The GROWER
THE TECHNICAL JOURNAL FOR HORTICULTURE
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IMPROVING DAFFODIL DIPPING

An alternative treatment to help manage basal rot and stem nematode in narcissus bulbs

UPDATE ON THE LATEST RESEARCH ON *TOMATO BROWN RUGOSE FRUIT VIRUS*

HOW DUTCH NURSERIES HAVE EMBEDDED AUTOMATION AND ROBOTICS IN THEIR BUSINESSES

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COMMENT

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Our industry faces unprecedented and rapid changes from Brexit, climate change and shifting consumer demands. Horticulture's challenge is to continue producing high quality food and plants against a backdrop of a contracting workforce, crop protection pressures and a new era of government policy and regulation.

This spring we'll be giving every grower the opportunity to have their say on how AHDB can help growers rise to the challenge and thrive in this new environment.

It's clear that the window of market failure in the horticulture sector is narrower than when levy boards were first established. It's a natural effect of consolidation, and it's a good thing. Yet, my take on where AHDB can still deliver value is simple. We provide the knowledge to help growers make the best decisions possible.

We do this by providing rare, applied research to tackle the fundamental disease, pest and weed challenges that growers face. We secure vital crop protection products with our chemical authorisations programmme. We help mitigate labour challenges through lean workforce management, and offering guidance in the emerging world of automation.

In future, I think our focus also needs to extend to improving environmental outcomes on farm and helping growers deliver to new government policy. And, where there's demand, providing data and insights that raise our game and maximise British horticulture's full market potential.

Alongside a more focused strategy on *what* we do, I am looking forward to announcing a new approach to *how* we do business with you – our customers. We have to be responsive to growers' feedback, be that directly to us, or the responses to Defra's Request for Views.

Above all, AHDB Horticulture must consistently deliver and demonstrate value. We will improve our engagement with growers, be focused on practical outcomes, and ensure that what we do makes a difference.

CONTENTS

CONTRIBUTORS

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

SPENCE GUNN

Technical journalist Spence Gunn was editor of ***Horticulture Week*** and ***Kew*** (the membership magazine for the Royal Botanic Gardens) before embarking on a career as a freelance, specialising in commercial horticulture and plant science. He edited ***HDC News*** and then ***AHDB Grower*** from 2006 to 2017 and now writes for various titles serving professional growers.

On page 10, Spence reports on the latest research trials at the Cut Flower Centre and on page 22, new advances in lighting for horticulture.

WAYNE BROUGH

Wayne Brough is part of the AHDB Horticulture Knowledge Exchange team, covering ornamental crops. He has responsibility for the generation of publications, electronic media and events into the hardy nursery stock, bedding plant, pot plant, cut flower and bulb sectors, along with a specific focus on the use of growing media across horticulture. Wayne joined AHDB in 2010 having spent 22 years with ADAS as an ornamentals consultant, specialising in the production of container-grown crops.

Wayne visited the Netherlands as part of our SmartHort campaign. On page 26, he shares the latest technology trends he discovered.

MATEVZ PAPP-RUPAR

Matevz is a plant pathologist based at NIAB EMR in Kent. His career started at the National Institute for Biology, Slovenia, where he completed an MSc on phytoplasma of grapevine, followed by a PhD on *Potato virus Y.*

His postdoctoral research at the University of Nottingham focused on UV-induced defences in tomato and cut rose production to control *Botrytis cinerea*.

In 2018, he joined the Pest and Pathogen Ecology team at NIAB EMR, where he is working on the development of new ecology-based pathogen control strategies for a variety of horticultural crops.

Matevz takes a look at new approaches to tackling bacterial canker in cherry on page 15.

IN **BRIEF**

NEW ONLINE HOME FOR AHDB HORTICULTURE

The latest AHDB Horticulture factsheets, events in your area and updates on EAMUs can now all be accessed through **ahdb.org.uk** This replaces the AHDB Horticulture website and has the added advantage of acting as a 'one-stop shop' for those who pay levies to multiple sectors.

WEED CONTROL COVER MATERIALS

A new guide from PCS Ornamental Plant Research has been produced to help growers select and use cover materials to prevent weed growth in hardy nursery stock grown in containers. The guide, which is based on independent research from PCS, |can be downloaded from **ahdb.org.uk/knowledge-library**

ASSESSING DOWNY MILDEW RISK

Onion growers will soon have access to an up-to-date environmental model for assessing the risk of downy mildew, thanks to an AHDB-funded project. MILIONCAST, which had not been updated since 2004, has had a facelift and will soon be available via **cropmonitor.org**, where it will be maintained and reviewed regularly.

MEET YOUR NEW EAMU PROGRAMME TEAM

Following the retirement of Vivian Powell, two new recruits have joined the AHDB EAMU programme team. Headed up by Bolette Palle-Neve, the team now includes Dr Joanna McTigue, who has extensive experience working with efficacy data for plant protection products and Adam Doxford, who brings hugely valuable knowledge of the regulatory system.

HORTICULTURE PANEL MEMBERS **BOOSTED BY NEW RECRUITS**

Eleven new panel members have joined AHDB Horticulture, providing expert advice to the organisation for a three-year term.

The new members represent the industry on five panels: Soft Fruit, Hardy Nursery Stock, Field Vegetables, Protected Edibles and Mushrooms, and Protected Ornamentals and Bulbs and Outdoor Flowers.

New panel member Cristian Marmandiu, Haygrove, said: "Over 14 years of growing and advising on soft fruit crops, AHDB's quality of knowledge has consistently impressed me. More recently, as a member of the research project looking at improving integrated pest management in strawberry crops, the opportunity to explore and challenge horticultural frontiers inspired me even more.

"In my role as an AHDB Panel Member I hope to bring knowledge, experience and a personal passion for horticultural excellence, to some of the issues and opportunities faced by our industry."

The panel members will support the delivery of the organisation's new five-year strategy, which will be launched this year.

The panel members were selected following an application process, which ran until October 2019.

EVENT **ALERT**

AUTONOMOUS GUIDED VEHICLES DESIGNED FOR HORTICULTURE

Our SmartHort Automation Challenge project is developing a prototype autonomous guided vehicle (AGV) for use in horticulture.

Following a competitive process last year, three businesses are working with automation experts, WMG from the University of Warwick, to create an AGV that can cope with diverse and complex horticulture production systems.

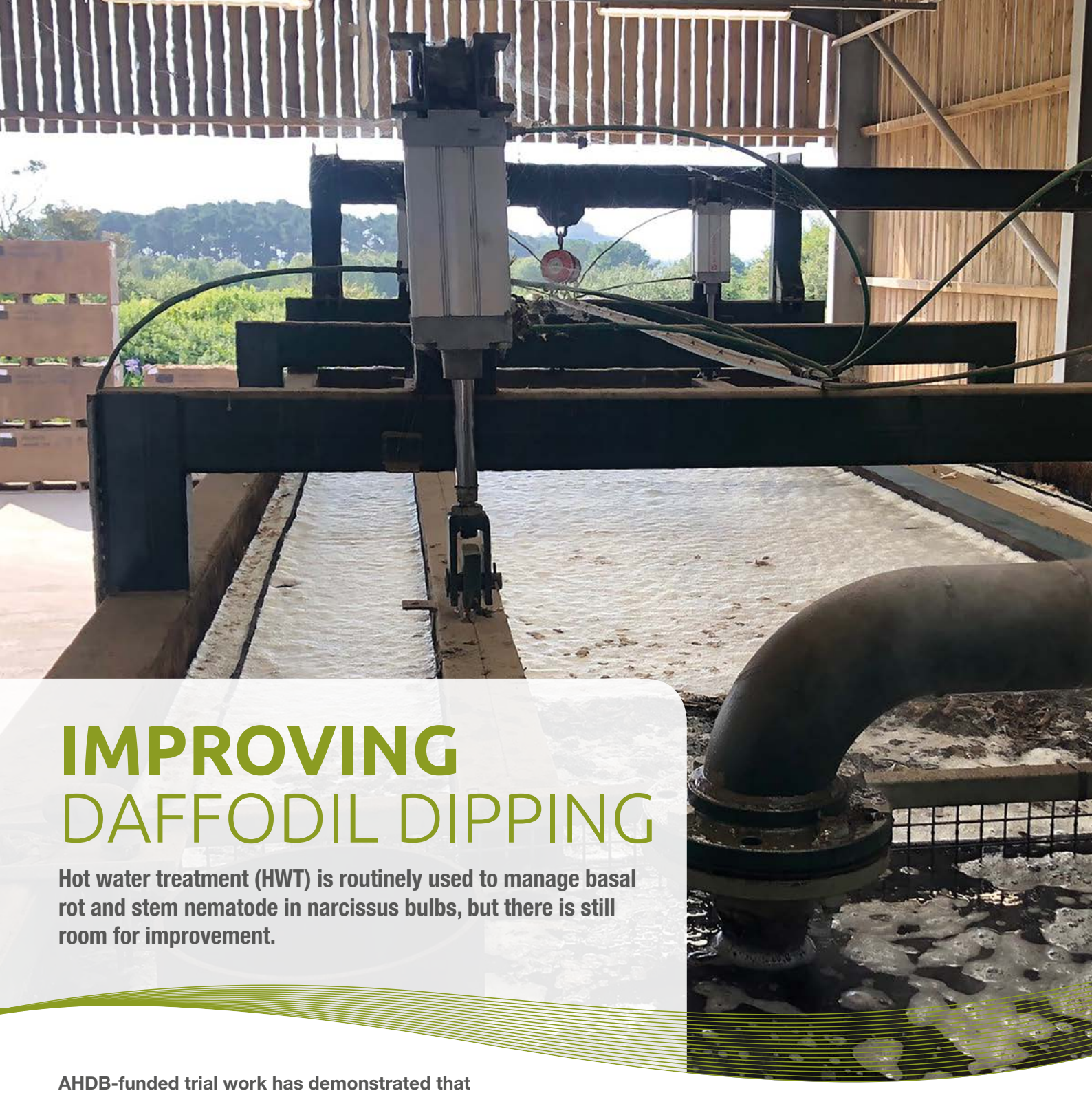
Join us at WMG, where we'll be updating growers on how the project is progressing. You'll also have chance to hear from Warwick Crop Centre, Fargro and the Digital Catapult about how the future of data collection and analysis could revolutionise crop production. 31 March 2020, University of Warwick.

Book your place at **ahdb.org.uk/events**

NEW HEAD OF CROP HEALTH FOR AHDB

Paul Neve has been appointed as AHDB's Head of Crop Health and Integrated Pest Management (IPM), following the departure of Jon Knight last year. Paul, who took up his new role in January, was previously a principal research scientist at Rothamsted Research, leading the weed ecology, evolution and management group, as well as the institute's Smart Crop Protection programme.

Paul, who graduated from the University of Liverpool with a PhD in weed ecology, spent 6 years working for the Australian Herbicide Resistance Initiative. Since returning to the UK, he held a lecturing position at the University of Warwick, before moving to Rothamsted in 2014.



IMPROVING DAFFODIL DIPPING

Hot water treatment (HWT) is routinely used to manage basal rot and stem nematode in narcissus bulbs, but there is still room for improvement.

AHDB-funded trial work has demonstrated that retrofitting chlorine dioxide dosing systems could markedly reduce the number of Fusarium spores present during dipping. During the 2019 dipping season, project BOF 077 explored these results further to help growers decide whether to invest in this technology at their own sites.

The project saw Ewan Cameron, from the Scotmas Group, install equipment at three sites to test the efficacy of chlorine dioxide in both hot and cold water dipping systems.

Alongside Ewan, Rob Lillywhite from the University of Warwick supplied the science – testing water samples and bulbs to measure the treatment effects during the 2019 season and beyond.

We spoke to the growers who took part in the testing to find out their thoughts on the potential value of the work and their experience of having the kit fitted.

Q: WHAT CHALLENGES ARE YOU HOPING TO SOLVE WITH THIS TREATMENT?

We're hoping this treatment reduces or eliminates fusarium basal rot in bulbs for planting, with the secondary effect of reducing nematodes in bulbs.

We're also hoping to reduce the cost, energy inefficiencies and time taken for hot water treatment by using this treatment as an alternative.

Q: IF THE TREATMENT IS EFFECTIVE AND BECOMES WIDELY AVAILABLE TO USE, WHAT IMPACT COULD IT HAVE ON YOUR BUSINESS?

A reduction in fusarium and nematodes would improve the health of our stock and, hopefully, flower yield. With less waste and better quality bulbs, this could have significant benefits for our sales.

Q: DO YOU THINK THE EQUIPMENT AND METHODS ARE EASY TO USE?

The principle of application seems to be straightforward and easy to apply to a commercial setting.

Q: DO YOU THINK THIS TREATMENT IS COMMERCIALLY RELEVANT?

Yes, very – depending on the outcome of this trial work and further on-farm trials.

We also asked Ewan Cameron for his views on the project.

Q: WHAT WOULD YOU SAY ARE THE BENEFITS OF USING THIS EQUIPMENT?

The main objective of this operation has been to supply the growers with an environmentally safe practice, while achieving the objectives of fungal control and maintaining the integrity and viability of the plant. Eliminating environmentally hazardous and unsafe practice has been at the core of our objectives.

Q: WHAT ARE THE COSTS INVOLVED?

Assuming that the work has been successful, preliminary estimates are that six litres of chemical will be needed for every 20,000 litres of water to produce a solution of 10 parts-per-million (ppm), initially, and being maintained at above five ppm for four hours. An average cost of £8 per litre is envisaged, which will treat 12 boxes of bulbs, averaging 950 kg of bulbs each.

Q: ARE THERE OTHER POTENTIALLY VALUABLE USES OF THIS TECHNIQUE FOR THE HORTICULTURE SECTOR?

Technically, anywhere water is being used, there is the potential to transmit to and cross-contaminate plants, seeds, surfaces, etc. so there are many possible applications of this technique. For example, treatment of tools and pots, greenhouse glass and even irrigation systems.

Q: IS THE EQUIPMENT CURRENTLY AVAILABLE FOR GROWERS TO ACCESS OR PURCHASE?

The equipment and chemicals have been available for many years.

Work is needed to be done, however, to reassure the industry that these methods are effective and can be applied to different growing systems and requirements.

THE TRIALS

- **Hot and cold water treatment testing at a site in Lincolnshire with front-loading tanks**
- **Hot water treatment testing at two sites in Cornwall – one front-loading, the other top-loading**

HOW THE TESTS WERE CONDUCTED

Water samples were collected from the tanks at the start of the day, with an additional sample taken once the concentration of chlorine dioxide in the tanks had reached the required level. The amount/concentration of chlorine dioxide varies, depending on how contaminated the water is with soil and biological material, for example fungal spores and bacteria.

Samples of bulbs and water were taken from batches of bulbs that had been dipped without the addition of chlorine dioxide and following the addition of the disinfectant. The water samples were tested to count the number of Fusarium spores present with and without chlorine dioxide. Half of the bulbs from the dips were incubated to see how much basal rot developed in both the treated and untreated bulbs and the remainder were planted to check for adverse effects on the growth or flowering of the bulbs over the next couple of seasons. This growing-on test will also be carried out by the participating growers on their own land.

CUT FLOWER CENTRE – HELPING STOCKS KEEP THEIR SHARE

With column stocks production estimated at 18 million stems per year, much of AHDB's work at the Cut Flower Centre in 2019 focused on disease control and variety trials for what is now a major protected crop for the UK flower industry, writes Spence Gunn.

HOPE FOR FUSARIUM CONTROL

Last year's results from the Cut Flower Centre (CFC) give hope that the soilborne pathogen *Fusarium oxysporum* can be tackled in column stocks in ways other than soil steaming, which – cost apart – is sometimes variable in its effects.

A trial of varietal susceptibility (in a polytunnel where the soil was inoculated with the fungus four years ago) has shown that some varieties have good resilience. "With the very high level of fusarium disease we have in the tunnel [measured in soil samples tested by the University of Warwick last year], I never expected anything to produce a marketable stem," says CFC project leader Lyndon Mason.

Of the varieties planted, some colours of the Japanese-bred 'Iron' series fared particularly well in assessments of marketable stems. 'Iron Cherry Blossom' produced 45 stems/m^2. Several of the commercial standards produced fewer than 5 stems/m^2, although 'Mathilda Yellow' was comparable with 'Iron Cherry Blossom'.

> "You need to start spraying early in the season, using a variety of appropriate fungicides. You should also amend the programme and timing according to the prevailing weather conditions"

Part of the trial included plants from four varieties treated with T34 Biocontrol, a biopesticide first tested against fusarium five years ago. It had then been applied as a module dip, as recommended by the label, but failed to suppress the disease. However, in AHDB-funded trials on lettuce last year, it was shown to have some control. "We mirrored the way the trial was conducted for lettuce – sowing seeds into lettuce blocks and drenching with T34 at seeding, followed by top-up drenches at planting and 10 days later," explains Lyndon.

"The two 'Iron' varieties treated showed no significant signs of fusarium, but it started to show up in 'Fedora' and 'Debora' – both susceptible to the disease – about four weeks after planting.

"Control may be better with less susceptible varieties in areas of lower disease pressure," he adds. "I think it's worth pursuing, even though it's not going to be a silver bullet."

DOWNY MILDEW

Downy mildew control in column stocks wasn't as difficult in 2019 as in the previous year – thanks, in part, to tests commissioned by the CFC to find out whether the pathogen had developed tolerance to commonly used fungicides and the new recommendations produced as a result.

Sensitivity tests found that the more aggressive disease strain growers encountered last year was very tolerant to metalaxyl-M.

"The control recorded for Fubol Gold was from the mancozeb element of the product, so use Manzate 75 instead," says Lyndon.

"You need to start spraying early in the season, using a variety of appropriate fungicides. You should also amend the programme and timing according to the prevailing weather conditions."

The results of the CFC tests were reinforced by recent AHDB-funded trials, which – again –found metalaxyl-M to be ineffective at controlling downy mildew. This reinforced the importance of rotating plant protection products with different modes of action.

The independent fungicide performance trials were undertaken by the James Hutton Institute in Scotland as part of a £294,000 AHDB-funded project to tackle downy mildew and late blight. The results reconfirm that AHDB's suggested spray programme can be used in the 2020 growing season without considerable changes.

VARIETY TRIAL

It has been 10 years since the CFC first investigated the potential to use autumn-flowering varieties to extend the production of column stocks into July or August. Since then, Japanese varieties have been introduced, which are reported to initiate flowers more reliably at higher temperatures than their main crop counterparts.

Some of these varieties produce very few single-flowered stems, so do not need to be selected for double flowers. However, for the majority that do, seedlings must be selected by hand because no distinct difference in leaf colour develops between 'singles' and 'doubles' after the seedlings have been exposed to cooling. Therefore, seedlings must be of high enough quality to attract a premium price and cover the extra cost of hand selection.

Last year's trial of Japanese varieties showed sufficient promise. Plants from the week 29 planting were able to initiate flowers, but excessive temperatures caused some of the developing flower spikes to distort, or stems to fall short of the required length. Because of that, four plantings of three series were made four to ten weeks earlier this year.

Plantings between weeks 19 and 25 resulted in cropping between weeks 27 and 31. Overall stem length of the Japanese-bred varieties was good, but weights following trimming to 45 cm were only comparable to the standard varieties trialled.

The Japanese varieties – the series 'Arrow', 'Avalon', 'Iron' and 'Venus' and the one-off variety 'Vintage Brown' – also offer some different colours to main crop varieties.

Find out more about the work of the Cut Flower Centre at **ahdb.org.uk/cut-flower-centre**

Lyndon Mason

Mark Eves

FRUIT WALL ORCHARD SYSTEMS FOR APPLE

Fruit wall orchards help to make mechanical pruning easier and quicker and reduce costs. We take a look at a recent trial comparing the performance of different nursery tree types in a fruit wall system.

Fruit growers around the world are developing strategies to reduce labour inputs and increase mechanisation and automation in orchards. Fruit wall systems can improve efficiency by enabling mechanical pruning and mechanised harvesting. In the UK, however, there is a lack of knowledge about the different types of trees that can be used to establish new fruit wall orchards.

COMPARING TREE TYPES

AHDB project TF 206 compared five different tree types to assess which was most suitable for establishing fruit wall orchards. The Fruit Advisory Services Team LLP (FAST) at Brogdale Farm, Favesham, Kent, conducted the trial. Royal Beaut trees, a Gala clone, were sourced from specialist nurseries and planted in March 2013 on a site that had been fallow for 10 years.

The tree types tested were:

- One-Year Five-plus-Branches
- One-Year Unfeathered
- Two-Year-Old (grow through)
- Standard Knip
- Twin Stem

> Managing trees in a fruit wall system may be suitable to growing at higher densities, which would likely lead to higher yields per hectare

Trees were planted at 3.5 m x 0.8 m (density 3571 trees per hectare), except for Twin Stem, which was planted at 3.5 m x 1.6 m. The five growing systems were replicated over six blocks, with a total of 270 trees. The trial orchard was not irrigated.

RESULTS

Yield results obtained over five years (2014–2018) showed differences associated with tree type in the initial years, but these differences reduced over time as trees matured and fruiting wood increased.

In 2017, One-Year Five-plus-Branches, Two-Year-Old and Standard Knip types achieved a marketable tonnage per hectare (t/ha) of 50.6, 50.0 and 47.6, respectively. This was a yield increase compared with commercial standard trees of the same age. However, in 2018, only Standard Knip trees yielded above the estimated percentage reduction of 5% and no tree type yielded above standard commercial expectations of 50 t/ha. This could be because of the challenging weather conditions in 2018.

At the end of the trial in 2018, Two-Year-Old trees had the highest cumulative yields and Twin Stem and One-Year Unfeathered had the lowest. Fruit quality was commercially acceptable at >80% class 1, despite the challenging climatic conditions of 2018. Marketable (class 1 and 2) fruit percentages were >90% for all tree types and there were no significant effects of tree type on average fruit weight.

Yield efficiency was also measured to predict potential yield and assess the relative productivity per area. Twin Stem trees maintained the highest yield efficiency throughout the trial and Two-Year-Old trees had the lowest yield efficiency in every year except 2014. Yield efficiency was lower in 2018 than 2017 for all tree types.

Based on the results of this trial, there would be minimal value to growers of adopting a fruit wall system until the fourth or fifth fruiting year and increased long-term returns are unlikely. However, yield responses in more vigorous orchards may be higher than in the non-irrigated trial orchard.

For orchards established in similar conditions to this trial, Two-Year-Old, Standard Knip and One-Year Five-plus-Branches trees would be more profitable than One-Year-Unfeathered and Twin Stem trees.

Managing trees in a fruit wall system may be suitable for higher density growing, which would likely lead to higher yields per hectare. At higher densities, Twin Stems or One-Year-Unfeathered trees may then become viable options, given their enhanced yield efficiency.

The cost of establishing an intensive orchard will vary with the tree type selected – some trees, like Two-Year-Old, can increase in volume more quickly, but this advantage might not be as important when planting at higher densities. In that case, less expensive trees, like One-Year Unfeathered, might be more economically beneficial.

EAMU LATEST

SEEKING SEED TREATMENTS

With many seed treatment approvals now lost, Bolette Palle-Neve looks at how we might plug the gaps in the future

Bolette Palle Neve,
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We have lost several seed treatments in recent years, including neonicotinoids and thiram, which provided important control of various pests and diseases. We are also shortly expecting an outcome on the future of metalaxyl-M, which puts the seed treatment uses for this substance at risk. The loss of these important products presents serious challenges in some crop sectors and straight replacements are unlikely to become available in the short-term.

Trials as part of SCEPTREplus have started investigating how we may fill some of the gaps. Products such as Maxim 480FS appear interesting; for example, as an option for controlling septoria in celery. We have already submitted EAMU applications for several new uses for Maxim 480FS and this should help provide some protection for certain crops.

Another product we are hoping to get approved for speciality crops in future is the biological seed treatment Integral Pro. SCEPTREplus seed treatment trials in 2020 will explore this further, along with other seed treatments – some not yet approved in the UK. We work closely with colleagues in Europe, as well as with crop protection companies, to make sure we are aware of any development products of potential interest for speciality crops.

Insecticidal seed treatments are having an even tougher time. Following the renewal of the tefluthrin label, we have been working towards renewal of the EAMUs for Force ST. Unfortunately, this has not been plain sailing and, at the time of writing, it is still not clear if our applications will be successful.

We are not aware of any new insecticidal seed treatments making their way to the UK market in the short term. It can be particularly challenging to secure approvals for such products for some speciality crops with high seeding rates. It is a real shame because a good seed treatment can help reduce the number of foliar insecticide applications required. However, the perceived risk to birds and mammals makes it difficult to fulfil the regulatory requirements.

EAMUS IN FOCUS

Sercadis

Recent withdrawal of key ornamental fungicides, including Rovral WG and the anticipated loss of products such as Tracker, continues to restrict treatment options and increases pressure on remaining chemistry. Dave Kaye, ADAS, said: “In SCEPTREplus trials on narcissus, Sercadis performed very well, reducing smoulder severity from 27.1% in the untreated to 6.45% in treated plots. Sercadis also significantly reduced the severity of botrytis in ornamental species, including protected Heuchera and Sedum. The recent EAMU for Sercadis is a much needed addition to combat botrytis and powdery mildew in these crops.”

TACKLING **CANKER LOSSES** IN CHERRY

Bacterial canker on stone fruit is a long-standing challenge for the tree fruit sector and can result in significant economic losses. Matevz Papp-Rupar takes a look at new approaches to tackle this disease in cherry.

Canker can reduce yields by infecting flowers and causes the girdling and death of branches and trees. In susceptible young orchards with high disease pressure, this can lead to the loss of the entire orchard.

Copper-based plant protection products, the most widely used of which was Cuprokylt, have helped keep the impact of this disease to moderately low levels in recent years. However, high levels of copper in the environment have been linked to gastrointestinal and neurodegenerative disorders in humans and impaired growth and chlorosis in plants. Most western countries, including the UK, have therefore banned or limited the use of these products.

The current lack of effective control, the high density of commercial planting of susceptible varieties and changing weather patterns in the UK, mean there is a considerable risk that bacterial canker will cause great economic losses in the near future. Therefore, as part of AHDB's SCEPTREplus initiative, which aims to identify and test existing alternative products across a variety of pests and diseases, AHDB is funding two strands of research at NIAB EMR, looking at potential methods of controlling bacterial canker.

The first project tested the bactericidal effect of two botanical-based products (AHDB9884, AHDB9885), two microbial-based biocontrol products (Serenade ASO, AmyloX), two common disinfectants (sodium hypochlorite, hydrogen peroxide) and a food supplement (N-acetyl-L-cysteine, NAC). Several products showed promising results, with NAC, AHDB9884 and hydrogen peroxide performing similarly to Cuprokylt across all assays, reducing both bacterial population and disease severity. Serenade ASO and AHDB9885 also showed encouraging results, especially on leaf tests.

The second project involved collaboration between NIAB EMR and the University of Reading to investigate the use of bacteriophages (phages) to control bacterial canker. Phages are viruses that specifically infect one or a few related bacterial strains and have several advantages over chemical controls. They inactivate bacterial cells instead of just slowing their growth, as some antimicrobial chemicals do. The concentration of chemicals generally decreases after application, while the nature of the phage life cycle enables them to increase their population in the presence of target bacteria, with no impact on beneficial organisms. They are also made of non-toxic proteins and nucleic acids, so are Generally Recognised as Safe (GRAS).

Despite these advantages, phages do have some limitations. Like chemical control, bacteria can develop resistance to phages; however, they have a rapid mutation rate and can overcome this. The narrow host range of phages also implies that new phages are normally required when new bacterial strains are introduced. On their own, therefore, phages are unlikely to give complete control and will most likely be one of several integrated pest management (IPM) strategies to reduce bacterial populations in orchards.

The AHDB EAMU programme team is working to find solutions for canker control for growers and is currently considering an emergency application for a copper-based product for the 2020 growing season. A basic substance has also proven useful in SCEPTREplus trials and the team is exploring the best route to get this approved.

SCEPTREPLUS

WHAT'S NEXT FOR **CAVITY SPOT?**

Cavity spot remains a top concern for carrot growers. We look back at previous AHDB-funded research into the causes and control of cavity spot and set out the next steps for work in this area.

Cavity spot is caused by *Pythium* species; slow-growing oomycete pathogen. Previous work has investigated control measures, including fungicide efficacy, addition of calcium, crop rotations, diagnostic tests, use of biofumigants, irrigation effects and host resistance. Attempts to replicate initial findings, or to test new products or techniques have often failed because of the variability of cavity spot incidence in the field. Attempts to inoculate trials using *Pythium* have also been difficult to interpret because of a lack of reproducibility in symptom development.

The main focus of recent AHDB-funded research has been on understanding more about the species causing the disease, developing tools to quantify *Pythium violae* in soil and development of an inoculation system to improve field trial reproducibility. This work was carried out at the University of Warwick through a research programme and an AHDB-funded PhD Studentship.

The findings have been extremely useful, with results from a large survey (125 isolates from across the country) providing clear evidence that *P. violae* is the main species causing cavity spot infections in the UK, but that other species (*P. sulcatum* and *P. intermedium*) are also widespread.

A new molecular assay to detect *P. violae* in soil gives a significant improvement in sensitivity compared with previous tools. It also allows larger numbers of soil samples to be tested than was previously possible – useful for a soilborne pathogen with patchy distribution. However, a relationship between *P. violae* DNA concentration in soil and the number of cavity spot lesions on carrot roots is yet to be established. The work at Warwick also progressed methods for artificial inoculation with *P. violae*, with the aim of achieving reliable infection and development of cavity spot symptoms in glasshouse and field macrocosm trials.

So, what next for AHDB's work in this area? Members of AHDB's staff have been liaising with growers to decide on how best to proceed.

We spoke to Ian Holmes, in-house agronomist from Strawson Ltd, to find out his thoughts: "Recent work on cavity spot has been useful for revisiting the basics of this unique disease, which we have struggled to ascertain, despite many years of research," he said.

"The PhD work carried out at the University of Warwick has provided some important markers to reinforce some of our understanding and help move ideas for further work forwards.

"One of the main challenges in cavity spot work has been to achieve repeatability and reliability of results. The development of a consistent inoculation technique that allows products or other solutions to be screened for inherent activity against *Pythium* species is therefore a very useful step in, hopefully, discovering some new control strategies. As with any soilborne pathogen, there are some complex interactions and relationships within the soil that determine the incidence and severity of infection. There is still a lot of work to do, both in understanding how the interactions in our soils work to cause infection of carrots and what other cultural or chemical control strategies we can employ to tackle the disease."

AHDB is developing new funding calls for work starting in 2020 under our Crop Diseases Programme to incorporate work on cavity spot. We also aim to carry out efficacy work in the SCEPTREplus programme to investigate potential new fungicide and biofungicide products. This will probably require initial pilot studies to ensure reproducibility of artificial inoculation methods before trials can begin.

Previous research and discussions with growers have highlighted factors to investigate to gain a better understanding of the risk factors for disease development. Physical factors, such as soil moisture status, water input as rainfall or irrigation, pH and nutrient status are all thought to have a role to play. Soil biology and health is another area of interest and the availability of high-throughput sequencing techniques could now enable exploration of the influence of soil microbial communities on the *Pythium* species causing cavity spot. We are considering how the relative importance of the different factors could be determined using research and grower data and AHDB's recently launched Soil Management Information System (SMIS).

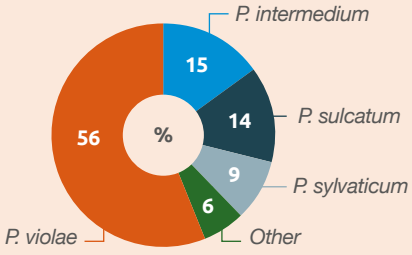
Ultimately, there is still work to be done in this area for several years to come, but AHDB remains committed to finding new solutions for growers.

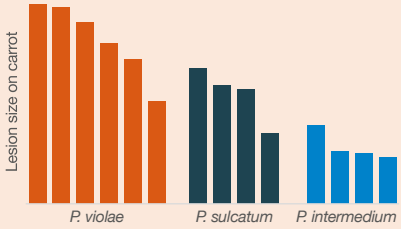
Identifying the causes of cavity spot

Why?

The identity and prevalence of *Phythium* spp. causing cavity spot in the UK was unknown.

- 178 *Pythium* isolated from cavity spot lesions were identified by DNA sequencing
- Different *Pythium* spp. isolates varied in virulence when inoculated onto carrot roots
- *Pythium violae* was the most prevalent species associated with lesions





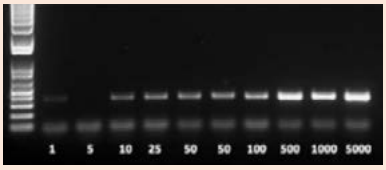
Developing tools for quantifying *P. violae* in soil

Why?

A diagnostic tool for identifying soils with high risk of cavity spot would help field selection.

A method was developed to capture *P. violae* spores from soil using sucrose flotation to increase the chances of detection.

- A quantitative DNA-based PCR test was developed for *P. violae*
- As few as 5 *P. violae* oospores could be detected in a sample



- BUT a clear relationship between PCR results and number of *P. violae* spores in soil has yet to be established

Developing an artificial inoculation system for *P. violae*

Why?

Field trials testing crop protection products or other disease management practices often fail because of low disease.

A method was developed to produce large numbers of *P. violae* oospores.

Carrots were grown in compost inoculated with *P. violae* oospores in glasshouse pot tests:

- Carrots inoculated with *P. violae* had reduced foliage, small stubby roots and typical cavity spot lesions

Carrots were grown in small pots in soil inoculated with *P. violae* oospores in the field:

- Carrots in the inoculated field plots developed a high incidence of typical cavity spot lesions

TOMATO BROWN RUGOSE FRUIT VIRUS – AN EMERGING THREAT TO UK TOMATOES AND PEPPERS

What do we know about *Tomato brown rugose fruit virus*? Adrian Fox and Anna Skelton, from Fera Science, explore how the virus spreads and how it can be controlled.

In June 2019, *Tomato brown rugose fruit virus (ToBRFV)* was reported for the first time in the UK. The outbreak was promptly reported to the Plant Health and Seeds Inspectorate (PHSI) and necessary steps were taken towards virus eradication, including crop destruction. At the time of printing, no further outbreaks had been reported.

Now that the disease has entered the UK, propagators and growers are advised to review their production protocols, particularly regarding imports of seed and plants, and crop hygiene.

Tomato and pepper are the major economic hosts of *ToBRFV,* but inoculation trials have demonstrated experimentally that *Nicotiana* species, as well as *Solanum nigrum, Chenopodium quinoa, Petunia hybrida* and *Chenopodium murale* can act as minor hosts, showing slight symptoms.

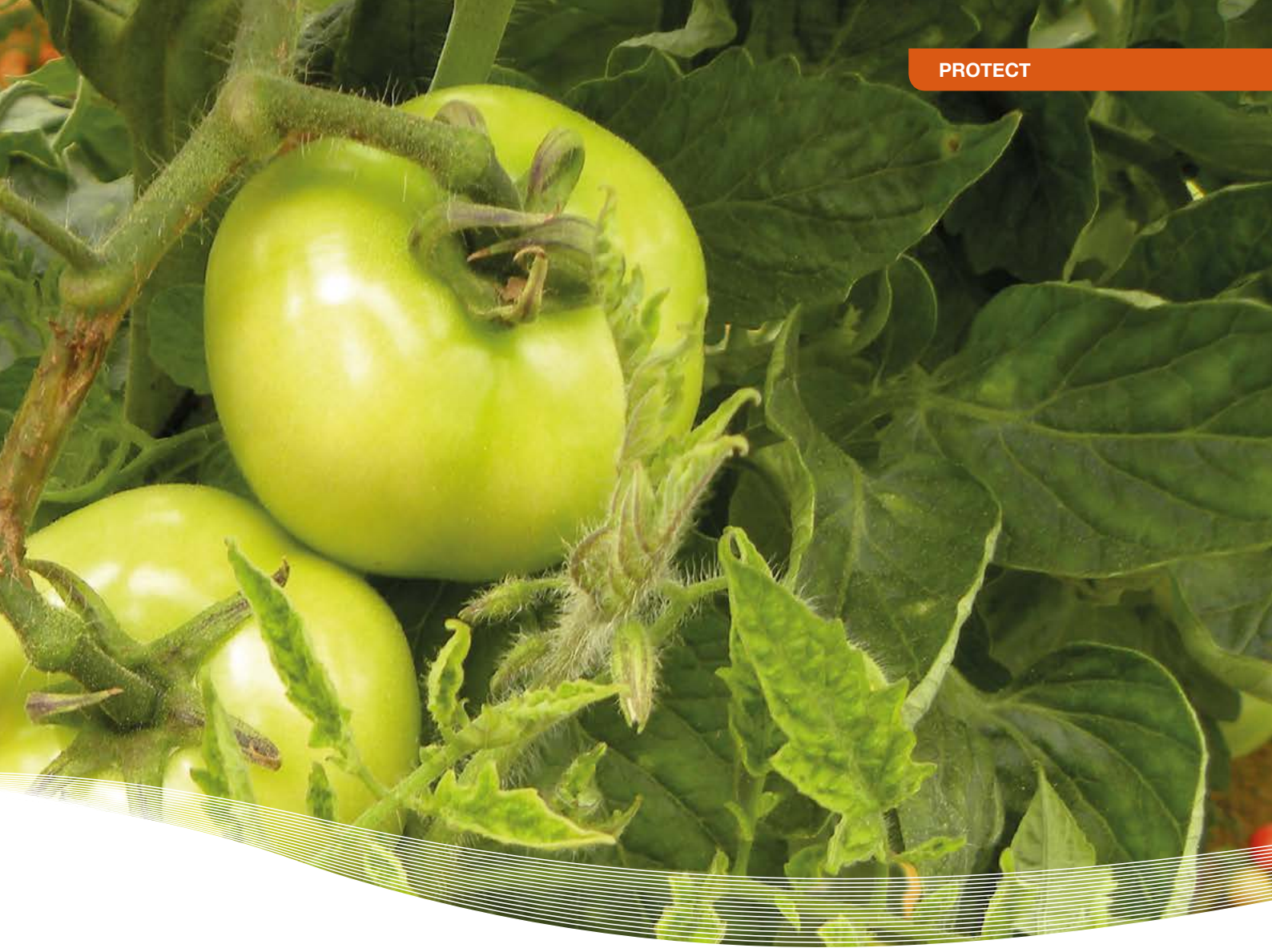
> “It is advised that glasshouse workers wear gloves when handling plants and these should be changed often. The virus is also likely to survive on clothing and hair”

SYMPTOMS

Symptoms of *ToBRFV* infection can vary with variety. In tomato, symptoms can include mild to severe mosaicism, discolouration of the leaves, with some leaves becoming narrower. Tomato fruits can be discoloured and misshapen, turning yellow or brown, with crinkling of the skin (rugose patches). Fruit can develop pale marbling similar in appearance to infection with other viruses such as *Pepino mosaic virus*.

ROUTES OF INFECTION

ToBRFV is closely related to the *Tobamoviruses Tomato mosaic virus* and *Tobacco mosaic virus*. However, *ToBRFV* can overcome the resistance genes to these viruses and, at present, there is no reported tomato resistance to *ToBRFV*. Tobamoviruses are stable outside of their host. The main routes of *ToBRFV* transmission are through propagation material (cuttings and grafts); contact through contaminated tools, hands and clothing; or plant-to-plant contact. As with other Tobamoviruses, it is also thought that *ToBRFV* is seed-transmitted. However, *ToBRFV* has not been found present within the seed, but rather on the seed coat, so good seed treatment protocols should reduce the risk of spread. It has also recently been reported that the virus can be transmitted by bumblebees during pollination.



CONTROL

ToBRFV is robust. Fera Science Ltd has been investigating whether implementing strict hygiene measures can help growers reduce the risk and limit the spread of the virus in a glasshouse. Initial experiments looked at the survival of the virus on skin and disposable gloves. Early results from the project indicated that the virus would survive on both skin and gloves for at least two hours. Washing hands for a minimum of one minute appeared to have some, but limited, efficacy in reducing spread of the virus. Given these results, it is advised that glasshouse workers wear gloves when handling plants and these should be changed often. The virus is also likely to survive on clothing and hair. Where foliage in plant rows is in contact with hair and clothes, zonal working should be considered to limit potential spread around a glasshouse facility.

Further work is being conducted on virus survival on glasshouse surfaces such as glass, aluminium, stainless steel, hard plastic (e.g. picking crates), polythene and concrete. So far, experiments have shown that *ToBRFV* survives for at least one month on all surfaces tested (glass, aluminium, stainless steel, hard plastic and polythene), while on concrete, it survived for at least seven days. Initial testing has shown that the virus survived after one minute of treatment with various disinfectants. Further tests of longer duration treatments are being carried.

From 1 November 2019, emergency measures have been implemented across the EU to limit the impact and spread of this virus. EU Member States must conduct annual surveys for the virus. Seed moving into and within the EU requires appropriate documentation, supported by official sampling and testing. In addition, plants for planting must originate from an area that is free from the virus and be accompanied by appropriate documentation.

As with all virus infections, once a plant is infected, it cannot be cured. Furthermore, it can also act as a source plant for onward infections. In the absence of mitigating measures, growers should employ hygiene best practice as a precautionary measure.

Further details of these measures and the latest updates on *ToBRFV* research can be found on the AHDB website **ahdb.org.uk/knowledge-library/tomato-brown-rugose-fruit-virus**

As the virus is a notifiable plant pathogen, growers should contact APHA for further advice if an outbreak of the virus is suspected.

RIGHT TIME **TO LIGHT**

As further gains in the energy efficiency of light-emitting diodes (LEDs) become harder to achieve, more growers may find it worthwhile to invest in systems that are designed to deliver specific crop benefits, reports Spence Gunn.

Recent advances in lighting technology, especially in LEDs, might have prompted some growers to defer investment because they anticipate further gains in energy efficiency or falls in capital costs. However, the pace of development is reducing, which could help sway the decision for some.

"A typical 400 W high pressure sodium vapour (HPS) lamp has an efficiency of 0.9 µmol/J, but the best is now 1.7–1.8 µmol/J," says Michigan State University floriculture professor Erik Runkle, who has been researching crop lighting for almost 20 years.

"LEDs have a range of 1.1–3.2 µmol, but while their efficiency is still increasing, the rate of progress will slow. I don't think we'll get to the theoretical maximum of 4.7 µmol, although we could get into the upper 3s in the next five years."

Another advantage of LED lighting is the ability to tailor the light spectrum – the balance between the various colour wavelengths a plant needs for photosynthesis and to control growth and development.

There is no 'ideal' spectrum, even for a given species or variety, says Professor Runkle, because it all depends on what crop effect you want, but certain requirements do need to be considered. While red LEDs are the most efficient and red wavelengths drive photosynthesis, plants grow best with some blue light present. Generally, he recommends LED modules that emit at least 10% in the blue spectrum and, if people are working under them, that include some white LEDs.

Much of Professor Runkle's research on spectral effects on growth and development has been conducted on petunia because it is particularly sensitive to changes in spectra. "When there is no far-red in the light recipe, flowering is delayed by two to three weeks," he says. "That's not necessarily so for all long-day plants, but it's enough of an issue that, when purchasing lights, you must ensure the spectrum is right for most of the crops you'll be growing.

"To encourage flowering in short-day plants, you need to include red light; for long-day plants you also need to include far-red."

Specialist horticultural LEDs designed to emit specific light 'recipes' are anything from two to 10 times more expensive than standard 'white' LEDs marketed for use in homes and offices, so growers have started to question whether they could be a viable alternative.

Professor Runkle has compared typical 'cool white' and 'warm white' LEDs for room lighting with horticultural LED lamps. "We expected that the general-use LEDs wouldn't be effective because they didn't emit enough far-red – and that was indeed the case," he says. "Antirrhinum took 53 days from transplant to flower using the horticultural lamps and was 10 days later with the 'white' LEDs, the same as when no lighting was used."

Despite the advances in LED lighting, Professor Runkle points out that there's still a place for HPS for supplementary light – the decision resting on overall costs. "On ornamentals, LEDs really start to become economical when you're using them above 2,000 hours a year," he says. That equates to 16 hours a day from mid-October to early March.

For growers investing in new installations, the cost of any additional power capacity needed can swing the economics, since LED systems require significantly less power.

The health and safety implications of crop lighting installations are often overlooked, but Lighting Industry Association technical manager Gareth John says it's an aspect on which suppliers should offer growers more guidance.

Most horticultural fittings will be classed as posing no hazard if workers adhere to normal behaviour, or only a hazard if stared at for longer than 100 seconds. However, some fittings with high UV outputs could fall into a higher hazard category. Dr John says growers' health and safety manuals should make reference to any lighting installations and the appropriate behaviour workers should follow.

Article based on presentations at the NIAB industry workshop Advances in grow lighting in October 2019, which was supported by AHDB.

RED DUSK FOR COMPACT POINSETTIAS

Research at LVG Ahlem has shown that short-duration red light (660 nm wavelength) applied just after sunset can control poinsettia growth on a par with plant growth regulator treatments. "We call this 'dark red'," says Dirk Ludolph. "It counteracts the effect of far-red in the sunset."

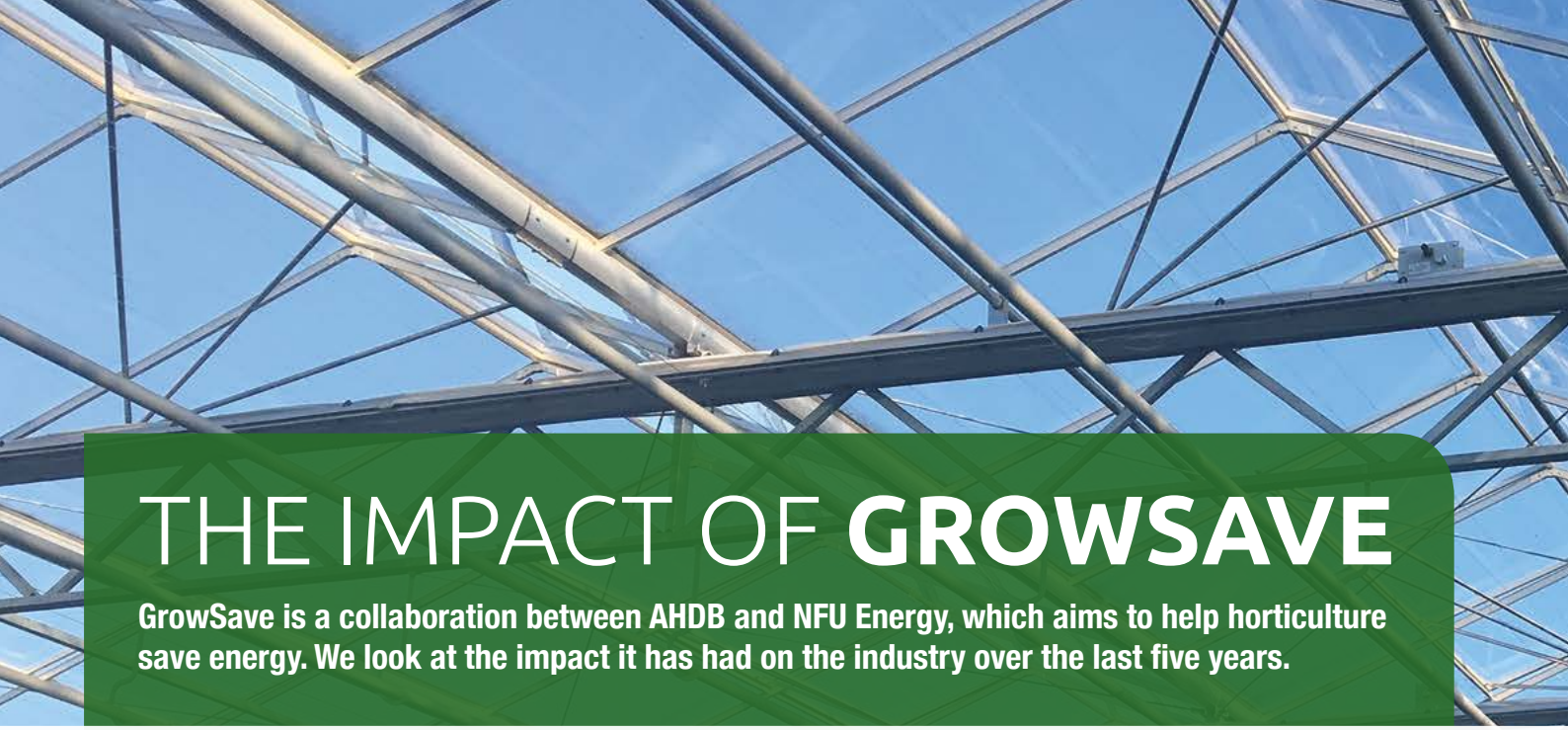
At 40–60 µmol/m²/s, the lighting used was relatively high intensity for photoperiod lighting. "It has to be applied around 60 minutes after sundown," he adds. "If you leave it until 2 hours after, the effect is lost."

LEDS ON THE MOVE

Because LEDs run cooler than HPS lamps, they can sit closer to the crop, which means less lighting capacity is needed per square metre. Some growers now have LEDs on moveable mounts and only bring them down to crop level at night. Meanwhile, growers in the USA are increasingly interested in mounting lights on spray or irrigation booms for photoperiod control under short-day conditions, says Erik Runkle.

These modules can be relatively high intensity, around 10 µmol, but fewer are needed because they pass over the crop rather than lighting the whole area.

The total amount of light received is critical. "Our trials show it needs to be at least 3,600 µmol/m^2, which in turn depends on the number of boom passes and the speed and the average intensity from the time the plant is at the 'front' of the beam to the time it passes out of the light," he says.



THE IMPACT OF **GROWSAVE**

GrowSave is a collaboration between AHDB and NFU Energy, which aims to help horticulture save energy. We look at the impact it has had on the industry over the last five years.

Originally borne from a desire to help horticulture businesses save energy and reduce their environmental impact, GrowSave has become a valuable resource for the UK horticulture sector. The volatility of energy prices over the last five years, as demonstrated by gas prices fluctuating between less than £0.30/therm and over £0.70/therm, coupled with the increased demand for year-round produce, has been a considerable driver in the desire of businesses to carefully manage their energy consumption. GrowSave has helped the industry keep abreast of the latest developments in energy-saving techniques, as well as advising on alternative (and often 'greener') sources of energy.

The availability of the Renewable Heat Incentive scheme since 2011 has been key to helping businesses reduce their carbon footprint by adopting renewable technologies. While substantial investment is often required to take advantage of the scheme, the advice and expertise provided by GrowSave has allowed many businesses to realise the long-term financial benefits of government incentives. Furthermore, adopting renewable energy sources can result in reduced reliance on fossil fuels, making production more sustainable in the long-term.

While switching energy sources can be a good starting point towards reducing environmental impact and lowering energy bills, further financial savings can be achieved by improved energy efficiency. By helping businesses recognise areas of potential energy efficiency improvements, whether through the use of thermal screens in glasshouses or by adopting more effective climate control strategies, GrowSave has substantially reduced the amount paid out by the industry in the form of the Climate Change Levy.

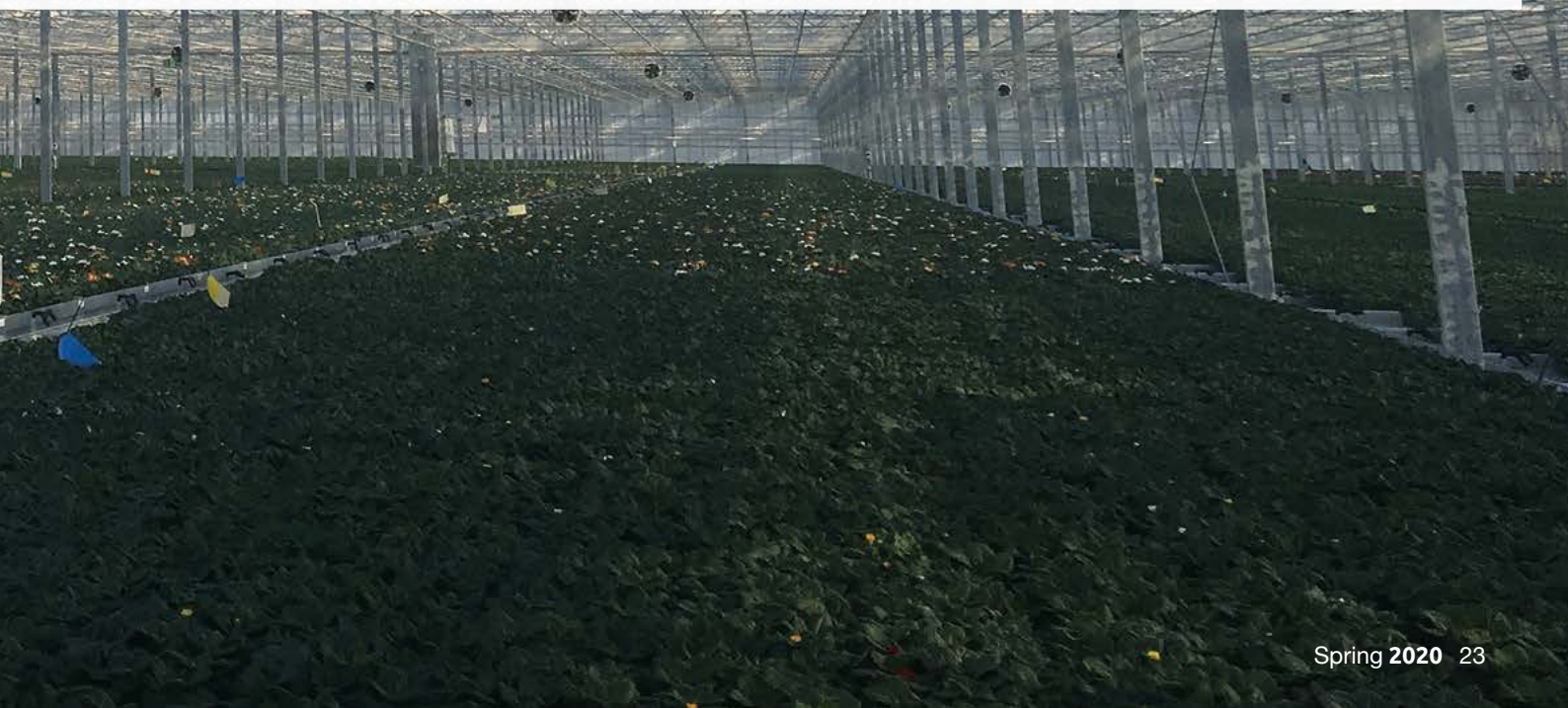
In addition to advising on established UK growing methods, GrowSave has spent a considerable amount of time investigating

best practice in other European countries, particularly Belgium and the Netherlands. The findings have been fed back to UK growers through seminars, study tours and a pilot study group programme, which trialled Next Generation Growing (NGG) techniques. Through this close collaboration with growers, those involved could understand the potential benefits of NGG and were given the confidence to implement techniques that may previously have left them feeling uncomfortable. Anecdotal evidence from the programme suggests that adopting the NGG approach has helped to increase yield, improve crop quality and reduce losses, reflecting outcomes seen in Dutch horticulture. In the same way that the use of thermal screens and temperature integration have become standard practice for many successful commercial growers over the last couple of decades, GrowSave believes that the NGG techniques will also filter through the industry over time, with recognised best practice continuing to evolve.

Another important factor in increasing the impact of the GrowSave programme has been its expansion into other sectors. Originally focused on Protected Edibles and Protected Ornamentals, GrowSave has recently also incorporated Soft Fruit. Investigations have already been carried out into how the UK industry compares with some of its European neighbours and work continues to help growers implement proven strategies for more profitable crop production.

Going forward, GrowSave will continue to provide effective energy saving advice to the industry, while also helping businesses keep abreast of the latest technological and strategic developments. NFU Energy (formerly FEC Energy) will continue to deliver the programme.

grow save
helping horticulture save energy



KILL THE TILL?

The land is cloaked in soil that makes it fit for cultivation and crop establishment, but this essential resource is highly vulnerable and needs protecting. James Taylor from AHDB's Horticulture Knowledge Exchange team, reflects on the importance of soil and the impact of AHDB's soil health research.

If soil health and preservation are compromised, the consequences can be catastrophic. A well-documented example is the Great Dust Bowl of the 1930s in the southern plains of America. Failure to implement dryland farming methods, along with the extensive use of deep tillage, led to vast degradation and topsoil erosion. The terrain became choked in dust storms and the agricultural industry collapsed.

Soils harbour life: a single tablespoon of soil contains more organisms than the entire human population of the earth. The biodiversity below ground far surpasses the diversity above it by orders of magnitude. This diverse community works in synergy to enhance the environment on which it depends. Despite soil fauna making up one-third of all living organisms, the mysteries surrounding their biology and importance are only just starting to be unravelled.

High amounts of organic matter are a signature of healthy soils. Many soil organisms can harness the nutrients of organic matter and excrete them in a form that crops can use. Earthworms are a prime example: they decompose and excrete digested organic matter in the casts they leave behind and help distribute nutrients throughout the soil profile.

Earthworms' extensive channelling nature also improves soil structure by loosening and aerating the soil. This reduces compaction and creates channels that aid water flow and considerably decrease run-off.

> "Tilling is one of the biggest contributors to declining soil health because it directly exposes fauna to predators and harmful UV radiation from the sun. It also destroys soil aggregates, severely dehydrates the soil and causes potentially huge losses of carbon"

FUNGAL FORAGERS

Nitrogen (N_2) is an essential nutrient for crop development. Despite the air containing around 70% N_2, plants are unable to directly access this source. They are therefore highly dependent on certain soil bacteria, such as rhizobia, which can fix N_2 from the air and convert it into ammonia (NH3), which can be readily used by plants. Because of this, plant families, such as legumes, have evolved a symbiotic relationship with N_2-fixing bacteria. In exchange for NH3, legumes provide bacteria with a home in their roots and organic sugars produced by photosynthesis. This relationship improves soil N_2 levels, hence is the reason legumes are common in crop rotations.

Phosphorous (P) is an equally important nutrient for plant development. P availability is limited in most soils because it is released very slowly from insoluble phosphates; therefore, it is commonly the most limiting factor for plant growth. However, a branch of soil fungi known as arbuscular mycorrhizal fungi (AMF) can vastly increase the availability of P for plants.

When plants roots are colonised by AMF, structures known as hyphae are formed, which branch extensively through the soil like a net. As hyphae are far thinner than root hairs, they can access far smaller pores of soil and extend far beyond the reach of roots.

Similar to N_2-fixing bacteria, there exists a symbiotic relationship in which AMF transfer captured P to the plant, in exchange for organic sugars produced by photosynthesis.

Bacteria and fungi, including AMF, have also been shown to exude compounds that physically bind soil particles together into micro-aggregates. These micro-aggregates provide soil fauna habitat, while making the soil considerably less prone to erosion and increasing its water retention capacity.

CULTIVATING SOIL HEALTH

Despite the benefits of soil fauna, modern practices can be detrimental to their survival. Tilling is one of the biggest contributors to declining soil health because it directly exposes fauna to predators and harmful UV radiation from the sun. It also destroys soil aggregates, severely dehydrates the soil and causes potentially huge losses of carbon. Furthermore, it vastly increases erosion rates and causes organic matter losses. Consequently, a growing number of farmers are adopting reduced tillage or no-till practices, with the aim of reducing these impacts.

AHDB SOIL HEALTH RESEARCH

Soil physics, chemistry and biology all play a role in maintaining productive agricultural and horticultural systems. While the physical and chemical properties of soil are relatively well understood, the same is not necessarily true for soil biology. This is why AHDB has funded a five-year research and knowledge exchange programme that aims to increase understanding of soil biology and develop a toolkit to measure and manage soil health.

This programme set out to evaluate soil assessment methods for growers, while improving their confidence in using approaches to analysing soil health and choosing suitable management options. It highlighted that small measures to improve soil health, such as using short-term green manures within a season, are worth the effort. It also identified the most useful and practical tools for soil testing across different horticultural production systems.

Further information can be found at: **ahdb.org.uk/greatsoils**

GREATSOILS

EMBRACING AUTOMATION

How have nurseries in the Netherlands embedded automation and robotics in their businesses? Wayne Brough, AHDB Knowledge Exchange Manager, went and found out.

Figure 1. Study tour delegates examine the automated bench system at Perry van der Haak Nursery

SMARTHORT

Nursery production systems have evolved over time in response to ever-changing influencing factors, including available technologies, environmental legislation and customer demand. With the increased availability of robotics and automation, many UK businesses have automated single tasks or several closely related tasks.

A classic example of this has been the rise of the automated transplanter, which has become a standard feature in many nurseries.

But is looking at the whole nursery production system, rather than individual tasks, a better approach?

Looking at the system as a whole has definitely reaped rewards at several large bedding and pot plant nurseries in the Netherlands, which have taken a strategic approach to automating their businesses.

PERRY VAN DER HAAK

Perry van der Haak is a specialist pelargonium nursery based near Gravenzande. The nursery is entirely designed around automated bench movement.

Within their new 3.2 ha site, the 4,000 production benches are controlled by a sophisticated software system that allows individual bench movement to be controlled throughout production and dispatch, either from the office computer or via mobile phone.

The system, installed by Codema, minimises the time staff spend moving around endless batches of plants. Plants can also move more easily through the various production zones to the dispatch area, which is located on a mezzanine floor in the glasshouse.

ZUIDBAAK NURSERY

This business, which is similar to a typical UK production nursery, has achieved a joined-up approach to nursery automation on a relatively small budget. Powered shovels and conveyors move bulk-growing media to the production lines. Transplanting occurs via a TTA transplanter, while a continuously moving chain pulley system, embedded in the concrete paths, automatically moves plants around the nursery on trolleys.

Plants are placed onto beds (and lifted) in bulk by several large, manually operated, powered forks. An irrigation tunnel can water several trolleys of plants at a time, prior to dispatch.

“4,000 production benches are controlled by a sophisticated software system that allows individual bench movement to be controlled throughout production and dispatch, either from the office computer or via mobile phone”

WOUTERS NURSERY

Wouters has again taken a whole-nursery approach to automation. A buggy or trolley system wirelessly follows a signal cable in the concrete path. A large, bed-sized, spacing machine spaces plants directly on beds. A Danish trolley shelving machine creates the necessary number of trolleys for dispatching the finished product.

BEEKENKAMP

Some businesses use intensive automation at key production stages. The young plant producer Beekenkamp has numerous seeding, sticking and gapping-up machines within their production lines, including 'next-generation' sticking equipment from ISO Group Agri.

Although their sister company, Deliflor, has used similar sticking machines for years, to stick chrysanthemum cuttings into peat blocks, the next-generation robotic arm can now handle various cutting materials. The latest model can be converted from a sticking machine to a transplanting machine with a change of heads.

GEBR. GROOTSCHOLTEN NURSERY

Rather than move equipment to beds, at Gebr. Grootscholten plants on benches are moved to the machines where they are graded and spaced, while still on the benching.

Not all innovation needs to be complex and expensive. This nursery also has home-made mobile seats for the staff who clean floor-grown crops by hand, to help minimise back stress.

BAAS NURSERY

Not all automation focuses on the production phase. At Baas Nursery, a prototype box-making robotic arm was being put through its paces on the dispatch line, prior to potential commercial installation.

Wayne visited these nurseries as part of the SmartHort and Bedding and Pot Plant Centre automation study tour group, organised by AHDB and BOPA. Many thanks to all the nurseries who hosted the tour.

Figure 3. Bed-wide spacing machine employed at Wouters Nursery

Figure 4. The ISO Group sticking machine in action, handling Osteospermum cuttings at Beekenkamp

Figure 2. The powered fork system employed at Zuidbaak Nursery for plant movement to and from production beds

Figure 5. Box-making robotic arm at Baas Nursery

Figure 1. The Harvest Automation HV-100 robot

THE RISE OF THE **MACHINES**

A variety of cutting-edge, specialist equipment was on display at one of Europe's leading nursery machinery trade shows.

SMARTHORT

Baumschultechnik is a nursery machinery trade show staged in Ellerhoop, a few miles north of Hamburg in Germany. It attracts thousands of visitors from all over continental Europe, particularly growers of field-grown nursery stock.

The show brings together a variety of specialist machinery manufacturers and distributors into a single location. A diverse array of equipment is on display, covering almost every aspect of production, including soil sterilisation, crop lifting, grading and bundling. Visitors can see new pieces of kit, upgrade old machinery, purchase spare parts and network with other growers. The show features a whole spectrum of machinery and automation, from simple wheelbarrows for delivering fertiliser to row-grown crops, through a range of tractor-mounted equipment, to robots for weeding and spacing container-grown plants.

ROBOTS ON DISPLAY

Several robots made their debut at Baumschultechnik this year. The Harvest Automation HV-100 robot, which has been in commercial use for several years in the USA, offers growers a fully autonomous option for spacing container-grown nursery stock on production beds.

Figure 2. Trooper spacing robot

A prototype product (Trooper) from Instar Robotics offers a similar solution, but several containers are held on a carousel arrangement on top of the robot. The manufacturers are interested in exploring the option of adding other capabilities to the robot, beyond spacing, which would enhance its potential.

Also on display was the Naio-Oz, from Naio Technologies. This small-scale robot is designed to undertake various inter-row crop cultivation operations, guided by laser and camera. Finally, Robotti from Agrointelli, is a larger-scale autonomous carriage linked to a Kubota diesel engine, which is designed to take various attachments for field cultivation and mechanical weed control.

Non-chemical weed control was an emerging theme at the show, with a range of electrical weeding equipment on offer from Zasso. This included a small-scale manual device for semi-industrial urban weeding, landscaping and gardening, along with tractor-mounted equipment for field-scale weed control. GrassKiller, developed by Droppelmann, is a 2,000 L bowser and application arm, towed by a tractor, which destroys weeds by applying cold water at a pressure of 1,000 bar into the ground down to a depth of 3–6 cm.

Another exhibitor at the show was Robot Makers, which equips other manufacturers' vehicles with intelligent steering technology to work autonomously. For example, instead of relying on the signal from a global positioning system (GPS), the Row Crop Pilot works with a complex laser scanner, enabling machines to autonomously mow or undertake band spray applications.

Various specialist multi-equipment carriers (manually steered or radio-controlled) were on display for use in row-planted hedges. Able to straddle row-grown hedging plants, these tracked or wheeled devices are capable of trimming or lifting plants and applying spray or fertiliser to crops.

There is increasing interest in the use of small drones as an inexpensive way of monitoring crop growth in horticulture. However, commercial drones with larger lifting capacities and longer flight times are less common. DJI specialises in the manufacture of drones for agriculture. Their latest model, DJI MG-1S Agras, has a lifting capacity of 10 kg and can work for 22 minutes at a time. It can be equipped with standard nozzles and a small tank for spray application to crops in hard-to-reach locations (depending on legislative requirements).

Figure 3. Multi-equipment carrier

Other spray application equipment included a tractor-mounted, single-arm, air-assisted, folding boom sprayer with maximum arm length of 12 m, specifically designed for container-grown crops and taller field-grown crops. A battery-powered, air-assisted backpack sprayer was a recent development from Birchmeier. The spray solution is fed from a knapsack into a hand-held blower and five settings on the device and three different cone nozzles permit application up to a distance of 13 m via several spray patterns and droplet sizes.

Figure 4. GEJO grading machine

Grading, preparation and dispatch are still the most time-consuming jobs in the production of field and container-grown ornamental plants. These are processes that can be difficult to automate because of the knowledge, dexterity and visual accuracy required. Two grading machines were on display at the show: a commercially available model from GEJO Grading and a prototype from SMO. Both apply camera and optical grading software technology to sort seedlings into different sizes prior to bundling. However, manual input is still required to place the plants onto the machine and to bundle or bag the plants post-grading.

We visited the Baumschultechnik trade show in August as part of our SmartHort campaign to connect the horticultural industry with the latest technology and automation to help speed up the uptake of innovation. You can find out more about SmartHort at: **ahdb.org.uk/smarthort**

CHANGING PERSPECTIVES WITH **LEAN THINKING**

The UK's first Strategic SmartHort Centres were launched last year to help growers address the challenges surrounding labour and its rising cost. We spoke to Willie Russell, from Easter Grangemuir Farm in Fife, to find out how getting involved with the project has benefited him both personally and professionally.

Willie Russell
Easter Grangemuir Farm

Easter Grangemuir Farm is a fruit, vegetable and arable business based in between Anstruther and Pittenweem in the East Neuk of Fife. Like many farms in the East Neuk area, the farm relies heavily on overseas labour to help them through the busy season.

"My role in the business is to manage the potatoes, broccoli and all the arable crops on the farm," said Willie.

"With that, much of my time is spent managing people and processes, looking for ways to reduce our costs while continuing to produce quality products."

Developing staff skills is a key priority for the farm. Willie became involved with the Thomas Thompson Strategic SmartHort Centre in Perthshire at the suggestion of colleagues. To date, he has taken part in two workshops.

"The workshops have been a great experience for me. I've enjoyed meeting new people and broadening my mind on how other businesses work and how other products are produced," he said.

"My favourite part, so far, has been the fantastic conversations that we have all had about how we do a certain task in our operation compared with how other businesses do it.

"No matter what the product, I have been able to extract small points from the conversation and use them to my advantage."

EMBRACING LEAN PRINCIPLES

The workshops have introduced delegates to the key principles of Lean, including pull systems to make the supply chain more efficient, visual management aids to trigger when to order new stock and testing a reorganised workspace to potentially reduce the amount of time wasted walking and waiting. Willie found the 'waste walks', examining where efficiencies can be made in the business, particularly useful.

"The information has always been in front of us in plain view, but it took this course to help me process it and work out how to alter certain areas of the business to become more efficient.

"It has made it easy to see on paper where the business could be more effective and what is effective already."

Participants are being encouraged to put the Lean principles into practice in their own businesses. In Willie's case, he is focusing on broccoli production, specifically looking at the packhouse.

"Broccoli production is labour intensive and any way we can cut down the costs and become more efficient is positive," he said.

> “No matter what the product, I have been able to extract small points from the conversation and use them to my advantage.”

Willie has already made some changes to the business, which have had a substantial impact.

“The changes I’ve made include placing a whiteboard in the packhouse with the day’s orders on it so that it is visible for everyone. This has reduced the downtime changing from one order to another, since when the forklift driver is not busy, he looks at the order and prepares the boxes or crates that will be used for the next order. This has saved 5–10 minutes per order switch.

“Making the flow of broccoli to the broccoli stalk trimmers continuous has made the process more efficient too. This was an easy fix, by training the stalk trimmers how to do their job smoothly.

“Implementing Kanban [a scheduling method] has been a huge positive in the overall production system, meaning less downtime.

“The next step I want to implement is to look over the whole business and see if there are other quick fixes that can be done to lower costs and become more efficient. I am also going to have a meeting with my colleagues and hopefully train them in the Lean principles.”

Willie is keen to encourage others in the horticulture sector to get involved with the SmartHort centres.

“I would 100% recommend this project to every business, no matter what size you are. This programme of work trains you to think about your business differently. It makes you realise the little things that, in the past, you have noticed but not identified as a bottleneck or an inefficiency.

“With costs going up for everything, apart from our product, we, as farmers, need to work on how to cut costs, while still producing a quality product.”

More information about the SmartHort project and the Strategic SmartHort Centres can be found online at: **ahdb.org.uk/smarthort**

If you’d like to find out about becoming part of the Strategic SmartHort Centre network in the future, please contact: **grace.emeny@ahdb.org.uk**

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