The GROWER

THE TECHNICAL JOURNAL FOR HORTICULTURE

AHDB

Issue No. 244
Feb/Mar **19**

A FLYING **FUTURE?**

Could we one day see a fleet of autonomous drones patrolling our fields?

AHDB

TREE FRUIT DAY 2019

Thursday 28 February
East Malling, Kent

Book your place now:
horticulture.ahdb.org.uk/events

Find out the latest on research into a new pest of pear - *Anthonomus spilotus*

Discover the optimum planting material for fruit wall production systems

Gain insight into tree fruit diseases, including apple canker, cherry canker and brown rot

ahdb.org.uk

@AHDB_Hort

ACKNOWLEDGEMENTS

If you wish to get in touch with our team about any aspect of this publication please use the following contact details:

GENERAL ENQUIRIES
hort.info@ahdb.org.uk

EDITORIAL
Luke Garner
Technical Writing Manager
luke.garner@ahdb.org.uk
Lauren Colagiovanni
Marcomms Senior Manager – Horticulture
lauren.colagiovanni@ahdb.org.uk

KNOWLEDGE EXCHANGE
Debbie Wilson
Head of Knowledge Exchange – Horticulture
debbie.wilson@ahdb.org.uk

DESIGN
Zoe Shackleton
Graphic Designer
zoe.shackleton@ahdb.org.uk

SUBSCRIPTIONS AND MAILING
The CRM Team
comms@ahdb.org.uk

IMAGE CREDITS
Rob Jacobson – page 12
Xiangming Xu – page 20
GrowSave – page 23
Rob Lillywhite – page 25
30 mhz – page 26
Johnsons of Whixley – page 35

One point is awarded per annum for BASIS registered members for reading this magazine. From 1 June 2018 to 31 May 2019, please quote reference CP/67833/1819/j

This publication is brought to you by AHDB

For more information contact:

AHDB Horticulture
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

T: 024 7669 2051
E: comms@ahdb.org.uk
W: horticulture.ahdb.org.uk
@AHDB_Hort
If you no longer wish to receive this information, please email us on the address above.

COMMENT

Hayley Campbell-Gibbons,
Chair of the AHDB Horticulture Board
hayley.campbell-gibbons@ahdb.org.uk

ARE YOU BREXIT READY?

It's never a comfortable feeling is it, when you're flying at 30,000 feet and the seatbelt sign comes on? No matter how dulcet the tone of the pilot's voice when he tells you there's a wee bit of turbulence ahead, we all dread what's coming and want it to be over as quick as possible.

That's how I'm feeling about Brexit. The government, the Bank of England, the media are telling us to be prepared. But how can you prepare for a no-deal Brexit? I run a business too, and I can tell you that I don't feel prepared for changes to the price and availability of coffee – our main input.

Currently the EU doesn't impose any tariff on imports of green coffee (what we call it before it's roasted). What's important is that the UK manages to renegotiate the same free trade agreements it enjoys now. As a business, there's not much we can do about it but sit, wait and ponder over how much more you can possibly charge for a latte.

For horticulture the threats are greater. The sector relies on tens of thousands of EU nationals being able to travel freely to the UK to work. Growers are price takers, not makers, so any tariff changes will affect the price of our inputs, which can't necessarily be passed on to the consumer. Then there's our unique reliance on imports of fruit, vegetables and flowers that we either can't grow, or supply year-round. Any changes to the seamless flow of these products we have now will be disruptive – to supply chains, prices and, potentially, retailers' loyalty to British suppliers.

What we can do at AHDB is assess the risks, raise awareness of the economic impact a 'no-deal' Brexit would have on horticulture (in the hope it can still be avoided), promote growers' stories about how they are getting ready for Brexit, and suggest how, if at all, businesses might prepare for what is undoubtedly going to be a turbulent time ahead. Buckle up folks.

CONTENTS

5 **Contributors**

6 **News and updates**

IN FOCUS

8 **A flying future**
Could autonomous drones one day patrol the skies over our fields?

10 **Our view: drones**
AHDB's Jim Dimmock examines the potential of drones for horticulture in the UK

CULTIVATE

11 **Not so busy bees**
Improving our understanding of pollination by native bumble bees

PROTECT

14 **EAMU latest**
AHDB's Bolette Palle Neve brings you up-to-date on all things EAMU

16 **Predicting potential pest problems**
Rosemary Collier explains how AHDB helps you to prepare for potential pest problems

18 **The next step against pests**
The latest from our SCEPTREplus project and how it is tackling pests

19 **Know your enemy**
Do you know your mirid bug from your *Macrolophus*?

20 **Minimising crop losses to Phytophthora**
What options are available to manage Phytophthora in initial planting material?

RESOURCE MANAGEMENT

22 **More than just hot air**
Tips and tricks to help you properly circulate air in your greenhouse

24 **In hot water**
How to control pathogens in the hot water treatment of Narcissus bulbs

LABOUR & LOGISTICS

26 **A smarter future for horticulture**
Discover the latest in smart tech with an insight to the SmartHort2019 Conference

28 **The £1 million payoff**
How one man's decision to invest in tech paid off big time

INNOVATE

30 **It's a bug-eat-bug world**
Controlling aphids with a promising bacterial biocontrol

32 **New lettuce robot holds a-peel**
Fumiya Iida reveals the world-leading robotic leaf peeling system that saves on labour

VIEWPOINT

34 **Insider insight: Are you ready for Brexit?**
Johnsons of Whixley's Graham Richardson explains how they're dealing with Brexit uncertainties

CONTRIBUTORS

Discover more about the people who have helped to contribute to this issue of The Grower magazine

ROB JACOBSON

Dr Rob Jacobson is an independent Integrated Pest Management (IPM) consultant with over 30 years' experience in biological pest control. He has a successful history of implementing IPM in commercial crops with clients as far afield as Australia. Rob has a proven record of managing and delivering R&D projects for government organisations, AHDB and many private companies. He is a member of the Tomato Growers' Association Technical Committee and is active in several IPM-related organisations. He has won the 'Science into Practice' category at the Grower of the Year Awards for his work on IPM in tomato crops.

The busyness of bees poses a problem for Rob on page 11

ROSEMARY COLLIER

Rosemary Collier trained as an entomologist and has worked on pest insects such as cabbage root fly and carrot fly for many years, most recently at Warwick Crop Centre, which is part of the School of Life Sciences at the University of Warwick. Her main research interest is in the development and application of IPM strategies for horticultural crops. This includes putting together the *AHDB Pest Bulletin*, which contains information on the activity of a range of pests of vegetable and salad crops grown outdoors.

Rosemary gets ahead of the pests on page 16

ROB LILLYWHITE

Rob Lillywhite is an Assistant Professor in the School of Life Sciences at University of Warwick. He is a research agronomist based at Warwick Crop Centre in Wellesbourne who specialises in crop nutrition, cropping systems and farm performance. His expertise covers a wide range of arable and horticultural crops including cereals, oilseed rape, various Brassicas, alliums and Narcissus. He undertakes strategic and applied research for various organisations including AHDB, Defra, WRAP and commercial businesses. He teaches under- and post-graduate students and supervises PhD students.

Rob gets into hot water on page 24

IN **BRIEF**

BECOME A CHAMPION

A new film is set to be released to help improve labour efficiencies by introducing champion pickers to UK soft fruit businesses. To be used as part of the induction process, the film motivates new seasonal workers to become a champion picker. Available soon in multiple languages at: **ahdb.org.uk/smarthort**

VEG POWER

A new marketing campaign to inspire everyone to eat more vegetables has been launched. The national campaign received £2m worth of advertising space from ITV which started on 25 January and will run for 13 weeks. Veg Power is an independent campaign funded by industry stakeholders, including AHDB. Find out more: **vegpower.org.uk**

WATERCRESS CHALLENGE

In response to demand from industry, AHDB has launched a new marketing campaign to help increase the awareness of watercress in the UK. It will show how social media can be used to reach targeted audiences to raise the profile of this salad vegetable. Search **#watercresschallenge**

HORTICULTURE TRADE AND THE BREXIT IMPACT

A new Horizon publication is due to be launched that considers the impact of Brexit on UK trade in horticulture products and considers potential changes to imports, exports and tariffs. A range of resources are available to help you find out if you're Brexit ready: **ahdb.org.uk/brexit-fit-for-the-future**

VALUE OF WILDFLOWER MARGINS TO **COURGETTE CROPS** REVEALED

An AHDB-funded PhD has revealed the value of pollination services to courgettes, finding that wildflower field margins can improve bee species' work, while aiding their conservation.

The study discovered that with pollinator insects like honey bees and buff-tailed bumblebees present, crop yields were 39% higher than when they were excluded. That additional yield could have been worth £3.6m to the 2017 courgette crop, with pollination services valued around £3,400 a hectare.

Results showed there was no significant difference in crop yield when humans pollinated each flower by hand compared to natural levels of pollination, showing how effective bees are with zero labour costs.

Wildflowers are essential for maintaining healthy bee populations and in courgette field margins, they were shown to attract bees into the crop, helping to provide stable long-term services across growers' land.

The research was led by Dr Jessica Knapp from the University of Exeter who said: "We set out to develop a clear understanding of courgette pollinators' behaviour and the crop's requirement for pollination. These findings could also relate to all crops within the cucurbit family, such as pumpkins, watermelon and cucumber.

"Notably, wildflower field margins did not create a distraction to bees' pollination work. They are an effective way of attracting pollinators into courgette fields and will help to conserve these important agricultural species."

Courgette nectar and pollen measurements were taken to simulate bee population dynamics in 'virtual landscapes' with courgette fields present, using a bumblebee population model called BEE-STEWARD.

Pollination rates and the abundance and diversity of pollinators were measured across 23 different study sites with most based in Cornwall, and some in Worcestershire and Cambridgeshire.

SECTOR PANELS WELCOME **NEW MEMBERS**

Nine new panel members joined AHDB for a three-year term in January. They will help to represent growers' views and interests and support the delivery of work to boost productivity in horticulture.

The new members of the soft fruit, protected edible and mushroom, hardy nursery stock and field vegetable panels will also play a critical role in shaping new research projects. The aim is to keep the UK horticulture industry resilient through the potentially turbulent years ahead.

Key priorities for all of the sector panels will be developing integrated pest management strategies and supporting industry to manage the challenge of access to affordable, effective labour.

Steve Tones, strategy direct for AHDB Horticulture, said: "There are likely to be challenges ahead for UK horticulture with the uncertainty around our withdrawal from the EU and the continued non-renewal of key plant protection products and actives.

"Having the voice of the industry represented by innovative growers, who are passionate about keeping the industry moving forward, is critical in helping us get the best return in investment for our levy payers and ensuring businesses are fit for the future."

Mark Yates, Wyeplants Ltd and new panel member for hardy nursery stock, said: "I joined as a panel member in order to have some influence on how resources are allocated to meet the most relevant challenges for both our own business and the sector as a whole.

"The industry will face many challenges over the next few years and AHDB will have an important role in research and development in order to help keep businesses competitive in the market place."

Positions are still available for some of the sector panels. To find out more about your new panel members and how to get in touch, or to apply for a position, visit: **horticulture.ahdb.org.uk/panel**

WELCOME TO OUR NEW PANEL MEMBERS

Field Vegetables:

Philip Langley, Sandfields Farms Ltd

David Bond, J Bond & Son

Carolyn Coxe, Pollybell Farms

Hardy Nursery Stock:

Mark Yates, Wyeplants Ltd

Protected Edible and Mushroom:

Matthew Simon, Glinwell Marketing

Ian Hammond, Valefresco

Kimberly Dawson, G's Fresh Mushrooms

Soft Fruit:

Gerard Olivier, Edward Vinson Ltd

Trelawney Greaves,P J Stirling Ltd

ANNUAL TREE FRUIT DAY DETAILS ANNOUNCED

This year's annual AHDB/EMR Association tree fruit day will be held at The Orchards Events Venue, East Malling, Kent, on 28 February. It will present a wide range of tree fruit research projects being funded by AHDB and others. It will include new research into surveillance for new pests and diseases, the latest findings about a new pest of pear (*Anthonomus spilotus*) and our final assessment of tree planting types for fruit walls. There will be a comprehensive focus on our latest understanding of tree fruit diseases including apple canker, cherry canker and brown rot, along with the most recent research into Spotted Wing Drosophilia control in cherry.

To register, visit **horticulture.ahdb.org.uk/events**

A FLYING **FUTURE?**

Could we one day see a fleet of autonomous drones patrolling our fields, carrying out tasks ranging from surveying to spray application? We look to the East to find an answer

It is no secret to anyone in the world of horticulture and agriculture that access to labour, particularly seasonal workers, has been getting tougher and tougher with each passing year for quite a while now. The dreaded B-word (Brexit) certainly hasn't made things any easier either. But what if there was a solution on the horizon that could negate the need for so many workers for tasks such as spray application? XAG (XAIRCRAFT), a drone and robot company based in China, are leading the way with their use of drones, particularly for use in spray application. We spoke to XAG to get an idea of what they're doing, the benefits to growers compared to traditional methods, and whether it will ever be a viable option in the UK.

Q: CAN YOU TELL US A LITTLE BIT ABOUT XAG AND WHAT YOU DO?

A: XAG was founded by a group of geeks in 2007. It is now one of the world's largest drone and robot companies. XAG focuses on agricultural automation and R&D of unmanned devices.

Q: WHAT ARE YOUR DRONES CURRENTLY BEING USED FOR?

A: Currently we have two types of drones being used: the C Series is for surveying and mapping and the P Series is for spraying.

Q: SO WHAT ARE THE BENEFITS FOR GROWERS OF USING DRONES OVER TRADITIONAL METHODS FOR SURVEYING AND SPRAYING?

A: First of all, drones are flexible to use in different terrains and for different crops. It is easier for farmers or professional plant protection teams to adopt them, especially when they need to spray more than one type of crop, as they don't need to use one tractor for the field while using another machine for the orchard; one drone can do both. Furthermore, using a tractor in the field could cause soil compaction and crushing of crops at the turning point. Aerial application helps to avoid such problems. Compared to manned aerial application, drones fly much lower, which greatly reduces the possible harm of drifts and makes spraying more precise in the field, with a reduced amount of water and chemicals.

The benefits of using drones in field surveying are also obvious. During our operation, we found that a lot of fields' boundaries were difficult to reach. They could be at the far end of the farm, or the tracks to the border could be covered by weeds or bushes which are difficult for humans to walk through, for example. Aerial observation comes in handy for these moments, especially as it 'sees' much larger fields and quickly identifies the boundaries, which is much more efficient than when using human labour.

Q: ARE THE DRONES AUTONOMOUS AND HOW MUCH HUMAN INPUT DO THEY REQUIRE?

A: Yes, the drones are guided by pre-set flight routes, flight/spray parameters and a Real Time Kinematic (RTK) station. In swarm mode, a single pilot-phone (a mobile phone-like remote controller) can control and fly up to five drones at a time.

Q: ARE THERE ANY REGULATIONS OR RULES YOU HAVE TO ADHERE TO BEFORE YOU CAN OPERATE THE DRONES AND APPLY SPRAYS?

A: There are rules and administrative codes issued by government agencies at all levels regarding farm chemical production and usage. Besides the needs of farm owners, we follow prescriptions given by experts to reduce the risks of chemical hazard. Before spraying chemicals on crops, users are required to read the label carefully for detailed safety and usage instruction and confirm the chemical is within validity with a complete set of three necessary certificates: Production Approval ID, Standard Verification ID and Registration ID.

Q: HOW DO YOU COMBAT THE EFFECTS OF WEATHER, SUCH AS WIND, WHEN SPRAYING CROPS WITH DRONES?

A: Vertical airflow from rotors can help to reduce drifting caused by wind and enhance the adhesive force and coverage of the droplet over the surface of the crop, but we still would advise users to lower flight height, speed or add drift-control additive when operating under windy conditions. Theoretically our drones can resist a wind speed of up to 15 m/s (33.5 mph), but practically, it is not suggested to spray crops when wind speeds exceed 5 m/s (11 mph).

Q: DO YOU HAVE PROBLEMS OR CHALLENGES WITH GETTING THE CORRECT APPLICATION LEVEL OF SPRAYS?

A: The dosage of chemical application for crops is usually instructed on the package. Meanwhile, we've been constantly doing examinations in our chemical research labs, in Xinjiang and Guangzhou. We also have a collaboration with Bayer which will push the development of producing drone application specified chemical forms, which will make drone spraying even more convenient and reliable.

Q: WHILE THE BENEFITS SOUND INTERESTING, CHINA IS OBVIOUSLY QUITE DIFFERENT TO THE UK MARKET. ARE YOU PLANNING ANY WORK HERE TO SEE WHETHER THE SAME METHODS WOULD BE APPLICABLE?

A: Yes, we've set up trial stations in 19 other countries, including the UK. Our strategic partner in the UK is Harper Adams University. They are using our drone to conduct spraying experiments as well as develop other plant protection devices based on drones.

> "Vertical airflow from rotors helps to reduce wind drift and enhance the adhesive force and coverage of the droplet"

OUR VIEW: THE LAW'S THE LIMIT FOR DRONES

AHDB Resource Management Scientist, Jim Dimmock, provides insight into the potential for widescale drone usage in the UK

Despite all of the excitement around drones, they're still critically limited in how they can benefit growers' businesses in the UK by Civil Aviation Authority (CAA) rules demanding that the operator must maintain 'direct, unaided visual contact with the aircraft… for the purpose of avoiding collisions' (**caa.co.uk**). So, as things stand, the label 'UAV', i.e. unmanned aerial vehicle is wrong as they are staffed at all times. This cripples their potential and could make them too expensive to be beneficial.

Fair enough, perhaps? Governments will do everything they can to ensure safety in their airspace, but is this the end of the story? What untapped potential is the cost of this risk aversion?

Justin Gong, Vice President of XAG, spoke recently about how his products are used at home, where the ruling Government operates a far more liberal policy in this area than ours: "Agriculture in China is structured very differently to the UK, with average holdings of under a hectare and where state-ownership of all land means there's limited collateral to back investment.

Together with cheap, freely available labour, this has created a food production system with minimal mechanisation".

There's another problem, much more applicable to home. China's booming economy and urbanisation has reduced the rural population by a quarter over the past decade, and the decline is ongoing; Chinese agriculture now faces a labour shortage on an epic scale.

So how do China's farmers apply pesticides safely when there's nobody available to do the job? With drones flying autonomously on pre-set flightpaths – autosteer, but with an extra dimension. And swarms of drones can be managed by a single operator. In a recent presentation at Harper Adams University, Gong said that XAG's drones alone had already made more than 1.7m flights, covering over three million kilometres, with a total flying time of 374,767 days – that's over 1,000 years.

This growing evidence of reliable, safe operation on such a vast scale creates a strong case for reviewing existing regulations, but given the government's current position, we have to question whether this could ever happen here. My opinion is that since self-driving road vehicles are taken seriously, even given the potentially disastrous outcomes of failure, then the potential contribution of autonomous lightweight aerial vehicles should be thoroughly explored.

> "This growing evidence of reliable, safe operation is making a strong case for reviewing existing regulations"

NOT SO BUSY BEES

Rob Jacobson, independent Integrated Pest Management (IPM) consultant, summarises AHDB-funded research conducted in 2018 by the Tomato Growers' Association and Warwick Crop Centre aimed at improving our understanding of pollination of small fruiting tomato cultivars by native bumblebees

The non-native bumblebees, *Bombus terrestris terrestris* (Btt) and *B. terrestris dalmatinus* (Btd), provided UK tomato growers with over 27 years of reliable and maintenance-free fruit set. The economics of tomato production changed considerably during that time and growers became dependent upon the benefits that were obtained from using biological pollination.

At the end of 2014, Natural England withdrew the licence to release non-native bumblebees in unscreened glasshouses although the native sub-species, *B. terrestris audax* (Bta) could still be used. The bumblebee producers acted quickly to step up production of Bta so that growers would still have the option of biological pollination. However, it was known that Bta was inferior to Btt/Btd for tomato crop pollination because it had been tested and rejected during the 1980s. So it was no surprise when it proved to be far from the reliable experience to which growers had become accustomed. One grower estimated that poor fruit set cost him £50,000 per hectare in 2015 and several others resorted to labour intensive manual pollination which had not been used since bumblebees were first introduced.

British tomato growers are not averse to using Bta if this can be done without significant financial loss. In 2017, AHDB funded the Tomato Growers' Association (TGA) to conduct an industry-wide survey to gather more information about the problem. Growers representing 98% of UK production participated and their clearest message was that Bta were less 'vigorous' than Btt/Btd and more likely to fail to provide adequate pollination if anything was sub-optimal. Small fruiting, high value cultivars, such as Piccolo, were most susceptible. The TGA organised this short project to further investigate the issues raised.

BTA COLONY DURATION IN TOMATO

Our first challenge was to see how Bta colony duration compared to Btt/Btd. We knew that each Btt/Btd colony began in the production unit with a single queen producing a batch of about eight eggs which she raised to become infertile workers. Thereafter she produced eggs while the workers took over brood maintenance tasks. The colony grew in size and was transferred to the tomato crop about 12 weeks from initiation with 50–60 workers present. Those workers foraged among the tomato plants and the colony continued to grow for a further 6–8 weeks. At that point, fertile males and females emerged and left the hive to mate with adults from other colonies, marking the end of the Btt/Btd cycle.

Twelve tomato growers participated in the 2018 study, providing a spread of locations as well as different bumblebee suppliers and types of tomatoes. The growers followed an agreed protocol to collectively monitor 161 hives with 777 individual colony assessments between mid-June and the end of September.

The Bta hives generally contained good active colonies upon delivery which were expected to continue to increase in size before completing their cycle. However, 62% went into decline within two weeks of being placed in a crop and this increased to 90% within four weeks. This rapid decline was in complete contrast to our expectations with no consistent differences between bumblebee supplier, location or tomato type. In fact, the only two common factors appeared to be 'Bta bumblebees' and 'tomato crops'; suggesting that Bta either do not like the growing environment or the plants do not provide adequate food.

> "British tomato growers are not averse to using Bta if this can be done without significant loss"

BTA BEHAVIOUR

This study was done at three sites: a crop of Piccolo at Warwick Crop Centre (WCC), a commercial tomato crop and an outside orchard. 'Bee traffic' was recorded by manually counting bees entering and exiting the hive from sunrise to sunset.

Activity followed a similar pattern regardless of hive location or temperature, with the first activity just after sunrise, rising to a peak between 11.00am and 2.00pm. Flights within one hour of sunset were rare. One notable feature was that activity in colonies in tomato crops was considerably lower than outdoors. This aspect of Bta behaviour requires further investigation.

One objective was to develop a method of remotely monitoring Bta activity for future use. This was done in collaboration with 'Arnia Hive Monitors' by adapting their honeybee remote monitoring system (RMS) to work with the much smaller bumblebee colonies. Prototypes of the modified RMS were tested at the sites used for manual bee counts. The RMS recorded changes in hive weight, brood temperature/humidity, outside temperature/rainfall, and acoustic data. The latter provided an indication of whether bees were foraging or performing other tasks such as 'fanning' to cool the brood. Data was continuously uploaded to the 'cloud' and accessed remotely in the researchers' offices. The RMS not only provided continual and more detailed information on activity than labour intensive manual counts but also provided information on the hive environment/health which will provide a valuable tool for future studies.

FLOWER DEVELOPMENT IN SMALL FRUITING TOMATO CULTIVARS

This study was done in a crop of Piccolo at WCC where plants were grown to commercial standards. A scale representing stages in the development of Piccolo flowers was devised and used to record development of flowers from dawn until dusk. Observations were confirmed using continuous time-lapse photography and validated in the commercial crop. Pollen flow was assessed on the same flowers

using established methods as well as a purpose built 'electric bee'. In addition, fruits were removed and their weight, diameter and number of seeds recorded.

Each flower opened on two successive days releasing most pollen on the first day between 12.30pm and 1.30pm. This was reasonably well matched to Bta flights although some flowers peaked much earlier or later. The anthers of each flower had the potential to produce many more pollen grains than required to fertilise all the ovules in the ovary, e.g. 20,000 pollen grains but fewer than 120 seeds. However, pollen was more difficult to extricate manually than from flowers of larger fruiting cultivars and we don't yet know how efficiently this is done by Bta.

Observations suggested that pollen production and release were inhibited by high temperatures which has previously been reported in published literature. High temperatures may have contributed to variability in pollen production by different flowers, which was more noticeable in August than September, and this may also have affected pollen viability. Further studies are required to investigate pollen release, pollen transfer to the stigma and successful germination of pollen grains.

Rob would like to acknowledge the important contributions made by Dave Chandler, Gill Prince and Ken Cockshull at WCC and thanks the numerous TGA grower members who participated in the project, with particular reference to Jan Bezemer & Sons, Yorkshire Organic Salads and R&L Holt.

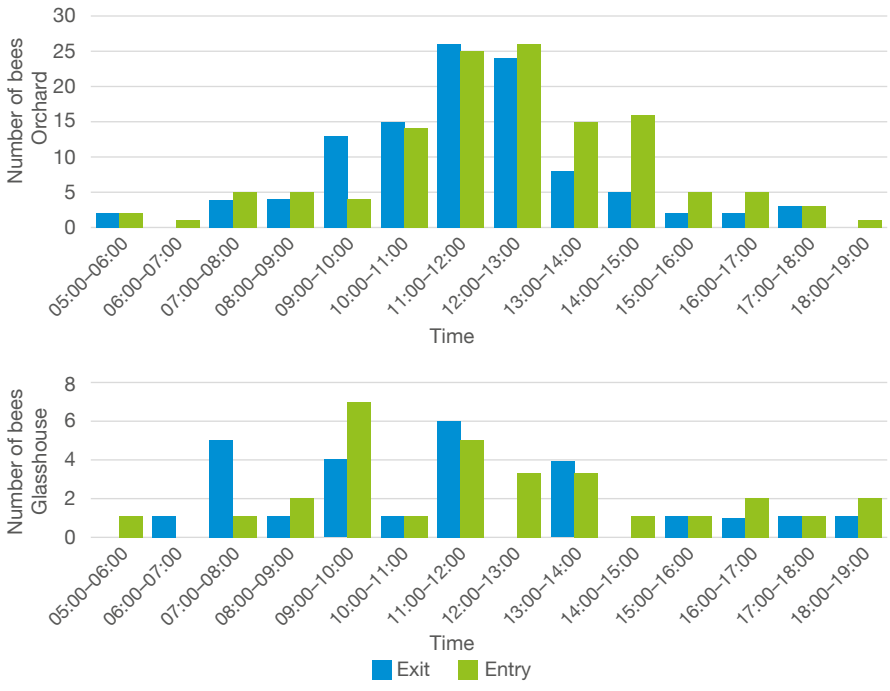


Figure 1. Number of bees entering and exiting hives on 14 August 2018

WHERE DO WE GO FROM HERE?

This project has improved the industry's understanding of pollination of small fruiting tomato cultivars by Bta and developed techniques to investigate the problem in greater depth. We have moved a step closer to achieving the industry's goal of reducing financial losses resulting from production deficit and increased input caused by the enforced change to Bta. In the short term, growers should:

- Liaise with their bumblebee supplier to produce a hive input programme that compensates for the shorter colony duration of Bta
- Monitor Bta foraging activity around midday, when most flowers have peak pollen flow, and supplement with manual pollination when there is little activity

AHDB project code: PE 031a

Project lead: Rob Jacobson, Rob Jacobson Consultancy

AHDB contact: Nathalie Key

EAMU LATEST

WHERE DID THEY GO?

AHDB Crop Protection Scientist Bolette Palle Neve explains the EU non-renewal process that causes loss of actives

Bolette Palle Neve,
Crop Protection Scientist, AHDB
bolette.palle-neve@ahdb.org.uk

A number of important active ingredients have been lost in the past 12 months and we have received many questions from growers who are keen to find out how this has happened.

Most of these has been lost through a decision in Europe to non-renew. Here is a simplified summary of how the process works which has been adapted from a summary done by Andy Richardson recently for the *BGA Newsletter*:

- The Active Substance (AS) manufacturer submits a data dossier to the Chemicals Regulation Division (CRD) equivalent in one of the 28 Member States (MS). This state is called the Rapporteur Member State (RMS). The RMS assesses the data package and produces the Renewal Assessment Report (RAR).
- The RAR is then sent to the Commission and copied to the European Food Standards Agency (EFSA) whose panel of experts may also be asked to evaluate the RAR and produce a recommendation for renewal/non-renewal. This is called the EFSA Conclusion.
- Based on the RAR and the EFSA Conclusion, the Commission then proposes renewal or non-renewal and the final decision is left to the Standing Committee on Plants, Animals, Food and Feed (SCoPAFF). SCoPAFF consists of representatives of the 28 MS and decisions are made on a qualified majority vote (QMV) basis.

EAMUS IN FOCUS

Nativo 75

"Following submission by AHDB via mutual recognition from a Belgium approval Nativo 75WG (tebuconazole plus trifloxystrobin) now has extensions of authorisation of use for celery, celeriac, leek, salad onion, swede and turnip.

"For celery and celeriac growers it brings an excellent level of control of celery late blight (*Septoria apiicola*). It was included as product AHDB9894 in AHDB's SCEPTREplus trial carried out this year by Aoife O'Driscoll at ADAS Boxworth, where it gave one of the best levels of disease control. Prior to this celery growers only had two fungicides, numbers of applications of which will be reduced for 2019, so it is a most timely addition.

"For leek growers it brings the welcome return of a product previously approved, but lost in the tebuconazole re-registration, with well-known good activity on leek rust. Again, numbers of applications of other existing leek fungicides will be reducing for 2019."

David Norman, Consultant Agronomist, Fresh Produce Consultancy Ltd.

To discover all of the latest EAMUs visit **horticulture.ahdb.org.uk/latest-eamus**

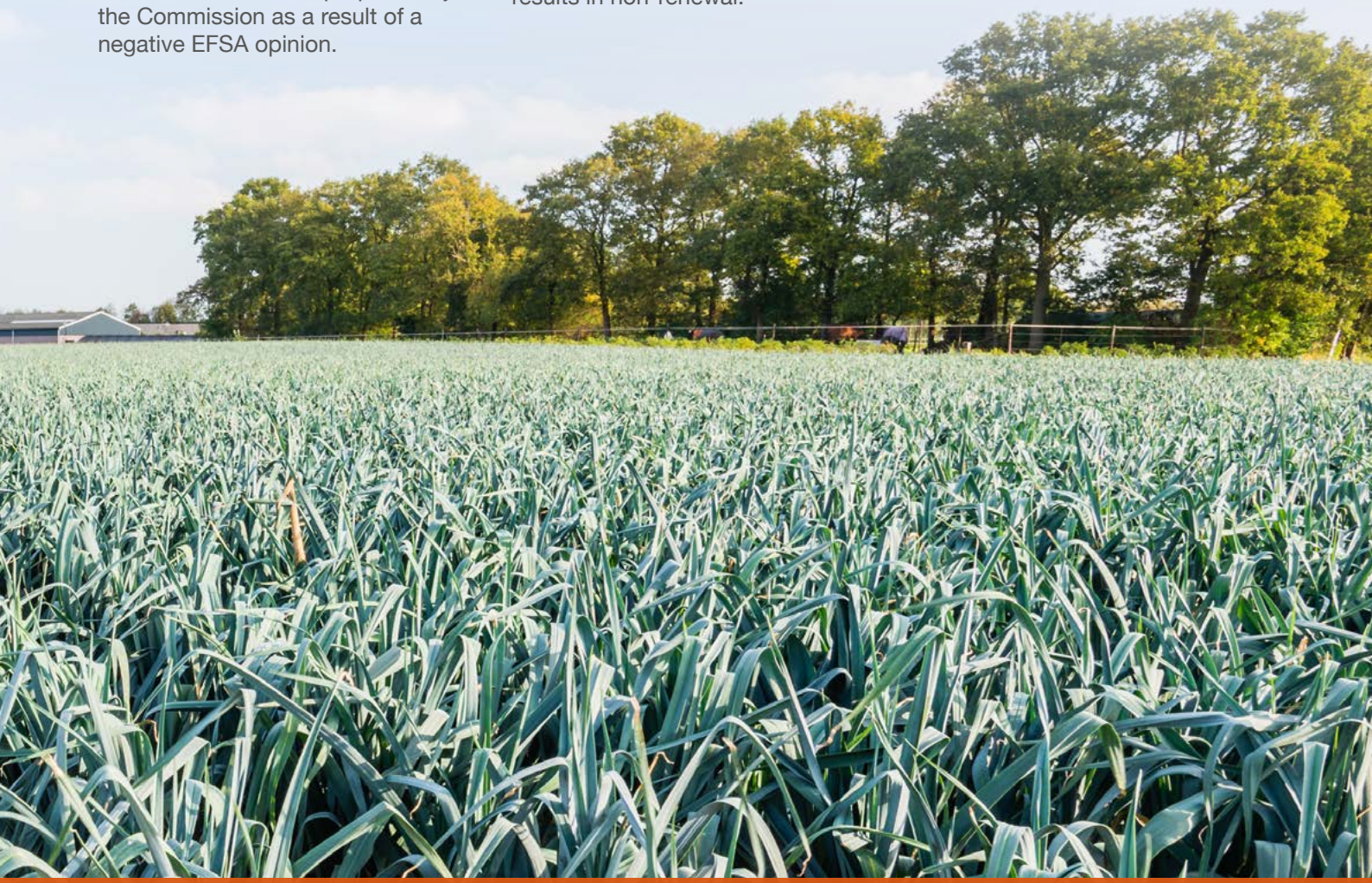
A qualified majority is only reached if the following two conditions are both met:

Fifty five percent of MS must vote in favour (i.e. 16 out of 28 MS). The proposal must be approved by countries representing at least 65% of the total EU population (this can be close – glyphosate got through with 65.7%). This means that the six countries in the EU with the largest populations can have a disproportionate effect on the vote (Germany, France, UK, Italy, Spain and Poland).

The issue that we have seen recently is that no qualified majority is reached in SCoPAFF meetings where non-renewal is proposed by the Commission as a result of a negative EFSA opinion.

This is due to the fact that a number of MS chose to abstain from voting – especially if the RMS had concluded that the active should be renewed. Unless a qualified majority is expected, then the vote is pushed from one meeting to the next. If SCoPAFF can't reach a decision, then the decision is passed upwards to the Appeals Committee. Membership on the Appeals Committee is similar to SCoPAFF and often this means that a qualified majority still can't be achieved. With no decision from the Appeals Committee, the decision goes to the Commission. The Commissions position is typically to go with the EFSA conclusion which inevitably results in non-renewal.

A number of important active ingredients will be going through this process in 2019 and we will make sure we keep growers updated through our monthly *Crop Protection Newsletter*. If you're not receiving this email and would like to, please contact **comms@ahdb.org.uk**



PREDICTING POTENTIAL **PEST PROBLEMS**

Entomologist Rosemary Collier explains what AHDB does each year to help you prepare for any pest problems that may come the UK's way

The very hot, dry summer of 2018 undoubtedly had an impact on pest lifecycles and has given us an inkling of what the longer-term impacts of climate change on some species might be. Through the AHDB *Pest Bulletin*, associated web pages and the weekly email to growers we have tried to raise growers' awareness of upcoming problems. There have also been discussions about some pests for which we do not have forecasting systems at present, such as bean seed fly and species which are not currently part of the AHDB ***Pest Bulletin***, such as swede midge.

Since the large invasion of migrant diamondback moths in 2016 we have been monitoring their activity and that of the silver Y moth by summarising information posted on websites in north-western Europe. This information has been available to growers and updated daily over the past two years.

It was the silver Y moth that caused the most serious problems in 2018, on lettuce in particular, and have been working this winter on obtaining information from growers and advisors to see whether we can improve warnings for 2019.

For diamondback moth the information from websites was supplemented by in-crop monitoring of commercial crops. This has given us further insights into the behaviour of this potentially very challenging pest. We've also learned more about its ability to survive winter weather conditions, in the south of the UK at least.

The hot, dry summer weather was also ideal for survival of cutworm caterpillars, as indicated by the cutworm forecast. There has been no feedback from growers to suggest this pest was a significant problem in 2018, perhaps because of the application of irrigation which helps to reduce their survival.

Apart from caterpillars, it is usually root-feeding fly larvae, aphids and whitefly that cause the greatest problems for field vegetables and salads. We know that the lifecycle of the carrot fly can be altered by hot weather and this year there was an

> "The hot, dry summer weather was ideal for the survival of cutworm caterpillars"

indication from sticky trap captures at Wellesbourne that this had affected the second generation in particular. Research by colleagues in Switzerland and France, where the weather can be even warmer, has shown that the second generation may 'disappear' in hot summers, to be followed by a significant third generation. At present this does not mean that we should alter the control strategy in the UK but we need to be aware that things may change. Cabbage root fly could potentially do the same.

Information on aphid activity is provided by several forecasts, and weekly bulletins from the Rothamsted Insect Survey are summarised in AHDB *Aphid News* and the *Pest Bulletin*. There is no evidence that aphid populations were particularly unusual in 2018. Examination of suction trap captures across the entire network shows that activity is usually earlier towards the south. Taking all locations into account, the peak week for flights of peach-potato aphid and cabbage aphid in 2018 was the week ending 8 July, while black bean aphid was later (22 July). There were autumn flights of the aphids that can overwinter on brassica crops, peach-potato aphid and cabbage aphid, which could mean further invasion and this appears to have been reflected in crops, for peach-potato aphid at least. Autumn flights of the aphids that overwinter on woody hosts were also detected in the suction traps (willow-carrot aphid, currant-lettuce aphid and black bean aphid). Of the aphids infesting carrot and parsnip crops the peak week for flights of willow-carrot aphid was the week ending 27 May, while the two species of parsnip aphid were later (week ending 22 July).

There is much more to learn about how to manage aphids and virus in carrot and this is the topic of a new AHDB project led by Adrian Fox at Fera. It is hoped that with improved understanding we will be able to provide better guidance on insecticide application timings, linked closely to progress with crop protection products within the SCEPTREplus project and to information from other sources such as field trials undertaken by agrochemical companies.

HOW CAN I STAY AHEAD OF PEST PROBLEMS?

The aim of the *Pest Bulletin* is to provide information that will assist growers in pest control application decisions. It is also increasingly important to record pest (and pathogen) problems to highlight where future activity within projects such as SCEPTREplus should be focused and also to provide real-time evidence of the scale of the problem so that AHDB are able to explore additional control options with CRD.

The AHDB *Pest Bulletin*, updated weekly, contains information on the activity of more than 20 pest species. Visit: **syngenta.co.uk/ahdb-pest-bulletin**

It is backed up by information on pest activity in the AHDB Pest Blog: **blogs.warwick.ac.uk/rosemarycollier**

Additional information is provided on diamondback moth and silver Y moth, with daily updates: **warwick.ac.uk/fac/sci/lifesci/wcc/research/pests**

> “The second generation of carrot fly may ‘disappear’ in hot summers, to be followed by a significant third generation”

THE NEXT STEP AGAINST **PESTS**

Sometimes finding out what we don't know, and where to look next, is the best way forward. AHDB's Joe Martin explains how both technical reviews and screening trials are contributing to the fight against pests

With an EAMU already secured for FliPPER as an insecticide for protected ornamental crops, SCEPTREplus has been working hard to deliver results on a range of key pests for growers. Targets include onion thrips, asparagus beetle, *Tuta absoluta* and two-spotted spider mite. Here we explore some of the results of trials for spotted wing drosophila (SWD), aphids and bean seed fly.

SPOTTED WING DROSOPHILA

With few effective SWD control products available, identifying products which can either deter SWD from laying eggs in developing fruits, or reduce egg hatch, would aid sustainable integrated pest management.

SCEPTREplus has tested seven chemical treatments on blackberry and blueberry to examine this.

Urtica gave statistically significant reductions (~50%) in numbers of emerging SWD adults on blueberry and is worthy of further investigation.

AHDB9931 gave the greatest reductions in numbers of SWD emerged, with calcium and AHDB9919 close behind, though the reductions (except in one case) were not statistically significant.

A further trial is being conducted using the promising treatments identified to validate the results.

APHIDS

Initial work has evaluated novel insecticides and bioinsecticides as foliar sprays for the control of willow-carrot aphid, currant-lettuce aphid, peach potato aphid and cabbage aphid.

Seven conventionals, 13 bioinsecticides, spirotetramat and pymetrozine standards were tested looking at efficacy and persistence using cabbage plants as the host.

Initial observations have shown all conventional products to be very efficacious, although they have different levels of persistence and a small proportion of bioinsecticides have shown to be efficacious.

This work continues and expands to include other aphid species relevant to a wide range of horticultural crops, including glasshouse potato aphid on pepper.

BEAN SEED FLY

The most effective treatment for bean seed fly in recent years has been seed treatments, but these have relied on a limited number of active ingredients. Recently we have lost chlorpyrifos for Phaseolus beans and thiamethoxam on peas, leaving growers in a vulnerable position.

SCEPTREplus has undertaken a review of current and potential control measures for bean seed fly in the UK and overseas and identified three areas for further investigation:

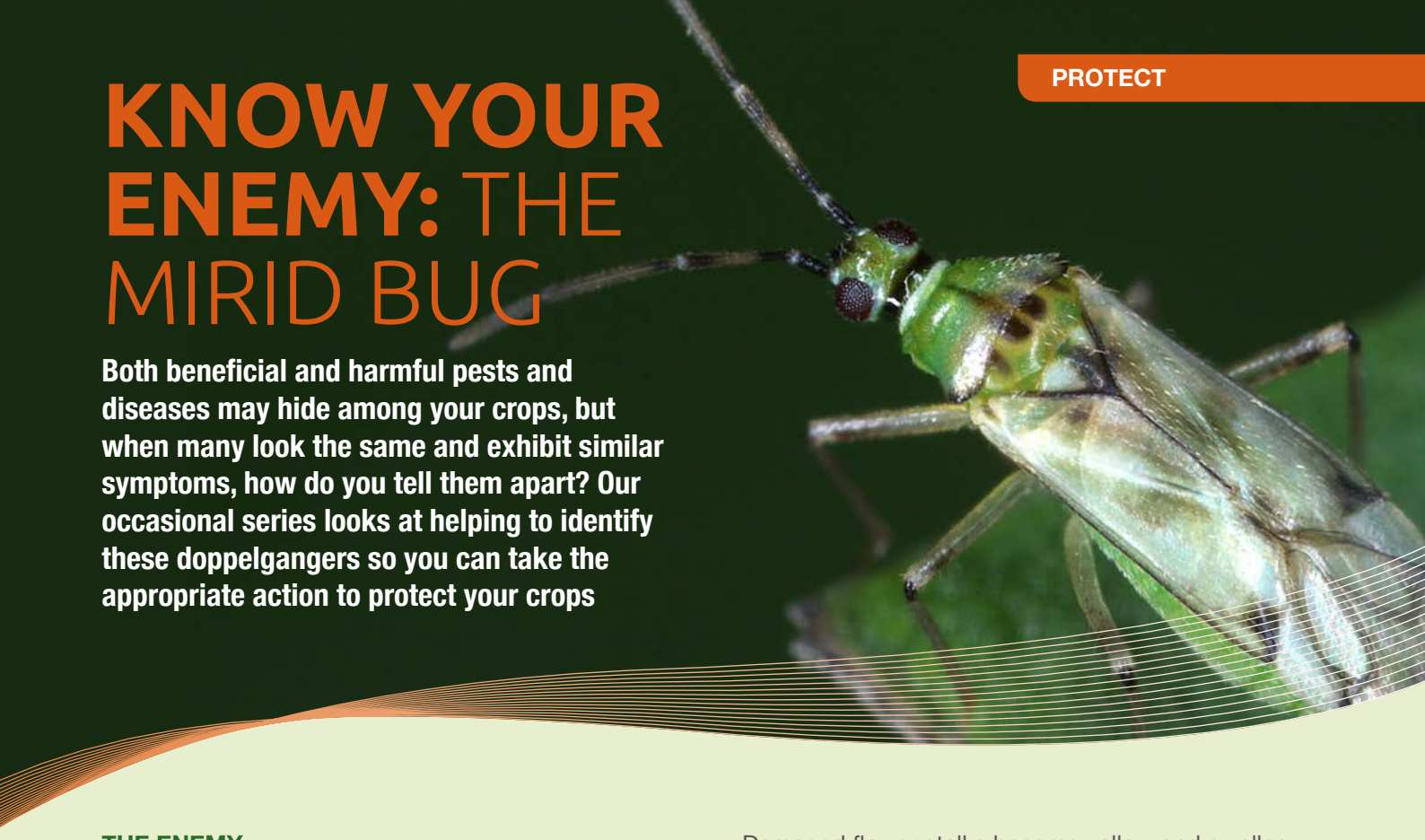
1. Exploration and evaluation of cultural control methods for specific crops grown in the UK.
2. Evaluation of the value of monitoring/forecasting information.
3. Trials to evaluate 'new' insecticide/bio-insecticide treatments (including nematodes) with a view to evaluating different methods of application.

Experimental work is planned this year.

Reports from completed SCEPTREplus trials and the full technical review for bean seed fly can be found at: **horticulture.ahdb.org.uk/SCEPTREplus**

SCEPTREPLUS

KNOW YOUR ENEMY: THE MIRID BUG



Both beneficial and harmful pests and diseases may hide among your crops, but when many look the same and exhibit similar symptoms, how do you tell them apart? Our occasional series looks at helping to identify these doppelgangers so you can take the appropriate action to protect your crops

THE ENEMY:

The mirid bug (*Nesidiocoris (Cyrtopeltis) tenuis*)

OFTEN CONFUSED WITH:

Macrolophus pygmaeus

WHO ARE THEY?

The mirid bug *(Nesidiocoris (Cyrtopeltis) tenuis)* is not a native to the UK but evidence shows that it has moved north and has already established itself in some greenhouses in Northern Europe. As a natural predator, it can make a useful contribution to integrated pest management systems (IPM) in tomato crops, feeding on pests such as whiteflies, spider mites, caterpillars and leafminers. However, in the absence of prey it can turn its attention to the tomato plants themselves and cause serious economic damage.

Typical damage by a mirid bug

Damaged flower stalks become yellow and swollen beyond the 'knuckling-off' point. This is followed by premature fruit drop, leading to incomplete trusses.

Macrolophus pygmaeus, on the other hand, is a similar mirid bug but is used for positive outcomes in IPM programmes in the UK and is generally considered as less harmful to plants than its relative.

HOW TO TELL THEM APART

Adult *Nesidiocoris* is approximately 5 mm in length, bright green, with bulging dark eyes. Yet, size and colour are not reliable markers for identification in either species as they are variable. However, *Nesidiocoris* exhibits a dark coloured band behind the eyes and black knees, two features which do not occur in *Macrolophus*.

Furthermore, some damage symptoms are only produced by *Nesidiocoris* and provide a good indication of which species is present. For example, brown rings that appear on stems and petioles following feeding are not produced by *Macrolophus*.

If in any doubt, growers should seek assistance from an entomologist with experience of working with both species.

For more information on the mirid bug (*Nesidiocoris (Cyrtopeltis) tenuis*) and how to identify it in your crop, download a *Nesidiocoris tenuis* biology and identification from our website: **ahdb.org.uk/knowledge-library**

MINIMISING CROP LOSSES TO **PHYTOPHTHORA**

Xiangming Xu, NIAB EMR, examines the causes of Phytophthora in initial planting material and options for its management available to growers

Adopting a clean propagation system is the first line of defence against strawberry crown rot and red-core diseases. This strategy had been working for many years, until recently. Currently, crown rot and red-core can cause significant damage in strawberry even in substrate production. The most likely cause is asymptomatic infection in planting material. Frequent application of fungicides, alleged to have occurred in overseas nurseries, may delay the onset of symptom development until post-transplanting. Subsequent disease spread is likely to occur because of over-irrigation or rain-splash. Recent research on *Phytophthora* in strawberry has concentrated on detecting the pathogens and seeking products to reduce root rotting (Photo 1). The next question is whether we could identify treatments that could minimise crop losses to *Phytophthora* in initial planting material. SF 157, a five-year project, is focussing on developing integrated methods to manage a range of strawberry diseases, including *Phytophthora* in initial planting material.

ARBUSCULAR MYCORRHIZAL FUNGI (AMF) AND PLANT GROWTH PROMOTING BACTERIA (PGPR) TREATMENTS ON *PHYTOPHTHORA CACTORUM*

We conducted several small-scale experiments at NIAB EMR to determine whether individual or combined use of AMF and PGPR could reduce *Phytophthora* development. Plants were initially potted into compost amended with AMF and/or PGPR and grown for three weeks before inoculation of wounded or intact crown tissues with *P. cactorum* spore suspension. *Phytophthora* symptoms were assessed over time before the final assessment of crown tissue discolouration and molecular detection of *P. cactorum* DNA in the crowns.

In all three experiments, AMF/PGPR treatments failed to achieve significant reduction in the development of *P. cactorum* in inoculated crowns. Wounding crown tissues led to a significant ($P < 0.05$) increase infection by *P. cactorum*; the likelihood of

detecting *P. cactorum* DNA is significantly ($P < 0.05$) greater in crowns with discolouration than in symptomless crowns, such that crown discolouration was used as an indicator of *P. cactorum* infection in subsequent experiments.

DIPPING AND DRENCHING TREATMENT ON *P. CACTORUM*

Given the difficulties with *P. cactorum* management trials due to the variable level (often low) of infection even in artificial inoculation studies, we did a large study in 2017-18 to investigate whether dipping at planting as well as post-planting drenching could significantly reduce *P. cactorum* development and subsequent crop losses. Nearly 3000 'Malling Centenary' tray plants were inoculated with *P. cactorum* in late autumn 2017 and moved to a cold store four weeks later. Five products were included: two new products (one synthetic chemical - F250, the other biological – F251), one standard fungicide Fenonemal (fenamidone + fosetyl-aluminium), and two biologicals (Prestop - *Gliocladium catenulatum* strain J1446, and F252). Each product was applied as a dip only and as a dip and post-planting drench. There were also two control treatments: negative (un-inoculated plants) and positive (inoculated plants) control. Dipping was applied immediately prior to planting in late May 2018 and drenching was applied two weeks after planting. Visual disease symptoms were assessed; after the final pick, crown tissues were assessed for discolouration and sampled for molecular detection of *P. cactorum* DNA.

Inoculated plants had a greater incidence of *P. cactorum*-like wilting symptoms (ca. 25%), compared to the un-inoculated control (ca. 12%). Overall, additional drenching did not lead to further significant ($P > 0.05$) reductions in either wilting or dead plants. One experimental microbial product (F251) treatments led to increased disease development (ca. 35%), compared to all other products and both inoculated and un-inoculated controls. All other products significantly reduced the incidence of plants with visual symptoms. Similar results were obtained for plants with crown tissue browning except that the inoculated control had the highest level of crown tissue browning (ca. 80%). All products except F251 led to significant ($P < 0.05$) increases in fruit yield over the inoculated control; the highest yield was from the Fenomenal dipping treatment, increasing the yield by ca. 25% over the inoculated control. Fenomenal was included as the industry standard fungicide at the time of the experiment. The Chemicals Regulation Directorate (CRD) has now published withdrawal dates for all products containing fenamidone (sale and distribution of existing stocks by 14 February 2019; disposal, storage and use of existing stocks by 14 November 2019). None of the products resulted in significant increases in yield over the un-inoculated control.

CONCLUSIONS

The survey results indicated that the level of *P. cactorum* in runners varied greatly between consignments, and could be as high as 37%, detected mostly in asymptomatic crowns. The level of *P. cactorum* is not associated with those particular cultivars we sampled.

Pre-inoculation of plants with AMF and/or PGPR did not reduce infection of strawberry crowns by *P. cactorum*. Pre-planting dipping with fungicides and some biological products can significantly reduce the number of plants with visual *P. cactorum* symptoms and reduce crop losses. Additional drenching treatment did not result in significant reductions in disease development and yield losses over the dipping only treatments.

Healthy

Floppy

Dead

AHDB project code: SF 157

Project lead: Xiangming Xu, NIAB EMR

AHDB contact: Scott Raffle

MORE THAN JUST HOT AIR

Correctly circulating air in a glasshouse can be tricky as you can't see currents and airflow. So, GrowSave's Ed Hardy reveals the tips and tricks you can use to optimise air movement in your glasshouse

> "Even if the glasshouse climate feels comfortable to you, it doesn't mean it is ideal for the crop"

Optimising the climate for crop health should be a key objective of any grower, but achieving the optimum conditions is easier said than done. It's worth remembering that plants don't respond to temperature and humidity in the same way that people do, so it's important not to use humans as measuring devices. Even if the glasshouse climate feels comfortable to you, it doesn't mean it is ideal for the crop. For a start, the crop could be at ground level, on a bench at waist height, or stretching upward several metres. The climate within the crop can be quite different from what we initially perceive, with temperature and humidity levels potentially less than ideal, or even harmful to crop health.

Using data from just one or two measuring boxes to steer the whole glasshouse climate is fairly normal practice, but it can mean that temperature gradients or large variations in humidity go undetected. A thermal imaging camera can help to visualise the issue, with experiments seeing leaf or flower temperatures over 10°C above the air temperature. Similarly, the crop could be radiating heat, causing leaf temperature to be significantly lower than the surrounding air, putting the crop at risk of disease. The good news is that these issues are relatively easy to solve.

An effective air movement system can help to achieve a homogeneous climate, i.e. the same everywhere. Many UK growers already have systems in place, such as horizontal fans suspended conventionally from the greenhouse structure, under hanging gutters with air ducts attached or a vertical fan setup. The real value though is in knowing which is the most effective and how best to use it.

Demonstrations at a recent GrowSave event gave a useful insight into how air moves inside a typical glasshouse. Without any fans running and with vents closed, there is little to generate movement, hence air remains static. As a result, leaf temperature can rise well above ambient temperature, as the plant tries to disperse energy to prevent overheating and subsequent damage. Visibility of the problem can be difficult without sensors in the right places, but action can be taken nonetheless. Running fans to stimulate air movement under a closed screen can bring the situation under control, although some systems will be more effective than others.

A horizontal fan setup pushing/pulling air around the glasshouse can be good for taller crops, but has less impact at ground level. In such cases, a vertical fan can be better. There has been considerable advancement in fan technology in recent years, with numerous horticulture-specific manufacturers entering the market. A well-designed vertical system will draw air from a wide area and disperse it downwards in a conical shape, ensuring penetration of the canopy and helping to create a homogeneous climate.

Air movement is also important to maintain target humidity levels. As the crop transpires, there can be a build-up of moisture in proximity to the plant. Ensuring sufficient movement of the air is important, therefore, to mix this moisture with the drier glasshouse air, thus reducing disease risk. Many modern screens allow moisture to move through the screen material. By using small amounts of vent on both sides of the ridge, excess moisture can be removed from the air below a closed screen without resorting to pipe heat or screen gapping, thereby saving energy.

Ultimately, the aim is to ensure the climate conditions around the crop are conducive to maintaining a healthy environment. Where there is any doubt about the effectiveness of existing fans, a simple smoke test can be carried out.

Recent GrowSave events have demonstrated to growers how to best circulate air in a glasshouse. If you want to know more, visit GrowSave's website: **growsave.co.uk/past-events/the-best-way-to-circulate-air-in-a-glasshouse**

grow save
helping horticulture save energy

IN **HOT WATER**

Rob Lillywhite, University of Warwick, provides insight into the work on controlling pathogens in hot water treatment of Narcissus bulbs

Biocides have always been used to control pathogens in the hot water treatment (HWT) of Narcissus bulbs, but the loss of formaldehyde and the lack of confidence in some of the alternatives, means that growers are always looking for new approaches and products.

AHDB project BOF 077 has been investigating biocidal approaches to control pathogens in HWT of bulbs and has recently examined UV light, filtration, chlorine dioxide, hydrogen peroxide and dodecyl dimethyl ammonium chloride (DDAC).

Hot water treatment, where bulbs are dipped in water at 44.4°C for three hours, can be a dirty business as soil particles and fragments of bulb scale quickly contaminate the dipping water. This dirty water subsequently reduces the efficacy of all chemical treatments and it's well known that UV sterilization, in particular, requires good water clarity to be effective. Filtration of tank water to remove these contaminants was investigated on-farm in 2017 (top right) but the very small size of the contaminants, between 0.4 and 20 µm, blocked the filters and subsequently reduced the flow of water through the tanks. A commercial scale UV unit was trialled at the same time. While the filtration issues restricted testing, one batch of bulbs was treated and subsequently replanted.

Inspection of the crop in March 2018 revealed no obvious negative impacts of the UV treatment between treated and untreated plants and the crop will be examined again in spring 2019 to confirm this result. The cost and installation of the filtration system and UV light were £3,057 plus VAT and £2,450 plus VAT, respectively. To improve the efficiency of filtration, it seems likely that far higher levels of capital expenditure would be required to improve water clarity to a usable level. However, reducing dirt and contaminants from being introduced into the dipping

tank can be achieved through bulb cleaning prior to dipping and it is recommended that growers focus on this at the moment.

Chlorine dioxide is used as a sterilant in many industries, including other horticultural sectors, and it is known that it has been used as a biocide in HWT in the United States. Its use in the UK has been examined in the past but never recommended as alternatives at the time were either more effective or cheaper. In addition, commercial testing in the past has been unsuccessful due to the difficulty of achieving optimum flow rates under the difficult conditions imposed by HWT, principally tank bioload. However, recent laboratory testing re-confirmed its efficacy so commercial use was re-examined during August 2018 using an automated dosing system supplied by the Scotmas Group.

> “Growers should ensure that their bulb stocks are as clean as possible prior to dipping”

This introduced chlorine dioxide into the treatment tank at a rate which varied according to a target residual concentration, i.e. molecules of chlorine dioxide left over once all target pathogen spores have been destroyed. At the start of the testing phase, residual levels of 0.4 ppm were being reported, which were too low, but revisions to equipment and settings increased that to 1.4 ppm which was considered to be a successful outcome. At this residual level, water samples contained under 100 colony-forming units (cfu), where a cfu is a measure of viable bacterial or fungal cells, compared to between 10,000 and 1m in untreated water.

The treated bulbs have been replanted and will be examined in spring 2019 and 2020 for any treatment positive or negative effects. The chlorine dioxide dosing system is available from Scotmas for under £10,000 and has running costs of approximately £16/hour.

The ability to keep water clean has two benefits, firstly to increase the efficacy of any chemical use, be it biocide or fungicide, and secondly to allow the use of a technological approach like UV. Unfortunately, our attempts to clean water through filtration were unsuccessful due to the very fine nature of the bioload, and while solutions do exist, they are expensive and unlikely to be of interest to growers unless they are an integral part of a new HWT system. The only recommendation at this time is that growers should ensure that their bulb stocks are as clean as possible prior to dipping and that any contaminants, especially soil clods, are removed before bulbs are dipped. Using chlorine dioxide as an alternative to iodine based biocides does show promise and crops will be assessed over the next 18 months to ensure that no physiological issues are present.

Rob Lillywhite explains more about the project in our video. View at **bit.ly/HWTnarcissus**

AHDB project code: BOF 077

Project lead: Rob Lillywhite, University of Warwick

AHDB contact: Cathryn Lambourne

A SMARTER FUTURE FOR HORTICULTURE

SmartHort 2019 is a conference dedicated to connecting horticulture with cutting-edge robotics and automation. Grace Emeny, Knowledge Exchange Manager at AHDB, explains why it's an event you definitely don't want to miss

During the time that I've been involved in the world of horticultural automation and robotics, one thing has become particularly clear: the level of fragmentation of the industry. The need for better links between growers, researchers, funders and technology specialists is something that I'm hearing more and more frequently from nearly all of the conversations I'm having with growers. That is one of the main drivers behind our upcoming SmartHort Conference: to try and break down some of these barriers, encourage discussion and facilitate links between all interested parties.

From innovations aiming to tackle the issue of labour shortages, through developing harvesting robots, to advances in vertical farming that could play an increased role in our intelligent production systems of the future, SmartHort 2019 will offer insights into a wide variety of the latest international developments aiming to revolutionise the way we grow.

WHAT CAN YOU EXPECT TO SEE?

Day one will focus on the opportunities for new technologies in light of the current labour challenges. It's widely accepted that robotics aren't a quick fix and can't be seen as a short term direct replacement for lots of jobs with a large labour requirement, but what is the realistic scope for these new innovations and what role can we expect them to play?

A range of world leading experts from the UK and across the world will be presenting on their latest work and their opinions on what needs to happen for these technologies to be implemented successfully.

On day two, we'll be hearing all about the wide range of developments underway to revolutionise horticultural production systems. From disease detection using visual imaging, high performance irrigation systems, advances in sensors and data collection to using technology to monitor crop quality, experts will tell you all you need to know about the latest tech and what you can expect to be seeing in the future. Do you want to find out more about how you can invest in some of these technologies and get involved in related projects? Take part in the afternoon drop in sessions for discussions with funding experts from different areas of the industry.

WHY SHOULD YOU ATTEND?

Are you interested in finding out more about new horticultural technologies, making new contacts who could help you to develop your own production systems and find out more about funding and research opportunities? If the answer to any of these is yes, SmartHort 2019 is for you.

> "SmartHort 2019 will offer insights into the latest developments aiming to revolutionise the way we grow"

SMARTHORT 2019

It is important that SmartHort delivers the most useful outputs for the UK horticultural industry. Do you have ideas for study tours, topic suggestions for webinars or advice on our labour efficiency programme? It would be brilliant to have as much input into this work as possible, please contact me with any of the ideas above, or anything else that you would like to see this campaign address. **gracie.emeny@ahdb.org.uk**

The conference is now fully booked, but will be live streamed. Go to **ahdb.org.uk/smarthort** to register to view.

THE NEED FOR CHANGE

Josse De Baerdemaeker, University of Leuven, discusses the challenges and opportunities for automation and robotics in horticulture ahead of his talk at the SmartHort Conference

Cultivation technology, automation, robotics and sensor-based decision-making tools are all undergoing rapid developments and it is clear they will all have an effect on the entire horticultural supply chain. Labour shortages, perceived unfavorable working conditions, environmental and sustainability concerns over the use of chemical products are all driving the need for improved and novel production technologies. However, these innovations will have a better chance of successful implementation when we also take the biology of the crop into account.

To be effective, we need to be willing to make changes to well-established growing practices, such as crop architecture and fruit distribution, to make the implementation of new technologies as efficient as possible. Creative use of technology that is already being used or is in development in other large industrial sectors, will also help to make this transition to new technologies more affordable in horticulture.

The rate of development in horticultural innovation is in part being driven by new entrants to the industry, alongside the wide variety of start-up companies that are from outside the traditional agricultural or horticultural field. However, to ensure the most successful implementation, progress will rely on co-engineering developments where crop breeders, growers, agronomists and engineers work together to define the role and scope of technologies in the future.

THE **£1 MILLION** PAYOFF

Ross Mitchell, Castleton Farm, reveals how his decision to invest in cutting-edge fruit sorting technology is helping his business to grow

It is no secret that labour availability has become an increasingly pressing issue for growers across the UK. In order to address the issue somewhat, one Scottish fruit grower has invested over a million pounds in fruit sorting technology to reduce his reliance on labour.

Ross Mitchell, whose family has run Castleton Farm in Aberdeenshire since 1992, took the decision to invest due to his growing concern about the availability of labour, which he identified as an issue even before the EU referendum in 2016.

"Every year we need to recruit 900 temporary staff members to get through the season, mainly pickers but also in the packing house, and year on year it has been harder to get staff in to do the job.

"Brexit hasn't caused this issue, although the devaluation of the pound has made it less attractive to come here. The industry needs to change, to become less reliant on such a large labour pool, because there just aren't enough people able to do the work."

With that in mind, Ross decided to look into alternative technologies which could allow his business to expand their blueberry production without needing to increase their staff numbers.

"We currently farm 321 acres of soft fruit, including raspberries, strawberries, blueberries and cherries, but it's the blueberries that we are expanding," Ross explains. "Not even 20% of UK-consumed blueberries are grown here and the market is growing at 10% a year, so it makes sense to increase our acreage in that area."

Ross has invested in a large-scale optical grader and sorter, one of just three currently working in the UK, which can sort blueberries and cherries into a range of grades through taking over 40 pictures of each individual fruit in just one second.

While Ross still requires staff to pick the fruit by hand they are now at least 30% faster as they no longer have to grade the fruit while in the field. Instead the machine, which can assess two tonnes of fruit every hour,

> “Staff are now at least 30% faster as they no longer have to grade the fruit in the field”

filters the specimens into different specifications through judging size, softness, colour and internal and external scarring.

“We still need around 500 staff harvesting in the fields at any one time,” Ross says, “but with our expanding acres we would have needed 50 extra this year, so we have made a definite saving in staff costs. It’s been a really worthwhile investment, and I think we will see more of these in the UK over time as the price decreases.”

Looking ahead Ross hopes the seasonal workers scheme pilot will be successful as he sees that as the best way forward for the industry in the short-term.

“It will be controlled migration rather than immigration so it should be a win-win for the industry and the workers involved.”

While access to labour is still the priority for Castleton Farm in the short-term, in the longer term Ross believes new technology and automation will drive the industry forward – but that they can’t expect all the change to come from elsewhere.

“We will need to change to adapt to the new technology which is coming in 15 or 20 years,” Ross says. “There is an amazing amount of interesting research going on into automated harvesting and picking, but we might need to adapt our growing systems to fit in with the technology, rather than vice versa.

“AHDB has a key role to play in that future, in testing our new technology, identifying what works, and getting that information out to growers.”

COULD DATA SENSORS HELP TO INCREASE YOUR LABOUR PRODUCTIVITY?

Antony Yousefian, UK Director, 30MhZ, talks about the potential benefits of data driven production ahead of his talk at the SmartHort Conference

Many horticultural businesses are beginning to see the gathering and analysis of data as a critical and core part of their crop production systems. From information on microclimate, moisture levels to disease monitoring, this data is helping growers to make better decisions on crop protection, nutrition and irrigation.

Perhaps less-widely recognised is the ability for data gathering via crop sensors to help increase labour productivity.

We have a growing customer base of soft fruit growers who are using sensors to monitor microclimates and moisture levels in their polytunnels 24 hours a day, seven days a week. This job has traditionally been done by people, walking extensive growing areas to manually take readings. By using real-time wireless sensors, this valuable labour resource can then be used in more productive areas, ‘more heads up and less heads down,’ as growers often say to us.

Working closely with the industry we’re continuously discovering new applications of sensory data and we believe it will play an increasing role in sustainable integrated pest management strategies.

Better knowledge of the environmental factors, such as soil temperature or humidity, coupled with an understanding of pest or disease pressures, could help growers to make better decisions about which biocontrols or biopesticides to apply and when.

By collating data, growers can produce evidence for the different factors which may affect plant stresses or identify when pest and disease outbreaks might occur, helping inform future crop management strategies.

Horticultural consultant Chris Need, who used wireless sensors at Newey Roundstone nurseries to monitor for pansy mottle syndrome, said, “We now have evidence to back our approach: we know we need to focus on what we need to control stress.”

IT'S A **BUG-EAT-BUG** WORLD

Research student Kristina Grenz, University of Reading, tackles potential aphid control by evolving a promising bacterial aphid biocontrol

It's no secret that aphids cause a major headache for growers. When infestations strike, they are capable of causing serious damage to crops through feeding and spreading a variety of plant diseases and, once established in a system, their rapid reproductive cycle can make them particularly hard to control. Chemical insecticides are commonly employed against aphids but indiscriminate use of some chemicals has led to resistance building up in some species, as well as harming other, non-target insects. As a result, growers face increasing pressure from consumers and supermarkets to find alternative, environmentally friendly, non-chemical means of control.

Although many biological controls exist to tackle aphids in integrated pest management systems (IPM), parasitic wasps, *Orius* bugs and ladybirds to name a few, increasingly work is being carried out to develop microbial pesticides. Harnessing the power of microbes, such as bacteria and fungi to tackle plant pests is a rapidly expanding field with numerous success stories. Often safer for humans and non-target organisms, they have less of an environmental impact and pose little or no threat to biodiversity as they are naturally present in the ecosystem. There is also the potential for bacteria-based treatments to become self-sufficient in the crop, offering protection against target pests without the need to be applied regularly. They may also be a solution to the issue of treatment resistance in pests. As bacteria have a rapid reproduction time, they are quick to evolve and so may be able to emerge alongside the pest species, such as aphids, and prevent them developing tolerance to treatment.

THE SEARCH FOR THE HOLY GRAIL

Previous AHDB-funded research conducted by Dr Amanda Hamilton investigated whether bacteria naturally occurring on plants possessed aphid-killing properties. She was successful in finding several species lethal to aphids

and the most effective was found on the roots of a cabbage plant, *Pseudomonas poae* PpR24 (*P. poae*). After vigorous testing carried out by Amanda and Dr Deepa Paliwal, *P. poae* appeared to be the Holy Grail of microbial aphid control. In the lab, *P. poae* kills 70% of aphids in 48 hours, possibly due to two toxin genes found in its genome, and it was also found to deter aphids from a plant when applied. Effective when used via soil drenching, injection into the leaves and as a foliar spray at no detriment to the plant, one application of the bacteria can last up to 21 days. Furthermore, *P. poae* also appeared to have a high specificity to aphids, being effective against seven different species but non-harmful to other insects with which may come into contact such as ground beetles, lepidopterans and bee larvae.

MOVING FORWARDS

Our ongoing research is the next chapter in investigating *Pseudomonas poae* as a potential biological control. Using sweet peppers and the peach-potato aphid, *Myzus persicae*, as our model system, the first part of this project has focused on developing traits that would improve the bacteria's efficacy as a biological control. We sought to improve *P. poae'*s ability to kill aphids, its survival on the plant and whether it could form biofilms.

Biofilms are formed when bacteria work together for their mutual benefit, such as sharing resources and protecting each other from other microbes and hostile environments. Such a trait could be beneficial to a bacterial biocontrol as it may improve its survival on the crop, thus providing more protection for longer, reducing the number of required applications. Furthermore, the ability to form biofilms may make it more lethal to aphids as it may be capable of forming biofilms inside the aphid, preventing it from feeding further.

We employed experimental evolution to attempt to improve our desired traits. Experimental evolution is where an organism is repeatedly exposed (known as passages) to external pressures (in this case the aphid) and over time adaptations evolve by random mutation. Bacteria lend themselves particularly well to this due to their rapid lifecycles, allowing mutations to emerge and spread through a population relatively quickly.

In an attempt to improve aphid virulence, 10 aphid sachet passages were set up. These involved aphids being placed in a Perspex cylinder with a sachet of aphid diet to feed on, treated with *P. poae*. The aphids were left to feed on the sachet for 48 hours and the number of dead aphids recorded. The bacteria were then recovered from the aphids and a new sachet inoculated with them, and the experiment repeated for ten passages. This resulted in 10 evolved isolates of our original *P. poae*, three of which proved to be more virulent to aphids than the original bacteria.

Evolving biofilm-formers followed a similar process. *P. poae* was passaged 10 times through a series of broths, each left to grow for a week. Biofilms formed at the surface of these microcosms and the strength and ability to attach to surfaces was tested. *Pseudomonas poae* proved most proficient at forming these structures and by the end of the ten passages one isolate was able to form a significantly strong biofilm.

WORTHWHILE TRADE-OFFS?

However, although they say the best things in life are free, that is often not the case in evolution. One trait often excels at the cost of another and after investigating these 'trade-offs', it became apparent that the ability to form biofilms came at the cost of killing aphids. Likewise, prolific aphid killers were far less effective at forming biofilms. Whether this means they are less effective at surviving on the plant surface remains to be seen. Other traits, such as bacterial growth rate and motility, have also been investigated.

> "There is the potential for bacteria-based treatments to become self-sufficient in the crop"

Research is ongoing to discover whether the volatiles emitted by our evolved isolates have also changed. This may affect *P. poae*'s sought-after ability to deter aphids from a crop. Furthermore, many natural enemies of aphids, such as parasitic wasps, rely on their ability to 'sniff out' the volatiles produced by plants when they are being fed on. Changes in *P. poae'*s volatile make-up may prevent the detection of these 'search-and-destroy' odours.

So far, our research has succeeded in evolving significantly different isolates of our wild-type *P. poae*. To maximise effectiveness, it is likely *P. poae* would have to work alongside other aphid biocontrol agents in an IPM system. We plan to investigate the behavioural and physical impacts of the bacteria on aphids and their natural enemies. Although, thus far, it has proven specific to aphids, it is essential to investigate whether *P. poae* is detrimental to insects already useful in controlling aphids.

AHDB project code: CP 120

Project lead: Robert Jackson, University of Reading

AHDB contact: Wayne Brough

NEW LETTUCE ROBOT HOLDS A-PEEL

Fumiya Iida explains how a group of researchers at Cambridge University have developed a world-leading robotic lettuce leaf peeling system

"Due to the increasing need for food and declining availability of manual labour, the need for automated robotic solutions for our industry has never been greater," said PhD student Luca Scimeca. "Our robust lettuce and stem detection software enables a robot to work in cluttered, field-like conditions with variable light levels and can handle wide variations in produce size, shape and orientation."

Developed at Cambridge University's Biologically Inspired Robotics Laboratory (BIRL), the handling system that Luca is working to develop is capable of peeling a lettuce in an average time of 27 seconds.

Removing the outer leaves of lettuces and other crops after harvesting is currently performed by farm workers – it's tediously easy for humans, but a hugely challenging vision and manipulation task for robots, which up to now has been a step too far. The Cambridge research team, led by Dr Fumiya Iida, lecturer in mechatronics, has taken a step toward commercial reality through designing and creating a 3D-printed nozzle which is mounted on a robotic arm and uses a vacuum to grab a leaf and tear it from the lettuce without causing damage to the saleable product.

Essential to tearing leaves accurately is a computer vision system which first detects the lettuce and then looks for the stem using a 2D web camera placed directly above the search area. If the stem isn't immediately visible, the robot arm will gently roll the lettuce over until it can be found, and when the lettuce is in the right position it can be peeled.

> The computer vision we have developed can be applied to many other crops, such as cauliflower

The head and stem detection algorithm was tested using 180 webcam images of individual lettuces taken in different positions and degrees of cluttering, varying both light direction and intensity with the webcam at heights between 70–100 cm. A further 30 frames were taken after storing the produce for three days, which resulted in stem colour changes. The algorithm was able to achieve 100% accuracy in locating the centre of the lettuce and 81% stem detection accuracy, enabling the research team to identify the optimum lettuce leaf removal point.

BIRL research team member Luca Scimeca, who is working on the vision system said the robot also has potential elsewhere.

"Lettuce leaf peeling is an interesting robotics problem from an engineering perspective because the leaves are soft, they tear easily and the shape of the lettuce is quite variable," he said. "The computer vision we have developed, which lies at the heart of our lettuce peeling robot, can be applied to many other crops, such as cauliflower, where similar information would be required for the post-processing of the produce.

"However, further work is needed to combine the three stages – detecting, positioning and then peeling the lettuce into one single end-to-end solution. We propose using a two-armed robot, which can combine the positioning and peeling stages."

Luca will be talking at the SmartHort 2019 conference. Live stream from **ahdb.org.uk/smarthort**

AHDB project code: CP 172

Project lead: Fumiya Iida, University of Cambridge

AHDB contact: Jim Dimmock

ARE YOU READY FOR **BREXIT**?

With no real answers from the Government and little time to go, Graham Richardson, Group Managing Director at Johnsons of Whixley Ltd., reveals what contingencies they are making and how they predict the UK horticultural landscape will change

Horticulture is an ancient trade. The UK landscape and gardens nationally have been adorned with shrubs, trees and plants from both national and European sources for thousands of years.

In the last 40 years, free trade has further embellished supply allowing the constraints of the UK's often unforgiving climate to capitalise on the colour, texture and form of thousands of plant variants from rich production centres in Holland, Belgium, Italy and the Mediterranean.

> "The prospect of trade tariffs could significantly limit the buying options of the public"

The prospect of trade tariffs could undo this natural enrichment overnight and significantly limit the buying options of the public.

In isolation, and irrespective of climate change, the UK landscape/ garden industry has neither the consistency of climate or sufficiently evolved production centres to provide a viable alternative. And, following a lead time governed by nature (production being speculative at best), a massive increase in home production inevitably means unacceptable exposure to waste.

In the last 10 years our industry has gone through a quiet staffing metamorphosis. Traditionally, our workers lived locally, aspirations were typically 'secure employment in the locality' and these workers have gone on to become our senior and middle managers via a combination of graft, commitment and expertise underpinned by schemes such as the modern apprenticeship scheme in the late 1970s and '80s.

Over the last few years however, rural house prices have soared and the vast majority of our nursery workers at Johnsons of Whixley now have to travel to get to work. Our produce is acutely price-sensitive and is usually the subject of a competitive tendering, a process which is 'infamous' for suppressing price increases.

Survival has insisted on cost savings and this has included a forensic knowledge of every area of expenditure and a radical overhaul of our staff profile. Our once 150-strong full-time payroll has now reduced to 100 (this has happened organically with very few

> "We are not planning for a staffing 'Doomsday', witnessing a mass exodus of our European brothers"

Name:
Graham Richardson

Company:
Johnsons of Whixley Ltd.

Job title:
Group Managing Director

redundancies). We now supplement the balance with seasonal workers who can react to seasonal and climatic peaks and troughs and who are prepared to put in a full day of manual work for a living wage paycheque. These staff are European migrants in the main and have a significant capacity to work. They do not appear as sensitive to transient careers dominated by choice and a 'change is as good as a rest' mindset.

Take Marcin and Krzysztof for example; they have both lived in the UK for over 15 years and have worked at Johnsons for 10 years. Through hard work, endeavour and a willingness to learn they are now both Junior Managers running production centres of excellence and both manage growing teams of both UK and European nationals. They no longer see Poland as their immediate home – they are settled, motivated and proud to contribute and benefit from a vibrant UK economy.

Frankly, we are not planning for a staffing 'Doomsday', witnessing a mass exodus of our European brothers as a result of Brexit and the introduction of a 'fortress mentality'. No reasonable policy could conclude that our country would be better off without these stalwarts of getting the job done.

Our own current experience is one of shaken confidence – business and the markets don't react well to uncertainty. We witnessed the immediate impact of a devalued '£' that suddenly bought us 17% less European stock, for the same money, and massively reduced the extent of the 'send home savings' for our European employee colleagues.

Common sense and middle ground are what we seek. All businesses have grumbled about the significant impact of unwieldy European legislation and the UK's usual forensic interpretation that results in our 'total' uptake of a new law, or standard, where our European cousins interpret it differently and avoid constraints or impact felt at source.

However, all business and individuals have benefitted from a lack of constraint and tariff free trade with immediate access to the world's biggest, most diverse and highly-evolved trading floor called 'Europe'.

I refuse to consider the impact of a so called 'Hard Brexit' – sometimes the prospect of the worst-case scenario is so horrendous that you are compelled to keep your face to the sunshine to obscure the shadows.

This is one of those rare occasions where I for one am burying my head in European sand and assuming that common sense, and a balanced Brexit, will prevail and bring further prosperity for all.

SMARTHORT 2019

Connect with the latest innovation in horticulture

Discover the latest high-tech advancements, meet the people behind the innovation and find out how to invest in the technology that could make a positive impact in your business.

Free two-day conference

6 and 7 March 2019
Stratford-upon-Avon

Fully Booked

Watch the live stream at: ahdb.org.uk/smarthort

#SmartHort2019

ahdb.org.uk

@AHDB_Hort