Field Vegetable Review 2018/19

HORTICULTURE

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Field vegetable panel

Martin Evans (Chairman), Freshgro

Current panel	Business name
Euan Alexander	Kettle Produce
Christopher Ashby	Wessex Plants
Tim Casey	J & V Casey & Son
Phillip Effingham	Greentech Consultants
Stephen Francis	Fen Peas
Robert Gibbs	Langmeads Group
William Iliffe	Southern England Farms
Keith Mawer	Strawsons
Stephen McGuffie	New Farm Produce
Rob Parker	G's Fresh UK
Sam Rix	PG Rix (Farms)
Andrew Rutherford	KS Coles
Jim Smith	Barfoots
David Gray	Independent Advisor

AHDB field vegetables team

Cathryn Lambourne	Crop Protection Scientist (disease) and panel manager cathryn.lambourne@ahdb.org.uk
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Foreword

Welcome to the 2018 AHDB Field Vegetable Annual Review.

It has been an eventful year, headlined with weather patterns many of us have really struggled through, with a very bitter winter followed by a prolonged dry spell. We growers are known for our resolve but these challenges, alongside longstanding issues of pest and disease control, have meant we have had to really use all the tools at our disposal.

This is where AHDB comes in. You will notice a change in emphasis in this year's magazine. We have decided to shine a light on some of our best and brightest work for field veg by looking more closely at specific themed projects.

We have seen the emergence of some key industry issues, including lettuce Fusarium wilt and this summer's rise in pest pressure, which have required AHDB to react quickly and plan for the future. Our plant protection authorisation team have been brilliant this season securing a raft of emergency EAMU's across a range of field vegetable crops.

The SCEPTREplus programme has been working to address key gaps in chemistry for pests, weeds and diseases. Our trial open days, for example, are really useful for discovering the latest promising varieties that could soon be available. You can find out more about these on our news pages.

Three GREATsoils projects have come to an end this year, but they leave behind a legacy of online resources including videos, factsheets and case studies, as well as online webinars. These were gathered during three years of grower engagement at field trials, field labs and workshops, all of which focused on evaluating methods of testing soil health.

Plans are currently underway to host a two-day conference, in Stratford Upon-Avon, looking at robotics and automation adoption for the horticulture sector. As a grower, I have found it challenging to bring new tech into the business, cost and expertise being limiting factors, but we need to re-visit this now more than ever. Therefore there is no better place to start than at SmartHort 2019 – read more on pages 18–20.

It is also the time of the year when we look to recruit new members for our panel and you'll find more information in the accompanying Grower magazine. I look forward to welcoming new, thought-provoking panel members to complement our great crop of current ones, helping to drive the industry forward together.

I hope you find some insightful new areas to start to think about that may bring positive results to your business.

Martin Evans
Field Vegetable
Panel Chair

Silver Y moth caterpillar

News and updates

Here is the latest news and updates from AHDB and across the field veg industry

Horticulture specialist joins AHDB Board

A new member of the AHDB Board has been appointed, who will also Chair the Horticulture Sector Board.

Hayley Campbell-Gibbons will take up her post from 1 November 2018. She brings 15 years' experience in rural affairs, including over a decade as Chief Policy Adviser to the National Farmers Union (NFU), where she specialised in horticulture from 2011 onwards.

First major cross-sector review of weed management

AHDB and BBRO have issued a joint call for a review of weed management in UK cropping systems.

Drawing upon national and international information sources, the review will cover horticulture (field and protected crops), cereals and oilseeds, potatoes and sugar beet, as well as grassland.

With £36,000 set aside for the work, it is hoped the review will identify improved ways to manage weeds and innovative research approaches by early 2019.

Crop Walkers' Guides

This year we have been busy updating our Crop Walkers' Guides to help you easily identify common pests, weeds and diseases out in the field. New updated guides are now available for outdoor cucurbits, salads, pea and bean, and sweetcorn. Common pest and disease posters are also available for pea and bean crops. Download from: **horticulture.ahdb.org.uk/knowledge-hub**

Challenging caterpillar season

This season, abundant numbers of silver Y caterpillars caused significant damage to UK lettuce crops. Growers were reporting that conventional control options weren't working, which may have been due to insecticide resistance issues, or because the pest is difficult to control once in the crop.

Guidance to help growers with lettuce pest identification and control options can be found in recently published guide, 'Pest insects infesting lettuce crops,' available from the AHDB website.

The AHDB Pest Bulletin alert, sent weekly, provides helpful monitoring information on pest numbers around the UK. If you're not receiving these alerts, which will start again in Spring 2019, sign up at: **horticulture.ahdb.org.uk/ahdb-pest-bulletin**

Have your say on pest monitoring service

To support good integrated pest management strategy, AHDB invests in pest forecasts, risk models, grower networks and monitoring services to predict when pest pressures may arise in UK crops. This helps inform when could be the optimum time to spray.

With technological advancements, from social networks to intelligent surveillance data gathering, and new services being proposed by the Crop Health and Protection Centre (CHAP), AHDB are taking this opportunity to review and assess how it invests in this area.

A survey to gather feedback from horticultural growers about the AHDB pest monitoring services has been sent to you with this Review. It is also available online at: **bit.ly/PestSurvey**. The survey closes 30 November 2018.

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

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Stratford-upon-Avon

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Big data gets a little easier

Applying 'big data' approaches can provide best practice guidelines for sustainable soil management, explains Cranfield University's Jane Rickson

Growers face a number of soil management challenges, including soil compaction, soil erosion, too much or too little water, pests, loss of nutrients and organic matter, and soil borne diseases. These problems often lead to reductions in crop yield, quality and reliability, which all hit the business' bottom line. Guidance on better soil management in horticulture does exist, but it is often difficult to find, is spread across a number of organisations, and even then its relevance can be limited by soil types, crops and management practices. In addition, much of the existing information concentrates on individual crops, rather than considering the effect of rotation on soil conditions and crop growth.

Despite being unconnected, soil information datasets continue to grow at an ever increasing pace and level of complexity. They include an increasing amount of on-farm data being collected regularly by growers through farm management software such as Gatekeeper. However, much of this farm data is currently not used by farms. In order to harness the collective knowledge and understanding the value that this data offers requires innovative analytical approaches to pick out patterns in the data that can inform sustainable soil management on-farm.

The Soil Management Information System (SMIS)

AHDB funded development of a Soil Management Information System (SMIS) as part of the GREATsoils programme. SMIS aims to help growers make better use of existing whole farm, cross-rotational data by combining it with other data on soil management.

The SMIS database comprises three key inputs. First, anonymised grower data (currently 300,000 entries) is linked to soil data held in Cranfield University's LandIS database (landis.org.uk) and to meteorological data sets. Second, research outputs from past and on-going projects provide further evidence of the effectiveness of different soil management practices. Finally, written material ranging from trade articles to technical reports to internationally published scientific papers have been reviewed and summarised, providing supportive evidence in SMIS as well as a helpful summary of, and links to, existing information. The integration of such wide-ranging data formats and sources makes SMIS unique – such a holistic approach has never been attempted before.

This unprecedented pool of knowledge and information can be used to define rules for soil management options and their impacts in different field scenarios, for example 'if I do that, this happens'. This rule-based database can then be interrogated by novel analysis techniques to 'unearth' valuable insights of the factors affecting real life issues such as crop yields, soil compaction and field vegetable diseases such as foot rot and cavity spot.

Development of SMIS

AHDB staff and growers have tested the diverse applications of SMIS at two workshops this summer. Using the simple interface, the unique grower database can be browsed to find the highest yielding as well as most consistent varieties of over 70 different types of crop. Experimental data and the literature held in SMIS can be searched for key soil management challenges and their solutions. Searches of the database can be filtered by crop type and variety, soil type, year, field operations and soil management options.

In addition, specific queries on the factors affecting yield and soil management issues, such as compaction and soil borne diseases, can be explored in SMIS. The results of these queries are what will help guide soil management decisions in the future. Feedback from workshop participants was very encouraging. Paul Flynn of the Soil Association's Producer Services said, "The potential is extraordinary. That I can now search for the best performing varieties within my area and on similar soil types is so helpful. I would just urge growers to get behind this and ensure they share detailed and accurate information, continuing to improve this platform."

Benefits for growers

For the first time, currently unstructured, non-centralised and difficult to find and/or access information on soil management will be available as one centralised resource. For individual growers, patterns in their own farm data are often obscured by the variations in soil management practices and their effects from season to season, year to year and from field to field. This 'noise' starts to fade as the pooled dataset gets bigger. The use of 'agri-informatics' is beyond the normal computing capacity of most individual agribusinesses, but SMIS allows meaningful interpretation of large datasets to unearth valuable insights that would otherwise have remained hidden. These insights can then inform future soil management decisions, such as improving soil health (with associated improvements in crop production) and avoiding soil degradation (and associated remedial costs). By looking at the full rotational context and the operations associated with it, SMIS is able to identify the optimal rotations and farming practices to mitigate soil borne pests and diseases and so help the industry to reduce reliance on chemical crop protection products.

"As vegetable producers growing on our own and seasonally rented land, Cobrey Farms has, over the years, become very aware of the importance of crop rotation considerations such as previous cropping (going back several years) and the interactions between crop variety, soil type, structure and fertility, pathogen loading and irrigation availability. The SMIS project is the first working big data platform that allows us to integrate these details as part of our crop planning procedure. The project now needs scaling up with more data and cropping records, but it is a brilliant example of the 'big difference' that 'big data' can make to the profitability of our business," explained John Chinn, Partner at Cobrey Farms.

How growers can get involved

SMIS is very much a live and dynamic project, new data, knowledge and information is continually being added. Growers' data is an essential element of SMIS because it brings an understanding of the timing, type and frequency of farm operations in a rotational context, including those that can lead to soil degradation, and provide an evidence base for those practices that promote sustainable soil management. Most importantly, anyone who agrees to share their data through SMIS can be confident that it will be fully anonymised and used solely to generate the SMIS 'rule-base'. As the database expands, SMIS's explanatory and predictive power increases. Our ability to interpret the database will be strengthened over time, as new and more sophisticated statistical and data-mining techniques emerge.

For further information on SMIS and details of how to contribute your own anonymised farm data, please contact Lynda Deeks at: **l.k.deeks@cranfield**

Discover more online at **www.ahdb.org.uk/greatsoils**

AHDB project code: CP 107d

Project lead: Jane Rickson, Cranfield University

Research consortium: Cranfield University, James Hutton Institute and PGRO

AHDB contact: James Holmes

Staying in control

AHDB's Joe Martin discusses the prospects for crop protection and how we can tackle its application challenges in a changing and uncertain future

Joe Martin
Crop Protection Senior Scientist - Weeds

Control of pests, diseases and weeds is one of the major challenges growers face in vegetable production with availability of chemical plant protection products declining due to legislation and increased pesticide resistance. Loss of products is an ongoing issue for growers, for example linuron, and the potential gap in replacement products coming through as well as difficult to control pests such as diamondback moth..

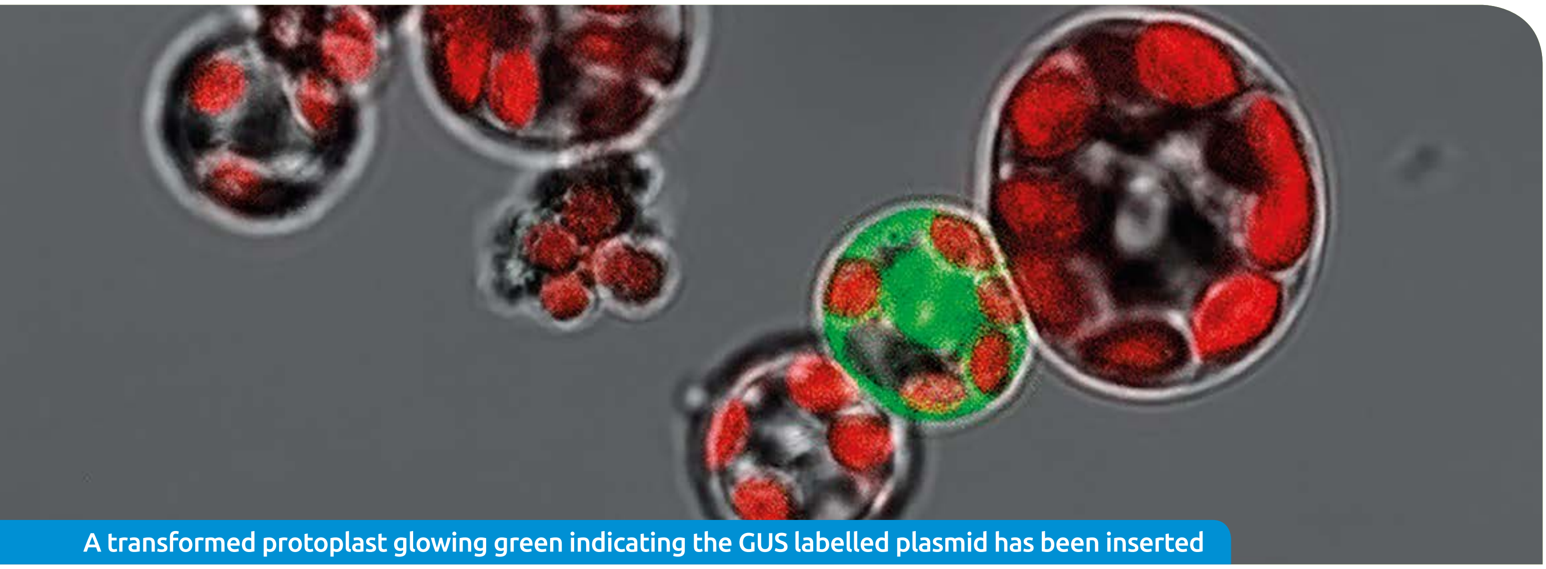
At AHDB the SCEPTREplus project and the EAMU team are working hard to try and plug some of these gaps in crop protection with at least four EAMUs secured after the first year of testing and promising results emerging in year two. Manufacturers are supporting our work, with over 20 companies involved, helping to supply potential solutions for testing. Continued discussion with regulators to explain and help them understand the ongoing problems is something which is needed and something which AHDB are continuing to carry out.

As well as looking at new chemical plant protection products, another area of increasing interest is biopesticides. Within the next 10–20 years the number of biopesticide products could well exceed the number of conventional pesticides. Interest from outdoor cropping is growing and the AMBER project, although looking at use in protected cropping and ornamental situations, is generating useful information that all growers will be able to take advantage of, including application and how to get the best out of a biopesticide product.

Innovation in crop protection is another area that needs focusing on by the industry going forward. Weed control can be particularly difficult in some field vegetables and the cost and supply of labour for hand weeding makes this approach particularly prohibitive. The EyeSpot project is looking at a different way of approaching post-emergence weed control in field vegetable. This project is looking at exploring an engineering solution combined with a non-selective herbicide where single droplets are targeted at individual leaves of unwanted plants. Results so far have shown a reduction in overall use of herbicides.

Many growers already use Integrated Pest Management (IPM), in which different crop protection tools are combined, including chemical, biological and cultural methods, but this will need to increase further. A combined approach using a range of techniques will be needed for the future and, along with further advances in crop protection, innovation should help growers to face some of the crop protection challenges they face.

“Within the next 10–20 years the number of biopesticide products could well exceed the number of conventional pesticides”



A transformed protoplast glowing green indicating the GUS labelled plasmid has been inserted

It's in the genes

Could new GM approaches be the answer to the virus family Potyviridae? Guy Barker, University of Warwick, explores further

Genetic modification and its potential for producing improved crops is often controversial. The public outcry against Genetically Modified (GM) crops was in part due to the randomness of the approach which meant the process often resulted in unexpected effects which could occur due to insertion of a gene in the wrong place. The relatively new CRISPr approach overcomes this due to its ability to target a specific sequence. This means that single base pair changes can be made in the genome, replicating natural processes. The consequence is that plants can be more easily modified to incorporate beneficial gene modifications identified through screens of germplasm collections such as the DEFRA supported vegetable gene bank at Warwick. The DEFRA VeGIN program goal is to facilitate the use of such genetic material and assist in the development of pre-breeding material as required by the industry. Alleles (different forms of a gene) identified in rare germplasm could help us address many of the problems farmers are currently facing. The principle difficulty in the approach is the time it takes to first identify novel alleles in the trait of interest and then to transfer them into elite breeding material. Speeding this process up is of particular importance if we are to produce resilient crops capable of withstanding the extreme climatic events we are now experiencing.

Luca Illing is funded through an AHDB studentship to try and develop more effective CRISPr approaches which will allow the transformation of the more difficult breeding lines. His focus being plant virus resistance. Plant viruses are a major problem in crop production and can cause severe reduction in yield as well as increases in production costs when employing preventative measures such as pesticides. In addition to this, viruses often show little or no visible symptoms making them extremely difficult to protect against.

Turnip Mosaic Virus (TuMV) is a member of the largest virus family Potyviridae, containing 36 per cent of all known plant viruses. This family causes significant losses in Brassica production worldwide by affecting both yield and quality of produce. CRISPr may be highly effective at introducing specific mutations however, it is apparent that it suffers from the same drawbacks which was found with older GM approaches. This problem is of particular importance in Brassica crops. The issue is that most Brassica varieties are not transformable. This is due to the fact that although mutations can be introduced into the nascent cells used, the genetic ancestry of the lines means that the cell cluster will not readily grow to create the transplants which can produce seed or pollen containing the genetic modification. The new approach is looking at the introduction of new transcription factors to assist the initiation of growth of transplants.

> “A successful outcome of the project will enable rapid demonstration of the effectiveness of particular alleles”

Currently florescent tags are being incorporated to allow the tracking of the transformants. This will allow the efficiencies at each stage to be determined so as to be able to be compare success rates. The figure shows a transformed protoplast glowing green. A successful outcome of the project will enable rapid demonstration of the effectiveness of particular alleles. This is important despite the recent disappointing decision by the EU to label CRISPr approaches as GM. The reason being that breeding companies can ascertain where to focus resources without being diverted by initially promising targets which prove, after many years of breeding, to be disappointing.

AHDB project code: CP 175

Project lead: Guy Barker, University of Warwick

AHDB contact: Cathryn Lambourne

The seed-borne identity

Philip Jennings, FERA, looks at how establishing whether a seed-borne or a surface contaminant could lead to a solution to basil downy mildew

Downy mildew in basil is a devastating disease caused by the plant pathogen *Peronospora belbahrii*. The disease was first reported on sweet basil (*Ocimum basilicum*) in the UK during the summer of 2010. Although new to the UK, the disease is endemic in many parts of Europe, North America, Africa, Asia and South America.

An infection results in damaged leaves and thus unmarketable plants, meaning the lack of any tolerance from retailers to blemishes and the rapid spread of downy mildew under favourable conditions has led to complete loss of crops grown under glass and up to 80 per cent losses in the field.

Typically, early symptoms start as a pale yellow, or yellow-white area, shown below (left). These initial symptoms can be easily missed as they resemble those caused by nutrient deficiencies, such as magnesium or nitrogen. Like other downy mildew pathogens, sporulation occurs almost exclusively on the underside of leaves showing the chlorotic symptom. Spores are produced during favourable weather conditions and are purplish grey to black in colour, shown below (right). A prolonged period of overnight leaf wetness, whether caused by, condensation, rain or from irrigation is required for successful spore germination and infection. The spores produced on the underside of leaves will not survive unfavourable conditions for more than a couple of days.

Previous work on basil downy mildew has determined the conditions required for sporulation, however little work has been done to address the sources of infection, conditions required for infection or the most effective ways to control the disease. Project PE 024 set out to examine how the disease might spread by looking at whether the pathogen was seed-borne and what alternate host existed, conditions required for infection (including temperature, humidity and lighting) and what were the most effective strategies to control the disease (cultural and chemical).

Philip Jennings
FERA

“Establishing whether the pathogen occurs in UK seed stocks would allow the industry to set in place measures to remove the source of infection”

Establishing whether the pathogen occurs in UK seed stocks would allow the industry to set in place measures to remove the source of infection.

> “Where practicable, it would be advantageous to minimise the period of overnight darkness as much as possible”

The measures taken would depend on whether the disease is truly seed-borne (systemic) or exists as a contaminant on the seed surface. Basil downy mildew has been shown to be seed-borne, with levels of infection as low as 0.02 per cent (2 seed in 10,000) leading to visible infection of crops. However, it is unclear whether the pathogen was truly seed-borne (systemic) or simply a contaminant (structures surviving on the outside of seed). Results from AHDB-funded project PE 024 suggested that the pathogen was systemic in seed with a high proportion of seed-lots tested contaminated with DNA of *P. belbahrii*. However, growing of plants from contaminated seed did not result in disease development. It is unclear whether the DNA detected in seed was rendered non-viable due to seed treatments, such as heat treatment, or whether the contaminated seed were present at a rate lower than could be detected in the screen set up. The significance of the presence of *P. belbahrii* DNA in seed lots remains unclear and is being further investigated in a follow-on project, PE 024a.

Limiting spread

Spread through dispersal of spores is dependent on the presence of a susceptible host species. In addition to sweet basil, coleus (*Solenostomon scutellaroides*) and Agastache species (both belonging to the Lamiaceae family) have been reported as natural hosts for *P. belbahrii*. Alternate host studies carried out in project PE 024 looked at 14 plant species from across the Lamiaceae family and showed that lavender, common sage and catnip were also susceptible to infection by *P. belbahrii*. Profuse sporulation was observed on lavender, with little or no sporulation noted on common sage and catnip. All the alternate hosts identified were crops of one type or another, so growers should take care if growing these along with basil. The lack of weed crops as alternate hosts should make disease management easier as there appears to be no route for overwintering/spread of *P. belbahrii* via weed species.

Infection experiments showed that spore production and infection of basil plants by *P. belbahrii* does not occur during daylight, with both occurring overnight. This suggests that, where practicable, it would be advantageous to minimise the period of overnight darkness as much as possible.

Infection of basil by *P. belbahrii* occurs over a wide range of temperatures (between 5 and 25°C), with the optimum temperature for infection being between 15 and 25°C. High humidity and prolonged moisture on the leaf surface (greater than four hours) is also required for infection.

Use of fungicides

Fungicides do not have curative activity against downy mildew pathogens, so fungicides should only be applied as seed or protectant treatments. Several active ingredients, screened in Project PE 024, were shown to provide good disease control in protected and outdoor crops (Table 1). A number of these products offered good protective activity when applied up to 10 days before infection and so could be used in a weekly fungicide programme to prevent the disease.

Downy mildew pathogens are recognised as being prone to developing resistance to fungicides. Therefore, fungicides should be used in a planned resistance management strategy alternating different modes of action (as indicated by FRAC codes in Table 1) to reduce the chances of further resistance developing. It should be noted that resistance to metalaxyl-M has been reported in *P. belbahrii* isolates collected in the UK, so products containing this active ingredient may not provide control in all instances. The significance of metalaxyl-M resistance in the UK basil downy mildew population is being investigated in the follow-on project PE 024.

Table 1. Fungicides shown to have activity against basil downy mildew in AHDB project PE 024

Active ingredient	Example product	FRAC code	UK approval (July 2018)
metalaxyl-M + mancozeb	Fubol Gold	4 + M	Off label for outdoor and protected basil
fenamidone + fosetyl-aluminium	Fenomenal	11 + 33	Off label for outdoor basil
mandipropamid	Revus	40	On label for outdoor and protected basil
dimethomorph	Paraat	40	Off label for outdoor and protected basil
fluopicolide + propamocarb HCl	Infinito	U + 28	Off label for outdoor basil
dimethomorph + mancozeb	Invader	40 + M	Off label for outdoor basil

AHDB project code: PE 024

Project lead: Philip Jennings, FERA

AHDB contact: Kim Parker

> “While aphids are normally the ‘major’ pest on a range of crops, this year caterpillars have come to the fore”

New pest challenges

Rosemary Collier, University of Warwick, provides a summary of the Pest Bulletin’s activity this year

The summer of 2018 has been a major challenge for growers, not least with regard to pest control. While aphids are normally the ‘major’ pest on a range of crops, this year caterpillars have come to the fore. This has been due to inward migration of diamondback moths and silver Y moths, and also because of the increased risk of damage by the ‘native’ cutworm (caterpillar of the turnip moth), due to the extremely dry conditions in the south/south-eastern parts of Britain in particular.

Through the Pest Bulletin and associated web pages we have been monitoring activity of the migrant moths in detail using ‘citizen science’ information from websites in the UK and north-western Europe, as well as through grower-monitoring of diamondback moth using pheromone traps. There have been two clear influxes of diamondback moth so far and the second caused some concern for growers. For the silver Y moth, large numbers were seen in the UK and elsewhere during July and early August. Their caterpillars have been causing significant damage in some lettuce crops but they do infest a range of crops. It has been possible for us to warn growers as soon as the moths arrive, however, we need to work on developing some more useful ‘threshold’ levels to trigger alerts, particularly for silver Y moth, and have requested help from lettuce growers to do this.

With regards to aphids, large numbers of peach-potato aphid and cabbage aphid have been captured in a number of the suction traps during July. Although numbers of winged aphids have declined now, they may still be developing in crops. Winged black bean aphids and pea aphids were also abundant at approximately the same time. Winged willow-carrot aphids were abundant earlier on (peak late May – early June) as predicted by the Pest Bulletin day-degree forecast. The currant-lettuce aphid has not put in much of an appearance yet, but there was a small peak of winged aphids in mid-July which was again close to the Pest Bulletin prediction. It is never caught in large numbers in the suction traps.

It is also worth mentioning that the hot weather appears to have had an impact on carrot fly activity at Wellesbourne, affecting the emergence of second generation flies.

Finally, flea beetles have been abundant at Wellesbourne and the weather conditions are ideal for cabbage whitefly and for onion thrips.

To keep up to date with pest activity, visit **horticulture.ahdb.org.uk/ahdb-pest-bulletin**

SCEPTREplus: seeking solutions and responding to crisis

The SCEPTREplus programme was set up to seek alternative crop protection products where gaps have arisen due to withdrawals of actives, resistance concerns or new pest and disease threats.

The agile structure, with new priorities set in each of the four years, has meant the project has been able to start trials this year for the control of lettuce Fusarium wilt and lettuce root aphid. Further funding was also agreed to continue to seek alternatives to the herbicide linuron following successful first year trials.

Tackling pests

Warwick Crop Centre (WCC) have been testing chemical, physical and biological treatments that could reduce the impact of lettuce Fusarium wilt, the disease first confirmed in the UK in October 2017. The treatments are being tested in both pot and polytunnel experiments using artificial inoculation.

Trials are also underway at WCC to determine the efficacy of novel treatments to control lettuce root aphids, following the loss of neonicotinoid seed treatments. A number of treatments are being tested including seed treatment, sprays, phytodrip and drenches.

As well as testing the efficacy, residue samples will be taken to give some evidence for product approval holders that MRLs will not be exceeded.

Other pest priorities for field vegetable crops being investigated this year include bean seed fly, capsids and aphids.

Last year, work was done to look at novel control options for *Thrips tabaci* in leeks. Two coded insecticide treatments reduced thrips damage to leek significantly compared with the untreated control. Six treatments, four of which were bio-insecticides, reduced significantly the numbers of plants damaged by leek moth compared with the untreated control. Further work would be advisable to ensure the most effective treatments identified in this trial are robust under higher pest (thrips) pressure.

Controlling weeds

Weed trials in 2018 have been looking at control options for Brassicas, leeks and onions, courgettes and pumpkins, outdoor and baby leaf salads.

The first year herbicide trials for carrot and parsnip crops also continued into this year in order to seek alternatives to linuron, following its withdrawal in June 2018. It is comparing a number of herbicide tank-mixes with the commercial standard (pendimethalin + clomazone) at two application timings pre-emergence and two application timings post-emergence for selectivity (crop safety) and efficacy, with a total of 20 treatments.

Herbicide trials in 2017 have already delivered four new EAMU approvals for field vegetable crops: Centurion Max on herbs, Dual Gold on sweetcorn, Gamit 36 CS on carrot and Wing-P on courgette and squash.

Dealing with diseases

Where appropriate, the SCEPTREplus programme has taken a model crop approach to trials, where treatments are tested on a specific target and results then extrapolated on to different crops. This was the case for downy mildew trials, which was identified as a key priority for many outdoor and protected crops, however trials were undertaken on protected lettuce.

Several conventional fungicides tested in the trial have the potential for future commercial use against downy mildew and will be further investigated for efficacy and crop safety. This year the downy mildew trials will continue and will focus on ornamental crops.

A trial to investigate control options for Septoria in celery will start this year and results will be available early 2019.

To find out more about the trials and project results so far, visit **horticulture.ahdb.org.uk/sceptreplus-trials**

“Several conventional fungicides tested in the trial have the potential for future commercial use against downy mildew”

Tools of the trade

John Clarkson, University of Warwick, reveals more about the work aiming to develop molecular tools to identify and quantify multiple Fusarium species

The genus Fusarium comprises many pathogenic fungi, which can cause disease in plants, humans, and animals. *F. oxysporum* is the most economically damaging Fusarium species for horticulture and is a species complex comprising more than 70 special pathogenic forms known as *formae speciales (ff.spp.)* which are adapted to infect different crop plant hosts. These are a major constraint to the production of many food crops including onion, leek, lettuce, tomato, brassicas, asparagus, cucurbits, peppers, coriander, spinach, basil, beans, peas, strawberry and watermelon as well as non-food crops such as carnation, column stocks and narcissus.

Control of *F. oxysporum* is challenging as the pathogen produces chlamydospores that survive in the soil for many years, resulting in the need for long rotations. In the past, control has mainly relied on soil sterilisation or fumigation but regulatory approval for use of these type of active ingredients has, in many cases, been withdrawn or threatened by further legislation. Other management strategies such as biological control have yet to be widely proven although two microbial products (Prestop, T34 Biocontrol) are currently registered for Fusarium disease control in the UK.

In some cases, plant resistance to *F. oxysporum* has been developed, but sometimes this has led to the evolution of new pathogen races which have broken this down. A notable example of this is the recent emergence of *F. oxysporum* f.sp. *lactucae* race 4 (FOL4) which has caused disease outbreaks in the UK for the first time.

The importance of pathogen diagnostics

In many cases it is difficult to identify which Fusarium species may be causing disease and these pathogens are notoriously difficult to identify by conventional means such as type of symptom, culture morphology on agar plates or microscopy, as even the same species can vary widely in appearance. For *F. oxysporum* in particular, even sequencing of genes that are widely used to identify different fungal species fails to distinguish between the different *F. oxysporum* ff.spp. or between pathogenic and non-pathogenic isolates. Hence new approaches are required to identify and quantify the key *F. oxysporum* ff.spp. affecting horticultural crops. This is important, firstly to understand which Fusarium species or *F. oxysporum* f.spp. are the main cause of disease, and secondly to provide molecular tools that could be used to assess pathogen levels in seed, planting material, soil or in harvested crops going into storage (e.g. bulb onions). Furthermore, such tools can also be used to understand the biology and dynamics of Fusarium pathogens, for instance to understand how long they survive in soil and if they colonise or even proliferate on crop plants used in rotations, without causing disease.

Developing diagnostics for key *F. oxysporum* ff.spp.

The main aim of project FV POBOF 452 is to develop diagnostics for the key *F. oxysporum* ff.spp. affecting onion (*F. oxysporum* f.sp. *cepae*, FOC), column stocks (*F. oxysporum* f. sp. *mathiolae*, FOM) and narcissus (*F. oxysporum* f.sp. *narcissi*, FON). To do this we carried out whole genome sequencing of these pathogens and, through bioinformatics analysis, identified unique genes in each one that are associated with pathogenicity. This has enabled us to develop specific quantitative PCR tests for FOC, FOM and FON and preliminary results have shown that we can now successfully detect these pathogens in infected plant and soil samples for the first time. Using the same approach we also identified FOL4 in

lettuce samples sent in by growers, when this pathogen first emerged in the UK, and are continuing to monitor for any further outbreaks. As many Fusarium species occur in disease complexes with other pathogens, further work is now developing a 'DNA barcoding' approach whereby gene targets are amplified from DNA from soil/root samples which will allow simultaneous identification/quantification of all Fusarium species, different *F. oxysporum* ff.spp. and other fungal pathogens, as well as other members of the microbial community.

Defining *F. oxysporum* inoculum levels required to cause disease

A further aim of the project was to define the critical levels of FOC, FOM and FON inoculum required to cause significant disease development on onion, column stocks and Narcissus respectively. To do this we infested compost with different amounts of each pathogen, transplanted the appropriate host plant and monitored disease development under controlled glasshouse conditions. Results indicated that a minimum level of 1,000 colony forming units per gram of compost were required for both FOC and FOM to cause noticeable disease symptoms while disease development was severe when concentrations of 100,000 and 1,000,000 colony forming units per g. were present. The requirement for a threshold level of inoculum to initiate significant disease may explain why in some intensive growing systems such as protected lettuce and column stocks, Fusarium disease is not initially observed and then suddenly causes extensive disease damage the following year as inoculum levels reach this critical threshold. Further work is now 'calibrating' results of the qPCR tests so that these can be related to the critical inoculum levels of each pathogen and hence potential to cause disease.

Identifying Fusarium pathogens in leek and asparagus

As part of the project we also obtained samples of leek and asparagus with symptoms of Fusarium infection in order to understand the range of species that can potentially cause disease in these crops. Following isolation, DNA extraction, PCR and sequencing of part of a gene that can accurately distinguish different *Fusarium* species we identified *F. culmorum, F. avenaceum, F. oxysporum* and *F. proliferatum* in diseased leeks and *F. avenaceum, F. culmorum, F. equiseti, F. oxysporum* and *F. proliferatum* in diseased asparagus. With the exception of *F. oxysporum*, all these species are known to be generalist pathogens that can affect a range of crops. Tests are now underway to confirm which of these species are pathogenic in leeks, with preliminary results suggesting that *F. culmorum* is particularly virulent.

Development of Fusarium disease areas

During this project we also artificially inoculated a field area at Wellesbourne with FOC and a polytunnel at the Cut Flower Centre with FOM. Following planting, these areas had high disease levels in crops of bulb onions and column stocks respectively and have provided a valuable resource for validating the molecular diagnostic approaches we have developed for these pathogens. In addition these areas will also provide a means of testing new disease control products and resistant crop varieties in the future.

AHDB project code: FV POBOF 452

Lead Researcher: John Clarkson, University of Warwick

AHDB contact: Cathryn Lambourne

Lessons on lettuce Fusarium wilt

Discover how improved hygiene measures can help tackle and prevent the devastating disease, lettuce Fusarium wilt

Following identification of lettuce Fusarium wilt at two UK sites in autumn 2017, the disease has now been confirmed by laboratory diagnosis at two further sites in Lancashire, with a further case confirmed in Cambridgeshire this summer. The disease has also been identified at a total of four sites in Ireland.

All confirmed and suspect cases of the disease to date have been on protected lettuce and are caused by FOL race 4 (also present in the Netherlands, Belgium and Ireland). An AHDB Technical Review, which was compiled by Andy Taylor of the University of Warwick soon after the initial outbreak contains current information on *Fusarium oxysporum* f. sp. *lactucae* (FOL) and potential management strategies; the review is available at **horticulture.ahdb.org.uk**

Lettuce FOL is primarily soil-borne so crop hygiene is essential to prevent spread of the fungus between lettuce crops, glasshouses, nurseries and plant propagators. Crop hygiene procedures across lettuce propagating and growing businesses must be reviewed and where possible access to cropping areas restricted.

Where the disease has been confirmed on-site, soil from affected beds should not be rotovated or spread to other areas of the nursery. Plant material should be uprooted and burned, or put in a covered skip for landfill. Growers should not bury affected material in soil or add it to discard piles or compost areas.

Prompt disease diagnosis is important to help minimise disease spread. Suspect lettuce plants should be cut in half from top to bottom to check for the red/brown staining in the root which is characteristic of Fusarium wilt. The samples should be sent to Dr Andrew Taylor, Warwick Crop Centre, School of Life Sciences, University of Warwick, Wellesbourne Campus, Wellesbourne, Warwick, CV35 9EF, for diagnosis, and to confirm whether it is race 4 or not. Andrew Taylor can be contacted at: **Andrew.taylor@warwick.ac.uk**

Unfortunately, FOL survives in soil for several years, although levels of the pathogen decline over time in fallow soil. Where the disease is reported or where rotations are short growers are advised to consider leaving affected areas uncropped or to plant non-host crops such as pak choi particularly during the summer when high temperatures are most conducive to disease development. For protected cropping, Basamid (dazomet) is approved for disinfestation of soil before planting (one application in every third year); it is known to have activity against lettuce FOL. Growers must read and follow manufacturers' label recommendations for most effective use of the product.

Funds have been made available for trials to progress under the AHDB SCEPTREplus project to test the efficacy of conventional and biological products that could be used during propagation and cropping, or for soil disinfestation. These are underway at the University of Warwick. New AHDB-funded work will also commence this autumn to further investigate the biology of lettuce Fusarium wilt, including pathogen survival, infection thresholds, temperature range and disinfectant activity.

Dr Kim Parker, a Pathologist at AHDB said, "All lettuce growers should aim to keep this devastating disease out of nurseries and fields by reviewing crop production hygiene measures and working with plant propagators to avoid the disease getting onto site. Where the disease has already manifested, growers should follow guidance provided in AHDB's review and other resources available at **horticulture.ahdb.org.uk/lettuce-fusarium-wilt-and-root-rot**

Variety is key for the pea

New varieties could hold the key to significant financial gains for vining pea growers. Stephen Belcher, PGRO, reveals some of the leading contenders

With the vining pea industry having a farm gate value of around £52 million per annum, and an estimated retail value of £500 million per year, improvements of just five per cent in yield and quality could net the industry an impressive £2.6 million extra at the farm gate each year.

AHDB project FV 340b is an extension of project 'FV 340: Vining pea trials' and hopes to be able to help deliver these financial benefits for growers.

In order to achieve this a number of varieties have been tested against one of the industry standard varieties, Avola, to ascertain changes growers could make to increase the profitability of their crop (the other standards being Bikini and Ambassador).

However, it is not quite as simple as picking a well-performing variety from a trial, as vining peas are grown on many different soil types, each giving potentially different results for each variety. To that end, AHDB has funded a series of variety trials grown on a light silt soil type in South Lincolnshire (near Holbeach). A separate descriptive list is now produced for this area and soil type and currently describes 52 varieties, with a range of leaf types, and maturities ranging from -1 to +15 maturity days compared to the standard Avola.

All of the varieties trialled represent improvements in yield, size-grade, colour, uniformity and/or disease vulnerability compared to Avola.

> "Improvements of just 5 per cent in yield and quality could net the industry £2.6 million extra"

Tried and tested

While there were many results from the trials, Beverly and Tomahawk showed considerable promise. The former, with a maturity of -1, is now the earliest maturing on the list. The latter, Tomahawk, has out-yielded the early standards. Another example of a successfully trialled variety was Maurice, which has out-yielded Oasis at TR100 and has good field resistance to downy mildew (*Peronospora viciae*). Also late maturing and out-yielding Oasis were Reflection and CS-445AF.

In a prior year's trial, Sherwood, an early maturing replacement for Avola, matured at the same time as Avola while giving a significant yield increase over it at TR100.

The battle against downy mildew

Currently downy mildew in peas is mainly controlled by the use of Wakil XL seed treatment, crop rotation (one year in five) and use of disease tolerant varieties in areas of high disease pressure. However, there are reports that some varieties do not perform well in all pea growing areas due to the presence of different races of downy mildew. AHDB project FV 436 is studying the effects of different races of downy mildew on pea varieties, with the results being passed on to pea breeders to aid in their selection and breeding programmes.

At a time when restrictions have been placed on the use of seed treatments to control downy mildew, the use of varieties with a high tolerance to the disease will be more important. The varieties Saltingo, D165618, Fantastigo and D856607 also completed trials in 2017 in project FV 340b and, encouragingly, showed good field resistance to downy mildew.

At its core, project FV 340b is designed to provide vining pea growers with independent, relevant and accurate trials evaluations on vining pea varieties so that a considered and informed variety choice can be made. Richard Fitzpatrick, General Manager at HMC Peas in Spalding, Lincolnshire, explained the benefit of AHDB's work to growers, saying, "This is an extremely worthwhile project as it allows growers to choose new varieties based on quality independent research. It demonstrates the strengths and weaknesses of new varieties in a climate of less reliance on pesticides and more emphasis on plant disease resistance and vigour. In times where we are experiencing more extreme weather events we also need to find varieties that are more able to withstand these extremes."

AHDB project code: FV 340b: Vining peas: Extension of variety evaluation trials

Project Leader: Stephen Belcher, PGRO

AHDB contact: Dawn Teverson

A tough road ahead

Employee solutions expert, Chris Rose from Chris Rose Associates, takes a look at the pressing issues in horticulture when it comes to the topic of labour

2018 is shaping up to be one of the most difficult seasons in memory for much of horticulture. The change in weather from very cold and wet to suddenly hot and dry has been particularly challenging for growing field vegetables. However, though that is painful and costly, next season could be totally different. The labour situation on the other hand is only expected to get worse.

Currently, as of September 2018, we have the increasing likelihood of a hard Brexit. While there has been an announcement by the government of a two year nationwide pilot scheme to bring 2500 workers from outside the EU each year, we must still anticipate labour to be more costly and harder to come by in 2019.

As an industry, horticulture must lobby government harder. Ironically with a major health crisis – obesity, diabetes, NHS struggling – eating more veg and fruit is a big part of the solution, and yet our ability to produce is being jeopardised. It will take 18 months to get a visa-based seasonal labour scheme up and running, according to DEFRA. Imports are not an easy alternative either as border controls are set to cause massive delays.

Robotic harvesting is not the answer yet, however mechanisation and automation must be looked at wherever possible. Reassess the financial implications of investing in the light of not just more expensive labour, but also real shortages. How much of the automation in large pack houses could you also put into harvesting rigs? Where people are carrying harvested product, can that be mechanised? Examine every operation involving labour and ask yourself ‘Is this the most efficient way of doing this?’

I recommend a full audit of labour utilisation, either with an external expert or internally using someone from elsewhere in the business with a fresh pair of eyes. Alternatively link up with a similar business and audit each other. This is an existential issue that needs collaboration not competition.

Ask your workforce – cutters, pickers, packers, carters, team leaders, etc. – if they have any labour saving ideas and reward any that get implemented. People will be more likely to work efficiently when they are recognised and rewarded for doing so. Cracking the whip is not the solution when the workforce can always find work elsewhere.

However short labour supply is, the best businesses tend to find enough. If you are using gang-masters, how well do they treat their staff? Are they getting paid what you think they are? Are they guaranteeing enough work? If not, perhaps it is time to look at employing directly and providing accommodation for seasonal staff, or at least for part of your needs.

If we cannot make the work itself easy and pleasant, we have to make everything else as positive as we can. Workers need to feel valued and treated as equal human beings. Invest time in training staff and communicating so that every individual feels needed.

> “Robotic harvesting is not the answer yet, however mechanisation and automation must be looked at wherever possible”

Smart ideas

With rising labour costs and a reduction in numbers of seasonal workers in the UK, Grace Emeny explains what AHDB are doing to help address the labour challenge in your business

While crop protection research remains at the heart of our activity at AHDB, we understand from talking to growers that access to affordable labour has become one of the biggest concerns for nearly all horticultural businesses.

Estimates put the current season shortfall of staff in horticulture at 15 to 17 per cent. The NFU labour provider survey revealed there was a 29 per cent shortfall in seasonal labour in September 2017, and levels were expected to dip as low this autumn too.

With around 70 per cent of the UK's horticultural workforce coming from Romania or Bulgaria, and only one in every thousand seasonal workers coming from the UK, the need for access to seasonal labour from overseas is evident.

Speaking exclusively in the August issue of The Grower, Farming Minister, George Eustice, said he was confident that a new policy would be brought in once the transition period from leaving the European Union had ended in 2020.

Even if the government agree a permanent seasonal agricultural workers scheme, following the two year pilot scheme recently announced, there is still a need for our industry to think about long-term sustainable and affordable labour solutions to protect productivity and profitability.

We have therefore launched the SmartHort campaign to make sure the industry is resilient to labour challenges, from rising wage costs, to difficulties in recruiting and retaining staff. The campaign has two clear strands; to look at improving management practices for the existing workforce and to identify new technologies and innovation, such as robotics and automation, which could play a role in providing longer term solutions.

> “We've launched the SmartHort campaign to make sure the industry is resilient to labour challenges”

Smart labour management

Through workshops, case studies, videos and publications we will be sharing the principles and benefits of introducing management techniques such as Lean, Champion and Continuous Improvement.

We believe these can make a difference to businesses of all shapes and sizes to improve labour efficiency, and can apply throughout the production system from picking to packing. Importantly, we want to help businesses to be confident that they are getting the best out of the workers that they have.

MPL, a specialist Lean consultancy, visited six diverse businesses last year and identified clear commonalities for areas of improvement and we are using this knowledge to build the activity within the campaign. For instance, we noticed there was very limited investment in management training for supervisors, so through our skills and education team at AHDB, we'll be launching supervisor training courses soon.

Eight Labour Efficiency workshops which ran around the UK to introduce the concepts of Lean, Champion and Continuous Improvement proved extremely popular with growers. Due to high demand, more workshops will be taking place again next spring. Each business that attends will have the opportunity to leave with a tailored plan to implement efficiency savings.

Smart technology

Over 84 per cent of horticultural growers plan to invest in automation or robotics to help off-set labour challenges, according to a survey conducted by AHDB in 2017.

As part of the SmartHort programme we will be seeking to help identify and assess the value of different kinds of smart technology available, both in the UK and overseas. This could be to directly off-set labour with automating repetitive tasks, or to bring big data to the production system to help improve productivity by off-setting waste or reducing yield loss.

In June this year, 20 growers joined us for a study tour to The Netherlands to look at new developments in automation and robotics. While specifically looking at new technologies for glasshouse crops, the advancements seen will likely lead to new solutions and innovation for field crops too.

Deep learning, a type of machine learning, was a key trend and has significant potential to play a role in horticultural production, including improving pest and disease detection and monitoring. Deep learning, put simply, is a systems ability to learn to recognise patterns in digital data, such as an object within an image, by teaching itself to learn what the data means. Google search algorithm's use this technology to learn to recognise say, a cat, within images, without having to be 'told' there is a cat in every single image online.

Wageningen University and Research (WUR) have used this technology to develop a system that can detect disease in seed potatoes out in the field before symptoms are visible to the human eye. Images are taken by a hyperspectral camera, and a classifier is built in that can learn to distinguish between stem and leaf disorders.

WUR have also used deep learning to develop smart yellow sticky traps that can learn to detect and count automatically any white fly and beneficial insects caught.

One of the key lessons we took from the study tour was that while there have been huge leaps in the development of automation, realistically this is still a long way from commercial reality to have any impact in the short-term on labour shortages. Instead, what we're seeing is partial mechanisation, using robotics and automation to support the more complex horticultural tasks such as harvesting. For example, automated trolleys are already working commercially in glasshouses, taking harvested products to the packhouse, alleviating the labour used to transport goods so they can focus on picking produce.

We'll be exploring the future of automation and robotics at SmartHort 2019, a free two-day conference dedicated to driving innovation into horticulture. Guest speakers from around the world will be sharing some of the most impressive and exciting technological developments that could change the way you grow.

It is also an opportunity to 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.

The SmartHort 2019 Conference takes place in Stratford-upon-Avon on 6 and 7 March 2019. You can book your place at **horticulture.ahdb.org.uk/events**

To find out more about the SmartHort campaign and how it could help your business, visit **horticulture.ahdb.org.uk/smarthort or contact gracie.emeny@ahdb.org.uk**

> "Each business will have the opportunity to leave with a tailored plan to implement efficiency savings"

Is it time for a robotic revolution?

AHDB's Jim Dimmock examines how technology might help solve the current issues facing horticulture, including whether drone usage has take-off potential

Jim Dimmock
Resource Management Scientist - Soils

Labour shortages for field work in the UK are nothing new - the Seasonal Agricultural Workers Scheme (SAWS) was introduced after WWII to allow migrant workers temporary residence to harvest fruit and vegetables. Farms quickly became dependent on imported labour and numbers grew steadily until the scheme was scrapped in 2013 because of the easy availability of EU workers as the Union expanded eastwards. Times have changed however; the fall in the value of Sterling and growing home economies are making seasonal field work in the UK less attractive. From the grower's perspective, this issue is further compounded by National Living Wage legislation forcing up staffing costs by significantly more than inflation. Labour shortages aren't just a local problem either – China's rural workforce has crashed by 25 per cent over the past decade through urbanisation.

So therefore, the need for robotic alternatives for manual labour is at an unprecedented level. Fortunately, the timing of this watershed seems just about right to coincide with major developments in technology. Despite robots having been used in major industrial applications, such as car manufacturing, since the 1980s, robots for fieldwork have been little more than academic pipedreams in the intervening decades.

However, recent work such as AHDB's 'CP 153a Development and demonstration of an automated, selective broccoli harvester' has seen the combination of practical robotic engineering with cutting-edge 'Deep Learning' artificial intelligence vision systems with genuine commercial viability. This, together with transferable technology from developments in closely-related horticultural fields, such as the recently-announced raspberry picking robot being field-tested by Hall Hunter and Plymouth University and AHDB-funded technology in project 'HNS/PO 194 GROWBOT: A Grower-Reprogrammable Robot for Ornamental Plant Production Tasks', show that robotic technology is maturing rapidly and will be able to contribute significantly to our industry within a very short timeframe, which we are seeking to further hasten through funding research in key areas, with PhD studentships in robotic vision (CP 153a, CP 170 Bioinspired vision systems for automated harvesting) and handling systems (CP 172 Vegebot - Robotic touch, sense, and learning of delicate vegetables).

A further interesting area is that of drones. We've seen plenty of promises of what drones might bring to growers' businesses, but a recent presentation at the Harper Adams Agricultural Innovation Conference given by XAG's Justin Gong, a drone company based in China, gave an insight into the benefits they are delivering in other parts of the world. While drone use in the UK is tightly constrained by Civil Aviation Authority (CAA) rules, in China they're in part solving labour shortages by applying pesticides using autonomous drones – XAG's drones alone have already made more than 1.7 million flights, covering over 3 million km.

Given the risk aversion in this area, we have to question whether this could ever happen, but my take is that since self-driving road vehicles are taken seriously even given the potentially disastrous outcomes of failure, then autonomous lightweight aerial vehicles, in a sane world, might be considered too.

“Robotic technology is maturing rapidly and will contribute significantly to our industry within a very short timeframe”

Testing times

AHDB's Cathryn Lambourne reviews the work being done to develop a diagnostic test for onions and Brassicas for use in-field

Developing tools to help growers manage their crops in an integrated way is a central tenet for the AHDB Crop Health and Protection team. Across the AHDB crop sectors (Horticulture, Cereals & Oilseeds and Potatoes) a number of projects are ongoing in which we are working alongside researchers and growers to develop, validate and demonstrate the use of monitoring in crops for airborne spores of crop pathogens. Gathering such data, and using it alongside disease models in crops, can provide growers with information to help them determine whether their crop is at risk of developing disease. Additionally, as this warning is provided before infection starts, it can provide a window of opportunity to apply suitable crop protection controls to protect the crop if required.

An example of such work, funded by the Field Veg Panel, is FV 456. We are working with Professor Roy Kennedy (Pershore College, Warwickshire College Group), to build on previously funded work carried out by Dr Alison Wakeham and Professor Kennedy while they were working at the University of Worcester. Work carried out in AHDB-funded projects (e.g. FV 333, FV 356, CP 099, CP 099c) produced antibodies to several Brassica pathogens, and also onion downy mildew. The aim of this project is to get all the tests into a robust in-field format so that growers could get an indication of disease risk within 10 minutes of running the test under field conditions. We also want the tests to be commercially available for growers interested in trying the technology themselves at the end of the project.

Within FV 456, four growers/agronomists have teamed up with Roy to use air samplers produced by Burkard Manufacturing Company.
The samplers – which can be either battery, mains, or even solar, powered – are being used to monitor the air for light leaf spot, ringspot and white blister in Brassica crops and downy mildew in both salad and bulb onions in crops in Warwickshire, Lincolnshire, Cambridge and Fife.

At the start of the project Alison and Roy had already managed to produce an in-field test for ringspot in Brassicas, and by the end of the first year this was added to with a test for LLS. The in-field tests utilise the same technology as the home pregnancy test kit – a lateral flow device. A sample of liquid, containing spores is taken from the field air sampler and dripped onto the test well. The liquid and spores permeate along a previously prepared test membrane, producing a line to show that the test is working correctly, and another to show whether spores are present in the sample and if so, at what concentration. An important difference from the home pregnancy test is that while that test shows the development of a test line when positive, in these tests, it is the failure of a line to develop that indicates a positive result.

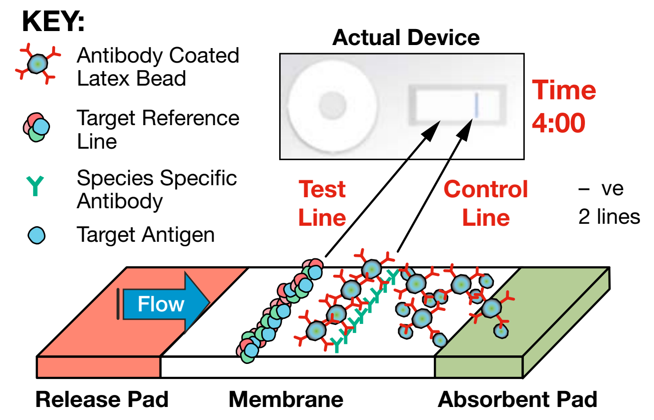
The test for onion downy mildew was less well developed at the start of the project in July 2017. Growers used a slightly different type of air sampler in the field, and sent the collection wells back to Roy for processing before a result could be obtained. This year, they are running two types of sampler alongside each other so that we can gather data to set disease risk thresholds for the new in-field lateral flow test. By the time the project finishes in June 2019, a lateral flow device will be available for this pathogen too.

We have also partnered with Mologic Ltd. They provide the route to develop robust tests in small production runs for validation and use during projects such as this one. They also have the capacity to scale production up and provide the tests directly to growers commercially when this project is complete.

Watch our video to find out how the diagnostic test could help your business grow. Available from: **bit.ly/FV456**

Many of you will be aware of the work that the Agritech Crop Health and Protection Centre (CHAP) are developing around pest and disease monitoring. Crop Monitor (www.cropmonitor.co.uk), funded via Innovate UK, will 'provide a platform for collecting data across the UK, providing a national network of risk forecasts for pests and diseases of wheat, barley, oilseed rape and potatoes using a weather monitoring network, national pest and disease surveillance data and advanced risk models'. This is a really exciting development and opportunity for those crop groups, but when, I hear you say, will horticultural crops be included? Rest assured that the AHDB team are exploring all possible routes, and it will hopefully happen in the very near future.

As one of our growers recently said 'if you can monitor it, you can manage it'. Pest and disease risk prediction is a valuable tool, to help us know what's coming before it becomes unmanageable. It also provides opportunities to target crop protection controls when they are most needed, rather than applying products prophylactically. Getting to the stage where growers can rely on and trust the information, and adjust their spray applications accordingly may be some way off yet, but hopefully projects such as this can help demonstrate what's possible, could reduce application costs, improve crop quality, and help the environment. As we see the availability of active ingredients reduce we must seek robust and sustainable alternatives. This type of technology is developing fast, and I'm sure that we will see great changes to the way we manage pests, weeds and disease in our crops over the coming years.



> This warning can provide a window of opportunity to apply suitable crop protection controls to the crop if required

AHDB project code: FV 456

Lead researcher: Roy Kennedy, Pershore College

AHDB contact: Cathryn Lambourne

AHDB projects

Here is a list of our other projects that we've been working on in 2018

CP 048c: AHDB Horticulture Pest Bulletin
Dates: April 2017 – March 2019
Project leader: Rosemary Collier, University of Warwick
Location: University of Warwick

This project provides regular updates as to pest activity throughout the season via weekly newsletters and a blog - www.syngenta.co.uk/ahdb-pest-bulletin

CP 107b: Growing Resilient Efficient And Thriving (GREAT) soils
Dates: April 2015 – March 2018
Project leader: Ben Raskin, Soil Association
Location: UK-wide

In year two, six field trials assessing different soil management practices were put in place and results assessed. This project generated a wide range of GREATsoils publications (e.g. green manures in intensively cultivated horticultural soils, soil pH and its measurement, soil water supply and infiltration).

CP 107c: Precision farming technologies to drive sustainable intensification in horticulture
Dates: April 2015 – March 2018
Project leader: Lizzie Sagoo, ADAS
Location: UK-wide

Soil assessment surveys have been taken, with demonstration trials held across the country throughout the life of the project.

CP 113: Maintaining and developing capability in vegetable crop pathology (fellowship)
Dates: November 2013 – December 2019
Project leader: John Clarkson, University of Warwick
Location: Warwick Crop Centre

The overall aim of this Fellowship is to train a postdoctoral scientist for plant pathology research of benefit to UK horticulture with a particular focus on vegetable crops.

CP 117a: Coriander: Potential management options for yield decline
Dates: July 2017 – June 2018
Project leader: Ian Singleton, Edinburgh Napier University
Location: Edinburgh Napier University

The project aims to assess the effect of 'deep' ploughing, a soil amendment, soil drying/desiccation and biofumigation on yield decline.

CP 118: Cucurbit pollination: mechanisms and management to optimise field crop quality and quantity
Dates: January 2015 – June 2018
Project supervisor: Juliet Osborne, University of Exeter
Location: Cornwall, UK

This project focused on the pollination dynamics of field-grown courgettes (*Cucurbita pepo*) as a model species for cucurbit crops.

CP 127a: Compendium of pest forecasting models
Dates: November 2017 – May 2018
Project leader: Rosemary Collier, University of Warwick
Location: University of Warwick

CP 134: "eyeSpot" – leaf specific herbicide applicator for weed control in field vegetables

Dates: October 2014 – March 2018
Project leader: Alistair Murdoch, University of Reading
Location: University of Reading

Research built on the expertise at Reading, Precision Farm Robotics and Knight Farm Machinery to develop a herbicide ejector which applies metered droplets to leaves of unwanted plants.

CP 136: Diagnostics: Development of Oomycete LFDs

Dates: January 2015 – January 2018
Project leader: Tim Pettitt and Alison Wakeham, University of Worcester
Location: University of Worcester

This project has worked to produce on-site and laboratory tests which can be used to accurately monitor infective propagules of oomycetes in environmental samples (i.e. plants, growing media and water).

CP 138: Transition to responsibly sourced growing media use within UK Horticulture

Dates: January 2015 – December 2019
Project leader: Barry Mulholland, ADAS
Location: ADAS Boxworth, G's Growers, STC

The project will provide a science-based quantitative tool for growing media formulation and ease the transition from a dependence on peat.

CP 140: Optimising the use of biocontrol agents to improve the control of Botrytis cinerea

Dates: October 2015 – September 2018
Project supervisors: Xiangming Xu, NIAB EMR, and Roy Kennedy, Pershore College
Location: NIAB EMR

With a focus on soft fruit and lettuce, this year student Gurkan Tut has been determining whether combined use of BCAs leads to synergy and reduced variability in efficacy.

CP 144: Developing integrated pest and disease control in vegetable crops (IAPAD) (HAPI)

Dates: June 2015 – March 2019
Project leader: John Walsh, University of Warwick
Location: University of Warwick

Among other things, this project is mainly working on optimising insecticide treatments so that vegetables are treated with less insecticide and hence have less insecticide residues in them. It also seeks to ensure that insecticides are applied at the optimum time to maximise control of aphid vectors and virus.

CP 145: Exploiting seed coat properties to improve uniformity and resilience in Brassica seed vigour (HAPI)

Dates: April 2015 – March 2019
Project leader: Steven Penfield, John Innes Centre
Location: John Innes Centre

A collaboration between Syngenta, University of Warwick and John Innes Centre which is exploiting emerging technologies in CARS microscopy to better understand uptake of Active Ingredients (AIs) by seeds with the potential to develop seed coat characters capable of maximum efficiency for AI uptake.

CP 150: A genetic approach to improving post-harvest quality in fresh produce (HAPI)

Dates: April 2015 – March 2018
Project leader: Jim Monaghan, Harper Adams University
Location: Various

This project aims to breed lettuce varieties with a reduced propensity to discolour, as a solution to the problem of pinking and browning, while trying to gain an understanding of the genetics and biochemistry of discolouration.

CP 151: Improving biological control in UK organic veg growers (ICASE studentship)

Dates: October 2015 – September 2019
Project leader: Simon Leather, Harper Adams University
Location: Harper Adams University, Cantelo Nurseries and Vitacress Herbs

An ICASE student is investigating the efficiency of the commonly used parasitoid wasp *Anagrus atomus*, a native predatory bug *Macrolophus pygmaues* and a proprietary biocontrol product *Macrolophus calignosus* against glasshouse leafhoppers.

CP 152: A systems approach to disease resistance against necrotrophic fungal pathogens in lettuce (HAPI)

Dates: May 2015 – May 2018
Project leader: Katherine Denby, University of York
Location: Various

This HAPI project is using gene editing techniques in an attempt to breed resistance to *Botrytis cinerea* and *Sclerotinia sclerotiorum* in lettuce.

CP 153a: Development of a selective broccoli harvester

Dates: October 2016 – September 2019
Project leader: Simon Pearson, Lincoln University
Location: Lincoln University

A follow-on from project CP 153, Simon and his team are developing a low-cost alternative to the selective broccoli harvester developed at KMS Projects, using a 3-D structured light camera.

CP 165: SCEPTREplus - Research for sustainable plant protection products for use in horticulture

Dates: April 2017 – March 2021
Project leader: Ed Moorhouse, Agri-food Solutions Ltd
Location: Various

The programme delivers applied research on high priority diseases, pests and weeds to support the approval of plant protection products. It seeks alternative chemical, biological and physical treatments to address gaps caused by the withdrawals of actives, resistance concerns or new pest and disease threats.

CP 166: Soil Biology & Soil Health Partnership

Dates: January 2017 – December 2021
Project leader: Elizabeth Stockdale, NIAB EMR
Location: NIAB EMR

Comprising eight scientific partners and six industry partners, the programme is designed to help farmers and growers maintain and improve the productivity of UK agricultural and horticultural systems, through better understanding of soil biology and soil health.

CP 172: Robotic touch, sense and learning of delicate vegetables – VEGEBOT

Dates: October 2017 – September 2020
Project supervisor: Fumiya Iida, University of Cambridge
Location: University of Cambridge

The challenge addressed in this project is to explore the use of the state-of-the-art robotics technology and to evaluate the feasibility of this approach in practice, and explore how, through using computer vision and other techniques, decision making can be automated within the harvesting process.

FV 344c: Combating resistance to aphicides in UK aphid pests

Dates: March 2018 – February 2019
Project leader: Steve Foster, Rothamsted Research
Location: Rothamsted Research

An extension to previous work, monitoring insecticide resistance in aphids and other important UK pests, for example pyrethroid resistance in diamondback moth, and spinosad resistance in thrips.

FV 348d: Onions: Independent assessment of field and storage potential of varieties

Dates: February 2015 – July 2018
Project leader: Bruce Napier, NIAB
Location: NIAB Cambridge

The aim of the work is to provide independent assessment of the yield, quality and storage potential of new onion varieties propagated from both seed and sets.

FV 391b: Carrots: Development of artificial inoculation techniques for cavity spot caused by *Pythium violae*

Dates: August 2017 – September 2018
Project leader: John Clarkson, University of Warwick
Location: University of Warwick

An extension to the earlier phases of the project, FV 391b aims to further develop artificial inoculation systems to induce cavity spot symptoms in pot and field grown carrots using *P. violae*.

FV 432: Carrots: Understanding the ecology and epidemiology of *Pythium violae* to enable disease management

Dates: October 2014 – September 2018
Project supervisor: John Clarkson, University of Warwick
Location: Warwick Crop Centre

This PhD project aims to understand the role of soil microbial communities in cavity spot disease development/suppression as well as develop experimental techniques to allow new potential control measures to be assessed under controlled conditions.

Discover more

Want to know more about any of the projects listed above? Visit our website for full reports and details on all of our AHDB horticulture projects: **horticulture.ahdb.org.uk**

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