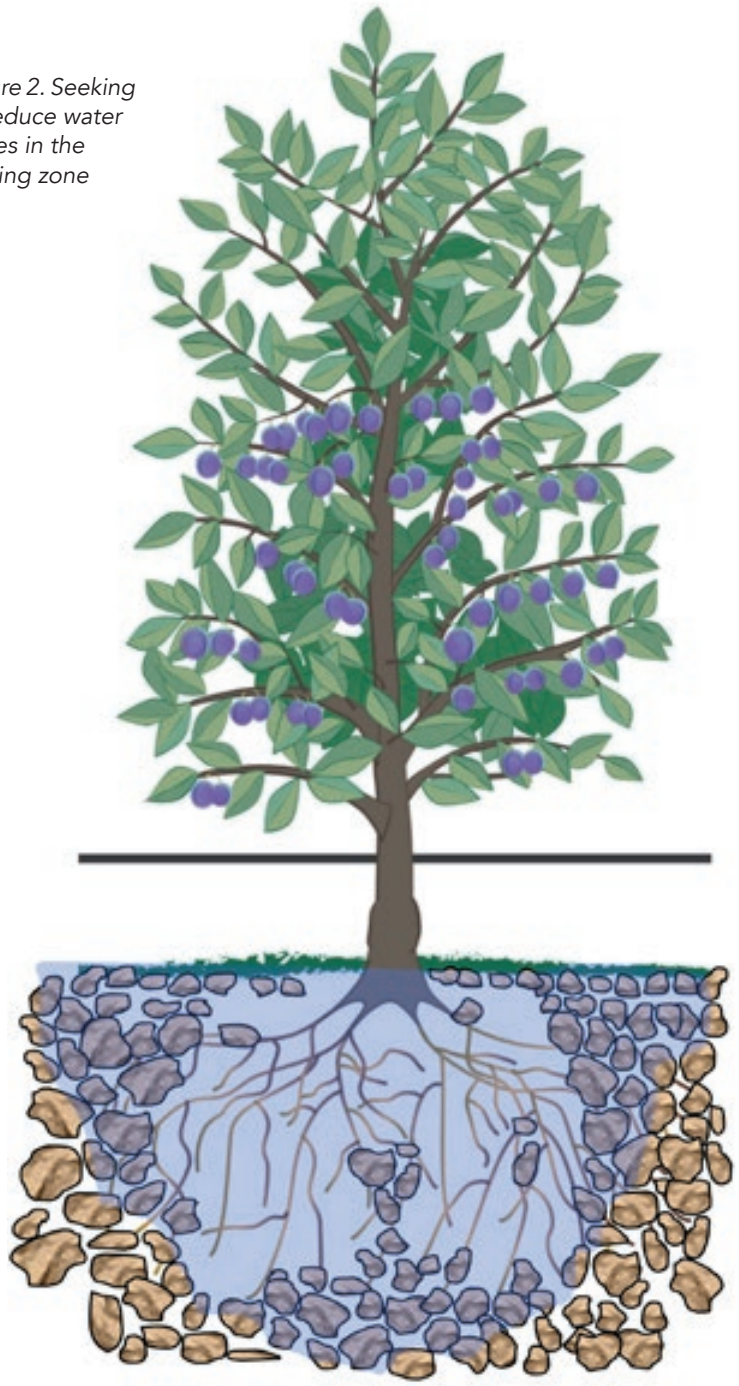


Figure 2. Seeking to reduce water losses in the rooting zone

Figure 3. Sonde technology to measure NPK leaching

Belinda Kemp, Viticulture and Oenology Research Leader

Boosting biodiversity in vineyards to harness their natural ecosystems for pest and disease control

Title: Flowering companion plants and chitosan influences biodiversity, soil health, grape juice and wine composition (FlowerChi)

Funder: Growing Kent & Medway

Partners: Baker Consultants, Chitolytic Ltd, Gusbourne Estate, Westwell Wine Estate and WineGB

Term: May 2025 to February 2026

Vines are perennial crops, which develop natural ecosystems in vineyards that support and sustain plant, animal and insect biodiversity. Despite this, vines are adversely affected by a range of insect pests, fungal diseases and weeds, necessitating regular crop monitoring and use of crop protection products to maintain economical control. With increasing pressure on growers to reduce the use of conventional crop protection methods, there is an opportunity to harness and further develop the biodiverse ecosystems that exist within vineyards to deliver more natural forms of control. This might be achieved through the combined use of companion planting and biofungicides.

The project

In this Growing Kent & Medway funded project, Niab worked with industry partners to investigate the use of German chamomile (*Matricaria chamomilla*) as a companion planted between vineyard rows, along with mushroom-derived chitosan (supplied by Chitolytic Ltd), a biofungicide and plant defence elicitor. Chamomile is a fast-growing insect-pollinated plant with a long flowering period that produces volatiles that attract beneficial arthropods, wasps and bees. Its fast-growing nature has been found to suppress weeds and it may also have a positive impact on soil health and vine growth. Low molecular weight chitosan is known to be compatible with companion flowers, has antioxidant properties and can promote plant resistance to several pathogenic related microorganisms, thereby improving grape and wine quality. The aim of this short-term study was to gather preliminary data for future longer-term funding applications by assessing their combined use on their ability to improve soil health, increase beneficial insects, and reduce pest and disease pressure in commercial vineyards.

Results

Investigations using chamomile and chitosan were carried out at the research vineyard at Niab's East Malling site on Chardonnay, and two commercial vineyards at Gusbourne Estate (Chardonnay) and Westwell Wine Estate (Ortega). The chamomile was sown in the alleys of the trial rows (Figure 1)

Figure 1. Chamomile was sown in the alleys of trial plots

and compared to control alleyways which had a short sward of grass. In addition, vines grown between both chamomile-sown alleys and grass-sown alleys were treated both with and without one of two different formulations of chitosan (crustacean-derived or mushroom-derived). All treatments were assessed for the numbers of insects visiting flowers and the numbers of pests and natural enemies in each subplot by an entomologist. The treatments were also assessed for the efficacy of disease control on the grapevines. In addition, industry partner Baker Consultants employed a technique knowns as 'bioaccoustics' to measure below-ground biodiversity (Figure 2), a new approach that inserted probes into the soil in test and control rows. The probes measured digging, chewing and scraping noises from different soil invertebrates such as beetles, with acoustic signatures unique to species.

Soil sampling was carried out both before any treatments were applied (Figure 3) and after the final treatments were carried out, and soil analysis consisted of selected soil health parameters (e.g. soil

extractable nitrate and soil moisture content). Chlorophyll measurements of grapevine leaves were also taken to determine whether there was any impact of the treatments on vine nutrient status. Grape, juice and wine quality were also monitored from August to harvest.

Chamomile treatments

There was a significant increase in invertebrate groups visiting flowers in the alleyways seeded with chamomile compared to grass, but no corresponding increase in the vines themselves. Across the three research sites, the soil soundscape, and activity and complexity, were comparable between chamomile-seeded and control rows. While some sites showed slightly higher acoustic complexity in chamomile rows the differences were not statistically significant. Chamomile appeared to have no impact on the incidence or severity of grapevine blister mite in the vines compared to the grass control alleys and also had no effect on soil nitrate at any of the three sites. It also had little impact on any of the grape and wine chemical parameters that were analysed.

Some caution should be used when interpreting these results as the increase in invertebrates seen in the newly prepared chamomile-sown alleys might have been brought about by the soil cultivation process, aerating the soil and encouraging extra activity. A lack of mowing in the chamomile alleys may have further contributed to this additional activity. Populations of insects in newly planted wildflower strips are known to take some years to reach stability, so ideally this study would need to continue for several years to allow populations of invertebrates to increase to a level that deliver repeatable and reliable results.

Chitosan treatments

In terms of disease control, all three sites needed to use additional sprays to the chitosan to gain control of powdery mildew. At the Niab site, five additional organic fungicides were applied. At the Gusbourne and Westwell sites, additional chemical fungicides were necessary to gain control of high levels of mildew, so the chitosan on its own was insufficient to gain satisfactory control, but it has been shown to reduce synthetic spray use. The chitosan sprays appeared to have no adverse effect on aboveground insect biodiversity, implying that chitosan treatments are likely to be broadly safe for invertebrates.

There were no apparent effects of chitosan use on soil nitrate at the Niab site or Westwell site, but at Gusbourne, there was an increase in nitrate in rows sprayed with chitosan although only in one set of samples. Across the Niab and Westwell sites, there were no differences in analyses of pre-harvest juice, harvest juice or final wine between the chitosan treatments. However, at Gusbourne, pre-harvest analysis showed differences in pH, with the highest values observed in the chitosan treatments and lowest values in the control (no chitosan). Differences in pH are important when protecting the juice and wine against oxidation and microorganisms as the effectiveness of free SO_2 is pH dependent.

Figure 2. Bioaccoustics allows us to measure soil biodiversity

Further work

These initial results have shown that chamomile might boost the diversity of invertebrates in vineyards but has no negative impact on grape or wine chemistry. Chitosan treatments are broadly safe to invertebrates but on their own in 2025 were not sufficient to control powdery mildew in grapevine and there is some evidence to show that it might affect pH in grape juice and final wine. Further trials spanning a number of seasons are required to assess the long-term impact of chamomile and chitosan on grapevine pests and diseases as well as on grape juice/wine quality.

Figure 3. Soil sampling was carried out before the trial

Mark Else, Head of Crop Science and Production Systems

Katia Zacharaki, TCEA Soft Fruit Specialist

Maximising strawberry yield potential

Title: Optimising the propagation environment in TCEA systems to maximise strawberry yield potential in all production systems

Funder: Defra Farming Innovation Programme

Partners: Berry Gardens Growers Ltd, The Blaise Plant Company Ltd, Cocogreen Ltd, Clock House Farm Ltd, Delta T Devices Ltd, Hugh Lowe Farms Ltd, Linton Growing Ltd, University of Reading (formerly led by Vertical Future)

Term: June 2023 to September 2026

With increasing volumes of berries being imported in the UK, particularly during winter, there is great potential to substitute a proportion of this demand with home-produced fruit across all growing systems (Figure 1). However, this can only be achieved if the quality and consistency of propagated strawberry plants is significantly improved. Innovation is therefore needed to support UK year-round production of high-quality, disease-free, pre-programmed propagules with reliably high cropping potential.

Internationally, there are ongoing efforts from both start-ups and research institutions to clonally propagate strawberry plants within Total Controlled Environment Agriculture (TCEA) systems for both short-day and everbearer varieties. Although some early results look promising, plants are not yet being grown on a commercial scale. A small number of niche TCEA growers have vertically integrated their operations and produce plants in-house, but this approach remains limited and primarily supports their own production.

Currently, the commercial strawberry sector recognises several bottlenecks in existing propagation systems. These include the carry-over of pests and diseases, variability in plant quality, and the seasonal availability of planting material. Together, these constraints limit flexibility in planting schedules and restrict opportunities to extend the production season.

Previous work at Niab in May 2022 demonstrated the effect of variable plant quality on cropping potential and consistency. Under consistent growth room conditions with optimal light levels and precision fertigation, an average yield of 2.5 kg per plant was recorded for Malling Champion, with individual plants ranging from 0.8 kg to 3.2 kg. A heat map analysis confirmed that plant position within the growth room had no effect on yield. This substantial variation, independent of environmental factors, indicated that plant quality is the primary driver of yield variability.

Figure 1. Strawberry appears to be an ideal candidate for vertical farming

TCEA-produced plants offer several potential advantages. These include reduced reliance on plant protection products, improved yield and fruit quality, greater uniformity of propagules, and reduced dependence on imported planting material. Plants produced in TCEA systems are suitable for use across all production environments, including polytunnels, glasshouses, and TCEA.

The project

If TCEA production of strawberries is to be successful commercially, it is vital to find ways of ensuring that

every plant is capable of producing high Class 1 yields, for example, 3 kg per plant. To achieve this, new ways of propagating high quality, high-health strawberry plants with an assured cropping potential are needed. The Defra Farming Innovation Programme Small R&D scheme is funding this project which is now in its final year.

The experiments began with tissue-cultured plants (Figure 2), which were raised to become the so-called 'mother plants.' These mother plants were grown in a prototype TCEA strawberry propagation facility at Niab East Malling using LED lighting, with the aim of accelerating runner production (Figure 3) and generating high quality daughter plants in a more consistent environment. The daughter plants were planted in coir substrate and moved to a second compartment, where they underwent flower induction treatments before being exposed to chilling conditions. In 2025, the marketable yield and fruit quality of these high-health plants were compared with those from commercially-propagated plants provided by the project partner propagators. These comparative trials took place in three production environments: conventional polytunnels, glasshouses, and TCEA systems.

Results so far

The high-health, disease-free status of the TCEA-produced tray plants was confimed in 2025 when significant losses occurred in some commercially-propagated plants due to crown rot, and powdery mildew was an issue in others. Overall, Class 1 yields were comparable to commercial controls in each of the three growing systems and so further research is needed to optimise flower initiation during the propagation phase. This work was done in late 2025 and TCEA propagules are now being planted for a second year of comaprative trials against commercially-produced plants.

Further work with Malling Ace grown in TCEA conditions over a 12-month period demonstrated that, following a brief reduction in yield after the initial flush, Class 1 production increased linearly. This suggests that high-health tray plants grown under optimum conditions with careful plant management can deliver the high and predictable Class 1 yields that the nascent UK TCEA strawberry industry requires.

Alongside this work, Niab has been experimenting with ways of using water more efficiently through regulated deficit irrigation (RDI). The work has demonstrated that Class 1 yields and fruit quality can be maintained when imposing mild RDI conditions, whilst water and nutrient use efficiencies are improved. Read the published paper here.

Figure 2. Experiments began with tissue cultured plants

Figure 3. The aim has been to accelerate runner production

Mark Else, Head of Crop Science and Production Systems

Katia Zacharaki, TCEA Soft Fruit Specialist

Improving growth control of strawberry in TCEA conditions

Title: TCEA N-demand: Optimising nitrogen and CO_2 inputs to improve assimilation and yields in TCEA strawberry production

Funder: Innovate UK

Partners: Innophyte Consulting Ltd (Lead) and Flex Farming Ltd

Term: January 2025 to December 2026

Soft fruit growers tend to use more fertiliser than is sometimes needed and this can lead to over-vigorous leaf canopies in strawberry (Figure 1) and raspberry crops. In tunnel-grown crops of strawberry, larger canopies may be beneficial since light levels are often below the saturation point for photosynthesis, but under Total Controlled Environment Atmosphere (TCEA) conditions where light availability is not limiting, excessive leaf growth often impacts on cropping potential and berry quality. Over vigorous leaf growth can also reduce light interception, increase crop management and picking costs, create an unfavourable environment that promotes plant disease and increases dehumidification costs, and lead to accumulation of ballast ions in coir which necessitates extra flushing events. Contamination of groundwater with fertiliser-rich leachates and higher emissions of greenhouse gases such as nitrous oxide also pose problems.

In the absence of scientifically-derived guidelines, soft fruit growers often struggle to match plant demand for fertilisers whilst trying to optimise marketable yields. For substrate strawberry and raspberry production, Niab has adapted an existing nutrition model developed for soil-grown tomatoes in Spain that uses thermal time and photosynthetically active radiation (PAR) to predict dry matter production. This then allows Niab to estimate the required amount of nitrogen needed to support this growth whilst favouring *in planta* partitioning of resources towards fruit production.

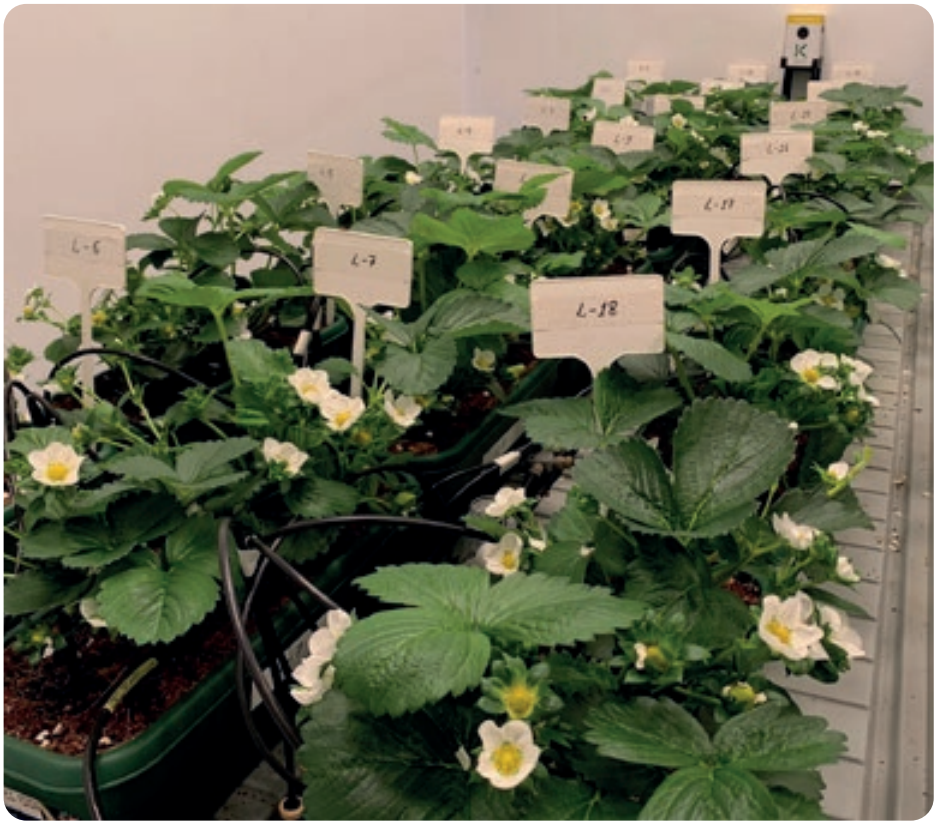
Figure 1. Vigorous leaf canopy in strawberries

In early work using the N-demand model with the Junebearer strawberry Malling Vitality, nitrogen use was reduced by 77% in the low-N treatment compared to the commercial control, whilst Class 1 yield, berry size and fruit quality were unaffected. When employing the model with the everbearer strawberry Malling Ace in growth rooms (Figure 2), nitrogen input was reduced by 52% over an eight-month cropping period compared to the commercial control, with no significant difference in Class 1 yield.

The project

In this Innovate UK funded project, Niab is working with industry partners Innophyte Consulting Ltd and Flex Farming Ltd to maximise the yield potential and production efficiency of Malling Ace in growth rooms. A TCEA-variety-specific N-demand model is being combined with the precision irrigation technology developed at its East Malling site to match nutrient and water application to plant demand. The objective is to match CO_2 enrichment with the plant's diurnal change in photosynthetic efficiency so that input concentrations and durations can be optimised. This information will inform the development of a new clean-and-green CO_2 capture-and-release system, using a metal-organic framework (MOF). The intention is to

Figure 2. Nitrogen input was reduced in Malling Ace



capture CO_2 from the atmosphere, bring it into the growth room, then pulse it into the crop canopy before reabsorbing it if needed.

Malling Ace was planted in two growth rooms on 11th March 2025 where it established and grew quickly under optimised growing conditions (Figure 3). The first ripe fruit were picked week commencing 28th April and picking continued for 23 weeks until early October.

Results

Malling Ace plants receiving N inputs dictated by the N-demand model were compared to plants receiving a commercial formulation. A 35% saving in the amount of nitrogen applied was achieved. The commercial control plants produced an average of 1.81 kg/plant over six cropping months, while the low-N plants produced 1.73 kg/plant; this 5% lower yield was not statistically significant. No differences in mean berry weight or soluble solid content (Brix) were recorded. There was a 13% reduction in canopy area in the low-N plants which would improve light interception and reduce de-leafing and harvesting costs in commercial systems.

Although employing the N-demand model helped to reduce canopy size and input costs whilst maintaining Class 1 yields, it is important to maximise cropping potential. In a second growth room, another Malling Ace crop was continuously enriched with CO_2, and growth and yield compared to Malling Ace plants grown under ambient CO_2 concentrations (see above). A 30% increase in Class 1 yield (2.34 kg/plant compared to 1.81 kg/plant over six cropping months) was recorded in the CO_2-enriched plants. This resulted from an increase in the size and fresh weight of individual berries. However, an expected but undesirable outcome of CO_2 enrichment was a 27% increase in leaf area compared to controls.

The Niab team measured leaf gas exchange in the low-N treated plants, the CO_2-enriched plants, and the respective control plants. Photosynthesis was lowered in the low-N plants but raised in the CO_2 enriched plants. Stomatal conductance was lowered in the CO_2 enriched plants, leading to higher water use efficiency, and preliminary data suggests that there were lower stomatal densities in the plants enriched with CO_2.

The next step is to find a way of maximising marketable yields whilst minimising leaf canopy area. Work will begin in 2026 to combine CO_2 enrichment with the N-demand model to try to limit canopy size, but rather than supplying CO_2 continuously, it will be pulsed at times when the photosynthetic capacity of the plant is at its optimum. Strawberry has a distinct diurnal rhythm of stomatal conductance and photosynthesis, so CO_2 will be pulsed in the morning to try to optimise Class 1 yield from low-N plants whilst limiting canopy growth.

Figure 3. Malling Ace was established in growth rooms

Charles Whitfield, Crop Protection Scientist

POME: Precision Orchard Management for Environment

Title: Precision Orchard Management for Environment

Funder: Innovate UK: Defra and UKRI Farming Innovation Programme

Partners: Hutchinsons (Lead partner), The Acclaimed Software Company, Outfield, Fotenix, Antobot, NP Seymour, HSE Chemicals Regulation Division, AM Fresh, A.C. Hulme, Plumford Farm, Newlands Farm, University of Kent, Loughborough University

Term: November 2023 to October 2027

There is substantial variation between trees in commercial orchards in terms of vegetative growth and size, and even greater variation in yield. A previous Innovate UK project has developed a prototype orchard 'Precision Variable Rate Spray' system (Figure 1) that can take account of tree size and apply a measured volume of spray to match the size and canopy density of individual trees, thereby reducing overall spray use which can optimise orchard treatments and be beneficial to the environment. This was achieved by using LIDAR scanning of trees to map their height and density. Specialised software was developed to calculate a variable rate prescription map from the canopy data. The software uses the prescription map to control individual nozzle output as the spray machine passes along the rows.

The project

The aim of the previous work was to prove that the concept could work. This new project will further develop techniques to quantify canopy density, fruit load and presence of pests and diseases, and calculate yield estimates and prescription maps to manage tree growth, crop load and spray application.

It is important to note that the prescription maps are calculated in advance rather than in real time. This means that the volume of product and spray that needs to be applied in the orchard is known before the spray round begins. The tractor is set up with the scanning system at the front (Figure 2) and whenever the tractor passes through the orchard for any task, it scans every tree.

The software handles all the scanned data, crunches the numbers, calculates a prescription map and works out how much spray to apply to every part of the orchard. The spray is dispensed from pulse width modulation nozzles. Each is controllable and is being continuously adjusted as it passes through the orchard.

Figure 1. The sprayer applies adjusted doses to individual trees

Trials are being carried out in a Gala orchard at Niab's East Malling site which consists of 16 rows with 80 trees per row. Three treatments have been set up to compare a constant rate sprayer that is used by most commercial apple growers, the variable rate sprayer, and an untreated control. Each treatment is replicated three times. In 2024, the variable rate sprayer was found to be depositing too little spray across the canopy compared to the constant rate sprayer. However, it provided a more uniform spray deposition within the trees. At the end of the 2024 season, adjustments were made to the algorithm that calculates the output from the nozzles and the work was repeated in 2025.

Results

The adjustments succeeded in increasing spray output from the variable rate sprayer so that it more closely matched the output from the constant rate sprayer. At the

same time, the uniformity of spray deposition was maintained. The next stage of the work was to compare the two sprayer types in a crop protection assessment. Two trials were carried out, one to compare them in scab control and one in codling moth control.

In the scab trial, a full fungicide programme was applied through the season and levels of primary scab infection recorded on the rosette leaves (Figure 3) in June and again in August. No significant difference in control was detected between the constant rate sprayer and the variable rate sprayer in either assessment. The levels of scab on fruit were also recorded at harvest time. 5% more scab infection was found on the trees treated by the variable rate sprayer than those treated by the constant rate sprayer, but this difference only occurred in one of the three replicates and not the other two. The partners have an idea of why this might have happened and will make further adjustments for 2026.

In the codling moth trial, a standard control programme was applied by both sprayers using the same replicated trial layout. Fruit damage was assessed at harvest time. No significant difference was detected between the constant rate sprayer and the variable rate sprayer but both provided significantly better control than the untreated control plots.

It should be noted that 35% less spray and product was applied by the variable rate sprayer compared to the constant rate sprayer in both of the above trials. This represents a significant financial saving for apple growers.

In 2026, the trials will be expanded into commercial orchards to make similar comparisons but on a much larger scale. The engineers will modify the dose adjustment algorithm that calculates the prescription map, to see if the deposition rate can be improved on the variable rate sprayer whilst maintaining satisfactory pest and disease control and making the same savings.

Figure 2. The tractor scans every time it passes through the orchard

Figure 3. Rosette leaves were assessed for scab levels in June and August

Michelle Fountain, Head of Pest and Pathogen Ecology
Matevz Papp-Rupar, Plant Pathology Research Leader
Francis Wamonje, Entomology Research Leader



Surveillance of emerging pest and disease threats of apple and pear

Title: PAPPLe III: Integrated pest and disease management in apples and pears
Funder: British Apples and Pears Ltd
Term: April 2025 to March 2026

Working on behalf of growers, British Apples and Pears Ltd (BAPL) is funding a project called PAPPLe where Niab is investigating novel control measures for some of the most damaging pests and diseases. As part of this work, Niab has been asked to survey and monitor the potential threat of newly emerging pests and diseases from overseas to apple and pear in the UK. This has been done periodically through the lifetime of previous PAPPLe projects as well as AHDB Project TF 223, and reported to the industry through BAPL.

The project

Niab monitors the potential threats by undertaking internet searches whilst Niab fruit pathologists and entomologists collaborate with international researchers and regularly attend international symposia and conferences, keeping abreast of emerging diseases and insect pests. A risk register of these is maintained along with associated recommendations for monitoring and effective control strategies. A brief summary of our latest knowledge and concerns is reported here. More detail is in the BAPL report available to BAPL members.

Figure 1. Diplodia bulgarica – Pycnidia on the bark of a pear tree

Results

Xylella fastidiosa (causing bacterial leaf scorch) and *Erwinia amylovora* (causing fireblight) are the principal bacterial concerns, with *Xylella* considered to be a high risk and *Erwinia* a moderate risk. New research into *Xylella* includes the assessment of natural products such as essential oils and potassium soap for their efficacy at controlling the froghopper/cuckoo spit insect (*Philaenus spumarius*), the major vector of the pathogen. A new

Figure 2. Black cankers on apple trees

phytoplasma (*Candidatus Phytoplasma mali* – apple proliferation) which is transmitted by the apple psyllid, is also of moderate risk. Phytoplasmas are relatively understudied, so vigilance is important with these.

Two fungal organisms continue to be major threats. *Diplodia bulgarica* - Figure 1 (causing black canker of apple and pear – Figure 2) has attracted much research funding which has shown that *Trichoderma* strains can effectively suppress the fungus, reducing disease severity. *Neonectria ditissima* (the cause of apple canker) is well known to all apple growers. Some recent research has identified that volatile organic compounds (VOCs) can be used as potential early indicators of infection.

There are nine potential viruses of concern which have been reported in the past. One recent study has noted that the application of salicylic acid appears to alleviate apple stem grooving virus. No new viruses have been identified as threats in the most recent survey.

Of the insect pests, the apple psyllid (order Hemiptera) is classified as a low risk but does transmit phytoplasmas. Of more moderate risk are borers such as the Pacific flatheaded borer and flatheaded apple tree borer, weevils such as the apple flea weevil and apple leaf-mining weevil, the fruitlet mining tortrix caterpillar, and the garden snail.

The potential risk of these insect pests increases as more broad-spectrum control products are withdrawn for use by growers. With fewer new conventional control products being developed, scientists are taking an increasing interest in potential new biocontrol methods, which could become important in the UK should any of these potential threats establish here.

In USA, where Pacific flatheaded borer has become a major pest, predatory beetles and four species of parasitic wasps have been identified that offer control. Parasitoids have been shown to provide effective control of apple flea weevil and apple leaf-mining weevil.

Growers and agronomists should continue to be vigilant to new disease and pest threats, taking particular care when importing plant material from overseas. Such plants should be isolated and checked for the presence of diseases or pests before planting, taking care especially to look for viruses. Any non-native species should be reported to the plant health authorities.

Growers should ensure plant material introduced onto the farm is fully certified and healthy. Plants should be isolated in the first instance and fully inspected before planting. Increases in global trade and human and plant movement increases the risk of pest and disease incursion. Early warning of signs, symptoms and countries of origin will enable UK growers to prevent and delay invasive problems in the future.

Francis Wamonje, Entomology Research Leader

Niab's continued surveillance for the brown marmorated stink bug

Title: Brown marmorated stink bug – UK surveillance
Funder: Defra
Term: April 2025 to March 2026

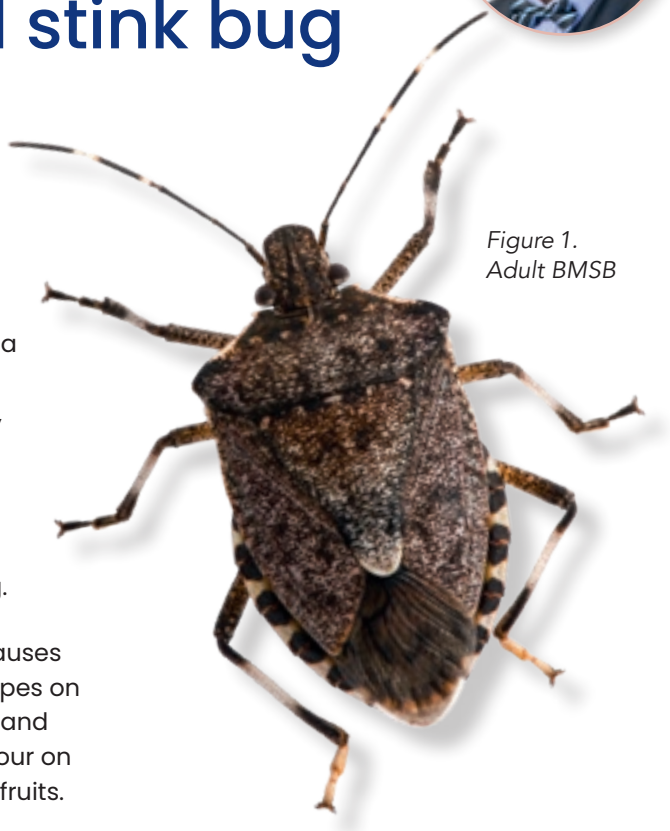


Figure 1. Adult BMSB

The brown marmorated stink bug (Figure 1) or BMSB (*Halyomorpha halys*) is a shield bug which originated in Asia and has become an invasive pest of fruit and other horticultural crops around the world, most notably apple, pear, kiwi, peach, apricot, cherry and hazelnut. It has become a particularly serious fruit pest in Italy where in 2019 it has been estimated that it led to total losses to fruit crops of €740 million. However, it is also a pest of residential and commercial properties where it leaves a rather unpleasant pungent odour, hence being labelled a stink bug.

Historically it was not considered to be a major threat to UK crops but with climate change bringing longer, hotter summers, particularly in the south and east of England, it has the potential to cause more serious damage in future. On apple and pear, typical damage is misshapen fruits (Figure 2) that are rendered unmarketable, although internal corking of the tissue is also common. The pest also causes collapse and death of drupes on raspberry and blackberry and swelling and a distinct odour on strawberry and blueberry fruits.

The project

With climate modelling predicting that BMSB will be suited to establishing in southern and eastern England by 2050 and probably earlier, Defra has been funding Niab to conduct a surveillance programme across the UK to detect if and when the pest becomes established here. Traps have been located in parks and gardens (Figure 3) within urban areas where temperatures are generally higher and more conducive to pest activity. Traps have also been located at caravan parks and at caravan storage sites where previous sightings have been regularly made as the pest hitchhikes back to the UK on these vehicles.

Figure 2. Mishapen fruits are unmarketable

Results

Since 2022, the numbers of annual sightings have increased with seven in 2023, 22 in 2024 and 35 in 2025, and the numbers of insects per sighting has also increased. In 2024, the first report of juvenile forms was recorded suggesting that the pest has now bred in the UK for the first time. In 2025, additional monitoring has been carried out around the edge of commercial UK fruit crops by British Apples & Pears Ltd (BAPL)

Figure 3. Monitoring in municipal gardens

surveillance and alert programme is to provide an accurate picture of how widespread the pest is becoming so that further measures can be implemented to prepare the fruit and horticultural industry for possible crop damage and how best to manage it. For growers who want to start to monitor for its presence, Russell IPM and other biocontrol companies are developing traps for use on commercial farms. Defra has produced a very helpful plant pest factsheet with full details of the pest's biology which can be viewed on their plant health portal.

and British Berry Growers (BBG), but to date no sightings have been recorded in commercial crops.

As part of Defra's surveillance programme, Niab has been actively raising the profile of BMSB amongst the public and through the caravan and campervan community. The public have been encouraged to look out for it and caravan and campervan owners asked to check their vehicles for the pest on returning to the UK. An infographic (Figure 4) has been circulated to caravan storage sites and adverts placed in the caravan and motorhome trade press. This has resulted in a great many samples being sent to Niab for correct identification. BMSB has a number of features which distinguish it from other shield bug species that are commonly found in the UK, so many samples submitted by the public to Niab are not positively confirmed to be BMSB.

In 2026 Niab will raise the profile of the pest further by promoting its presence to the UK haulage industry and an arrangement has been made with the Port of Dover Authority to advertise on electronic display boards at the front of assembly lines where queues of vehicles form when entering ferry boats. We aim to raise awareness of the pest and encourage owners to check their vehicles when returning to the UK.

The purpose of this combined

Figure 4. Infographic circulated to the caravan and campervan sectors

The long journey towards control of apple canker

Niab pathologists have been working for many years to develop novel approaches for management of apple canker (Figure 1). Despite assessing a wide range of new biological and other non-fungicide control products, even the most effective candidates did not provide satisfactory control of leaf fall infections. A single 1 cm long canker lesion can produce 10,000 conidia and ascospores every time it rains, so canker spread is unavoidable using protectant spraying alone. Removal of canker lesions by pruning during dry conditions is the most effective way of reducing disease, but for maximum impact, four dedicated canker pruning walks through an orchard are required each year, which is very expensive for growers.

Niab recently worked with Agrovista and AM Fresh on a Growing Kent & Medway funded project which investigated if amending the roots of newly planted commercial apple orchards with arbuscular mycorrhizal fungi (AMF, PlantWorks) and two Trichoderma based biocontrol products (Trianum-P and Vintec) can reduce canker. Work was also done to increase the populations of AMF in established orchards by sowing wildflowers (known to support AMF activity – Figure 2) and inoculating alleys and tree rows with AMF.

Gala trees amended with 50 ml of AMF and 0.2 g of Vintec had five times lower mortality (<1%) three years after planting compared to untreated trees (>5%). This effect was consistent across six commercial orchards. AMF and Trichoderma treatments did not affect the number of mainstem cankers, which likely originated form nursery infections. AMF amendment did however significantly reduce the number of cankers on the branches. This reduction was most noticeable on sites with the highest canker and tree mortality rates. The work to increase populations of AMF in established orchards was also conducted and has shown that both wildflowers alone and wildflowers with added AMF increased AMF root colonisation in all orchards.

A more recently completed study has examined the links between apple canker and soil type and nutrient content.

Matevz Papp-Rupar, Plant Pathology Research Leader

Xiangming Xu, Director of Research

Title: Sustainable management of apple canker

Funders: Biotechnology and Biological Sciences Research Council and The East Malling Trust, and supported by British Apples and Pears Ltd

Term: October 2023 to September 2025

A previous canker research trial managed by Niab used trees propagated in the same nursery and uniformly inoculated with *Neonectria ditissima* (the cause of apple canker). Trees were planted on three different commercial orchard sites in Kent. Significant differences in the incidence of mainstem and branch cankers were observed between these three sites and within blocks on the same site. There were differences in soil properties between the three sites so it was questioned whether these differences might explain the observed differences in canker expression.

The project

In this project, Niab worked with industry through British Apples and Pears Ltd and the help of many apple growers, to gather existing orchard data from over 160 orchards across the UK. Data included variety, orchard age, canker infection level and previous soil sampling results. From these, 72 orchards of a similar age (not too young or too old), with the most relevant varieties (Gala, Braeburn, Jazz) and different levels of canker, were selected for further investigation.

Niab counted canker lesions in selected orchards by walking through each in a grid-iron pattern. Two soil samples were collected from each orchard, one combined soil sample from five trees with no or low canker, and one from the five trees with the highest canker incidence. The soils were analysed for both macronutrients and micronutrients as well as the percentage of carbon and content of sand, silt and clay. A total of 144 soil samples were collected from 14 farms across four regions in the east and south-east of England representing eight different soil types.

Results

The first conclusion was that the soil type and nutrient levels were not solely responsible for differences in canker observed within each

orchard. There was a low or even no correlation between the numbers of cankers recorded in trees and the soil parameters within an orchard. In fact, many orchards had both very high and very low canker trees where soil types and nutrition were almost identical. The Niab pathology team therefore assumed that canker variability in the orchard was most likely due to different levels of initial (nursery) infections and variations in canker removal efficacy and spread in different parts of the orchard rather than soil variation.

Further investigation was made to try to correlate the average number of cankers recorded across all assessed trees with the average soil parameters recorded in the orchard. This correlation provided some more conclusive results. Orchard soils with high levels of organic matter, total carbon, total nitrogen, calcium, soil cation exchange capacity (CEC) and a high percentage of clay content, had on average higher levels of canker. Those orchards with soils recording high levels of iron, molybdenum and silt had on average lowers levels of canker. It is not known if levels of these parameters have a major influence on canker development and more work is needed to validate these results.

The results surprised the team, especially regarding the CEC and calcium levels, as CEC is normally associated with healthier soils as it provides better nutrient retention, pH buffering, less leaching and more stable soil microbiome. Similarly, calcium is involved in defence signalling and cell wall integrity suggesting that trees with a plentiful supply would be less at risk from disease infection, which is the opposite to the observations.

The nitrogen result was less surprising as research from New Zealand has already shown that nitrogen rich soils have a tendency for increased canker in apple.

Increased iron and molybdenum relating to lower canker is the most promising results for growers, who may be able to increase their levels in orchards to decrease canker severity. This link however will be further investigated in 2026 in a British Apples and Pears Ltd funded PROSPER project where different fertigation regimes will be applied to trees and canker response measured.

It should be noted that the study was limited to 72 orchards which is not a vast number and orchard management practices may be having a stronger influence than soil type or soil nutrition. A range of other factors may also be at play such as variety and tree age. Furthermore, this assessment was done at one moment in time and did not cover an extended period required to draw firm conclusions.

Figure 1. Branch dieback caused by Neonectria ditissima

Figure 2. Wildflower mixes support arbuscular mycorrhizal fungi

Michelle Fountain, Head of Pest and Pathogen Ecology
Sarah Arnold, Entomology Research Leader

Novel approaches to management of apple blossom weevil

Title: PAPPLe III: Integrated pest and disease management in apples and pears
Funder: British Apples and Pears Ltd
Term: April 2025 to March 2026

With the continuing loss of authorised plant protection products in apple and pear crops, some pests and diseases are becoming more prevalent in orchards and new approaches to control are urgently required. Apple blossom weevil (*Anthonomus pomorum* - Figure 1), has become a more serious pest in recent years. Incidence is rising resulting in very significant yield loss for some growers with up to a third of flowers or more being lost. Adult females lay their eggs in developing flower buds in spring leading to capped blossoms with the weevil larvae developing inside. The flowers fail to develop into fruits. The larvae pupate in the blossom and the adult emerges around a week later, causing light feeding damage on the foliage for the remainder of the season.

Working on behalf of growers, British Apples and Pears Ltd (BAPL) funded PAPPLe in which Niab investigated novel control measures for some of the most damaging pests and diseases. In the case of apple blossom weevil, attention has turned to natural and biological means of control.

Figure 1. Apple blossom weevil has become a more serious problem

The project

Niab investigated three different control agents including naturally occurring parasitoids, introduced entomopathogenic nematodes (EPN) and entomopathogenic fungi (EPF). At the start of the project, the entomology team conducted a questionnaire of growers which sought to correlate the prevalence of apple blossom weevil with certain orchard characteristics. They later carried out experiments with the natural control agents to assess their usefulness within control programmes.

Results

The questionnaire showed some slight indication that apple blossom weevil may be more prevalent in orchards with less vegetation growing in the alleyways between the tree rows. It also identified higher populations of weevils close to mixed hedgerows, particularly containing hawthorn (*Crataegus monogyna*), and potentially more prevalent close to vine and cherry crops. Further work should be carried out to build up a more robust dataset and better understanding of those crops at greatest risk.

Parasitoids

Commercial growers kindly submitted samples of capped blossoms to the team from orchards across 22 production sites. 12.1% of the blossoms examined contained a parasitoid. On two sites, over 30% of the blossoms contained parasitoids. The main species identified was *Scambus pomorum* (Figure 2), a parasitoid which

according to historical records was twice as abundant in the past. It is thought to be more prevalent in organic orchards, but this is unsurprising as apple blossom weevil is also more prevalent there. Further work is required to learn more about its preferred environment, if it can be reared commercially to boost natural populations, and ascertain if it is sensitive to commonly used spray control products.

Entomopathogenic nematodes

Predatory nematodes are commonly used to control the larvae of other weevil pests such as vine weevil in soft fruit and ornamental crops. Niab assessed two species (*Steinernema carpocapsae* and *Steinernema feltiae*) for their efficacy at controlling apple blossom weevil larvae. The larvae are hidden within the flower petals so targeting them is difficult, but as nematodes can swim in films of water, it was proposed that they might be able to penetrate apple blossoms in the spring.

In the field, the team dipped capped blossoms (Figure 3) in nematode suspensions containing a wetting agent (0.5% solution of Silwet-77). 100% infection of weevil larvae was achieved when the blossoms were returned immediately to the laboratory for incubation. However, control was slower and incomplete where the blossoms were left in the field for longer periods. Infection of weevil larvae reached 50% if left in the orchard for nine days. Further investigation is required but it is hoped that given time and under the right conditions, the nematodes will enter the buds and infect the larvae. Although they are unlikely to achieve 100% control in the field, weevil populations may steadily decline if nematodes are applied annually. Wetting agents in spray applications help nematodes spread to the target. Some leaf toxicity was found following use of the 0.5% Silwet-77 in the application, so it may be necessary to reduce the concentration of Silwet-77 further to 0.05%.

Entomopathogenic fungi (EPF)

Many EPF strains are isolated naturally from beetle and weevil species. Commercially available *Beauveria bassiana*, *Metarhizium anisopliae* and *Metarhizium brunneum* are already sold to control all life stages of various weevils. Niab carried out laboratory bioassays using Naturalis-L (*Beauveria bassiana*) and a *Metarhizium* product, not yet registered for use, to assess if either were effective against apple blossom weevil. Although EPF infection of apple blossom weevil adults was achieved the efficacy was low. Further research is required to optimise EPF use for apple blossom weevil control before these can be adopted by growers.

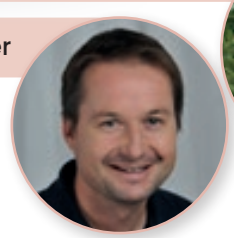
Further work

Future research should focus on understanding how to manage alleyway vegetation to attract and support natural enemies of apple blossom weevil such as parasitoids which are already present in orchards. The optimum mix of native trees that will harbour *Scambus pomorum* also needs to be identified to provide positive guidance to growers on enhancing the diversity of vegetation around their orchards. Although nematodes have high potential to control blossom weevil larvae, further work should focus on optimising application methods and the timing of application.

Figure 2. Scambus pomorum was isolated from capped blossoms

Figure 3. Capped blossoms were dipped in nematode suspensions

Michelle Fountain, Head of Pest and Pathogen Ecology
Adam Walker, Study Leader



Augmenting the apple canopy with earwigs to enhance woolly apple aphid control

Title: PAPPLe III: Integrated pest and disease management in apples and pears
Funder: British Apples and Pears Ltd
Term: April 2025 to March 2026

Woolly apple aphid (*Eriosoma lanigerum*), continues to be a major research priority for apple growers (Figure 1), with pest activity starting early in spring when temperatures reach an average of 10°C, as overwintering forms emerge from the soil and crevices in the tree. In summer, the crawling stages feed on new young shoots and feeding causes galls to form on the branches, adversely affecting nutrient uptake, growth and vigour of the tree. The galls can split leaving branches more vulnerable to canker infection. The wax producing crawlers also invade developing fruits leaving their characteristic woolly contamination.

Control has become more challenging given the continual loss of available aphicides and one of the more effective products Batavia (spirotetramat) will be withdrawn from use at the beginning of 2027. Batavia works better when the trees are actively growing but in spring, when the pest is becoming active, control can be variable if weather and growing conditions are not optimum for the product. Other contact acting control products are available, but these can have an adverse effect on beneficial insects. Entomopathogenic fungi and predatory nematodes offer an alternative, but these are temperature and humidity dependent and potentially expensive to use. Naturally occurring parasitoids (*Aphelinus mali*) can provide up to 50% control but knowledge on optimum management of this is lacking. The industry used to rely on rootstocks conferring resistance to the pest, but many aphid biotypes have overcome this resistance. A new approach to control is needed urgently.

Working on behalf of growers, British Apples and Pears Ltd (BAPL) is funding a project called PAPPLe in which Niab is investigating novel control measures for some of the most damaging pests and diseases. In this project, attention turned to the use of earwigs, generalist predators that are often found in orchards and which feed on codling moth, psyllids and aphids.

Figure 1. Woolly apple aphid can be particularly damaging on apple

The project

Although earwigs (Figure 2) have been shown to provide very effective control of woolly apple aphid in previous research, their populations in orchards are variable. Methods to attract and protect earwigs in apple orchards are needed to make them a more reliable biocontrol agent. This project set about using pre-loaded earwig refuges (Wignests provided by Russell IPM – Figure 3) to investigate their effect on woolly apple aphid control. A trial was run over two

seasons (2023 and 2024) in three commercial apple orchards. Niab entomologists assessed groups of trees with Wignests (pre-loaded with five earwigs each) and compared these to an untreated control group of trees.

Results

Counts of woolly apple aphid colonies, the colony size, and the levels of infestation on new young shoots were made, along with the number of earwigs in refuges over the duration of the project. The earwig numbers were correlated to the numbers of aphids and aphid colonies.

There were no significant differences in the numbers of aphids or aphid colonies between the earwig refuge group of trees compared to the untreated control and similarly no significant difference in aphid populations on the new shoot growth between the two treatments. No significant correlation existed between the numbers of earwigs recorded in the refuges and the total number of aphids in the colonies, although there was a definite trend towards fewer aphids where earwig numbers were higher over the two years. There was also a trend showing that earwig numbers were increasing over the seasons and perhaps if the trial had been extended for a third year, this might have had a more measurable impact.

The results from this work have demonstrated that at present, growers should not rely solely upon earwigs to control woolly apple aphid. However, better results have been delivered by other research projects where higher numbers of earwigs have been introduced in the first year.

A significant factor that growers should consider is the composition and timing of spray programmes that may be utilised during the nymph life stage of earwigs. Although sprays may not include insecticides, repeated applications of contact acting and fungicidal products with wetting agent formulations may have sublethal effects on earwigs. Minimising spray applications may give earwigs a better chance of increasing their abundance. Earwigs only have one generation per year, so it takes years for populations to recover from negative impacts.

Other factors that might influence earwig success are tree architecture and soil drainage. Well pruned trees with open structure make it easier for earwigs to search for aphids, while water retentive soils provide a more humid environment which favours earwigs. Long hot dry summers with dry soil may inhibit earwig establishment and population growth. The availability of alternative food sources for earwigs might also help while a diverse richness of plant species in hedgerows and orchard alleyways will help to support earwig populations. Further research is needed to identify the reasons behind inconsistent earwig numbers in apple orchards and if populations will continue to increase over years of sympathetic earwig management.

Figure 2. Earwigs can provide effective control of woolly apple aphid

Figure 3. Pre-loaded earwig refuges were implemented in the orchard

Michelle Fountain, Head of Pest and Pathogen Ecology
Francis Wamonje, Entomology Research Leader

Testing ant baits to control rosy apple aphid

Title: PAPPLe III: Integrated pest and disease management in apples and pears
Funders: British Apples and Pears Ltd, Innovate UK
Partner: Russell IPM
Term: April 2025 to March 2026

Rosy apple aphid (*Dysaphis plantaginea*) has long been a serious of pest of apple that causes yellowing and curling of outer rosette leaves in spring (Figure 1). As aphid feeding continues, leaves become severely curled and distorted. Damaged fruits are often small, malformed with uneven, wrinkled and sometimes waxy skin and often develop a rosy colour. With very few effective aphicides available for apple growers to gain control, alternative approaches are needed. Working on behalf of growers, British Apples and Pears Ltd (BAPL) is funding a project called PAPPLe in which Niab is investigating novel control measures for some of the most damaging pests and diseases.

The project

Some ant species attend aphid colonies, protecting them from generalist predators so that they can feed on the honeydew produced by the aphids. The common black ant (*Lasius niger*) will even move aphids to fresh leaves to start new colonies. Previous research has shown that sugar-based pellets can disrupt ants, preventing them from attending the aphid colonies, exposing the aphids to predation and successfully reducing aphid populations. In this project, Niab wanted to test a range of sugar pellet formulations provided by Russell IPM both for their suitability in field experiments and to test their ability to disrupt ant tending of rosy apple aphid. The pellets were spread on the soil around the base of the trees (Figure 2) to attract ants and prevent them from climbing the trees, leaving aphids exposed to predators.

Figure 1. Rosy apple aphid colony on young leaves

Results

Six different pellets were assessed in field trials for longevity. Three were found to last on the soil surface for up to 17 days. Two of these were significantly attractive to ants (Figure 3). Pellets were then applied directly under apple trees with

known rosy apple aphid colonies, before ants were active in the spring.

Apple leaf damage was assessed as a proxy for rosy apple aphid populations. There were more damaged leaves in the plots where sugar pellets had been deployed. Similarly, there was more damage to fruit where sugar pellets had been deployed.

As expected more predators such as ladybirds, hoverflies, spiders and earwigs, were recorded in the vicinity of the large aphid colonies.

It was concluded that two pellet formulations from Russell IPM were attractive to ants on the orchard floor, but more research is needed to determine the best pellet placement in the orchard. For example, pellets were tested on small plots underneath trees. Pellets may work better if applied in the alleyway away from trees or on a larger scale.

The trial was further hampered by a hungry fox who visited in the night and continued to feed on the 'tasty' pellets. In 2026, Niab will work with Russell IPM on making the pellets attractive to ants but distasteful to mammal predators.

Figure 2. Sugar pellets were spread at the base of trees

Figure 3. Two forms of pellets were attractive to ants

Francis Wamonje, Entomology Research Leader

Novel biocontrol approaches for the large raspberry aphid

Title: A phenology-perceptive integrated biocontrol programme for large raspberry aphid (*Amphorophora idaei*) control: PHENCONTROL

Funders: Growing Kent & Medway and Innovate UK

Partners: Asplins PO, Biobest and Rumwood Green Farm

Term: May 2023 to May 2025

The large raspberry aphid (*Amphorophora idaei* – Figure 1) was relatively easy for raspberry growers to control in the past through an adequate armoury of conventional aphicide spray products, coupled with in-built genetic resistance. The A1 gene provided resistance to two of the four biotypes of the aphid and the A10 gene provided resistance to all four biotypes. More recently however, the breakdown of some of this genetic resistance, coupled with commercial withdrawal and revocations of the majority of aphicides has left growers with few options other than biocontrol approaches.

The move to growing early crops of raspberry under glass and fixed tunnels has provided the pest with the perfect climate to feed and breed on the crop and growers employing these conditions have struggled to contain the pest using biocontrol measures, whilst the deployment of predators and parasitoids is labour intensive and very expensive. Research is required to learn more about the best options available to growers.

The project

Three of the commonly used biocontrol options include parasitoids, the green lacewing (*Chrysoperla carnea*) and brown lacewing (*Micromus angulatus*). However, we don't currently know how effective these are in raspberry crops and how to get optimum results. This Growing Kent & Medway funded project was developed in partnership with Asplins PO, Biobest and Rumwood Green Farm to develop an integrated biocontrol programme that would provide adequate protection from large raspberry aphid throughout the growing season.

In particular, the industry wanted to find out if the current mixes of parasitoids commercially available to raspberry growers will work effectively against large raspberry aphid. We also wanted to develop a mechanised system of distributing lacewings through the crop that would avoid using hand labour. Brown lacewing is known to work effectively at lower temperatures than green lacewings, so it was also important to investigate at what temperatures they work effectively and how early in the spring or in protected crops we can introduce them to predate spring emerging aphids.

Figure 1. Large raspberry aphid on the underside of raspberry leaf

Results

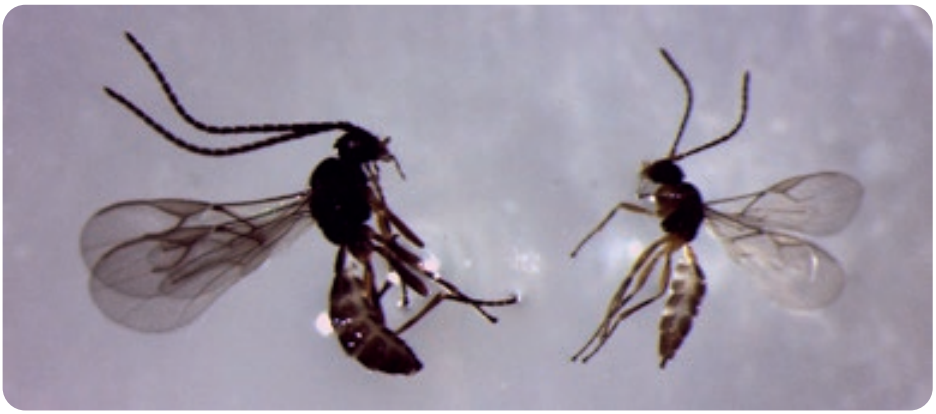
Parasitoid mixes

In early work with parasitoid mixes, Niab monitored and recorded the different parasitoid species (Figure 2) that are found occurring naturally in raspberry crops. It was found that the species supplied commercially are all found naturally in field-grown raspberry crops. The commonly used species *Aphidius ervi* and *Praon volucre* were particularly prevalent between April and July, but a number of additional species not commonly found in commercial mixes were found between July and September. The results have been shared with commercial partner Biobest to allow them to consider refining or adding to the mixes they currently offer to raspberry growers through the season to enhance season-long control.

Distributing green lacewings

To find a cheap way to distribute green lacewings, early work was done to assess the use of different sprayer types to cover the crop with lacewing eggs whilst also assessing a range of materials to add to the spray solution to stick the eggs to the leaves. A gravity designed knapsack sprayer proved to be most effective and two different 'materials' coded TX1 and TX2 showed promise as egg adhesives. A replicated experiment was set up at Rumwood Green Farm (Figure 3) using both adhesives with the chosen sprayer type. Records were collected of how well the eggs adhered to the leaf immediately after application and what percentage of

Figure 2. Aphidius genus parasitoids



egg hatch occurred after incubating leaves with eggs.

Eggs suspended in a solution containing the TX1 adhesive tended to sink to the bottom of the spray tank and were not dispensed, and those that did hit the leaves failed to stick and fell off soon after application. Results with the TX2 adhesive were better with the eggs effectively suspended in the spray solution and sticking to the leaf. The hatch rate for both stickers was 41% which was comparable to results achieved commercially by Biobest in work on other crops such as lettuce. Further work would be required to secure an authorisation to use the TX2 product should the industry or one of the partners wish to take this forward.

Efficacy of brown lacewings early in the season

Niab set up laboratory experiments to assess whether brown lacewing larvae would predate large raspberry aphid early in the season when crop temperatures are still relatively low. This was done by assessing their performance at 8, 10 and 12°C and assessing their activity 24, 48 and 120 hours after introduction to assess when they start to predate aphids and for how long. Five replicates were set up for each temperature with equal numbers of replicates used with no predator introduction. The numbers of aphids were counted before introduction and again after a set period of exposure to brown lacewings (Figure 4). It was found that the level of predation improved both with increasing time and increasing temperature. Significant increases in predation occurred at 12°C.

This finding was tested in an unreplicated experiment in a commercial tunnel-grown raspberry crop of Malling Bella with a high population of large raspberry aphids. A single tunnel received weekly introductions of brown lacewings for six weeks and compared to a second tunnel which received no introductions. Aphid colonies were tagged in a pre-assessment and then monitored through the duration of the trial for both pests and predators. Lacewings were introduced from the third week of March onwards, and by mid-April, a significant reduction in aphids had occurred. However, as the experiment was not replicated, firm conclusions cannot be drawn at this stage.

Figure 3. Green lacewing eggs being applied with adhesive

Integrated programme

During the 2024 season (before the brown lacewing work was carried out), Niab evaluated a fully integrated biocontrol programme between May and September in a commercial tunnel-grown raspberry crop. The programme included the fortnightly release of a commercially available aphid parasitoid mix (Berry Protect) and Aphidoletes predatory midges. In addition, green lacewings were deployed as spot treatments, applied to hotspots in the crop at a release rate of 30-50 eggs/m^2. Capsid control was also implemented using the capsid repellent product Lybolty deployed in a grid iron pattern of emitters across the central 1,600m^2 of the crop.

The crop was monitored for both parasitoid species and natural enemies. However, in 2024, there were unusually low numbers of aphids and no significant differences were recorded between the biological control and control groups. Further work would be hugely beneficial to reassess the findings of this whole project in an integrated biological control programme on a commercial production site.

Figure 4. Brown lacewing adult on raspberry leaf

Michelle Fountain, Head of Pest and Pathogen Ecology

Developing a novel form of mite dispersal on strawberry

Title: MiDeVa: Integrating mite dispersal with UV treatment in strawberry
Funder: Growing Kent & Medway Prototype and Demonstrator fund
Partner: Saga Robotics Ltd (Lead)
Term: May 2024 to February 2025

The introduction and dispersal of predatory mites in strawberry crops is labour intensive, time consuming and costly for strawberry growers. The consistency of spread through a crop can also be variable when mites are being decanted from shaker bottles by hand and this can influence the establishment of the mites and the speed and efficacy of the resulting biocontrol. Saga Robotics employ the Thorvald autonomous robotic platform to administer a UVC light treatment to combat powdery mildew and other fungal diseases in strawberry. The mechanical envelope of the robot lends itself to offering additional crop husbandry functions whilst passing through strawberry tunnels. Might it be possible to combine the UVC light treatment with an automated dispersal of predatory mites to strawberry crops (Figure 1)?

The project

This Growing Kent & Medway funded project allowed Niab to work with lead partner Saga Robotics who have developed a bolt-on tool for the Thorvald platform to automate the introduction of predatory mites whilst the platform is being used for UVC application. The aim of the project was to assess its efficacy at distributing the mites on commercial strawberry crops grown on table-top systems under polythene tunnels. Niab also assessed the impact of the UVC treatment on the introduced predatory mites to ensure that the mites were not being harmed, which would render the whole process counterproductive.

Figure 1. Investigating if the Thorvald UVC platform could also distribute predators

Results

Mite dispersal

The bolt-on tool developed by Saga Robotics was positioned on the front of the platform owing to insufficient space on the side of the mechanical envelope. The tool consists of a hopper which holds the predatory mites and a conveyor belt that moves the mites to the top of the robot and distributes the mites onto the strawberry plants as the platform moves through the crop. The principle of this automated system appears to be good, but

in practice, Saga Robotics found a major hurdle which needed to be overcome. Although the conveyor belt is very effective at moving the mites from the hopper to the plants, the conveyor also picks up moisture from the plants and carries it back to the hopper, which can lead to clogging within the hopper, preventing even distribution and requiring constant servicing of the machine.

In discussion with grower customers, it is clear that there is a huge appetite for an automated mite distributor to be bolted onto the Thorvald platform, which is now being used to treat 20% of UK strawberry crops for powdery mildew control. However, in its current form it fails to meet customer expectations and various modifications have been requested.

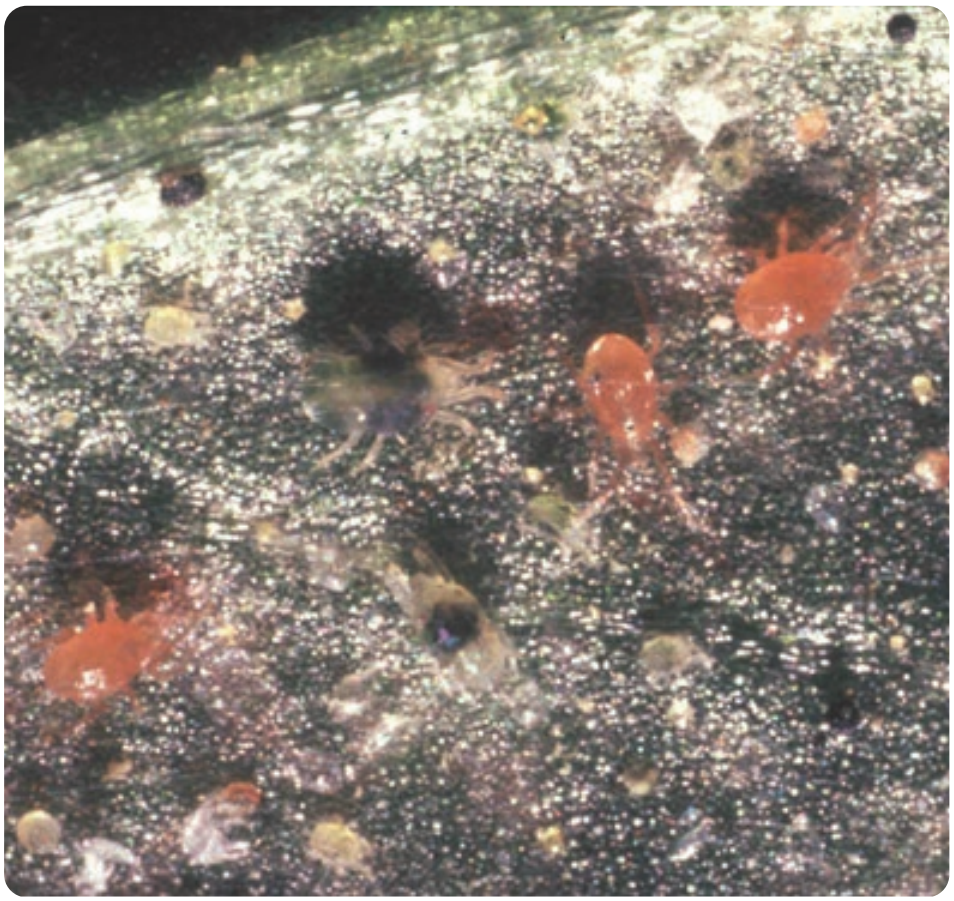
Further discussions have ensued between Saga Robotics and biological crop protection specialists Koppert UK, who have developed alternative mite dispersal technology that is generally attached to the back of a tractor. Koppert have developed a custom assembly specially for Saga Robotics which can be attached to the Thorvald platform. It too employs a hopper which feeds mites through an auger that transports the mites through a special pipe to a venturi styled air blaster which releases the mites into the crop. Saga is planning to use this latest iteration in customer trials in 2026.

Impact of UVC treatment and other weather effects on predatory mites

During the dispersal assessments, Niab assessed the impact of the UVC treatment on the mites that had been released onto the crop. They found that there was no obvious impact on the survival rate of *Neoseiulus cucumeris* mites.

Given that UVC light treatment is normally applied to strawberry at night, the Niab entomology team also considered the impact of introducing predatory mites to crops during different periods of the day.

Figure 2. Niab considered optimum conditions for predators such as Phytoseiulus persimilis



Most predatory mites have narrow temperature ranges at which they are active and predate other insects. Similarly, the relative humidity is very important if the predatory mites are to thrive and actively feed on their prey, and they generally prefer higher humidity ranges, typically above 60% relative humidity (RH). At lower humidities they are prone to drying out.

The team considered the optimum temperature and humidity ranges for four commonly used predatory mite species in strawberry including *Amblyseius andersonii*, *Neoseiulus cucumeris*, *Amblyseius swirskii* and *Phytoseiulus persimilis* (Figure 2). The entomologists also considered the daily fluctuations in temperature and humidity that occur in a typical day in August in the south east of England under a polythene tunnel. A typical temperature of 15°C occurs between midnight and 10am, with temperature rising to 33°C by 4pm and returning to 15°C by 11pm. These temperatures generally lend themselves to activity and predation by these four species. However, the humidity fluctuations are less conducive to predatory mite survival. Although typical humidities are above 65% between midnight and 10am, between 10am and 6pm it is not unusual to record 40-65% RH in August and this can result in lack of activity and worse, mites may be prone to drying out.

The advice to growers therefore is to carefully consider the time of day when mites are introduced. Doing so during the night from a Thorvald platform applying UVC is ideal when humidities are high. In summer conditions, early morning or evening introductions will also work well, allowing the mites to settle in and acclimatise in the crop before they experience low humidities. Introducing between late morning and late afternoon is not ideal as low humidities might lead to poor dispersal of the mites. At all times of the year, growers should take both temperature and humidity into account before deciding upon the optimum time for release.

Francis Wamonje, Entomology Research Leader

Genetic identification of thrips made easy

Title: Isothermal detection of cryptic thrips
Funder: Innovate UK
Term: April 2024 to April 2026

Thrips species have been a major pest of strawberry crops in the UK for 30 years. Initially, high numbers of certain species feeding on flowers were associated with some level of fruit damage, caused by the larval and adult stages feeding in the flowers (Figure 1). The non-native species *Frankliniella occidentalis* (western flower thrips – WFT) arrived in the UK in the 1980s but it was not found to be causing damage to strawberry until 2002 when it developed resistance to a number of control products, most notably Tracer (spinosad). WFT causes serious damage to strawberry leading to a brown or bronzed appearance on the fruits which very often fail to develop to their full size. With the help of research and agronomists, many growers developed successful biocontrol programmes for WFT (Figure 2), but other species continued to be found on strawberry and it is difficult for growers and agronomists to identify which species are present in their crop.

Other species typically found in strawberry include onion thrips (*Thrips tabaci*), rose thrips (*Thrips fuscipennis*) and flower thrips (*Frankliniella intonsa*). As these different species require different management and control approaches, it is vital to know which species is in the crop, but accurate identification is difficult due to the small size of thrips and subtle variations between species. Niab entomologists at East Malling have the skill to make such identification but this requires slow microscopy work. A much quicker and simpler method is required.

The project

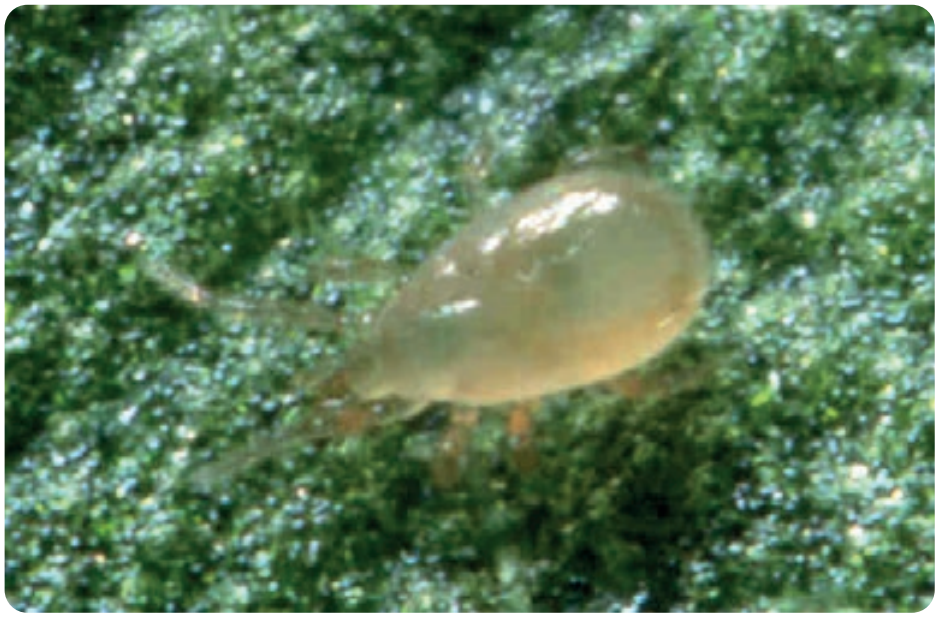
This Innovate UK funded project set about creating a user-friendly, rapid in-field test for WFT, that would enable growers and agronomists to make informed pest management decisions without requiring specialised entomology skills. If a successful test could be developed, Niab would work with industry collaborators to create similar detection tools for a range of other native and non-native thrips species including those commonly found in strawberry.

Results

Through the duration of the project, Niab sampled thrips in commercial strawberry crops to survey the prevalence of different species typically being found. In the first year, the populations identified were largely made up of WFT, onion thrips and rose

Figure 1. Thrips feeding in a strawberry flower

Figure 2. Growers rely on Neoseiulus cucumeris to control WFT



thrips, with virtually no flower thrips, but in the second year of surveillance, populations of flower thrips were more prevalent along with the other three species.

Early work set about identifying genes and sequences of genes that could be used as markers to identify WFT. Primers were developed which allow scientists to find these markers within the DNA of an organism and are employed in developing test kits that might be used in the field. Having developed a primer specifically for WFT, the work expanded into identifying genetic markers and producing primers for onion thrips, rose thrips and flower thrips. This was successfully achieved so that we can now identify all four thrips species using molecular marker technology.

The next stage of the work was to find a practical way of collecting the DNA from the different thrips in the field. Asking growers or agronomists to collect samples of every thrips species that might be present in the field and submit them to scientists is impractical and runs the risk of not identifying every species that is present in the crop. The team chose instead to develop a way of collecting environmental DNA from the crop. Environmental DNA (eDNA) is made up of traces of genetic material that all living organisms leave in the environment, so in the case of strawberries, a visit from any thrips species to a flower in the crop would leave a trace of their genetic material behind.

Different methods were trialled, including generating flower washes, which would be used to harvest the genetic material contained within the flowers and direct extraction from fresh and dry flowers, with the latter proving most efficient. Growers or agronomists would collect 20 strawberry flowers from a cross section of the crop and send them to Niab, who captures genetic material from visiting thrips, which is then identified using the primers developed for each thrips species. Niab will develop a full protocol with guidance for growers and agronomists on how to collect flower samples (Figure 3) for the test.

The end goal is to develop a practical test kit that would allow growers to sample the flowers and identify the thrips species for themselves without having to submit samples to scientists, or alternatively, work with an agronomy provider to do periodic assessments as part of their routine monitoring. Niab is currently talking to commercial technology providers who might help to develop this final step in the process.

Figure 3. Thrips DNA can now be extracted from strawberry flowers

Sarah Arnold, Entomology Research Leader

Too hot to pollinate?

Title: Too hot to pollinate? Pilot data on temperature regulation in commercial bumblebee hives
Funder: The Worshipful Company of Fruiterers
Partners: Asplins PO, Biobest and Rumwood Green Farm
Term: February 2024 to November 2024

Soft fruit growers using bumblebees for pollination (Figure 1) are only permitted to use the native UK subspecies *Bombus terrestris audax* which could be less active and less tolerant than other species in hot conditions. Bumblebees regulate the temperature in their nests by wing-fanning to cool the brood, but this distracts them from their pollination work. Our UK industry would benefit from identifying the temperatures at which *B. t. audax* noticeably starts to reduce foraging activity and also identify the temperature at which commercial bees struggle to cool their brood. Finding ways of measuring this will allow growers to identify periods when pollinators are unlikely to work effectively alerting them to order replacement hives promptly.

The project

The Worshipful Company of Fruiterers funded Niab to study the behaviour of colonies under heat stress, to predict the potential impact on pollination and to explore ways of mitigating heat stress.

The work was done at Niab's East Malling site between the spring and autumn of 2024, when 12 colonies of *B. t. audax* were placed either in exposed (hot) locations or sheltered (cool) locations. For four of the colonies, the cool locations chosen were 'bee-pits' (Figure 2) cut into the ground surface, protecting them from extreme heat. Temperatures were recorded on the inside (Figure 3) and outside (Figure 4) of each colony box using thermocouples and the bee activity of each was recorded twice each week by counting the number of bees leaving the hive and the number of bees returning with pollen on their legs.

Figure 1. Bumblebees are relied upon to improve pollination in strawberry

Results

Throughout the trial, the temperatures recorded outside the colonies varied with weather conditions as expected but in the first 30 days of the trial the internal temperatures were less variable, averaging 33-35°C, suggesting that young hives may be able to maintain a relatively constant hive temperature, almost independently of the external temperature. However after 30 days the hives appeared to move into a 'senescent' phase when hives failed to thermoregulate as effectively. Whereas young hives maintained a relatively constant internal temperature, the older hives' internal temperature was largely dependent on the external temperature.

In terms of location, hives positioned in exposed locations experienced more extreme high external temperatures (>35°C) and also had more spikes in the recorded internal temperature, indicating that hives in hot locations,

Figure 2. Bumblebee hives were positioned in bee pits

such as exposed polytunnels, are likely to undergo heat stress. By comparison, the 'cool' hives did not normally experience such extremes and so their internal temperatures also spiked less.

When assessing the activity of bees at different temperatures and locations, in young colonies, there was little difference in the activity levels between cool and hot colonies at any given internal or external temperature. However, at the highest external air temperatures, older hives positioned in cool sheltered locations appeared to maintain higher activity levels than those in exposed, hot locations.

Within the spring-summer period of 2024, temperatures did not get high enough to cause all hives to reduce activity consistently, and the results showed that at temperatures up to around 30°C, *B. t. audax* is tolerant of summer heat. However, in most summers, temperatures in polytunnels during heatwaves can be considerably higher than this.

So in the short-term, what can soft fruit growers learn from this project? Firstly, where it is safe to do so, Niab recommends that growers implement bee pits in cropping situations which are prone to overheating in summer, especially where temperatures regularly exceed 34°C. For most UK conditions, a basic pit in the ground, with no irrigation or insulation, space around all sides of the hive for air movement, and the hive lid positioned a few centimetres below the soil surface, is likely to be sufficient. Further research is needed to explore different methods of cooling or shading the hives, to optimise the pit depth and size, and measure the impact on activity levels, especially during extreme heatwaves. Growers should also anticipate a drop in performance of bumblebee hives after approximately 30 days of deployment and consider replacing older hives if large temperature changes are forecast.

Figure 3. Temperature measurement inside the beehive

Figure 4. Temperature measurement outside the beehive

Sarah Arnold, Entomology Research Leader

Managing pollination problems in protected crops

Title: Managing the activity of pollinators in protected cropping systems (MAPP-CS)
Funder: Biotechnology and Biological Sciences Research Council
Partners: Agriculture Investments Ltd, Biobest Ltd, Buzzup, Clockhouse Farm and The East Malling Trust
Term: May 2024 to April 2028

Soft fruit production under fixed protective structures is highly dependent on introduced bumblebees (*Bombus terrestris*) for pollination. Their performance under such structures can be less reliable as they can be less active, suffer from higher mortality and sometimes fail to return to the hive, resulting in lower fruit yields and quality. This BBSRC funded project is researching the drivers of pollinator underperformance in enclosed systems, including lighting and navigational factors, and a range of affordable interventions to improve pollinator activity, reduce mortality and improve profitability.

The project

In the first two years, Niab set about assessing whether bumblebees are the best pollinators for soft-fruit crops in protected systems (Figure 1), and whether other methods could supplement them effectively. Options other than bumblebees can include hoverflies (commercially available and non-aggressive, but expensive), or air-blowing using machinery (labour intensive and may not deposit pollen evenly or accurately). Initial experiments included releases of two species of hoverflies in a large (>3 ha) soft-fruit polyhouse and follow-up monitoring to investigate how they dispersed across the crop over the following days.

Niab also wanted to ascertain what impact the light spectral environment had on bumblebee health and behaviour along with efficacy of pollination. The effect of adding coloured films and covers to both the walls of a commercial blackberry polyhouse (Figure 2) and a semi-field strawberry crop in enclosed polytunnels was investigated.

Figure 1. Are bumblebees the best pollinators for soft fruit crops in protected systems?

Results

Are bumblebees the best or only way to pollinate protected fruit crops?

In work to assess the potential of using hoverflies as an alternative to bumblebees, the team found that although some hoverflies were active close to their release point in a crop, for up to seven days, many individuals also moved tens of metres away across the crop over this time.

This means that multiple release points in the crop are likely to be necessary for the best pollination service by hoverflies, ensuring their uniform distribution. Whilst hoverfly adults are delivering a pollination service, their larvae provide aphid control and are worthy of further investigation as hoverflies could provide multifunctional benefits in some crop systems.

Niab supplemented the farm's ordinary bumblebee pollination boxes with either releases of the

Figure 2. Pink film was used to try to reduce bee death in the house

hoverfly *Eupeodes corollae* (a medium-sized hoverfly that can be purchased commercially), or manual air-blowing using a motorised leaf-blower. Both interventions yielded small but significant results for a blackberry crop – hoverfly pollination was associated with a small increase in drupelet size (meaning berries might appear 'plumper' and more juicy-looking), while when the crop received an air-blowing treatment the berries were longer (meaning punnets could be filled faster). This implies that getting pollination right can provide commercial benefits, and that bumblebee pollination can benefit from supplementation by other methods.

Changing light environment for bee and crop health

Niab learned that green film in the commercial blackberry polyhouse gave the highest bee activity (significantly higher, surprisingly, than high-diffusion uncoloured film which allowed maximum light in). In the mini-tunnels, pink-covered tunnels had the highest bee activity (Figure 3). Pink films also significantly reduced bumblebee deaths – perhaps because bees were then less likely to fly to the walls and get disorientated/stranded. In contrast, more bees died in areas without coloured film in both the setups.

Buzzup's HiveHeart devices gave insights into the bee behaviour inside the nests too; the frequency (pitch) of 'buzzing noises' inside the nest varied a lot between nests and over time. For honeybees, a change to more high-pitched buzzing can be associated with stress or swarming behaviour but the significance for bumblebees is not well understood. Analysing this further may help us to judge stress in bumblebee hives sooner.

When it came to harvest time, however, the fruit from the different coloured film conditions was the same, i.e. the fruit size, mass, quality scores, skin firmness scores and Brix (a measurement that approximately corresponds to sweetness) were indistinguishable, for both blackberry and strawberry. This implies that green and pink-coloured horticultural films offer benefits for bee welfare (reducing deaths and possibly colony stress) and activity on the crop, but this does not reliably translate to economic benefits for the farm. Consequently, growers' decisions to invest in potentially expensive coloured film may be determined by factors other than the pure business case. Insect welfare is a growing area of research interest as increasing evidence suggests that they have more advanced cognition than previously assumed.

This project will continue for a further two years.

Figure 3. Using pink-covered film in mini-tunnels encouraged bee activity and reduced bumblebee deaths

Michelle Fountain, Head of Pest and Pathogen Ecology

Understanding the impact of landscape complexity on pest control and pollination: ecosystem services to strawberry

Title: Agrobioconnect: Connections in the landscape. Role of landscape complexity in agroecosystem sustainability

Funder: Defra SusCrop ERA-Net

Partners: Berry Gardens Growers and AM Fresh

Term: February 2023 to January 2026

Intensive horticultural practices which focus on expansive cropping with little consideration to a patchwork of habitats within a landscape, can lead to a homogenous growing environment which does not deliver essential ecosystem services to crops and can require increased inputs to obtain pollination and pest control. In the past, fruit crop management has not always taken account of biodiversity and the ecosystem services provided to the grower on farms. The use of some crop protection products can also disrupt beneficial arthropods, further exacerbating the production of poor-quality fruits. With fewer authorised conventional spray products available than ever before, Niab is increasingly working with growers and other industry partners to harness naturally occurring, introduced beneficial arthropods, and biocontrol agents, to develop more sustainable crop production strategies.

It is generally understood that increased biodiversity on a farm can lead to more resilient ecosystems, which give more long-term assurance of pollination and pest regulation. However, these require a holistic understanding of the ecological mechanisms at work including understanding how landscape structure and complexity affect the supply of 'agroecosystem services', or put another way, the ability of the landscape structure to provide natural forms of pollination, and pest and disease control.

Figure 1. Niab studied the landscape around strawberry farms

The project

In this project, Niab was one of a European science partnership investigating the effect of landscape complexity and land cover/productivity dynamics on the above and below ground ecosystem services in a range of European agricultural landscapes. The general objective of Niab's part of the project was to examine how the landscape surrounding strawberry crops (Figure 1) influences beneficial organisms, specifically parasitoid wasps that help to control aphids, and wild bees that pollinate the crop. The intention was to gauge whether being in a better landscape (i.e. one with more habitat diversity or better connectedness) results in more beneficial biodiversity on farms.

A particularly important element of this was developing and testing DNA barcoding methodologies for aphid parasitoid and solitary bee identification. Many solitary bees are very similar and difficult to identify accurately using only visual identification, so supporting this with DNA analysis can help to differentiate between similar species. The plan was to assemble a GenBank-hosted repository of genetic data for open scholarly access. Niab also aimed to observe insect pollinator and aphid parasitoid diversity shifts over time and space on different farms. The team then compared calculated

Figure 2. Bee communities on each farm were studied

diversity measures with landscape traits from satellite data provided by the other European project partners.

Results

Eighteen commercial strawberry farms in the midlands and south of England were used in the study. All employed conventional tunnel production and were geographically distinct from each other. They were visited by Niab researchers three times each, in late summer 2023 and spring and late summer 2024. Aphid colonies were collected and monitored in the laboratory for parasitoid emergence. Bee communities on each farm were also studied (Figure 2) along with their interaction within the crop and wildflower margins, while soil samples were collected for European partners to examine soil microbial communities.

Four aphid species were identified across the eighteen sites including black bean aphid (*Aphis fabae*), melon and cotton aphid (*A. gossypii*), strawberry aphid (*Chaetosiphon fragaefolii*), and potato aphid (*Macrosiphum euphorbiae* – Figure 3). The analysis of emerging parasitoids, using morphological methods and confirmed by DNA barcoding, revealed that the invasive parasitoid, *Lysiphlebus testaceipes*, was dominant at many sites. This was an important discovery and the first report of this parasitoid in the UK.

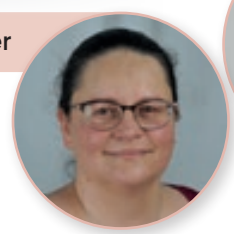
Bee observations and barcoding yielded 37 distinct species from pan traps, including several scarce species and some that are expanding in range. Barcoding was especially useful in identifying cryptic solitary bee species, helping to distinguish between *Lasioglossum leucopus* and *Lasioglossum morio*. This data is crucial for both conservation and optimisation of ecosystem services from bees. Only a subset of bee species visited the crop.

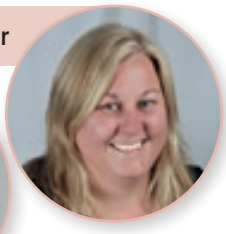
Analyses of bee and parasitoid abundance and diversity measures, and different measures of the landscape structure, enabled the team to examine the relationships between the landscape and beneficial insects. These analyses highlighted that landscape factors are probably less important than site management and floral resources for predicting bee and parasitoid abundance and diversity; few landscape factors were consistent predictors of the bee and parasitoid measures, and those that were, often related to the consistency in patch sizes and configurations across the landscape, rather than measures like how large habitat patches were.

In summary, the work demonstrated that strawberry farms in England harbour varied aphid, parasitoid and bee species, including a new dominant invasive aphid parasitoid that may be playing an understudied role in aphid-parasitoid species dynamics. The landscape did not strongly constrain or predict bee and parasitoid diversity, implying that local farm management actions can have real effects which is encouraging for fruit growers implementing habitat improvements on farms. Growers are advised to maintain their efforts to conserve bee nesting habitats and wildflower margins, and to sustain natural pollination and pest regulation. In this project DNA barcoding tools have been useful to gain stronger insights into insect diversity in our landscapes, ensuring that biodiversity measures are more accurate.

Figure 3. Potato aphid was found on most strawberry farms

Louisa Robinson-Boyer, Plant Microbial Interactions Research Leader
Matevz Papp-Rupar, Plant Pathology Research Leader
Feli Fernandez, Senior Plant Breeder





AMF boost raspberry production in spent coir

Title: Improving propagation efficiency and production sustainability in intensive cultivation systems for a Kent-bred raspberry variety

Funders: Growing Kent & Medway and Innovate UK

Partners: Recoir (Lead) and Blaise Plants

Term: May 2023 to April 2025

The demand for high-quality long-cane raspberry plants is continuing to rise, with demand outstripping supply. The quality of plants is not always uniform, with survival rates lower than growers would expect. The industry needs to find a way of growing high quality raspberry canes producing consistently high yields. Raspberry growers are also heavily dependent on coir substrate for production, but availability is becoming limited while increased shipping costs, the associated carbon footprint, and labour required to dispose of waste coir are a concern. A more affordable and reliable alternative is needed.

The project

Solutions to both challenges may lie in the use of beneficial microbes in the growing substrate and the use of recycled coir from strawberry crops. Arbuscular mycorrhizal fungi (AMF) and plant growth promoting rhizobacteria (PGPR) are known to enhance root growth while the UK has a plentiful supply of spent coir from strawberry crops. This project investigated the amendment of virgin and spent coir with AMF and PGPR to enhance both propagation and fruiting of raspberry, while studying their compatibility with spent coir.

Results

Raspberry tip propogation

Malling Bella mother plants were planted in virgin coir amended with and without AMF and grown for eight months. AMF amended plants grew taller, had more leaf buds and produced higher root health scores compared to untreated. The roots were harvested, transplanted into trays, covered with virgin coir and the emerging shoot tips recorded. The AMF-treated roots produced 30-40% more tips which translated into 25-30% more rooted tips compared to untreated (Figure 1). A similar trend was seen in AMF-treated Malling Bella canes grown in the field which produced more spawn than the untreated.

Figure 1. AMF treated roots produced higher numbers of shoots for cuttings

Mother plants grown in coir recycled from strawberry production produced the same number of raspberry tips as mother plants grown in virgin coir, but the level of rooting was improved from 55% of collected tips in virgin, to 65% in recycled coir. Addition of AMF had the same effect in recycled as in virgin coir, with AMF amended mother plants producing 25% more rooted tips compared to unamended. In virgin and recycled coir amended with AMF or not, the growth of the plantlets post-rooting was the same.

This project demonstrated that a combination of recycled coir and AMF can significantly improve propagation efficiency and sustainability of Malling Bella nursery stock production.

Primocane establishment and fruit production in virgin coir

In 2023, Malling Bella tips were planted late in the season in virgin coir amended with AMF, PGPR, both AMF and PGPR or neither. The canes were cut down and cropped as primocanes in 2024. There were no significant differences in marketable yield or waste fruit per plant between treatments. AMF and AMG+PGPR treated coir, however, gave rise to a significantly increased berry size of 6 g compared to 5.3 g in the untreated control. PGPR alone resulted in a slight increase in berry size that was not statistically significant. The AMF treatment also led to a three-day delay in the time taken to produce first ripe fruit. The experiment was repeated in 2024. As in 2023 no increases in fruit yield or quality were observed. It is likely that the addition of beneficial microbes to a crop with optimum nutrition cannot further increase fruiting performance. Future work should investigate the use of these

beneficial microbes in crops under environmental or nutritional stress.

Long-cane establishment and fruit production

In 2023 Malling Bella tips were planted, grown into long canes and cropped in 2024. The experiment was repeated in 2024, but due to the limited project duration, cropping in 2025 was not possible. Instead, the total number of fruiting buds was measured as a proxy. In both experiments plants were amended with AMF, PGPR, both or neither. Across both years there were no significant differences in growth, fruit yield or fruit quality. As in primocane production, the beneficial microbes need to be assessed in canes under stress.

Suitability of recycled coir for raspberry production

The performance of recycled coir from strawberry production as a growing medium for raspberry production was assessed in 2023 and 2024. Malling Bella primocanes and long canes were planted in both virgin and recycled coir media with and without added AMF. The primocane crop was cut down at the end of 2023 and cropped in 2024. The long cane was grown in 2023 and cropped in 2024. In each year the coir and root microbiome along with chemical and physical properties of both growing media were assessed.

In the primocane crop, there was no significant difference in marketable yields between plants grown in recycled and virgin coir. Recycled coir, however, produced a slight (not statistically significant) increase in Class 1 yield and a significant reduction in waste fruit per plant (0.43 kg per plant) compared to virgin (0.58 kg per plant). Berry size was increased in plants grown in recycled coir with or without the addition of AMF compared to unamended virgin coir. There was no significant effect on fruit quality.

In the long canes, there were no significant differences in marketable yields between plants grown in virgin and recycled media with or without AMF. There was a very slight (not statistically significant) reduction in Class 1 yield and berry size in recycled coir without AMF compared to virgin without AMF, but also a slight reduction in waste fruit. When plants were planted in recycled coir with AMF, both yield and berry size were restored to virgin coir levels. Plants grown in recycled coir had significantly thicker and taller canes, produced less spawn and more branches than plants grown in virgin coir.

Figure 2. Good raspberry root colonisation of recycled coir

In comparing recycled and virgin coir, the respective microbiome was compared before planting. A higher diversity of fungi and oomycetes (e.g. Pythium, Phytophthora, etc.) were found in recycled media and higher diversity of bacteria in virgin media. Detailed analysis revealed overall similar microbiome risks of virgin and recycled media before planting. Increased levels of Botrytis species were found in virgin media while Penicillium and Cladosporium species were more abundant in recycled media. Beneficial Trichoderma species were more abundant in recycled media. Seven oomycete species were more abundant in virgin and four were more abundant in recycled media, indicating comparable risks of oomycete pathogens in both media.

After harvest, the microbiome of plants grown in recycled media had less fungal diversity and similar bacterial and oomycete diversity as plants grown in virgin coir. Many potential fungal (Diaporthe, Plectosphaerella, Sarocladium) and oomycete (*Pythium intermedium*) pathogens were more abundant on plants grown in virgin coir indicating that virgin coir may be more prone to pathogens than recycled. Potentially beneficial bacteria (Bacillus) and fungi (Inocybe) were more abundant in recycled coir.

Recycled media also had higher nutrient content, slightly lower air filled porosity and higher water holding capacity. This will have to be taken into account when designing irrigation and fertigation practices.

Conclusions and industry impact

In this research the application of AMF and the use of recycled coir has significantly improved propagation of Malling Bella plants. The project employed commercially available AMF (PlantWorks, UK) and recycled coir (ReCoir, UK) products that can be easily obtained and used by UK plant propagators such as Blaise Plants to produce large numbers of high-quality plants, sustainably and locally.

The addition of AMF and PGPR in primocane and long cane fruit production did not improve or decrease yields. Only small positive effects on fruit size and fruit timing were detected. The use of beneficial microbes may be more important in future growing systems with reduced water and nutrient inputs.

Recycled coir from strawberry production was shown to be as good or better than virgin coir in both primocane and long cane raspberry production (Figure 2). Microbiome analyses showed that contrary to common belief, both recycled and virgin media possessed similar levels of pathogen risks with recycled substrate providing potentially more beneficial microbes. This would allow recycled coir to be used as a direct replacement for virgin substrate for increased sustainability and affordability of growing media in raspberry production, resulting in lower carbon emissions and higher income generation for growers.

Xiangming Xu, Director of Research

Supporting private soft fruit breeding programmes in the UK

Title: Soft fruit genetic improvement network (GIN)
Funder: Defra
Partners: ADAS and the James Hutton Institute
Term: October 2024 to June 2029

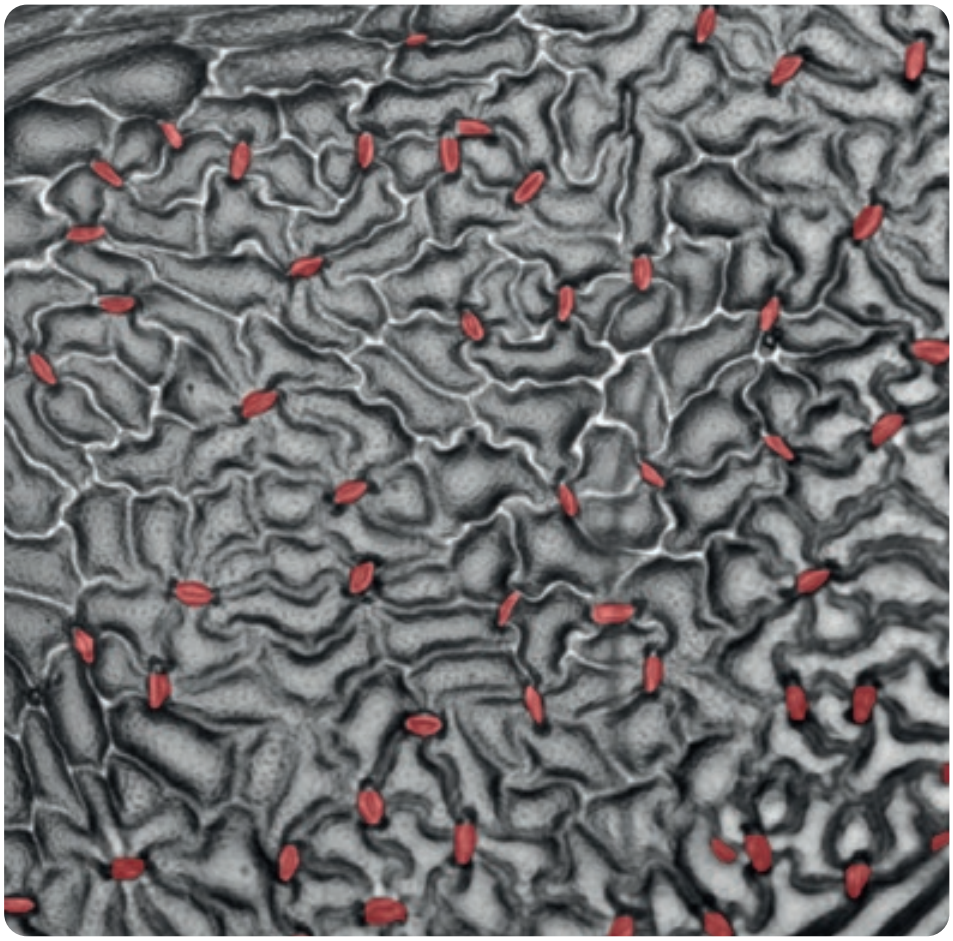
There are increasing numbers of privately funded breeding programmes in the UK soft fruit industry which would all benefit from a co-ordinated research approach to pre-breeding genetics of key traits and new breeding tools. Defra is funding several genetic improvement networks (GIN) on different crops in the UK to support public breeding objectives which are not near-market or driven by private breeding programmes at present. Defra's motives are to meet its 'net-zero' obligations through precision breeding, specifically to improve nitrogen use efficiency and drought resilience and to reduce pesticide use, whilst supporting the careers of future scientists. Defra is funding this Soft Fruit GIN project to focus on quality and nutritional aspects, yield enhancement and improved sustainability, pest and disease resistance, and resource use efficiency.

The project

The Soft Fruit GIN has been set up initially for five years with an option to extend it to ten years. It is being co-led by Niab and the James Hutton Insitute in Dundee, with additional work provided by ADAS. The work will focus primarily on strawberry, raspberry and blueberry, but will also develop genetic tools and resources for minor crops such as blackberry and honeyberry to support increased production in the UK. All three research partners will work closely with private UK breeding programmes to guarantee that the research is shaped by the needs of industry whilst ensuring that the industry adopts the results. The findings and genetic tools delivered by the project will then be adopted by these programmes, who couldn't undertake this work with their own limited resources.

The outcomes of the work will help breeders to respond to climate change with higher temperatures by breeding for improved drought tolerance, improved water use efficiency, resistance to heat stress and changes in disease pressure. They will also lead to improved nitrogen use efficiency, improved plant architecture to improve fruit presentation to pickers and machine harvesters, and improved understanding of the genetics behind flower initiation and physiology. The work will also develop tools for precision gene editing for strawberry (Niab) and raspberry (the James Hutton Institute). In previous work in a CTP for fruit crop research studentship project at Niab, genes were identified which confer resistance to powdery mildew as well as providing forms

Figure 1. High resolution image of false coloured stomata on the leaf epidermis



of early defence. For strawberry, Niab will use this powdery mildew resistance as an example trait to see if it can be copied to a commercial variety using the precision breeding tool.

Progress so far

In the first year of the project, the work has focused on water use efficiency (WUE) in strawberry, nitrogen use efficiency (NUE) in blueberry and resistance to large raspberry aphid in raspberry.

Water use efficiency in strawberry

The water use efficiency work in strawberry is being led by Niab at East Malling. The approach is to study stomatal density on strawberry leaves. Stomatal density can be reliably measured, is genetically controlled, and can be used as a proxy for WUE. Stomata are epidermal pores found on the underside of leaves (Figure 1) where gas exchange takes place, CO_2 is taken in by the plant, and water is lost by the plant. The size and density of stomata can dictate how much water is lost by the plant, with leaves of higher stomatal density likely to lose more water than those with lower density.

In this project, Niab is trying to understand the developmental control over stomatal density, and how this affects WUE. Improving WUE will reduce water use in strawberry production, delay the onset of water stress that constricts photosynthesis, and mitigate against heat stress. The initial work has been screening a wide range of strawberry varieties to identify lines with extremely high or extremely low stomatal density. Those with extremely low density will be physiologically assessed to confirm they have improved WUE. If successful, the team will look for genetic markers for low stomatal density that can be used in breeding programmes.

So far, Niab has developed a form of machine learning that can quantify stomatal density automatically, to avoid the painstaking job of doing this manually. The team has created

Figure 2. Licor device measuring chlorophyll fluoresence

images from over 300 strawberry varieties identifying a range of between 100-300 stomata per mm^2 of leaf. In the next stage of the work, Niab will cross varieties with both high and low stomatal density to develop breeding populations with variation in stomatal density, making these available in the long-term to breeding programmes. The plan is to map genes that control stomatal density and markers associated with stomatal density to help speed up the breeding process. The team will also assess and confirm that both high and low stomatal density affect WUE, fruit production and fruit quality.

Nitrogen use efficiency in blueberry

The nitrogen use efficiency work in blueberry is being led by the James Hutton Institute. JHI will identify techniques to accurately assess plant response to nitrogen application and assess blueberry plant performance under reduced nitrogen input. The work will utilise an established mapping population for nitrogen content under differing feed regimes to identify candidate genes in blueberry for NUE as well as developing a new mapping population derived from parents with extremes of NUE. Results will then be validated against a diverse range of varieties.

In the first year, JHI decided to work on the varieties Bluecrop, Brigitta and Duke which offer a diversity of agronomic traits, quality traits, nutrient requirements and seasonality. Glasshouse fertigation trials were carried out using a commercially available blueberry feed supplied by Omex (18:18:18 with trace elements), comparing the use of a 100% feed strength with reduced strength feeds of 50% and 25%. The nitrogen applied was primarily in the form of urea with low volumes of ammonium nitrogen (NH_4) and the feed was applied four times per day, three times per week for a total of five weeks. Measurements of plant height, health, chlorophyll content, yield and quality were recorded. Leaf samples were collected for sap analysis which was measured before first feed, 24 hours after first feed and then five weeks under differing feed regimes. Urea is taken up quickly by the plants and converted to NH_4 nitrogen. In most samples in all three varieties, the NH_4 was significantly higher in the samples collected 24 hours after feeding than those collected before feeding.

Gas exchange was also measured including CO_2 assimilation and transpiration while a Licor device was used to measure chlorophyll fluorescence (Figure 2). There were significant differences between the varieties but no significant differences between the fertigation treatments in year one. A complete data analysis of all the results in the first year are being carried out at the time of writing. In 2026, these glasshouse trials will be repeated to assess the impact of the treatments on two years of feeding and additional fertigation trials will be carried out in field-grown blueberries.

Resistance to large raspberry aphid in raspberry

This work is being led by ADAS at Boxworth in Cambridgeshire. The large raspberry

aphid (*Amphorophora idaei* – Figure 3) is a major vector of several raspberry viruses (Figure 4), which reduce plant vigour, yield and lead to premature plant death. There is no genetic resistance available to these viruses, but geneticists have identified up to 12 genes that confer resistance to the large raspberry aphid over several decades. Their interaction is rather complicated and not all work effectively when present in raspberry on their own. There are four biotypes of the large raspberry aphid. Raspberry gene A1 confers resistance to some biotypes while gene A10 confers resistance to all four biotypes. However, in recent years, a new biotype of the aphid has developed and appears to be resistant to gene A10.

There are two parts to this work. First, it is necessary to identify which aphid biotypes are present in raspberry crops in different parts of the UK. This could help to understand if any of the current resistance genes are working. ADAS has done this by collecting aphids from raspberry crops from different growing regions and rearing them in culture. A total of 15 populations were collected and established in culture, with 12 tested to determine their biotype by rearing them on Tulameen Pearl (susceptible to all biotypes), Glen Ample (A1 gene conferring resistance to two biotypes) and Autumn Bliss (A10 gene conferring resistance to four biotypes).

ADAS has found two populations in Kent and East Anglia that are still susceptible to the A1 and A10 gene. Five of the populations are A1 gene breaking aphids and five are A10 gene breaking aphids. Those that are breaking A10, also break A1, suggesting that those that have emerged to break A10 will also break A1.

The second part of this work focuses on assessing the tools available for developing new genetic resistance. ADAS has begun to screen 50 raspberry varieties to find out the current effect that existing resistance genes have on aphid populations. The genetic location of resistance genes needs to be determined to be able to identify genetic markers for breeding programmes to use.

Figure 3. Large raspberry aphid

Figure 4. Raspberry ringspot virus is transmitted by the large raspberry aphid

Benefits to the industry

One commercial breeder who sees major benefits in the Soft Fruit GIN is Lucy Wilkins, breeding programme director for Angus Soft Fruits. In the Soft Fruit GIN meeting delivered as part of the Niab Soft Fruit Technical Day in December 2025, Ms Wilkins explained that new varieties must meet the needs of the whole supply chain, starting with ensuring profitability on the farm, all the way through to quality for the end consumer. New varieties need to be produced with lower inputs to reduce production costs and take care of the environment they are grown in. Some of the challenges facing breeders in developing new varieties require a more collaborative, industry-wide approach, as they are too large for any single company to address alone; just one reason for Angus Soft Fruits supporting the Soft Fruit GIN.

Ms Wilkins pointed out that "The pre-breeding work being undertaken in this project will allow us to identify and study in detail, the genetics which underpin traits of interest, helping us to understand responses we see and then think about how we can utilise them in our breeding programme. It also expands the genetic pool that we are working in. This offers us the chance to increase the genetic diversity that we are working with, opening new opportunities for breeders to bring in new traits. It can also allow for new traits for important characteristics such as disease resistance or fruit quality, which are found in obscure backgrounds such as wild alpine strawberry, allowing us to move these genes from a wild relative into a modern background, so it can be used by a conventional breeder without incurring a size or yield penalty".

Next steps

To find out more about the Soft Fruit GIN project and its activities, or to engage with the work, go to: www.soft-fruit-gin.com/. Alternatively contact project administrator Mitzi Else at: Mitzi.else@niab.com.

Simon Barnes, Programme Director, Growing Kent & Medway

Growing Kent & Medway

Growing Kent & Medway (GKM) has been supporting the food, drink and horticulture sector in the Kent and Medway region since 2021. A world-class research, innovation and enterprise cluster supported by UKRI's 'Strength in Places' fund, it has been led by Niab working with the University of Greenwich, the University of Kent and Canterbury Christ Church University.

Its mission has been to invest in sustainable research, innovation and technologies to help the horticultural and plant-based food and drink industry in Kent and Medway to continue to thrive. It is now a highly valued and unique innovation ecosystem designed to accelerate the growth of food, drink and plant-based businesses operating in horticulture and fresh produce. This Niab Fruit Review has reported annually on the progress of GKM and what it has delivered in each year since 2021, but with 'Strength in Places' funding winding down in 2026, it is worth reflecting on how much it has delivered for the sector through that period.

Research infrastructure

Initial funds were utilised to develop new high-technology facilities to support the scientific research and development (R&D) work being offered to the sector by each of the research organisations. GKM has invested a total of £8.6 million across the partnership.

Niab's facilities at East Malling now include modern polytunnels and climate-controlled glasshouses along with seven independently controlled environmental growth rooms, allowing Niab to investigate the future of sustainable horticulture by developing resilient, low-carbon production systems for a changing climate (Figure 1).

At the University of Greenwich, the 'Medway Food Innovation Centre' now provides world-class facilities and research and development to transform the UK food sector, offering expert support in alternative proteins, sustainable packaging, and product development to help businesses to scale.

At the University of Kent, the 'BioTechnology Hub' can apply high-tech approaches to production and processing of high-value foods and plant-based compounds from plant material and waste, pathogen identification and control, and maintenance of healthy soils.

The 'Agri-Engineering Hub' at Canterbury Christ Church University can now offer world-class research and development facilities to transform the UK food sector, offering expert support in agri-engineering, automation, and advanced manufacturing to help businesses to scale.

Research and development funding

Since 2021, GKM has invested £3.5 million in secondary grant funding for R&D and innovation activity and leveraged an additional £3 million of industry co-investment. Many of the new facilities developed in the early work were subsequently utilised for this activity. The funding spanned a series of programmes including two rounds of large R&D grants, two rounds of Business Innovation Vouchers (BIVs), two rounds of a Business Sustainability Challenge and a single Prototype & Demonstrator fund.

All strands of the competitive

Figure 1. New research facilities allowed Niab to extend its scientific capabilities

Figure 2. Niab assessed the varietal resistance of strawberry and raspberry to SWD

grants were designed to deliver improved productivity and sustainability in horticultural food and drink production. The priority themes and scope of acceptable projects included:

- Minimising waste and maximising recycling
- Improving resource use efficiency and sustainability
- Increasing productivity
- Supply chain resilience
- Precision technologies, sensors, AI and robotics
- Access to labour.

In all the large R&D grants and BIVs, the grant recipients partnered with Niab or one of our GKM researchers, seeking to find solutions to common production problems faced by horticultural production and food or drink businesses which met the themes listed above. GKM has been committed to inclusive and sustainable economic growth, so all grant recipients have been required to deliver social value to the region through community engagement or education activities.

As a condition of grant funding, recipients were required to commit a corresponding level of time towards social value activity, dependent on the size of the grants awarded. This included sharing the results of the research at events and conferences, liaising with local communities, through schools, colleges and universities, and posting news and case studies of our work on the dedicated GKM website.

Many of the R&D grants and BIVs were awarded to fruit-related projects which sought to find solutions to production problems. Included in the research grants were projects to:

- Extend the season of Kentish cherries
- Speed up the breeding process of apples
- Develop improved management and control of apple canker
- Identify varietal resistance to spotted wing drosophila in strawberry and raspberry (Figure 2)
- Breed for improved plant architecture in strawberry
- Improve the consistency of propagation in raspberry
- Identify novel biocontrol methods for the large raspberry aphid
- Develop sustainable recycled coir growing media
- Assess the role of biochar to improve land productivity and remove atmospheric greenhouse gases.

In the BIV grants, fruit innovation projects covered:

- The improvement of low-oxygen storage of Gala apples
- Integration of novel control products for apple scab management
- The potential health benefits of Nashi Gold pears
- The development of soaker pads for raspberry punnets
- Raspberry breeding to improve fruit texture quality
- The impact of strawberry decontamination on strawberry sensory properties
- The use of augmentoria to boost natural control of spotted wing drosophila
- Exploring the links between soil microbiome and carbon sequestration.

In the Business Sustainability Challenge, one project benefited the fruit sector by investigating ways to improve the energy efficiency of apple cold stores without compromising the quality of the fruit. The prototype and demonstrator fund supported two fruit projects, one that sought to develop

an automated system to dispense predatory mites in strawberry crops and the other to employ artificial intelligence to detect and predict downy mildew and powdery mildew infection in grapevines.

Growing Green

Growing Green was another GKM sustainability grant and training programme for horticultural and plant-based food and drink businesses in Kent and Medway. This was targeted at local small and medium-sized enterprises in the food sector to help them to move towards net-zero. The flexible programme was created to enable business owners to cut their energy use, find value from their waste materials, and reduce their inputs or resources. Two separate programmes were run, the first in 2022 and the second in 2025. Both offered grants of up to £7-8,000, accredited training and professional qualification, environmental sustainability assessments, personalised action plans, networking and events. A number of fruit growing businesses benefited in different ways.

Robert Mitchell Farms identified that an ill-fitting door on an apple cold store was incurring energy losses and increasing energy consumption. The farm took part in the first Growing Green programme and applied for a grant to help to replace the door with the latest sliding door technology (Figure 3), easy seal, and magic thermal efficiency. This made large energy savings, estimated to be £1,348 per year. The farm tapped into the second programme in 2025 and benefited from a smart tariff timer which allows the cold stores to be run on cheaper electricity at night. With the smart sensors, running hours depend on the weather. If the weather is hot, the stores run 24/7, but in winter, the hours can be cut down when electricity is so cheap. Scan the QR code for full details:

Adrian Scripps Ltd received a grant to install a rainwater harvesting system from the packhouse roof with an estimated annual collection of 900,000 litres, improving the resilience of the farm to drought and saving on the cost of mains water.

E H Holdstock & Son replaced an overhead orchard irrigation system with trickle irrigation, saving 5.6 million litres of water and £1,980 worth of red diesel per year.

J A Colthup & Partners received a grant to fund a rapid roll door to reduce energy leakage, significantly reducing the cold store's energy requirements and fruit waste.

J I B Cannon received a grant to purchase an inverter and coupled condenser fans to reduce cold store electricity consumption, saving an estimated £6,300 per year.

J Myatt & Co received a grant to fund equipment to divert winter water run-off from an existing pond into a new filtration and storage system. This saves an estimated £30-40,000 per year on mains water and has positive effects on biodiversity in the pond.

Victoria Farm used its grant to fund the addition of two solar storage batteries to capture energy that was previously being lost. This has reduced the farm's reliance on mains electricity and saves an estimated 6,935 KWh and 1,338 CO_2e per year.

Other business support

GKM has supported businesses in ways other than just grant funding for research, innovation, circularity and sustainability. Additional programmes have been run to support businesses including Mentoring, Food Accelerator and Be Your Own Boss.

The Mentoring programme run by the University of Kent, supported people working in fresh food and drink on a wide range of areas, from getting started, market research, sales, people management, finance or legal, through to supply chain development or marketing strategies. In particular, a number of startup business owners benefited from one-to-one support provided by experienced and retired business owners who gave up their time and talents for free to share their own business experiences and provide guidance to navigate the difficulties encountered in the early years of a new business. In total, during the process, 67 mentors supported 139 entrepreneurs.

Aligned to the Mentoring programme, the Food Accelerator programme also provided free support to new businesses in the food, drink or horticulture sector. Based at the Medway Food Innovation Centre at the University of Greenwich, the programme was run by experts in food product development, processing, handling, storage, and food waste. The experts worked with owners to assess a new idea, identify any technical and business gaps, and define a clear direction to take an idea to market. New businesses also received technical support with access to cutting-edge facilities and equipment, whilst helping to

Figure 3. Growing Green helped to fund a new door for a store at Robert Mitchell Farms

develop a product, produce a viable prototype and develop a new process, practice or technology. In total, the Food Accelerator programme supported 161 businesses, enabling the launch of 62 new food and drink products.

The Be Your Own Boss programme, led by the University of Kent, provided ambitious individuals with the knowledge, skills, and confidence to start their own food or drink business, without assuming any prior experience (Figure 4). Three separate programmes were delivered in partnership with community interest companies, including Sunflower House, a community hub in Folkestone; The Perfect Place to Grow, a café and training kitchen in Margate designed to help young people in Thanet into full-time employment; and Sunlight Development Trust, a local charity in Medway who work closely with the community to improve wellbeing. Participants received help to develop a new food and drink business idea, along with training on marketing, finance and product development, and guidance from industry experts. A helpful toolkit has been produced providing an evidence-based blueprint for organisations aiming to tackle local youth unemployment through entrepreneurship with food and drink.

Figure 4. Be Your Own Boss helped ambitious people to start their own food and drink businesses

Outreach and communications

Since its inception in 2021, one of the key GKM activities has been to reach out both to the community and businesses in the region to promote the type of support on offer through GKM and to inspire new businesses to get involved in food, drink and horticulture activities to strengthen these traditional industries in the area. This has been achieved through a dedicated website, a series of helpful publications, press activities, social media posts, exhibits at local and industry events and outreach to schools, colleges and universities through the STEM Hub run by Canterbury Christ Church University. An annual GKM Showcase Day has also presented the latest successes, offering many of the businesses that have benefited from GKM support to promote their products and outline the progress they have made. In parallel with these activities, GKM grant recipients were sharing the results

Figure 5. The GKM team worked with Fermenti to teach schoolchildren at the Living Land event

of R&D activities with the public and other businesses and industry groups as part of their social value commitments to their projects.

To support food, drink and horticultural businesses, GKM either funded or was involved in the production of a number of reports on issues relating to investment, innovation, circularity and sustainability. Reports produced and available to read include:

- 'Place-based investment in Food and Farming Innovation'. This includes critical components of an effective model of regional investment for innovating our food systems.
- 'Reviving the British Hop Industry'. This report examines how a targeted strategic place-based investment can support the industry and revive British hops in Kent and Medway.
- 'Plant Crop Waste and Valorisation in South-East England'. This explores the untapped potential of horticultural by-products in the south-east, to drive a biobased circular economy. Additional individual reports were produced for fruit, vegetable, mushroom, hop and cereal waste.
- 'Be Your Own Boss Programme Toolkit'. A toolkit for organisations aiming to tackle youth unemployment through entrepreneurship with food and drink.
- 'The Alternative Protein Roadmap'. This outlines the strategic actions required to capture a share of the $27 billion global market for alternative proteins.
- 'Workforce 2030: Agri-food Skills Strategy'. Following consultation with industry and further education providers, GKM produced a strategy to help address the skills challenges facing the land-based, horticulture, viticulture and food and drink sector. This report sets out practical recommendations and objectives to up-skill and attract the right talent to the sector.

Niab's GKM team supported and organised a number of exhibits in 2025 at events which allowed all GKM-funded projects and activities since 2021 to be shared with the industry and local community.

Figure 6. GKM supported Cecii to develop new gut health products

Fruit Focus offered the chance to promote the innovative work of Aridom Sanex who have been decontaminating strawberry fruit using dry fogging, Aures Packaging who outlined its work on sustainable food packaging from brewers' spent grain, and Re-Generation Earth, who demonstrated biochar for carbon capture and soil health.

The 2025 Living Land Show at Kent's County Showground (Figure 5) aimed to educate primary school children about where their food comes from. The GKM team attended with Fermenti, a startup business that has received GKM support to develop a fermentation process to produce healthy snack foods. The children were taught about their digestive system and the route that their food takes through their bodies.

The Niab GKM team participated in a STEM Hub Day hosted by Canterbury Christ Church University to provide secondary school children with a taste of agri-tech careers. This allowed the children to explore the amazing array of science, technology and engineering roles involved in food and farming, from computer vision counting ripe cherries to 3D printers creating tasty snacks and a simplified version of how Niab studies genetics and carries out fruit breeding.

The annual showcase event in September 2025 allowed over 100 guests at Niab's East Malling site to learn about the impact GKM has made in advancing research and innovation in the region. Sixteen GKM-supported businesses showcased innovative, nutritious, and tasty food products – including cacti-based chocolates, gut-health shots (Figure 6) and freeze-dried baby food.

Since GKM was set up in 2021, the outreach has been delivered to 236 signed-up member businesses, 636 businesses who have engaged in various GKM work programmes, and 989 recipients who requested to receive news and updates.

Find out more about Growing Kent & Medway

For comprehensive information about how GKM has supported the horticultural, food and drink businesses in the region, along with links to case studies and reports, scan the QR code:

Niab

Fruit

For further details or information about Niab Fruit contact: horticulture@niab.com

niab.com

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