



Your guide to current AHDB Horticulture work and how it can help your business



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Introduction Contents

Working alone or in groups, growers have a long track record in developing, for instance, highly innovative production techniques or harvesting systems and finding ways to become ever more efficient in their use of labour, energy and water. But when it comes to crop protection R&D – whether we're talking about chemical, biological or cultural methods – the specialised facilities, expertise, legal knowledge, time and financial resources required are almost impossible for individual horticultural businesses to support. That's where AHDB comes in.

For the past 30 years HDC, and subsequently AHDB, has been able to react to the industry's demand for new and improved crop protection products and biological control agents so growers can continue to produce the level of yields and quality that they need to remain profitable. We provide this service in several ways but mainly through trials to test new or alternative products for their effectiveness at controlling pests, diseases or weeds in horticultural crops. More recently, an increasing number of projects has looked to develop novel control methods that will reduce growers' reliance on chemical crop protection products

“An increasing number of projects has looked to develop novel control methods that will reduce growers' reliance on chemical crop protection products”

and assess ways of using them as part of integrated pest management systems. We also fund research into specific biological control programmes.

Regular 'gap analyses' enable us to identify the combinations of crops, pests, diseases and weeds that growers have the most problems in managing because of the lack of available products, commissioning new research in response to find alternative products or techniques. Where these require new authorisations for horticultural crops, we act on the industry's behalf by submitting data to the Chemicals Regulation Division – the UK regulatory authority – and publicise new authorisations to growers.

This issue of *AHDB Grower Crop Protection Review* outlines how we achieve this in collaboration with many different organisations in the UK, elsewhere in Europe and further afield. It also explains how the research that you fund results in new product approvals and other new crop protection methods – and some of the hurdles we have to overcome along the way.

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Information in this publication about crop protection substances or products is intended to inform growers about work undertaken by AHDB Horticulture or other organisations and is not intended to endorse or recommend their use.

Only products officially approved as crop protection products should be applied to control pest, disease or weed problems or used as plant growth regulators.

Before using any such substances, growers should refer to product approval and label documents and seek guidance from a BASIS qualified consultant.

Where views are expressed in this publication they are the views of individual contributors and do not necessarily reflect the views or policies of AHDB or its AHDB Horticulture division.

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AHDB's crop health and protection team

The expertise of AHDB's crop health and protection team spans agriculture and horticulture. Its head, Jon Knight, is one of the horticultural specialists along with scientists Joe Martin, Cathryn Lambourne and Kim Parker; and Vivian Powell and Bolette Palle Neve who specialise in regulatory issues and product approvals for horticulture.

The team works with the horticulture sector panels on crop protection projects ranging from trials for specific crops to wider programmes aimed at tackling some of the most pernicious pests, diseases and weeds that all farmers and growers have to deal with – such as aphids or oomycete diseases. The work we commission includes learning more about their fundamental biology and behaviour, and developing integrated control

measures based on crop protection products, biopesticides and biological controls, plant resistance and cultural practices. The research we fund is complemented by knowledge and new information from elsewhere around the world.

Our goal is a relevant and rapid response to growers' needs. Our 'gap analysis' helps identify the combinations of crops and pests, diseases and weeds that growers are having, or could have in future, the most problems in managing. Anticipating changes in availability of products, however, is increasingly difficult. So we're bringing in a new member of the team later in 2017 to monitor changes in the regulation and registration of pesticides in Europe and the UK, to gain as much warning as possible for growers and to enable us to

begin looking for replacement products or control measures as soon as possible.

Our long-term SCEPTREplus and AMBER projects will not only help identify these alternatives but will also generate data to support EAMU applications and guide growers on the use of the new chemical products and, increasingly importantly, biopesticides.

We work closely with organisations that need our independent information in their work supporting the industry, such as the NFU, British Growers Association, Association of Independent Crop Consultants and the Crop Protection Association, sharing intelligence and knowledge. And we meet regularly with manufacturers to find out about new crop protection products, risks to existing ones and to collaborate to apply for new EAMUs.

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Gaps and priorities

Joe Martin describes how AHDB decides on the key pest, disease and weed targets for its trials to focus on

Screening new products already used in other farming sectors, and even those that may not yet be on the market, to see if they have anything to offer horticultural crops is a vital part of AHDB's crop protection work. The key to doing this efficiently is to know the 'gaps' in control that matter most to growers – the crops and targets for which there are currently no, or very few, effective measures and where growers are vulnerable to products being withdrawn in the near future.

So in 2016 AHDB Horticulture completed a comprehensive survey of the pests, diseases and weeds that growers are trying to contain – enabling us to pinpoint the gaps in the measures available for controlling them and hence where we should be focusing our R&D or knowledge exchange work. It was the first such survey since the Defra-funded report *Impact of changing pesticide availability on horticulture* in 2010.

Taking that as our starting point we surveyed and documented the range of crop protection strategies growers employ across 45 crops or crop groups. We included cultural control methods as well as the chemical and biological products used and covered all current pests, diseases and weeds as well as those considered a potential future risk. The analysis was undertaken by researchers or advisers with particular expertise in each crop. From the results we were able to identify and rank in order of priority the gaps that exist for each combination of crop and pest, disease or weed target.

With the amount of new legislation affecting the availability and use of crop protection products that has been brought in since 2010, the introduction of new biopesticides, the development

of resistance to some existing chemical products, and the emergence of new pests and diseases that may lead to current practices breaking down, it's an important time to have such a detailed report on growers' options – or lack of them.

Our prioritisation was judged in part on the frequency that a pest, disease or weed occurs, and its financial impact, along with the number of cultural, biological and chemical options available to control them. The compatibility of products to current integrated pest management programmes was also taken into account – where the only products available against a particular target were incompatible with IPM, then we interpreted it as a gap.

We also highlighted gaps likely to arise where growers depended on products that could soon be withdrawn, such as neonicotinoid insecticides or products likely to be classed as endocrine disrupters.

Although several products may be effective against a particular combination of crop and target, it doesn't necessarily mean there isn't a gap – the actives may have similar modes of action, for example, meaning there's a high risk of resistance evolving in the target species. To fill the gap we need to find other products with different modes of action, or cultural or other approaches, to use in resistance management. So, where few controls are available or there is a high risk of losing them, the problem was ranked as a gap of high or medium priority.

Summaries of the current analysis for each crop group are available on the AHDB website at horticulture.ahdb.org.uk/gap-analysis and I've outlined some of the key ones here. Given the ever-changing situation, it's important to keep the gap analyses updated and we'll start that process later in 2017.

WEEDS

One of the biggest challenges for growers is to reduce reliance on chemical herbicides as the number of available products continues to fall – our analysis found high priority gaps in weed control in 38 of our 45 crop groups. Inability to manage weeds could render some crops uneconomic to grow in the UK in future.

The looming loss of linuron is particularly critical – the final use date for this pre-emergence herbicide is June 3, 2018. Its loss will leave a big gap in weed control in field vegetables.

Work in the original SCEPTRE project identified herbicides that might fill some gaps, particularly those containing the active substance metobromuron, a pre-emergence herbicide that performed well in the trials. We have since used the data from SCEPTRE and the results of our gap analysis in discussions with manufacturers on the future availability of some of these herbicides and to see where we might be able to apply for new approvals or EAMU authorisations.

New UK authorisations for metobromuron are expected to be granted between 2018 and 2020.

Weed control will remain central to the new SCEPTREplus project and there has been a good level of interest from manufacturers in offering herbicides for assessment. For instance, trials will assess options to replace linuron in carrot and parsnip. SCEPTREplus will also look at other novel weed control options such as electric weeding.



New weed control measures are a high priority for 38 of the 45 crop groups covered in the gap analysis

DISEASES

Disease control still relies heavily on fungicides applied as foliar sprays, drenches and seed treatments. Soilborne disease organisms remain particularly difficult to manage.

As is the case with pests, the ongoing loss of active substances will increase the chance of pathogens evolving resistance to those that remain. In future, disease control will rely more on the newer types of products such as biofungicides and plant elicitors alongside chemical fungicides.

Disease management will also depend more on a combination of different techniques to maintain plant health, including cultural methods, the use of clean plant material, resistant varieties, diagnostic tools and disease forecasting, some of which will need further R&D before they can be used commercially.

The gap analysis confirmed that oomycete pathogens are becoming increasingly difficult to control. In leafy brassicas, for example, a lack of products that can be applied during propagation means losses of up to 15% can occur in the field as a result of downy mildew. The problem also persists in baby-leaf crops which have such a short production time that the required harvest intervals of crucial fungicides often can't be met. SCEPTREplus will seek solutions to this.



ADAS

Downy mildew in cauliflower: oomycete diseases are becoming increasingly difficult to control across all sectors

Botrytis is one of the most serious diseases affecting pepper crops but there's a lack of alternative fungicides with differing modes of action to combat it. Management is particularly difficult at the end of the season. The disease is also a major problem for stored cabbage since the loss of approval for iprodione (Rovral) and finding a replacement product or strategy will be a priority in SCEPTREplus.

PESTS

The analysis highlighted the significant loss of pest control options that has reduced growers' ability to manage some of our most damaging insect pests. Some of those that remain will be subject to reregistration as their existing approvals come up for renewal – and more stringent criteria could result in restrictions on their future use or even see them being lost altogether. The increasing availability of biopesticides could help to close some of the gaps that we have identified but the analysis confirmed that growers lack confidence in using them. That's why AHDB is funding the AMBER project (see p12) to find out how crops can be managed and products applied to obtain the control from biopesticides that they are capable of.

Gaps in aphid control were judged a priority for many crops, especially where there's an associated risk of virus transmission. For example, yield losses from the viruses aphids transmit, coupled with direct damage to young plants, can be as high as 30% in leafy brassicas.

Aphicide resistance has also limited the number of useful products so a more robust resistance management strategy is needed, not just in field crops but in glasshouses, too, where resistance has been observed in populations on crops such as peppers. The added complication is that in greenhouse crops growers need complementary products that will support existing IPM systems.

The results of the gap analysis led to aphids being considered a priority for the first year of SCEPTREplus, with products being screened first in the laboratory so the most promising can be trialled later on crop plants.

Western flower thrips was also identified as a priority in protected edible crops and in ornamentals – it's one of the biggest issues for flower growers. The pest was investigated in the MOPS project on ornamentals and this work will continue in SCEPTREplus.



ADAS

Western flower thrips damage on verbena: the pest is now widely resistant to most insecticides available to growers of ornamentals

Back to basics

Some familiar substances are becoming valuable crop protection tools, as Bolette Palle Neve reports

Even with the enormous effort we put into finding horticultural uses for new crop protection products – and the work we do with their suppliers and the registration authorities to secure approvals for them – there can still be pests, diseases and weeds that can't be managed effectively in some crops.

That's why it's so important to keep all options open – and one that is becoming increasingly relevant for growers is that of 'basic substances'. These are substances commonly used for all sorts of purposes other than crop protection, such as calcium hydroxide (lime) and sucrose (sugar), that are deemed safe to people, animals and the environment. Calcium hydroxide is known to be effective in controlling fungal diseases such as canker in apples, while sucrose has some activity

against codling moth on apple and corn borer in sweetcorn.

The European Commission (EC) has an avenue for approval of such substances for plant protection, which is adding an increasing number of useful products to a grower's crop protection toolkit.

In crop protection, a basic substance is 'an active substance, not predominantly used as a plant protection product but which may be of value for plant protection and for which the economic interest of applying for a full approval may be limited'. Criteria are laid down for their approval and specific provisions set enabling them to be legally used in the EU after having been specifically approved as basic substances. Fifteen are currently approved by the EC for plant protection and these are listed in the table.

We're continually working with scientists, industry bodies and growers to keep abreast of substances which offer potential in crop protection so that we can submit applications for authorisations.

One recent example is the authorisation

of sodium hydrogen carbonate as a basic substance for use as a fungicide and herbicide. Its potential as a liverwort treatment was recognised by Mike Norris, then general manager at New Place Nurseries in West Sussex, who heard about its use from New Zealand growers at a meeting of the International Plant Propagators Society. This led to its inclusion in a herbicide screening project (HNS/PO 192a) in container-grown ornamentals, where it worked extremely well – it has a physical mode of action, drawing water out of the liverwort by osmosis and drying it out.

Based on its performance in the trials, AHDB sought an approval for liverwort control as an extension to an existing EU basic substance approval as a horticultural fungicide. We were helped by Patrice Marchand from the French organic farming research institute who has built up considerable experience in putting together the required dossiers for submission of basic substance approvals to the EC. Unlike crop protection products, which have to be approved by each EU member state before they can be used in that country, the EC accepts submissions for basic substances by any member state on behalf of all the others.

One important benefit of basic substances to growers is that their ubiquitous nature means they tend to be cheaper to purchase than approved plant protection products, the cost of which has to cover the vast amount of trials and safety data that has to be generated by their manufacturers (see p16).

We at AHDB are pleased that the EC has recognised the value and benefit of these basic substances as a component of integrated crop protection that growers need to remain competitive. We'll continue to work to gain approval for further substances that we think will have significant benefit for growers.

Further information about basic substances, and those that are currently approved, can be found on the AHDB website at horticulture.ahdb.org.uk/basic-substances.

Currently approved basic substances

SUBSTANCE	APPROVED PURPOSE*
Calcium hydroxide	Neonectria and other fungal diseases on pome and stone fruit
Chitosan hydrochloride	Elicitor of plant defences against bacterial and fungal pathogens on vegetables, berries and small fruits
Clayed charcoal	Soil-applied against complex of soil-inhabiting fungi causing black measles on vines
Diammonium phosphate	Attractant to aid management of mediterranean fruit fly, cherry fly and olive fly in orchards
<i>Equisetum arvense</i> (extract)	Scab, mildew and peach leaf curl on fruit trees, cucumber and tomato
Fructose	Elicitor of plant defences against codling moth on apple
Hydrogen peroxide	Liquid disinfectant for mechanical cutting tools to help prevent spread of soilborne plant pathogenic bacteria in protected edibles (eg tomato and pepper)
Lecithins	Powdery mildew in various salad and fruit crops and ornamentals; and tomato late blight
<i>Salix</i> spp. (cortex)	Fungal leaf diseases on fruit trees, including apple, and vines
Sodium hydrogen carbonate	Apple scab, mildews on soft fruit, vegetables and ornamentals, liverwort in pot-grown ornamentals
Sucrose	Elicitor of plant defences against codling moth and sweetcorn borer
Sunflower oil	Powdery mildew on tomato
<i>Urtica</i> (extract)	Aphids, caterpillars, spider mites and foliar diseases
Vinegar	Fungal and bacterial leaf diseases on tomato, ornamentals and various vegetables
Whey	Powdery mildew on cucumber, courgette and squash

*See horticulture.ahdb.org.uk/basic-substances for full details before use

Prospects for new solutions

Long-term projects such as SCEPTRE, MOPS and SCEPTREplus are resulting in more answers to pest and disease control, write Joe Martin and Bolette Palle Neve

For many growers, our work testing new crop protection products and developing new strategies for using them is the most significant aspect of AHDB's role.

More and more of this is now being undertaken as part of a long-term strategic approach, particularly when it comes to work on targets such as aphids or downy mildews that affect crops across the horticultural sectors.

That doesn't mean, though, that we can't respond to new or highly specific crop protection problems as they arise – the arrival of a new pest, for example, or the unexpected withdrawal of a key product. Our programmes are, in fact, designed to allow for just that kind of event.

The first of these long-term projects was 'Sustainable crop and environment protection – targeted research for edibles', or SCEPTRE, which ran from October 2010 to March 2015. It was co-funded by Defra under the Horticulture LINK scheme. A similar approach for the ornamentals sectors was 'Managing ornamental plants sustainably', or MOPS, which ran from December 2013 to January 2017.

In April 2017 we launched SCEPTREplus to test products on both edible and ornamental crops.

SCEPTRE (CP 077)

More than 80 chemical products and 60 biopesticides were screened on fruit and vegetable crops in a series of trials to assess their effectiveness against a range of pests, diseases and weeds. For those showing most promise, AHDB worked with the manufacturers and with the Chemicals Regulation Division to obtain authorisations – either as on-label



Apple mildew: trials on its control in SCEPTRE led to a new EAMU for the fungicide Talius (proquinazid)

approvals or through EAMUs. The project included work on how these products could be integrated into growers' existing control programmes.

The list of products identified for horticultural roles in SCEPTRE is too long to include in this article but there are some notable examples which have, or soon will, help the industry.

In cucumber, for example, Amistar (azoxystrobin) gave good control of pythium and phomopsis root rots. We have since secured an EAMU which allows growers to apply it through drip irrigation.

The active substance sulfoxaflor gave excellent control of aphids. We're currently generating residues data to support its use in protected strawberry

and raspberry; and we're working with colleagues in Belgium to generate data to support approvals for protected leafy salads. Meanwhile, Teppeki (flonicamid) performed extremely well against aphids on carrots and in 2016 we worked with colleagues in Sweden and the product manufacturer to generate residues data.

Herbicide trials in field vegetables showed that Successor (pethoxamid) offers pre-emergence control of groundsel and is safe to use in onion, leek, lettuce, courgette, vining peas and dwarf green beans. We have recently generated data to support future approvals in alliums and plan to generate the required data for cucurbits in 2017.

Talius (proquinazid) successfully controlled powdery mildew in apple and we subsequently secured an EAMU which allows its use twice per season. A new product, Luna Sensation (fluopyram + trifloxystrobin), also offered excellent control of powdery mildew in protected strawberry and now has a full approval.

MOPS (CP 124)

We knew some of the new crop protection products identified by SCEPTRE would have potential for ornamental crops so investigated these further in the MOPS project.

Nine chemical fungicides and five biofungicides were tested against powdery mildews and rusts while six chemical insecticides and eight bioinsecticides were pitted against pests including aphids, carnation tortrix, vine weevil, western flower thrips and whitefly.

Three of the chemical fungicides including Reflect (isopyrazam) and Luna Sensation performed well against both powdery mildew and rust, while two

including Takumi (cyflufenamid), now approved for use in ornamentals, gave good control of powdery mildew. Three biofungicides, including Serenade ASO (*Bacillus subtilis*), showed broad-spectrum activity against both powdery mildew and rust.

Two chemical insecticides (sulfoxaflor and an experimental product from Syngenta) were effective against peach-potato aphid and melon and cotton aphid; the experimental product was active against western flower thrips, too, while sulfoxaflor also controlled glasshouse whitefly.

The bioinsecticides tested were useful against aphids with some effect on whitefly, western flower thrips or vine weevil. The approved biopesticide Botanigard WP (*Beauveria bassiana*) mixed with Majestik (maltodextrin, which has a physical mode of action) also had useful activity.

When screened on a range of cut flower, protected ornamental and hardy nursery stock crops, none of the treatments tested in MOPS caused significant or long-lasting phytotoxic damage.

We compared disinfectants with conventional fungicides, a physical control method and a biological system of anaerobic soil disinfection for controlling fusarium and pythium on surfaces or in soil. All the methods tested showed some promise although registering disinfectants for such uses is likely to be challenging. A molecular diagnostic technique was investigated for detecting and identifying leaf and bud nematodes.

As a result of MOPS we secured an EAMU for Reflect for ornamental plant production and we're currently working with manufacturers to seek UK authorisations for sulfoxaflor and Syngenta's experimental insecticide which we hope will include approvals for ornamentals. We're also discussing the opportunity for an EAMU to use Luna Sensation in ornamentals.

Future work on ornamentals will be included under SCEPTREplus.

SCEPTREplus

The four-year £1.4 million SCEPTREplus programme carries forward the work from both SCEPTRE and MOPS.

Embracing pest, disease and weed control in fruit, vegetable, protected edible



Two novel chemical products and two biopesticides tested during MOPS were effective against aphids on ornamentals

and ornamental crops, it's designed to respond to emerging crop protection problems as well as addressing longer term issues.

It includes work on chemical, biological and physical crop protection methods and will look at novel products as well as new uses for those already on the market. Some new approaches including physical techniques such as electric weeding may also be tested.

SCEPTREplus will link with other crop protection projects already underway. In particular it dovetails closely with the AMBER project on biopesticides (see p12). Both projects will test biopesticide products for their activity against specific pests and diseases, though AMBER is focusing on helping growers to get the optimum performance out of approved products already on the market, when using them under commercial growing conditions. The lessons learned in AMBER will, in turn, feed into trials on novel biopesticides in SCEPTREplus, to give us the best chance of seeing their full potential. With this in mind we are also keen that growers who are willing to share their experiences of using biopesticides get in touch to add to the valuable bank of information that will underpin our efforts to develop more reliable control using these products across the industry.

SCEPTREplus is also closely linked to projects such as HNS 198 on weed control in hardy nursery stock, FV 446 on white tip control in leeks and the programmes on

IPM in fruit (SF 156, SF 157 and SF 158 and TF 223), making sure that lessons learned on one crop can be applied to others and that nothing is duplicated.

The project is being undertaken by a consortium chaired by Ed Moorhouse of Agri-Food Solutions and includes ADAS, NIAB EMR, Stockbridge Technology Centre and the University of Warwick. There is flexibility to bring in other researchers to access relevant expertise cost effectively.

The programme is backed by a high level of support from manufacturers and suppliers of agrochemicals and biopesticides. Eighteen companies are already providing materials, products and in-kind support and a number are supporting it financially too.

There are more than 30 priority targets and the plan for the first year includes more than 20 trials, chosen following consultation with sector panels, grower associations and using AHDB's gap



Trials of celery herbicides in the first season of SCEPTREplus are already showing some with promise

SCEPTREplus targets for year 1

TARGET	SECTOR	CROP
Diseases		
Bacterial canker	Tree fruit	Stone fruit
Bacterial diseases	Hardy nursery stock	All hardy nursery stock
Downy mildew	Bulbs & outdoor flowers Field vegetables Hardy nursery stock Protected edibles Protected ornamentals	Brassicas, onion, herbs, baby-leaf salads, cucumber, nursery stock, pot plants and bedding plants; including edibles and ornamentals in propagation
Powdery mildew	Protected edibles	Pepper, tomato
Oomycetes (<i>Phytophthora</i> & <i>Pythium</i> spp.)	Bulbs & outdoor flowers Protected edibles Protected ornamentals	Range of crops
Leaf mould/ <i>Phytophthora</i> /pythium root and foot rot	Protected edibles	Tomato
Botrytis	Field vegetables	Brassicas (post-harvest, pre-storage)
Pests		
Spotted wing drosophila	Soft fruit	Cherry, plum, strawberry, cane fruit, blueberries
Western flower thrips	Bulbs & outdoor flowers Hardy nursery stock Protected edibles Protected ornamentals	Cucumber, pepper, tomato, range of ornamentals
Thrips	Field vegetables	Leeks and a range of other crops
Two-spotted spider mite	Protected edibles	Cucumber
Tomato russet mite	Protected edibles	Tomato
Asparagus beetle	Field vegetables	Asparagus
<i>Tuta absoluta</i>	Protected edibles	Tomato
Aphids	Field vegetables Protected edibles	Range of crops, including management of virus transmission
Weeds		
Broadleaf weeds and grasses	Soft fruit	Blackcurrant (includes electric weeding)
Broadleaf weeds and grasses	Field vegetables	Leek and onion (includes electric weeding)
Range of weeds including perennials and annuals	Soft fruit	Rhubarb
Groundsel, willowherb	Bulbs & outdoor flowers	Narcissus
Groundsel	Field vegetables	Celery, salads
Broadleaf weeds and grasses	Field vegetables	Carrot, herbs, sweetcorn

analysis (see p4). The project has been designed to include as wide a range of fruit, vegetables, protected edibles and ornamental crop types as possible from the start. Priorities for the following years will be refined in further consultation with growers and based on the trials results.

All trials will follow EU standards so the results can be used to support approvals where appropriate in the EAMU programme. They will also be designed after consultation with growers to ensure they follow commercial practice and are relevant to current production systems.

With at least one event to be held for each trial growers will have opportunities to see results for themselves and to talk to researchers to gain early insights into the implications for crop management. We're also planning other meetings and workshops and the use of blogs and webpages to enable growers not only to follow the results but to

comment on and influence the project.

An industry steering group has been set up for SCEPTREplus with a member from each sector. The members, who are listed in the panel, will be involved in designing the trials and choosing the products to be tested.

Representatives from the British Carrot Growers Association have already helped to identify products and programmes for the first trials which focus on weed control in carrots and parsnips and are being run on sites in Cambridgeshire, Nottinghamshire and Suffolk. Other weed control work will include a product screen for herbs and trials in rhubarb, sweetcorn and celery. An electric weeder will also be assessed.

For pests and diseases that are common problems across horticulture, such as downy mildew or aphid control, we're starting with product evaluations and crop safety trials.

SCEPTREplus WHO'S WHO

INDUSTRY REPRESENTATIVES

Field Vegetables Philip Lilley

Hardy Nursery Stock Alastair Hazell

Protected Edibles and Mushrooms

Ben Cruikshank

Protected Ornamentals and Bulbs & Outdoor

Flowers Phil Collison

Soft Fruit Roger Vogels

Tree Fruit Nigel Kitney

RESEARCH LEADERS

John Atwood (responsible for ornamentals and for herbicides and plant growth regulators)

Rosemary Collier (field vegetables and insecticides)

Jerry Cross (soft fruit and tree fruit and nematocides and beneficials)

Martin McPherson (protected crops and fungicides)

Roma Gwynn (biopesticides and basic substances)

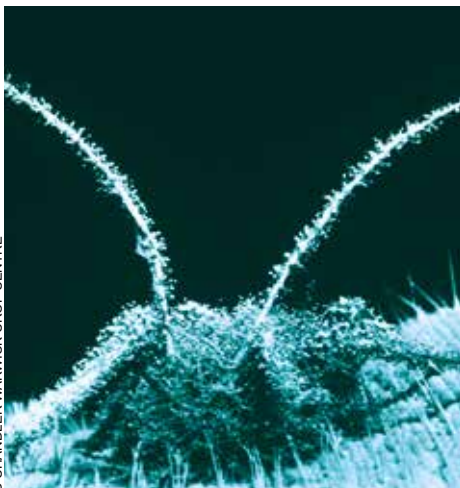
Biopesticides

Biology steps up

With biopesticides set to play an increasingly important role, Roma Gwynn considers how market forces, legislation and R&D are affecting their availability in the UK



INTERFARM



D CHANDLER WARWICK CROP CENTRE



Biopesticides such as *Bacillus thuringiensis* var. *kurstaki* (far left, which has successfully controlled these caterpillars), *Lecanicillium muscarium* (left, seen here infecting an aphid, photographed under a scanning electron microscope) and *Metarhizium brunneum* (formerly *M. anisopliae*, shown above infecting vine weevil larvae) have been available for several years but there are now more new ones awaiting approval in the EU than there are in chemical products

Growers are increasingly turning to biopesticides as part of their integrated pest management programmes. Not only are they effective at reducing populations of pests and pathogens, they can also help to reduce the risk of resistance developing to chemical crop protection products, and aid residue management.

In the early 1990s, the global market for biopesticides and biological controls was estimated to be around \$100 million; by 2015 it had grown to \$2.5 billion and is forecast to reach around \$80 billion by 2021. And at the beginning of 2017 the number of biopesticide active substances awaiting approval in the EU was greater than for chemical products.

Defra's pesticides use survey shows that the area of protected edible crops treated with biopesticides in the UK increased by 65% between 2013 and 2015. The most widely used products in terms of treated area were the biofungicide Serenade ASO (*Bacillus amyloliquefaciens* strain QST713, formerly known as *B. subtilis*), used on 1,002ha; the bioinsecticides Dipel DF and Lepinox Plus (*Bacillus thuringiensis* var. *kurstaki* strains ABTS-351 and E2348 respectively), used on 545ha; the biofungicide Prestop (*Gliocladium catenulatum* strain J1446) used on 51ha; and the bioinsecticide Naturalis-L (*Beauveria bassiana* strain ATCC 74040) at

33ha treated. The picture is more mixed when it comes to field vegetables where use of Dipel DF and Lepinox Plus halved over the same period while the area treated with Serenade ASO increased by 8%.

The wider use of biopesticides is reflected in the range of products available in the UK. There were 16 authorised in 2009; by 2014 there were 23 and now there are 46, based on 31 active

THREE ROUTES TO CONTROL

BIOLOGICAL CONTROL AGENTS

These are non-microbial organisms such as predatory mites, parasitic wasps and insect-killing nematodes. Products based on them don't require authorisation as a crop protection product but a licence is needed for use of those based on non-native organisms.

BIOPESTICIDES

There are three types of biopesticide, all of which require authorisation as plant protection products before growers can use them.

Microbial: the active substance is based on a microorganism – usually these are living organisms but products may include active compounds produced by microorganisms.

Botanical: active substances based on plant material or extracts of plant material.

Semiochemicals: active substances that are based on chemicals emitted by plants, animals and other organisms and which are used by these organisms for communication – insect sex pheromones, for example, or compounds released by plants in response to a pest infestation. These include synthetic copies of the natural substances. When used purely for monitoring (for example, as lures in insect monitoring traps), semiochemicals don't require authorisation – but they must be authorised if they are used as plant protection products, such as for mass trapping, lure and kill, or mating disruption.

BIOSTIMULANTS

These are substances, mixtures or microorganisms that are not nutrients but which stimulate a plant's metabolism in some way. If used for crop protection they generally require authorisation as plant protection products: confirmation on the status of specific products should be obtained from the Chemicals Regulation Division.

substances including microbials, botanicals and semiochemicals (see panel). Work by AHDB Horticulture through the EAMU programme and projects such as SCEPTREplus is only likely to make more available in the future.

However, while the range of biopesticides and the targets they are effective against are expanding, there are still fewer available in the UK than in the rest of the EU, where more than 120 biopesticide active substances are approved. The UK's small, fragmented market, coupled with low demand by growers in some crop sectors are among the barriers, along with regulatory hurdles. The number of biostimulant products on the market also limits demand for authorised biopesticide products.

FASTER APPROVALS

All biopesticides are registered as plant protection products in the same way as chemical pesticides. However, as microorganisms represent special types of active substances, the data requirements for them have been adapted and under the current regulations the whole process from submitting the dossier to product approval is meant to take no longer than five years.

The most efficient of the regulatory agencies in the member states, helped by good quality dossiers, are meeting the time limit and some, such as the Netherlands, are quicker. Many have made efforts to develop their expertise in biopesticides and are using it to support those applying for approvals and to train staff in agencies in other member states. The EU has been working with the International Biocontrol Manufacturers Association to shape guidance for those applying for approvals, which will further streamline the registration process.

The EU has also come up with a category of 'low risk substances'. This is expected to apply to many biopesticides, for which the product evaluation stage should take no more than 120 days instead of up to 18 months, meaning such products should get onto the market more quickly.

The big question, of course, is what happens after the UK leaves the EU? We know that differences in regulatory approaches are already a barrier to companies wanting to market products in the UK. Retaining the same regulatory frameworks would at least minimise any

THE LAW AND BIOSTIMULANTS

Labels and other written claims for biostimulants usually steer a careful path to indicate that while they can support plant health, they are not plant protection products – because if they were, they would need EU approval, authorisation by the Chemicals Regulation Division (CRD) in the UK and have to carry a MAPP authorisation number.

The situation can be confusing for growers, many of whom tell us that some of the verbal advice they receive from suppliers goes beyond the written claims in terms of their biostimulants' effectiveness in crop protection. However, unless they are officially authorised, these products have not been independently evaluated for their safety or effectiveness. While a few of the biostimulants on offer can be used without authorisation, the majority can't so their use is most likely to be illegal. There is growing evidence that some companies are using this so-called 'grey area' to market products that are illegal plant protection products and when reported to CRD this has usually been confirmed.

A grower's safest policy, therefore, is only to use products that are authorised and have a MAPP number, or to ensure that the supplier can explicitly confirm that the product has been exempted from authorisation or is out of scope of plant protection product regulations.

A new regulation being drafted by the EU on changes to the fertiliser CE mark will propose that biostimulants are defined as substances that aim solely to improve the plant's nutrient use, crop quality traits or tolerance to environmental stress (ie not caused by pests, diseases or weed competition) and so are similar to fertiliser products. Any product that also has crop protection claims or attributes would be excluded and have to be registered as a plant protection product. Once finalised, this change should help clarify the situation for biostimulants.

potential hurdles for new biopesticides. AHDB published an analysis of the various options in an Horizon report in January 2017.

INNOVATION

Many of the new biopesticides being approved in the EU are variations on existing ones. For example, the first *B. amyloliquefaciens* strain (QST 713, the active substance of Serenade ASO) was approved in 2007 – now there are

a further six strains of the same species approved and a further three pending. It's a similar story for other microbials such as the insect-killing fungi *Beauveria bassiana* and *Metarhizium brunneum* (formerly *M. anisopliae*).

But there are some completely new ones which will expand the range of pests and diseases controlled, such as the microorganism *Pasteuria nishizawae* strain Pn1 for use in the management of plant parasitic nematodes, or botanical actives such as orange oil for use against insect pests. So far no new active substance for weed management has been approved, leaving just one, Barrier H, based on plant oils, on the UK market.

Until recently, many biopesticides new to the EU originated in the USA. But now more are being developed within Europe, either by research establishments or commercial companies with their own screening and development programmes. Products are also being brought forward from other countries such as Australia, Brazil, India and Kenya.

FUTURE

As experience in biopesticide technology advances, we're gaining a better understanding of how the active substances work and how to use the products effectively. For example, the AMBER project (see p12) is showing how adjustments to application methods and timing can get the best results from products already on the market.

With alternative technologies such as biopesticides becoming more common, crop protection is becoming more complex. Initially restricted to protected cropping, the use of biopesticides in field crops is growing too.

We're beginning to understand that the way crops are grown may need to change to help us make the most of both applied and naturally occurring beneficial organisms. Research into plant and soil ecology, for example, is revealing the significant role of microorganisms in crop health. That in turn has implications for plant breeding, to influence a plant's ability to attract and then maintain a beneficial microflora on its leaf surfaces, around its roots and even in internal tissues. By implication this means that the types and timing of crop protection treatments will need rethinking too.

Biopesticides

Life chances

A five-year AHDB research programme aims to reshape our expectations of biopesticide performance on edible and ornamental crops

The first commercial biopesticides were introduced as far back as the 1970s but until relatively recently there has never been more than a handful on the market. Interest from companies in developing more has cranked up several gears, though, with the arrival of the EU's Sustainable Use Directive, which obliges growers to use chemical treatments only as a last resort. At the same time, through legislative and market changes, there has been a dramatic reduction in the number of synthetic chemical crop protection products registered in Europe.

Biopesticides offer the advantages of low risk, no residue and, in particular for protected crops, short re-entry times. Microbial biopesticides often have more than one mode of action, and this is likely to reduce the chances of pests and diseases developing resistance to them. When used in integrated pest and disease management, biopesticides can also help reduce the likelihood of resistance developing to chemical products. This means that more widescale use would help prolong the effective life of some of our most important chemical treatments.

But while some biopesticides have proven their worth, others are falling short in terms of the results that growers expect from them. "There's already plenty of evidence that, under the right conditions, biopesticides can be valuable crop protection tools," says Warwick Crop Centre microbiologist and entomologist Dave Chandler. "The good things about them are their safety and compatibility with integrated pest and disease management. However, depending on the product, they can be slower acting and are not always as effective in terms of 'percentage kill' of the target pest or pathogen as the best-performing chemical products."

Biopesticides that are based on living

microorganisms are significantly affected by environmental conditions, particularly temperature and humidity, and they can be inactivated by strong sunlight. "The upshot is that they're a lot less 'forgiving' than chemical products and have tended to give more variable results," he says. "They certainly require a higher level of knowledge to get the best out of them."

Consequently AHDB Horticulture is funding a major five-year project, CP 158, 'Application and management of biopesticides for efficacy and reliability' – or AMBER – which Chandler is leading, to find out what's causing some products not to work as well as they should and what growers can do to improve that.

The pests and diseases to be studied have been selected by the project's steering group. They were chosen because they attack a wide range of protected and nursery stock crops, have pesticide resistance issues and cause significant financial losses if not controlled.

"We are focusing initially on certain commercially available biopesticides and on a select number of pests and diseases on crops representing a variety of types," he says. "The results can be turned into a set of general principles that can then be transferred and tested on other crops later in the project. Once in place, the principles can be applied to other biopesticide products that become available in the future."

FIRST STUDIES

In the first phase of the project, which got underway in the summer of 2016, the research team has been establishing benchmarks for the performance of various biopesticides against natural pest or disease outbreaks on commercial nurseries, to see how they perform when applied according to current best practice guidelines.

Four benchmarking studies have so far been completed: aphids on an organic glasshouse pepper crop and western flower thrips on pot chrysanthemum, in each case using an insect-pathogenic fungus and a botanical extract; botrytis on pot-grown cyclamen, using a bacterial antagonist; and powdery mildew on glasshouse cucumber, using a fungal antagonist.



The crops were chosen for their different leaf shapes and sizes, and growth habits, which may result in different responses to spray applications in terms of the amount of coverage, deposition to the underside of leaves and so on. In a fifth study, which started in the autumn, biopesticides were used against root rots on choisya and dianthus.

In each study, the researchers have been working with nursery staff who applied the products following the label information and technical guidance that the manufacturer provided. The project team has monitored the natural infestations of the target pest or disease, collected information on the environmental conditions within the crop and recorded details about the 'mechanics' of the biopesticide application such as spray pressure, water volumes, and water temperature. They have also looked for any changes in the survival of the biopesticide organism after spraying, measured the amount of biopesticide deposited on leaves, and checked its persistence in the crop.

"This information is giving us a 'baseline' measure of biopesticide performance under commercial conditions," says Chandler. "We'll analyse the data in detail and – working with our grower partners and the biopesticide manufacturers – identify things we believe can be improved in order to get the maximum effect from the products."



Project leader Dave Chandler assesses biopesticide coverage after application to pot chrysanthemums

concentration – sometimes both – and occasionally a water volume. The growers all aimed to deliver the maximum volumes or doses where specified. Some additional technical information was supplied with each product but Chandler says it was rare to find much that related to application technique. Recommended water volumes were often very loosely and subjectively defined – ‘sufficient water to ensure uniform coverage’, ‘foliage should be sprayed until the plants are wet thoroughly, but not to run-off’, and ‘apply at a high volume’ are just three examples. “As these are open to interpretation, it’s no surprise that the doses applied will vary,” he says.

Some biopesticides marketed for ornamentals give ‘per plant’ dose requirements and growers need to convert these into a dose per unit area based on the number of plants per sq m or ha in their production system. For both the peppers and cucumbers, the growers had to convert a recommended dose per ha, as specified on the product label, into application requirements for a ‘vine’ crop sprayed with a vertical boom.

Mixing posed a problem with two of the biopesticides – which had instructions on their labels similar to those for chemical products. Adequate dispersion and suspension of a biopesticide in the water are crucial to its performance yet this was a major issue in more than one case and will be investigated in more detail later.

Calibrating systems where the dose depends on the speed of movement through a crop has always been an issue with plant protection products but is a particular concern with biopesticides because accuracy is so much more important. While inaccurate application might not always be noticeable with chemical products applied at high doses, there’s likely to be less margin for error for biopesticides.

The project team estimated actual speeds by timing across a known distance, but had to assume that pressure gauges were accurate and nozzles were neither worn nor damaged so that the nominal flow rate was correct. Regular calibration of equipment, and replacing of worn or damaged nozzles, is essential for accurately controlling the dose applied. In general, the spray equipment

Biopesticide effectiveness is very dependent – even more so than for most chemical products – on delivering the correct dose. This is particularly the case for those that are contact acting – which includes nearly all the microbial products. “Growers can sometimes get away with a less than perfect spraying technique when using a chemical product if it’s highly persistent or can move within the crop through systemic or translaminar action, but this is not so for most biopesticides,” he says.

The five nurseries in the project’s case studies so far represented a wide range of approaches and equipment. Handheld sprayers were used on two of the three ornamental crops, and a horizontal automated boom on the third. The peppers and cucumbers were sprayed by vertical booms. “What was common to all the nurseries, though, was the grower’s intent to make a good application and keen interest in how to improve practice,” he says.

LABELS

It can be difficult before you even start because the application requirements on the product label are rarely tailored to the spraying equipment available, and the information that is provided to enable you to work out what’s needed for a particular crop varies so.

None of the labels for the biopesticides used in these studies carried any technical application guidance, just dose or a

EVOLUTION AND APPLICATION

In the early days of commercial biopesticides, most of the products were based on microorganisms, but as new products have been investigated or developed, they now extend to natural plant extracts and ‘semiochemicals’ – natural compounds that affect the behaviour of insect pests and their natural enemies, such as insect sex pheromones.

Microbial biopesticides include fungal and bacterial diseases of insect pests, and microorganisms that act as antagonists or parasites of plant diseases. These, and the plant extract products, are normally applied as sprays to control foliar pests and diseases, or as drenches or granules for use in the root zone. Usually, they can be applied with the same equipment used for chemical products.

available to growers in the ornamentals and protected edibles sectors lags some way behind that used by field vegetable growers and arable farmers.

The balance between coverage and spray retention is likely to be particularly important with biopesticides. All the applications in the study were at very high volumes, as recommended by the suppliers. “We know that the proportion of spray retained on a plant reduces as the water volume increases,” says Chandler. “On the other hand, the area of plant surface covered by spray liquid increases, up to a point, with volume. The optimum balance depends on the product, its mode of action, the crop, and where on the plant the spray needs to be targeted.

“We now need to find out how application techniques can be changed to enable biopesticides to give the best performance they are capable of. The two main questions that we need to answer are what is the optimum applied water volume for each product and crop; and how can we make it easy for growers to achieve this.”

The next step is small-scale studies, including in commercial crops, to investigate the interactions between product, crop ‘architecture’, application technique and the impact on pests and diseases. “We’re also looking at providing better information for spray operators than is currently available for calibration and calculating doses; and we will identify alternative application equipment that might make this easier,” he adds.

At the front line

AHDB's expertise in research and knowledge exchange enables the industry to respond quickly to new pest and disease threats, write Dawn Teverson, Grace Emeny and Scott Raffle

Horizon scanning is an essential task for AHDB's crop protection team. It means not only keeping track of changes in product availability and approvals but keeping watch for the pests and diseases that are spreading through Europe and other parts of the world. That allows us to alert growers to potential problems and gives us time to commission research into practical ways to manage them should they arrive here.

Typical examples in recent years have been diamond-back moth on brassica crops – a sporadic pest in the UK, which migrates here annually from continental Europe – the South American tomato moth *Tuta absoluta*, and spotted wing drosophila which damages soft and stone fruit.

DIAMOND-BACK MOTH

Diamond-back moth is present worldwide wherever its host plants grow. Its caterpillars are a serious pest of field-grown brassicas and can also infest cruciferous ornamentals such as column stocks and wallflowers.

In 2016, a very large migration started at the end of May and was monitored week by week. The AHDB Pest Bulletin kept growers up to date with how populations were building up and moving. Millions of moths arrived and were found in large numbers, from south-west England to Orkney. Until now the moth wasn't expected to overwinter but in 2017 there were reports that some populations had survived.

Diamond-back moth is often described as a 'super-pest' because it has a rapid life-cycle and has been found to be resistant to some crop protection products. In 2016, Rothamsted Research entomologist Steve Foster tested three diamond-back moth samples – from Lincolnshire, Suffolk and Scotland – and found them all resistant to pyrethroids.

It was important for AHDB to get this information out to growers, because



WARWICK CROP CENTRE

One of the Trapview moth traps used to monitor diamond-back moth in FV 440. The caterpillars (inset) feed only on brassicas and other cruciferous crops

where pyrethroid-resistant caterpillars are present, products based on this group of active substances are likely to give poor control. We included the advice that more selective products would be more likely to result in effective management of outbreaks as natural enemies such as parasitoid wasps have been found parasitising the moths' caterpillars.

With the pressure the crops were coming under from the mass migration in the face of limited control options, AHDB was successful in securing an emergency 120-day authorisation for Benevia 100D (cyantraniliprole) for use on Brussels sprout, broccoli, cabbage and cauliflower for the 2016 season. AHDB crop protection senior scientist Vivian Powell continues to work with industry, Brassica Growers Association members and the Chemicals Regulation Division (CRD) to gain new approvals to enable the industry to manage the pest in the long term.

Work on diamond-back moth was also included in project FV 440, on control of caterpillars in lettuce and baby-leaf salads, which began the previous year.

AHDB organised a workshop in January 2017 to give brassica growers, agrochemical companies and researchers the opportunity to discuss the 2016

situation, learn lessons and develop strategies to manage similar outbreaks in the future. Presentations from the workshop can be downloaded from the AHDB Horticulture website, along with information from a presentation by David Grzywacz, principal scientist at the Natural Resources Institute, University of Greenwich, who talked about the pest at the 2017 Brassica and Leafy Salad Conference.

Monitoring resumed in 2017. Updates about migrations and population movements this year are being posted in AHDB Horticulture's monthly emails and in the Pest Bulletin. Warwick University Crop Centre director Rosemary Collier, who compiles the bulletin, gives further details in her accompanying pest update from Wellesbourne and on the Centre's website.

TUTA ABSOLUTA

The South American tomato moth first arrived in the UK in 2009 on imported fruit from Spain and its leaf-mining larvae quickly became the most important pest on the UK crop.

AHDB responded by commissioning a research programme (project series PC 302, followed by PE 020) designed to

develop a reliable method of controlling it which growers could integrate into their existing IPM programmes.

By 2013, the research had come up with a strategy based on the predatory bug *Macrolophus pygmaeus*, supported by physical control measures and three IPM-compatible crop protection products with different modes of action that should have kept to a minimum the risk of the pest developing resistance.

An AHDB factsheet explained how to implement the programme and included guidance on pest monitoring and the importance of resistance management. Later research, in PE 020, resulted in further information for growers on supplementary feeding strategies to maintain macrolophus populations in crops.

The IPM programme proved very successful and growers were able to manage the pest confidently for several seasons – until 2015 when some had begun to experience problems. Testing found the moth resistant to at least one of the control products.

In consultation with the British Tomato Growers Association, AHDB responded by commissioning project PE 028 which identified two more products with modes of action not previously used against the moth. They have the potential to replace those now compromised by resistance but we still have to investigate how they can be integrated into the existing programme. That's currently being addressed by new work which began in 2017 (PE 032) while associated trials on product effectiveness are being undertaken in the new SCEPTREplus project.



Tuta absoluta moths in a tomato crop: AHDB research devised an IPM strategy against the pest, whose caterpillars damage leaves and fruit, based on the predatory bug macrolophus (inset)



NIAB EMR

Research instigated as soon as spotted wing drosophila arrived in the UK found ways to dispose of affected fruit and to monitor for the pest's presence

SPOTTED WING DROSOPHILA

AHDB was first alerted to spotted wing drosophila in 2010 when it was damaging soft and stone fruit crops in North America. It had originated in Japan and spread to America, before moving to mainland Europe. We published a factsheet to warn growers of its likely arrival in the UK, the damage it causes and how best to monitor for its presence.

It was first confirmed in the UK by entomologists at NIAB EMR in Kent in August 2012 but the chairman of the AHDB Soft Fruit Panel at the time, Harriet Duncalfe, had already set up a working group to plan how to deal with the pest. This included discussions with Defra's and the Scottish government's plant health departments, both of which consulted with growers. The group is drawn from representatives from grower associations, government, scientific institutes, marketing groups, British Summer Fruits and AHDB and continues to share new information on the pest's spread in the UK, the damage it's causing and the latest scientific research results. It works closely with British Summer Fruits to manage publicity surrounding the pest.

Meanwhile, AHDB commissioned a new research project (SF 145) – funded by Defra, the East Malling Trust, British Summer Fruits and The Worshipful Company of Fruiterers – which began in 2013. The work continues as SF 145a funded by AHDB from April 2017.

Managed by NIAB EMR and the James Hutton Institute, Dundee, the research aims to improve our understanding of the pest's behaviour and life-cycle in UK

conditions, its spread around the country, how to monitor for its presence, how to manage plantations to reduce the risk of attack, how to dispose of affected fruit and how best to control it. The new project is also looking at alternative control strategies through the use of narrow-mesh netting, repellents, bait spraying and 'attract and kill' methods.

Other research is under way in the UK through PhD projects funded by AHDB and others, while an EU-supported project is being led by scientists at Fera in York.

Despite work to develop novel approaches, growers currently rely on crop protection products to maintain effective control of spotted wing drosophila. AHDB's Vivian Powell has been working closely with agrochemical manufacturers and CRD to secure EAMUs and emergency 120-day authorisations for products that would otherwise have not been available for a number of susceptible crops, for which there were no effective approved treatments.

The importance of this pest and the significant damage it causes means it's vital to get research results out to growers as quickly as possible. We regularly update growers via broadcast emails and the spotted wing drosophila webpages, where you can view training videos on how to monitor for the pest. We supported a series of workshops held around the country soon after the pest was first recorded here, as part of British Summer Fruits' 'Spot it stop it' campaign alerting growers to the threat it posed, and have also published a series of technical factsheets.

The work continues, but growers say they have benefited hugely from the research results and guidance AHDB has generated so far, which has helped them to maintain control.

The long road to market

Janet Williams explains why it takes so long, and costs so much, before growers can benefit from a new crop protection product

News that a new treatment is on the way, especially if it's for a pest, disease or weed that growers are struggling to control, is inevitably met with great interest. But that's often followed by disappointment when the realisation dawns that it will be another few years before the product is authorised and available for use.

There are two parts to the authorisation process, which is designed to take account of human and environmental health and safety, and most of the work involved in securing a new authorisation is in generating the data that demonstrates the active substances and the product will meet those requirements. The active itself must first be approved by the EU; then products containing it must be authorised before they can be used and that is done by the individual member states – so in the UK, the Chemicals Regulation Division of the Health and Safety Executive (CRD) has to authorise each product for use here.

The safety data needed to begin the EU authorisation process is increasingly expensive to produce. More than 100 specific tests are required on the active substance's physical and chemical properties. Data is also generated on toxicity, metabolism in plants and animals over both the short and long term, food residues, environmental fates, ecotoxicology and effectiveness for the uses that are going to be on the label. Long-term field and health studies are also undertaken to monitor possible effects of exposure.

Maximum residue levels, or MRLs, for each active substance are then set by the EU scientific authorities for each food



ISTOCK

Generating all the safety and other data required for a product authorisation takes around nine years and costs on average £4 million

crop. Trials data is required to show these won't be exceeded when the substance is used in accordance with the product label. The MRLs include wide safety margins and are well below levels that could have any adverse effect on consumers' health.

The agrochemical manufacturer funds the generation of this data, though some residue data supporting uses on speciality crops may also be generated by grower groups or AHDB.

A dossier of risk assessments based on all this data is collated by the manufacturer and submitted for authorisation in a designated 'rapporteur member state' for assessment. Their report is reviewed by the European Food Safety Authority before it's put before the European Commission's Standing Committee on Plants, Animals, Food and Feed – experts nominated by member states who will make the decision on whether or not the active is approved.

Once an active is approved, each member state where products containing

it are intended to be used must examine further data to support the product's authorisation there. They take account of local climate, cropping patterns and diets but the criteria they use is harmonised across the EU. A member state may grant a full authorisation or one restricted to particular crops. Some impose additional specific national data requirements and assessments and some applications are rejected.

The EU encourages 'mutual recognition' of authorisations within its three geographical zones – northern, central and southern. The UK is in the central zone so, for example, if the Netherlands (also in the central zone) is the rapporteur then its assessment can be used by CRD when deciding if a product can be authorised for use in the UK.

Active substance approvals are usually time-limited, to a maximum of 15 years, when they must be re-evaluated for renewal – but can also be reviewed at any time in the light of new scientific evidence.

The process of generating and compiling all the required safety and additional data into a dossier typically takes an agrochemical manufacturer around nine years and costs on average £4 million. It then takes another three years for the authorities to evaluate the dossier before authorisation is granted and the product can be sold.

With patent protection only lasting 20 years, the company that comes up with that eagerly awaited new product has about eight years of exclusivity to recoup its costs and make the profits it needs to invest in researching the next generation of treatments, before generic manufacturers have free access to the available data.

Recently, manufacturers have been offered additional data protection where minor uses or speciality crops are included on the product label – and that should help to encourage communication between them and grower organisations.

Minor uses, major efforts

Vivian Powell and Scott Raffle outline some of the routes that AHDB takes to secure new product approvals for growers of horticultural crops

Horticulture has always felt a little like a 'Cinderella' sector of agriculture when it comes to the availability of crop protection products. Despite the high value of most of the industry's 300 or more crops, they're grown less extensively than their arable counterparts, which makes the commercial returns from developing products and applying for authorisations for horticultural uses less attractive to manufacturers.

The situation hasn't been helped by changes in the legislation that governs the supply and use of products. The EU's 1991 directive to harmonise approvals meant all products had to be re-evaluated for health and environmental risks which resulted in growers across Europe losing pest, disease and weed control treatments that they had previously relied on. Then, in 2009, regulation 1107 changed the way crop protection substance safety is evaluated from 'risk-based' to 'hazard-based' criteria, leading to further losses of products with the result that growers have been left with no effective treatments for some situations. The AHDB minor use programme aims to minimise the impact of such losses and find alternative solutions for UK growers.

In the long term, much of the crop protection research AHDB funds aims to develop novel integrated and biological techniques to manage pests, diseases and weeds. But in the short term, as products continue to be lost, rapid remedial action needs to be taken by securing EAMUs and emergency authorisations so that crop production remains commercially viable.

AHDB's crop protection managers Vivian Powell and Bolette Palte Neve work with the industry to identify the problems that need addressing to

EMERGENCY AUTHORISATIONS

There are occasions when the industry faces an emergency, when a pest or disease is spreading rapidly and no control method is available. In such situations the Chemicals Regulation Division is permitted, in certain circumstances, to grant an emergency authorisation for 120 days. This can be issued in the absence of residues data, but only if AHDB, on behalf of the industry, can demonstrate that work is in progress to generate the data and that research projects have been instigated or commissioned to develop new or improved methods of control – as these 120-day authorisations are rarely repeated.

A recent example was the emergency 120-day authorisation for the use of Cuprokyll (copper oxychloride) to control neonectria canker in apples and pears. Full approval for Cuprokyll, which growers had relied on for years as the only effective treatment for application in the dormant season, lapsed in January 2017. The industry has been desperate for a replacement and its investment through AHDB in researching several novel approaches to managing the disease helped to justify the emergency authorisation. One was also granted for use of Cuprokyll on ornamental prunus and laurel to control bacterial canker.

Last year's 120-day authorisations for Exirel 10SE and Tracer against spotted wing drosophila proved crucial for the cherry industry – as with canker control, the long-term answer is our research to develop novel and improved measures to manage this pest.



AHDB's work on the EAMU programme maintains a supply of practical treatments for growers

Approvals

maintain a supply of practical treatments for growers, even if they are only short-term solutions. It can only be done by close collaboration with a network of organisations.

Vivian and Bolette meet regularly with agrochemical and biopesticide manufacturers to learn about new actives and products being developed and to talk to manufacturers about opportunities for including them in our project trials.

It's also a chance to identify products that may be useful on crops which are not currently included on the product label as we can seek extensions of authorisation for minor use, or EAMUs, for these – as long as the product is already authorised in the UK. Residues data is required for EAMUs on edible crops, but data on the product's effectiveness or crop safety for that particular use is not.

That makes EAMUs a useful compromise – growers can use products on crops they would not otherwise have been able to, but at their own risk in terms of effectiveness and crop safety. It's not a complete leap of faith, though, as the EAMUs AHDB chooses to apply for are based in many cases on results of trials in our crop protection projects.

Generating residues data from scratch requires expensive trials and laboratory analysis to official standards, so where possible we seek other more cost-effective ways to provide it.

One of these is through the EU 'mutual recognition' scheme that allows us to secure an EAMU if an identical authorisation is already in place in another EU state. For outdoor crops, this has to come from the same geographical zone as the UK but for protected crops it can be from anywhere in the EU. This is often the quickest and most cost-effective way to obtain an EAMU, although specific UK requirements, currently under review, do sometimes present additional hurdles.

The EU has established a series of 'commodity expert groups' which are starting to work together to make residues data available. The data is generated with collaborative support from the manufacturers and through data sharing between EU member states and is particularly useful when there are



For outdoor crops, mutual recognition has to come from the same geographical zone as the UK but for protected crops it can be from anywhere in the EU

no EU approvals that can be 'mutually recognised'. In 2016 AHDB used data from the appropriate expert groups to support our applications for emergency authorisations for Exirel 10SE (cyantraniliprole) and Tracer (spinosad) to control spotted wing drosophila on fruit crops.

We also liaise with organisations similar to AHDB elsewhere in Europe to share residues data which they may already hold. We recently applied for new EAMUs for herbicides on carrot and protected leafy salads using data obtained in this way and are awaiting the result from CRD, the Chemicals Regulation Division of the Health and Safety Executive which is responsible for crop protection product approvals in the UK.

The USA government's IR-4 minor use programme generates residues data to support product approvals that agrochemical manufacturers can't justify commercially and there's a similar scheme in Canada. We're able to source data from these schemes, too, though

additional supporting data is also sometimes required to demonstrate that residues under UK conditions would be in line with their results.

Unfortunately, however, there are cases where an EAMU is required for which the residues data just doesn't exist so AHDB has to fund trials to generate it – and where applications are based only on UK trials, two seasons worth of data is needed for outdoor crops. If a problem is particularly urgent, some of the data generation can be carried out as part of existing AHDB projects. In the original SCEPTRE project, for example, we generated residues data during herbicide trials and this was used to secure new authorisations for Wing-P (dimethenamid-P + pendimethalin) on lettuce and associated crops.

One of Vivian and Bolette's key responsibilities is to liaise with CRD to keep its staff abreast of the UK growers'

crop protection issues. We believe this helps them to understand the problems that farms and nurseries face so that they can advise on how authorisations can be delivered quickly and efficiently. A good example of this is the regular liaison we have had over the last five years on spotted wing drosophila. There are times, though, when the regulations slow down or prevent the delivery of new products to the industry which is frustrating for everyone involved.

We're likely to see further losses of crop protection substances, and further restrictions on those that remain, in the coming years. So it's vital that AHDB continues to liaise with growers, our sector panels, crop associations, marketing groups and agronomists, to understand the impact this will have. Being forewarned through such liaison, and through our regular gap analyses, will allow us to react on your behalf by developing new research projects and applying for new EAMUs and emergency authorisations.

Re-entry in your hands

The protection offered by splash-resistant gloves gives growers more choice of products to use when crops have to be manually handled, says Richard Glass

Among the many safety assessments that are made before a crop protection product can be approved is the likelihood of workers coming into contact with it when they handle crops after the plants have been treated.

In these assessments the Chemicals Regulation Division takes into account the amount of product on the plant, how much it's likely to degrade in the days following treatment and how much of this deposit could be transferred to the hands of workers handling the plants.

Until recently these risk assessments assumed that workers weren't wearing protective gloves, resulting in estimates of skin exposure which exceeded what CRD judged to be safe levels. Without gloves, the only way to reduce exposure is to prevent the plants from being handled, by imposing a 're-entry' interval long enough for the deposit on the plants to reduce to a safe level before workers are allowed back into the crop. The need for a re-entry period of several days, however, restricted the use of some products in crops which have to be regularly handled.

An AHDB survey showed that many workers were, in fact, wearing a range of different types of gloves to keep their hands clean or to protect them from sap or thorns. AHDB discussed the results with CRD, which then conducted a study to look at the level of protection offered by specific types of 'splash-resistant single-use' (SRSU) gloves. It concluded that wearing them when handling treated plants could give adequate protection if they are selected correctly, worn properly,



Workers will need training on the correct choice and use of gloves

removed safely and replaced regularly – and published a regulatory update to confirm that its risk assessments will now accept the use of appropriate gloves as a way of reducing skin exposure on hands.

This change of approach is allowing plant protection products to be authorised for use with less stringent re-entry limitations if workers wear SRSU gloves which comply with the EN374-2:2003, Level 2 standard, so products can be used on crops without the restriction of a re-entry period between the treatment of plants and the workers needing to handle them. It should also lead to more products gaining UK approval in the future. The product label or EAMU specifies the requirements for gloves, including the period after treatment this applies for.

AHDB is playing its part by providing information to nursery owners and managers who are responsible for ensuring workers are trained appropriately on the potential risks of handling treated crops and surfaces and how to identify when gloves need to be worn – including what to look out for on the signs put out at the entrance

to glasshouses and other treated areas.

Each nursery needs to implement a system to ensure that all workers are aware of the requirements and that there is a supply of gloves for them which comply with the conditions of the label of the products in use and which allow them to carry out their tasks without undue difficulty but give adequate protection from other hazards.

An AHDB factsheet gives full details and an AHDB wallchart has been sent to nurseries as a training aid and reminder to workers about how to select, use and remove the gloves safely. It also explains the information that must be displayed so that workers know when they need to wear them. A video has been prepared to show how to remove gloves without transferring any contamination on the outside of the gloves to the hands.

Further information and copies of the factsheet and poster can be downloaded from horticulture.ahdb.org.uk/gloves. The video can be viewed on your mobile device, by using the QR code on the wallchart, or on the website.

A world of expertise to draw on



Jeroen Meeussen looks at the increasing international co-operation that's helping to sustain availability of plant protection products for horticultural crops

The continuing erosion of the range of products to deal with the huge variety of horticultural crops and the pests, diseases and weeds that can harm or impair them is a problem that's not confined to the UK. Growers elsewhere in Europe and further afield, while they may sometimes have access to individual treatments unavailable here, are facing exactly the same challenge.

As Janet Williams outlines on p16, much of the reason for this lies in the equation between the investment

needed to gain an approval for use of a product on a particular crop in a particular country, and the likely financial returns. For many horticultural crops the area grown or the number of likely applications just don't stack up commercially for the manufacturer, even if in some cases making the product available would have significant commercial advantages for growers.

The comparatively small-scale uses that lead to this situation – small, that is, when compared with arable crops – tend

to be associated with so-called speciality or 'minor' crops but can also occur in situations where pesticide use is restricted, in areas where new pests or diseases are starting to emerge or where particular pests or diseases occur infrequently in 'major' crops.

The problem for horticulture is that the term 'minor' includes most vegetables, fruit, nursery crops, flowers, forest trees and even some arable crops. It's estimated that overall in Europe they are worth more than 70 billion euros per year, or between

INTERNATIONAL COLLABORATION

This October sees an international 'minor use summit' in Montreal, Canada, to develop new strategies for minor use programmes and harmonising approvals requirements internationally to reduce the costs of approvals for products on speciality crops. *write Daniel Kunkel and Jerry Baron.*

It's the third such summit. Previous ones in 2007 and 2012 proved critical in focusing international attention on the issue and highlighting the need for greater co-operation and harmonisation of standards for chemical and biological crop protection products.

Discussions by around 300 participants from 60 countries at the first two summits, including growers, scientists, regulators and manufacturers, agreed the need for:

- Global networks to work on 'minor use' issues
- A system by which developing countries can participate in setting standards to give their growers access to safe products
- The UN Codex Committee on Pesticide Residues to better support minor use crops in terms of common MRLs and data requirements
- Collaborative global research projects to generate and share data (a global database has already been developed to identify and track growers' needs)
- Regulatory incentives that promote the registration of minor uses.

If regulatory authorities can agree common data standards, so that data

generated in one country will be acceptable to another, it would reduce the data requirements in any single country and make better use of resources, but still provide regulatory agencies with robust data against which they can judge whether or not to grant an approval. A pilot global residues data project was recently undertaken as part of the USA's IR-4 minor uses programme, in partnership with Bayer and based on the company's new systemic insecticide flupyradifurone (the active substance of the product marketed as Sivanto in the USA).

Joint data generation is routinely used by the USA and Canadian minor use programmes but expanding this concept globally could significantly help minor uses. The UN's Codex committee does now recognise the importance of consolidated data sets and has provided guidance on creating them. Meanwhile, in 2015 the USA government established a specific 'global minor use fund' for its IR-4 programme and challenged other countries to contribute to it to support international research projects.

The third Global Minor Use Summit runs from October 1 to 4 on the theme 'Filling the grower tool box: developing strategies for specialty crops and minor use programs and harmonization'.

More information about the summits and international work on minor uses can be found on the website at gmup.org.

WORKING TOGETHER

One of the most important aspects we at AHDB have benefited from since the EU's Minor Uses Coordination Facility was established has been the improvement in information exchange across Europe, sharing experience gained at the national level and enabling two or more countries to undertake minor use projects, *writes Bolette Palle Neve*.

All such projects are managed by the commodity expert groups. Made up of representatives from each EU member state, they meet to discuss crop protection issues and, working with crop protection product manufacturers, agree projects on a range of crops. As AHDB Horticulture's specialists in pesticide regulation, Vivian Powell and I attend two of these commodity expert groups, for fruit and vegetables and for ornamentals, which meet every six months but there is considerable communication between us and the other group members between meetings too.

AHDB has taken part in a number of projects helped by the coordination facility, aimed at increasing the availability of new treatments for speciality crops. For example, residue data to support the use of Tracer (spinosad) on bush and cane fruit was generated as part of one such collaborative project and has resulted in EAMU authorisations for the control of spotted wing drosophila and thrips.

And, since last year, we have been working with colleagues in a number of member states generating residue data for the use of Teppeki (flonicamid) to control aphids on carrots and on several soft fruit crops. We have submitted an urgent EAMU application using the carrot data to support an approval in carrots, red beet, swede, turnip and celeriac.

The coordination facility has also been very helpful when we have been looking for approvals in other countries that could help us address crop protection gaps that we have identified in the UK. That's because it enables us to access a number of databases including Homologa, the international crop protection registration database, which we can ask the facility to search to

identify approvals for suitable plant protection products in Europe and further afield.

At the moment it isn't clear how the UK leaving the EU will affect registration of plant protection products here. But it is essential that we continue to build on the key relationships we have established through the commodity expert groups to ensure UK growers maintain access to plant protection treatments that enable them to remain competitive.



EU minor use co-ordinator Jeroen Meeussen (centre) meets AHDB crop protection specialists (from left) Bolette Palle Neve, Jon Knight, Vivian Powell and Joe Martin at the Fruit Focus exhibition in Kent in 2016

a fifth and a quarter of the value of the EU's total crop production.

The European Commission has recognised the need to address this problem in a more coherent way by setting up the EU Minor Uses Coordination Facility in September 2015, with additional financial contributions from the governments of France, Germany and the Netherlands to get it started.

Based in Paris, it consists of a small technical staff who co-ordinate work carried out in individual countries across Europe in support of minor uses. Its mission is to enable 'farmers' in the EU to produce high quality crops by filling the gaps in minor uses 'through efficient collaboration to improve availability of chemical and non-chemical tools within an integrated pest management framework'.

Projects designed to fill these gaps are undertaken by commodity expert groups made up of crop specialists and representatives of growers' associations. There are currently seven groups, covering

fruit and vegetables, hops, mushrooms, ornamentals, rice, seeds and tobacco. Issues that affect minor uses across all these commodities are dealt with by the intriguingly named 'horizontal expert group' – AHDB's crop protection staff are members of that group as well as of the fruit and vegetables and ornamentals groups.

At the coordination facility we're currently building up a new EU minor uses database to help the expert groups manage their work. When it's launched later in 2017 growers will have access to some of the information it holds on minor use gaps and find out about progress with the projects designed to plug them. We're always looking for ways to involve growers in the minor uses work as this is a key element in finding commercially relevant solutions.

We also held our first minor uses stakeholder advisory forum in Brussels earlier this year. The forum helps to ensure our work meets industry needs and its

members agreed that we have made good progress in helping to establish a 'level playing field' for growers across Europe, addressing regulatory hurdles and bringing more focus to bear on finding effective non-chemical crop protection measures.

The coordination facility doesn't just work within Europe. It co-operates with other networks working on minor uses, notably the IR-4 programme in the USA, the Canadian minor use pesticides programme and the minor use work in Brazil.

We're still waiting to see how the UK's departure from the EU will affect minor use work in Europe. A possible way forward could be that any country which benefits from the work of the Minor Uses Coordination Facility should have the opportunity to support it financially and participate in its work programme.

For more information visit the website minoruses.eu where you can subscribe to a newsletter to receive regular updates on the facility's work.

Clean and compliant

Grace Choto asks the Chemicals Regulation Division and Food Standards Agency for their latest guidance on using chlorine-based irrigation and produce hygiene treatments

Chlorine compounds are widely used to disinfect water in irrigation systems and for post-harvest produce washing – as well as by water companies to ensure mains water is safe to drink. Chlorine-based biocides are also used to wash-down surfaces, machinery and equipment.

Such treatments are vital to crop hygiene in many production systems but they can lead to byproducts in the form of chlorate and perchlorate – and moves by the EU to review the statutory maximum residue level, or MRL, for chlorates in all foods is now causing concern for many fresh produce growers. If they are reset at levels that can't be achieved using current crop hygiene treatments, businesses could be faced with making large investments in new and unproven technology at short notice.

We recently wrote to the Chemicals Regulation Division (CRD) and Food Standards Agency (FSA) asking them to update the industry about progress with the EU review and its potential impacts on the fresh produce industry. Here are our questions and their replies:

Are regulators enforcing the statutory chlorate MRL?

The current statutory MRL for chlorate in all foods, set in 2005, is 0.01mg per kg. In 2013, routine monitoring identified residues above this level in a number of foods. This raised issues of compliance balanced against the importance of continued use of chlorine-based products as biocides and for water treatment. No exercise had taken place to set appropriate levels to address the residues arising from these important treatments, so the European Commission and member

state authorities agreed not to enforce the statutory MRL while the issue was being addressed. Instead enforcers would apply expert judgement in acting on the levels found. This approach has remained in place. Monitoring data has been gathered and the Commission is deliberating internally on the future regulatory approach.

Should growers who detect, during their routine analyses, levels above 0.01mg per kg but below the levels proposed in November 2015 be concerned?

Growers should not work to the tentative chlorate MRLs identified by the European Food Standards Agency in November 2015. These were simply first considerations at that point and more monitoring data has been submitted to the Commission since then. If growers are exporting to other member states they should obtain advice from those states on the enforcement stances they are taking. In the UK we are taking a pragmatic approach to any levels found and we have concluded that most levels arising in foods will not generate concerns or the need for action.

Any future proposal to set substantive MRLs for chlorate will be considered by the Standing Committee on Plants, Animals, Food and Feed (Pesticides Residues section), following a promised open consultation with stakeholders.

Is the Commission's intent to deal with chlorate levels in drinking water first, as this is the biggest human exposure?

We understand the Commission is

considering the issue of residues in water alongside the issue of residues in foods. We are yet to receive any indication of their conclusions or the management or ordering of any proposals they will make.

Would you advise growers to think about changing crop hygiene systems or switching to other disinfection methods?

The FSA has not advised people to switch disinfectants. However, if a food business operator decides to switch to other disinfectants they should review their processes carefully to ensure that the microbiological safety of foods is not compromised.

This information provided by CRD and the FSA suggests that new chlorate MRLs are still very much a 'work in progress' at European level, making it difficult for growers to decide at this point whether or not to switch from chlorine-based water treatment or disinfection. Until the European Commission reaches an MRL position on which it is ready to consult with stakeholders, AHDB Horticulture recommends growers continue to monitor for chlorate in produce and implement measures to minimise residue levels.

Recommendations in a new EU guidance document on addressing microbiological risks in fresh fruits and vegetables at primary production through good hygiene include:

- Using the lowest possible concentrations of chlorine disinfectants that achieve the desired disinfection level
- A sufficient 'refreshment rate' of the washing water to prevent chlorate residues building up as the chlorine evaporates
- Proper storage of disinfectant products, as exposure to light or high temperature causes the degradation of chlorine to chlorate prior to use.

Measures to mitigate against chlorate exceedances are detailed in the report for AHDB Horticulture project CP 154a which can be downloaded from the AHDB Horticulture website. Additional crop hygiene information for growers is available at horticulture.ahdb.org.uk/microbials-keep-edible-fresh-produce-clean.

The full choice for ornamentals

Search AHDB's Liaison database for plant protection products you can legally use

You can't apply a plant protection product to any crop unless it has been approved. Since the 1980s, however, there have been special arrangements in place in the UK which allow some products already approved on an edible crop to be used on certain ornamentals by 'extrapolation' under what's known as the Long Term Arrangements for Extension of Use (LTAEU) agreement.

The rules can be hard to interpret and the list of products and their uses that LTAEU applies to changes regularly, as more and more uses are either converted to EAMUs or the approvals are dropped altogether. So to help growers navigate this potential minefield, AHDB offers an online tool by which you can search for products and uses that are allowed under the agreement. Funded by AHDB, it's managed by the research agency Fera to ensure that it draws on all the latest data from the Chemicals Regulation Division and the EU regulatory authorities.

Easy and free to use, the Liaison LTAEU website shows which products can be used under the arrangements, as well as those specifically approved for ornamentals on-label or via an EAMU. It also shows which products are no longer permitted under LTAEU.

Biological and physical control agents that don't need to be registered are also included to help growers meet the demands of the Sustainable Use Directive, which requires non-chemical crop protection methods to be considered in preference to chemical products.

The listing of chemical products can also be sorted by the mode of action codes to help when it comes to designing application programmes that minimise the risk of resistance.

To access Liaison, please visit horticulture.ahdb.org.uk/liaison-website.

HOW TO USE LIAISON

The Liaison website is quick and easy to use.

To access it, go to horticulture.ahdb.org.uk/liaison-website and then:

1 Select your crop from the drop-down menu. If your specific crop doesn't appear, use a general crop

category such as 'ornamental (outdoor)' or 'ornamental (protected)'

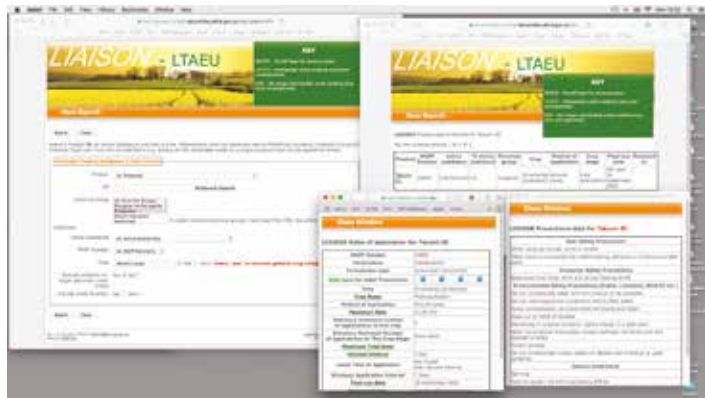
2 Select the required 'chemical group' (fungicides, herbicides, insecticides, plant growth regulators and so on) from the drop-down menu

3 Click 'search'

This will result in a list of products that will be colour coded:

- White background means there is an on-label or EAMU approval for the product for the selected crop
- Green background shows the product is legal to use under LTAEU for the selected crop and situation (outdoor or protected)
- Red background means use of the product is no longer permitted under LTAEU.

To sort products by mode of action, select 'yes' from the option 'include mode of action' and then 'yes' for the option 'sort by mode of action'.



Clicking on an individual product takes you to more detailed information about its approval status and the crop or crops that the main approval applies to.

By clicking on the product name again, you will be able to find:

- Application rates
- Maximum number of applications per season
- Application intervals
- Harvest intervals
- Label information
- Handling conditions
- Disposal and safety precautions
- Environmental warnings
- Tank mix compatibility

Within the next 12 months CRD is expected to publish an updated list of products that can still be used on ornamentals through LTAEU.

DISCLAIMER

If using a product under LTAEU all safety precautions and statutory conditions relating to use must be observed.

If the LTAEU use is based on an EAMU then in addition to all label safety precautions and statutory conditions, all conditions relating to use

specified on that EAMU must be observed. Products must only be used in the same situation (outdoor or protected) as that specified on the product label or EAMU approval for the use on which the LTAEU is based. The relevant approvals are included in the Liaison search results.

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