Crop Production in Northern Britain 2024

Apex Hotel Dundee, UK

27th-28th February 2024

PROGRAMME, ABSTRACTS and DELEGATE LIST

www.cpnb.org

Association of Crop Production in Northern Britain
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Association of Applied Biologists, Warwick Enterprise Park, Wellesbourne, Warwick CV35 9EF, UK
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CPNB 2024 (“The Dundee Conference”) is the foremost Conference concerning environmental management and crop production and associated topics in northern environments. Whilst the long-established Association for Crop Protection in Northern Britain is not changing its name, the change in the title of the Conference to Crop PRODUCTION, reflects the wider remit of recent conferences.

We are delighted to be working with the Association of Applied Biologists to organise our 2024 meeting, which will bring the commmunity back together for an in-person meeting hosted at The Apex Hotel in Dundee.

The scientific presentations at CPNB are divided into sessions on ‘Potatoes’, ‘Combinable Crops’ and ‘Agriculture and the Environment’.

PROGRAMME

Tuesday 27th February

08:30 REGISTRATION OPENS

09:30 WELCOME and INTRODUCTION
FIONA BURNETT (SRUC, Edinburgh)

Keynote Speaker

09:45 **Climate change impacts on land: a north-south divide**
MIKE RIVINGTON (James Hutton Institute, Aberdeen)

Session One: Agriculture and the Environment

CHAIR: AMY GEDDES (Arable farmer and Chair of Scottish Voluntary Initiative)

10:15 **Update from Scottish Government**
LORNA SLATER MSP (Minister for Green Skills, Circular Economy and Biodiversity in the Scottish Parliament, Co-leader of Scottish Greens)

10:20: **Update from Scottish Government**
JACKIE HUGHES (SASA, Edinburgh)

10:50 **Exploiting phyllosphere microbes to strengthen UK cropping systems**
LORENA RANGEL (The James Hutton Institute, Dundee)

11:10 BREAK

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11:40 **OurSmartFarm: A crop growth monitoring and decision support system for Scottish farmers**
MOHAMED JABLOUN (The James Hutton Institute, Dundee)

12:00 **Ten years of the SEEDS database: What can seed testing results tell us about cereal seed quality in Scotland**
LAURA BOWDEN (SASA, Edinburgh)

12:20 **To plough or not to plough?**
JACK JAMESON (Teagasc, Carlow, Ireland)

12:40 **Grieves House Tillage Trial: What have we learnt from six years of transition to no -tillage cultivation**
TRACY VALENTINE (The James Hutton Institute, Dundee)

13:00 LUNCH

Session 2: Combinable Crops

CHAIR: Neil Havis (SRUC, Edinburgh, UK)

14:00 **Grain Sustainability Challenges: a Scotch Whisky Perspective**
JAMES BROSNAN (The Scotch Whisky Research Institute, Edinburgh)

14:30 **Optimise your nitrogen program using new endophyte technology from Syngenta - introducing Nuello iN & Vixeran**
Jon Ronksley (SYNGENTA UK)

14:50 **Investigating the impact of different cultivation systems on crop performance in cereal crops**
LAURIE ABEL (RSK ADAS Ltd)

15:10 **Multiplex digital droplet pcr assay for the detection of barley pathogens**
RABISA ZIA (Teagasc, Carlow, Ireland)

15:30 **Fusarium spp. from Irish cereals: Contributions towards the development of a decision support system to minimise mycotoxin levels in cereal produces**
DIANA E BUCUR (Teagasc, Carlow, Ireland)

15:50 BREAK

16:20 **Mycotoxin contamination in Scottish oats and potential mitigation strategies for growers and processors**
SILVIA W GRATZ (Rowett Institute, University of Abderdeen)

16:40 T**illage, season, management and crop history all affect yield ranking. Which is more important for resilience assessment?**
ADRIAN C NEWTON (The James Hutton Institute, Dundee)

17:00 **Monitoring the sensitivity of Zymoseptoria tritici populations to the azole fungicides**
STEVEN KILDEA (Teagasc, Carlow, Ireland)

17:20 **Potential for vcontrol of Ramularia leaf spot in barley**
LAURA ROEHRIG (RAGT Seeds)

17:40 POSTER SESSION AND DRINKS RECEPTION

P1 **Improving aphid and BYDV monitoring**
JACK PERRY (Teagasc, Carlow, Ireland)

P2 **Influence of grazing winter cereals with sheep on agronomic factors including crop pathogen and weed pressure**
LUKE HARROLD (SRUC, Edinburgh)

P3 **An evaluation of the potential for Bokashi manure treatment in the UK**
AUDREY LITTERICK (Earthcare Technical Ltd)

P4 **Varietal resistance as an IPM tool for Scottish barley crops**
HENRY CREISSEN (SRUC, Edinburgh)

P5 **IPM information on social media: Using large language models (LLMs) and keyword extraction to identify trends on YouTube data**
HENRY CREISSEN (SRUC, Edinburgh)

P6 **Risk perception influences crop protection decisions**
HERNAN DEGIOVANNI (SRUC, Edinburgh)

P7 **Control of Barley Diseases using Integrated Control Measures**
NEIL HAVIS (SRUC, Edinburgh)

P8 **Why and how government should support IPM**
HENRY CREISSEN (SRUC, Edinburgh)

P9 **Ramularia – Predicting Disease Outbreaks**
KAIRSTY TOPP (SRUC, Edinburgh)

P10 **Integrated Pest Management Plans – Plan development and analysis of data 2021-2023**
NEAL EVANS (The Voluntary Initiative)

19:00 CONFERENCE DINNER

February 28th 2024

09:30 REGISTRATION OPENS

Session 3: Potatoes

Session Chairs: Alison Lees and Archie Gibson

10:00 **What is happening with the regulation of new breeding techniques in Europe?**
EWEN MULLINS (Teagasc, Carlow, Ireland)

10:30 **IPM Strategies for potatoes – A farmers perspective**
DAVID BELL (Champion Mixed Farmer in Fife)

11:00 BREAK

11:30 **A National Potato Innovation centre for the UK and beyond**
IAN TOTH (The James Hutton Institute, Dundee)

11:50 **Impact of a changing pathogen population on efficacy of control measures for potato late blight**
ALISON LEES (The James Hutton Institute, Dundee)

12:10 **Potato cyst nematodes and the future of potato production in Scotland**
JAMES PRICE (The James Hutton Institute, Dundee)

12:30 OPEN DISCUSSION ON UPTAKE OF NEW TECHNOLOGIES TO ENSURE THE FUTURE OF POTATO FARMING IN NORTHERN BRITAIN

1300 LUNCH

14:00 **Potato Storage Research Capabilities in the UK**
ANDY EVANS (Crop Health & Protection, York)

14:10 **A Proactive Approach to Managing Aphid Vectored Viruses in Scottish Seed Potato Production**
FIONA BURNETT (SRUC, Edinburgh)

14:30 **Patterns and predictors of potato viruses in Scotland**
PETER SKELSEY (The James Hutton Institute, Dundee)

14:50 **The potential contribution of potassium phosphonate to the control of potato late blight in northern Britain**
RUAIRIDH BAIN (SRUC, Edinburgh)

15:10 **Psyllid behavioural studies help understand the risk posed by "*Candidatus Liberibacter solanacearum*" to UK potato and carrot production**
FIONA HIGHET (SASA, Edinburgh)

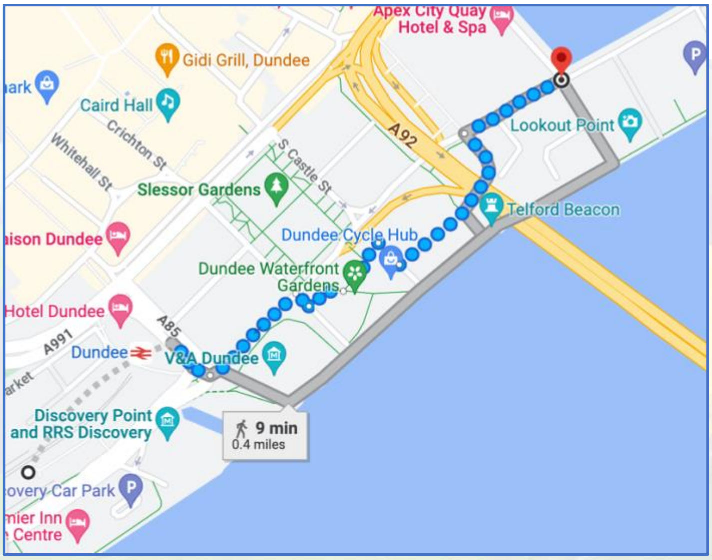
15:30 FINAL THOUGHTS AND MEETING END

CPNB24 Delegate Information

Thanks for attending Crop Production in Northern Britain 2024

The meeting venue is at **Apex City Quay Hotel & Spa**, 1 West Victoria Dock Road, Dundee, DD1 3JP. https://www.apexhotels.co.uk/destinations/dundee/apex-city-quay-hotel-spa/

The hotel is a short walk from Dundee Train Station.



The CPNB24 sessions take place in City Quay Suite, which is where registration will open at 8.30am on Tuesday February 27th. On February 28th registration will open at 9.30am.

The poster session and drinks reception will also be in the City Quay Suite.

Dinner is not included for delegates staying at the hotel on February 26th. The conference dinner on February 27th will take place in 'The Art gallery' and is an optional event. After the dinner there will be a short fun and competitive quiz!

The hotel guest WiFi information will be made available during the event.

Presenters should either bring their talks on a USB drive or email them to geraint@aab.org.uk. Posters should be printed in portrait orientation, maximum size A0.

If you have any questions about the meeting please contact Geraint Parry geraint@aab.org.uk

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ASSOCIATION OF APPLIED BIOLOGISTS

ENQUIRIES

Enquiries concerning the technical content of the Abstracts should be addressed directly to the authors; however, other matters should be directed to the Executive Officer, Dr Geraint Parry (geraint@aab.org.uk) at the AAB Office, Warwick Enterprise Park, Wellesbourne, Warwick CV35 9EF, UK

Climate change impacts on land: A north-south divide

MIKE RIVINGTON, MOHAMED JABLOUN and EMMANUEL UDUGBEZI

James Hutton Institute, Craigiebuckler, Aberdeen AB158QH, UK

ABSTRACT

Climate change posses many risks to society, ecosystems, agriculture and crop production and the food system, but also possible opportunities as well. However, these risks and opportunities will be variable in space and time, both on a global scale and within the UK. To better understand the impacts of climate change, it is useful to present information at a high spatial and temporal granularity to help farmers identify the risks and opportunities they face and plan and implement mitigation and adaptation actions. Such information also supports better informed policy development such as Agricultural Reform in Scotland.

Here we present a suite of modelling and data visualisation tools to illustrate the spatial and temporal variations in climate change impacts across the UK. These include: the spatial application of crop simulation models, the Land Capability for Agriculture classification system and a wide range of agrometeorological indicators and climate summaries and extremes, all presented as maps. Together these illustrate how land capability and crop production (using barley as an example) may vary with 12 different climate projections in Scotland, whilst the agrometeorological indicators show how key climatic factors influencing agriculture across the whole UK have changed in the past and likely to do so in the future.

Our research on barley responses to climate change indicates that yields are likely to decline in some parts of Scotland under most climate projections, but also remain stable or increase elsewhere. Similarly, the Land Capability for Agriculture is likely to change in the future due to changes in climatic constraints. Prime agricultural land may become more vulnerable to drought conditions, whilst currently marginal land may become more flexible in land use types. These responses are primarily influenced by the spatial variation in soil water holding capacity and climate. However, there is increasing competition for land for carbon offsetting objectives, impacting land available for agriculture. Agrometeorological indicators suggest that agriculture in southern UK may become severely impacted by increased water scarcity. These findings are placed in the context of both UK and global scale 'north-south' differences.

Collectively these results, alongside other key economic and policy drivers for Net Zero, Biodiversity, 30 × 30 protected areas, Water and Food Security imply the need for large-scale changes in land use types and management, as well as food system transformation in order to meet multiple objectives for human health and environmental sustainability.

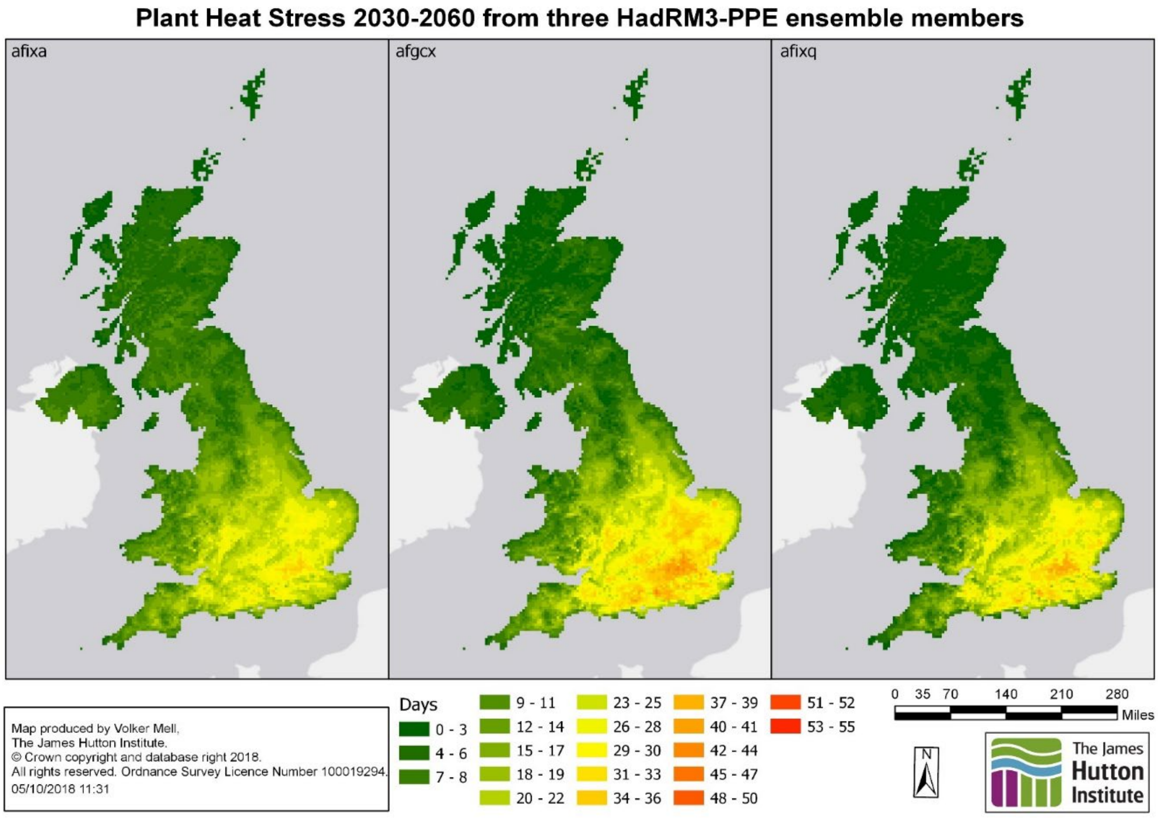

Fig. 1. Illustration of three plausible future projections of Plant Heat Stress Indicator (the count of the number of days per year when the maximum temperature is greater than 25°C) for the period 2030–2060.

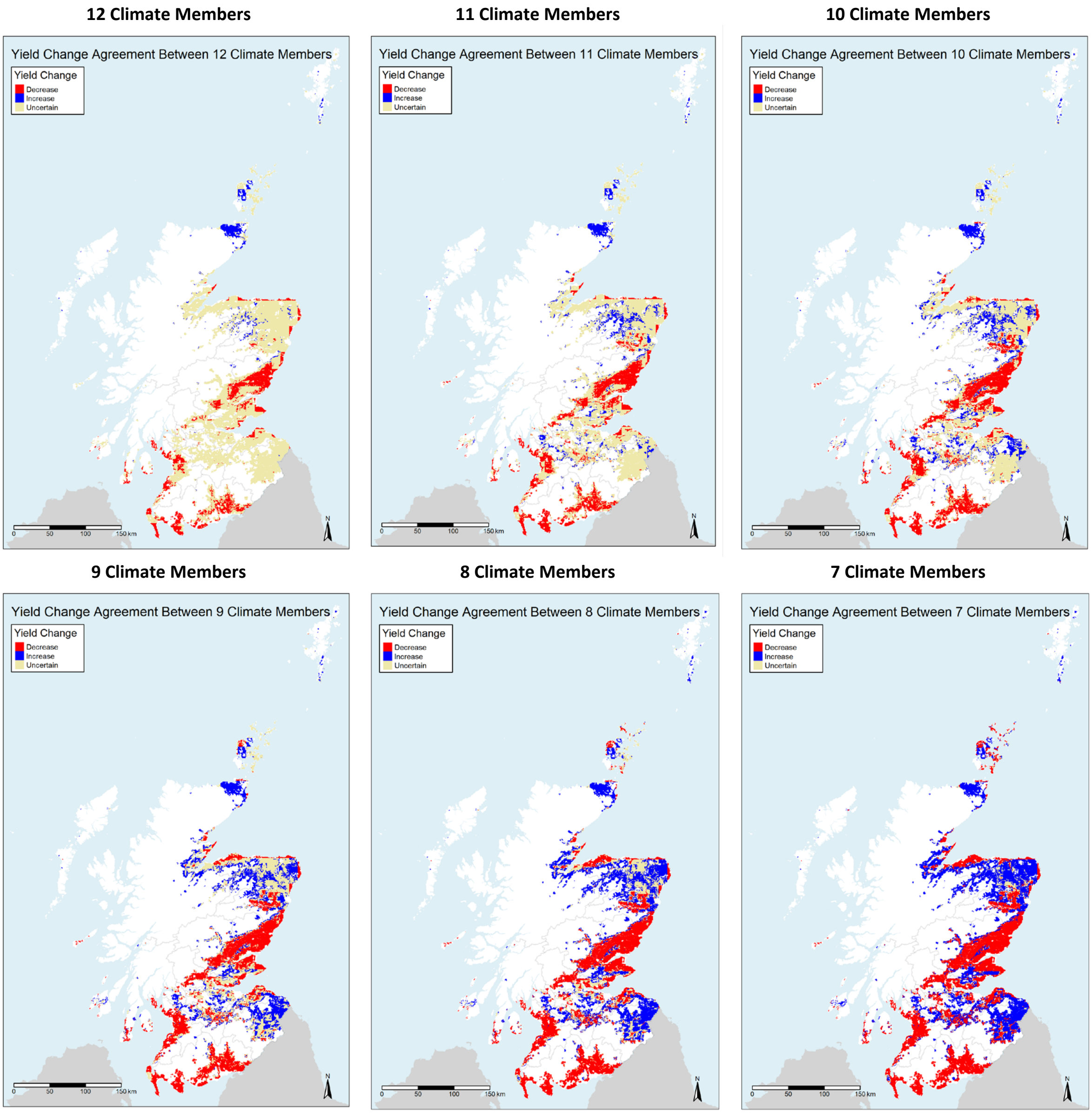

Figure 2. Spring barley responses (blue = increase, red = decrease, yellow = no agreement) under 7 to 12 different climate projections (2020 – 2050).

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Exploiting phyllosphere microbes to strengthen UK cropping systems

LORENA I RANGEL[1], NATHAN WYATT[2], MARI B NATWICK[3], MADISON CHRISTENSON[3], and MELVIN D BOLTON[2]

[1]*The James Hutton Institute, Invergowrie, Dundee DD2 5DA, UK*
[2]*U.S. Department of Agriculture, Northern Crop Science Laboratory, Fargo, ND, USA*
[3]*North Dakota State University, Fargo, ND, USA*

ABSTRACT

Integrated pest management (IPM) strategies are crucial for maximising yields of any large-scale agricultural operation. IPM can be defined as the intentional mitigation of crop damage using cultural, physical, biological and chemical means. Many crops battle foliar, or phyllosphere, pathogens that can cause devastating losses if left unmanaged. Currently, phyllosphere pathogens are managed heavily with expensive and environmentally damaging chemicals. As the global discouragement of chemical applications for agriculture fields increases, precision agriculture and smart technologies generating alternatives such as biopesticides are necessary for expanding output sustainably. Presently, less than ten biological control agents are registered in the UK, and these are used in seed treatments or post-harvest applications. There is a major need for biological IPM supplements or substitutes to abate chemical dependence during the field season.

The phyllosphere harbours a diversity of microorganisms, including but not limited to bacteria and fungi. These phyllosphere-dwellers occupy many ecological niches where their focal interactions may be with the plant, neighbouring microbes, or both. This environment is rich with microbes that are equipped to exist on the leaf surface alongside pathogens. Furthermore, cohabitating microbes must defend themselves against many of the toxic compounds produced by the pathogen, and studies have shown that microbial communities co-occurring with fungal pathogens are highly dynamic during disease progression. Preliminary work focusing on the ability of phyllosphere bacteria to control the fungal disease Cercospora leaf spot of sugar beet has shown that naturally occurring foliar microbes are capable of inhibiting fungal growth. Little is known regarding the multipartite interaction occurring between phytopathogens, host plants and what are considered phyllosphere commensals, although these interactions may directly affect disease outcome. An understanding of naturally occurring antagonising microorganisms and the compounds responsible for this suppression can be a valuable tool in managing important crop diseases. This approach can easily be translated to other crop phyllosphere pathosystems pertinent to the UK and offer a foundation for innovative IPM.

Fig. 1. Pre-harvest sugar beet plots with Cercospora leaf spot resistant (left) and susceptible (right) cultivars. Bacterial phyllosphere communities are significantly different between the two cultivars as exemplified by the petri plates harbouring isolates from leaf washes. The genetic capacities of these diverse microbes can be explored for use against co-occurring pathogenic microorganisms.

OurSmartFarm: A crop growth monitoring and decision support system for Scottish farmers

MOHAMED JABLOUN and MIKE RIVINGTON

The James Hutton Institute, Dundee AB15 8QH, UK

ABSTRACT

We present a new two-way data exchange and simulation modelling research platform, OurSmartFarm, serving as a bridge between farmers and scientists to help resolve the challenge of increasing crop production while reducing agriculture's environmental impact. Meeting multiple production and environmental objectives requires a better understanding of key factors limiting crop yield and quantification of the within-field spatial variation. Much of this spatial variability in production results from variation in plant population and soil properties, either naturally occurring or induced by management (e.g., compaction, organic matter depletion) that in turn regulate soil water holding capacity and nutrient supply. A better understanding of this within-field spatial variation can, therefore, lead to improvements in the precision and effectiveness of field-level crop and soil managements with potentially substantial yield benefits. A constraint however is the availability of field level data for use in process-based crop growth models that simulate complex relationship between soil properties, weather conditions, cultivar choice and agricultural practices and have been widely used to understand the factors that limit crop yield and cause spatial yield variability. Such models have the potential to provide crop intelligence and decision support to address within-field yield variability. However, their utilization raises many challenges regarding driving data, model calibration and validation and usually their usage is intended for researchers and experimented users. The latest advances in earth observation (EO) technologies also enables the monitoring of crop status and growth, and spatial and temporal variability of the main factors driving crop productivity at a national scale. However, the interpretation of the large data sets produced by EO, and its application to crop management requires the collection of field observations (field operations, sowing, phenology, crop yield) to help build the empirical models relating data to variables of interest to farmers.

To overcome this, OurSmartFarm establishes a two-way relationship between scientists (who develop the platform and interpret earth observation data) and farmers (who provide the filed-scale data). The new tool provides a state-of-the-art research platform that is also a DSS, crop growth monitoring and a data management system allowing farmers to upload their own field operations and observations, utilize multiple spatial data (field topography, satellite multispectral vegetation indices) and crop model outputs to enable improved data driven decision making. Therefore, combining the use of EO data, crop models and farmer supplied field observations in OurSmartFarm creates an improved synergistic relationship between scientists and practitioners.

Ten years of the SEEDS database: What can seed testing results tell us about cereal seed quality in Scotland

LAURA BOWDEN

SASA, Roddinglaw Road, Edinburgh EH12 9FJ, UK

ABSTRACT

Since 2012, the results of all seed quality tests performed by the Official Seed Testing Station for Scotland have been recorded in the SEEDS database. This resource, developed in house at SASA, means that sample information (for example growing area, variety, harvest year) plus associated test results (including viability, weight and seed health data) can be downloaded for further analysis. The OSTS laboratory tests approximately 5000 samples per year, and the database now holds a significant amount of data. Initial analysis has focussed on the most commonly grown crops in Scotland – barley, wheat and oats.

Understanding seed quality is complex as it is made up of many different components, as well as there being factors that influence these various components at various stages throughout seed production. Figure 1 provides an overview of these relationships. There are many potential uses of Scottish grown seed, and stakeholders will value different aspects of seed quality depending on the end use of the seed. For example, organic farmers will be particularly interested in levels of disease, seed merchants will want a crop with high germination levels, while other producers will place most importance on yield.

We see differences in viability (both germination and tetrazolium) between certification and advisory samples, with certification samples having higher viability. Certification samples also tend to have a higher thousand seed weight. These differences are consistently seen in different cereal crop kinds and across different years of production and regions of growing and provide evidence that the seed certification system in Scotland is ensuring that good quality seed is being marketed. Differences in viability between crop kinds are also evident, with barley samples having greater viability than both wheat and oat samples.

It is well known that seed production is influenced by the environment during seed development, and we observe trends in poorer and more variable seed testing results in years with adverse environmental conditions. Of all factors investigated, regression analysis showed that year of production had the most significant effect on germination results. This is largely due to weather differences between years. There is a significant effect of both summer rainfall (P<0.01; see Fig. 2) and summer temperature (P<0.05) on germination in wheat seed. The effects of environmental conditions on crop production are more significant for some crops than others, with summer rainfall and temperature significantly affecting germination and disease levels in wheat, but the effect of the environment being less apparent on barley. Seed quality is lower in years with lower temperatures and higher rainfall, with weather conditions over the summer months better explaining variation. This suggests that conditions during the later stages of seed maturation may be most critical for seed quality. While not as strong a relationship as for environmental factors, we also see an effect of other factors such as variety and growing area on seed quality parameters.

The Met Office Climate Projections for Scotland predict that summers will become warmer and drier with an increase in extreme weather events. Crops such as wheat may initially become more productive under the predicted scenarios. However, in some years the occurrence of extreme weather events is likely to adversely affect crop production and seed quality. Monitoring rainfall levels and temperatures during the seed development period may give an early indication of potential crop quality.

In future, Scotland may have better conditions for crop production relative to many other European countries. However, increased competition for land use, together with a potential decrease in the area of land suitable for arable farming as a result of changes in climate is likely to increase the demand for land suitable for growing crops in Scotland. Ensuring that seeds produced are of as high quality as possible is one way to make sure that the best use is made of the land available. Exploring the data held in the SEEDS database to investigate the factors affecting seed quality will allow us to provide information to farmers and agronomists that helps them to better understand variation in seed quality and make informed decisions on future crop production.

FIGURES

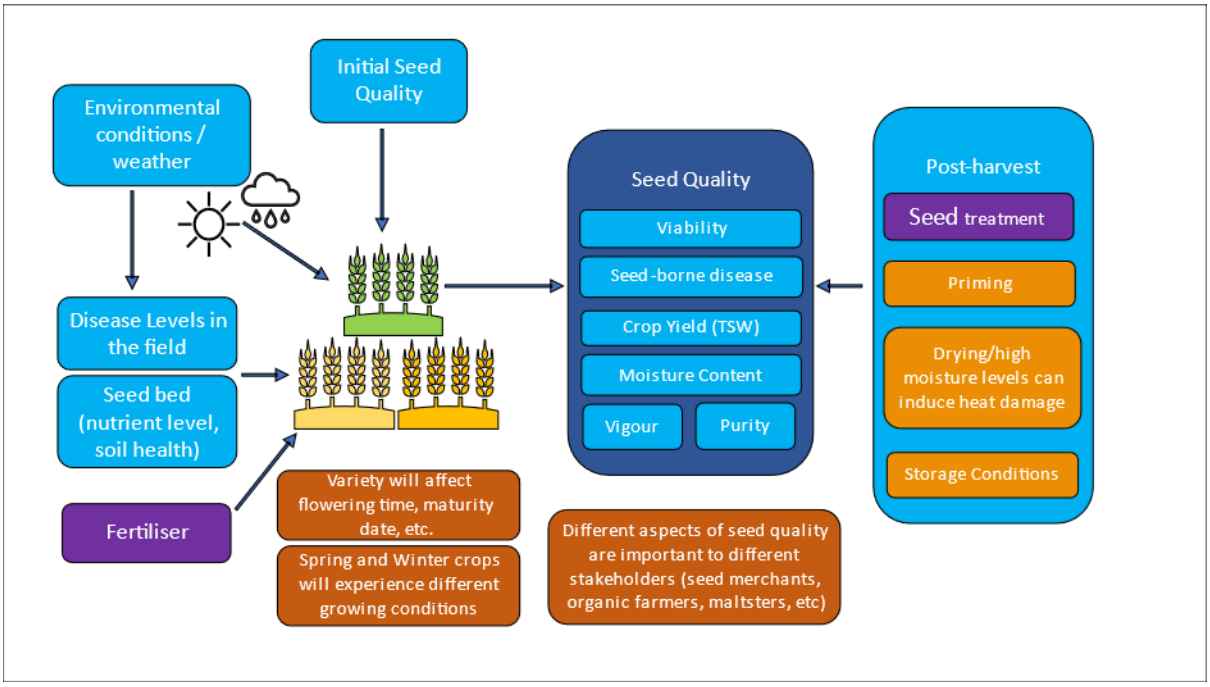

Fig. 1. Factors affecting seed quality are complex.

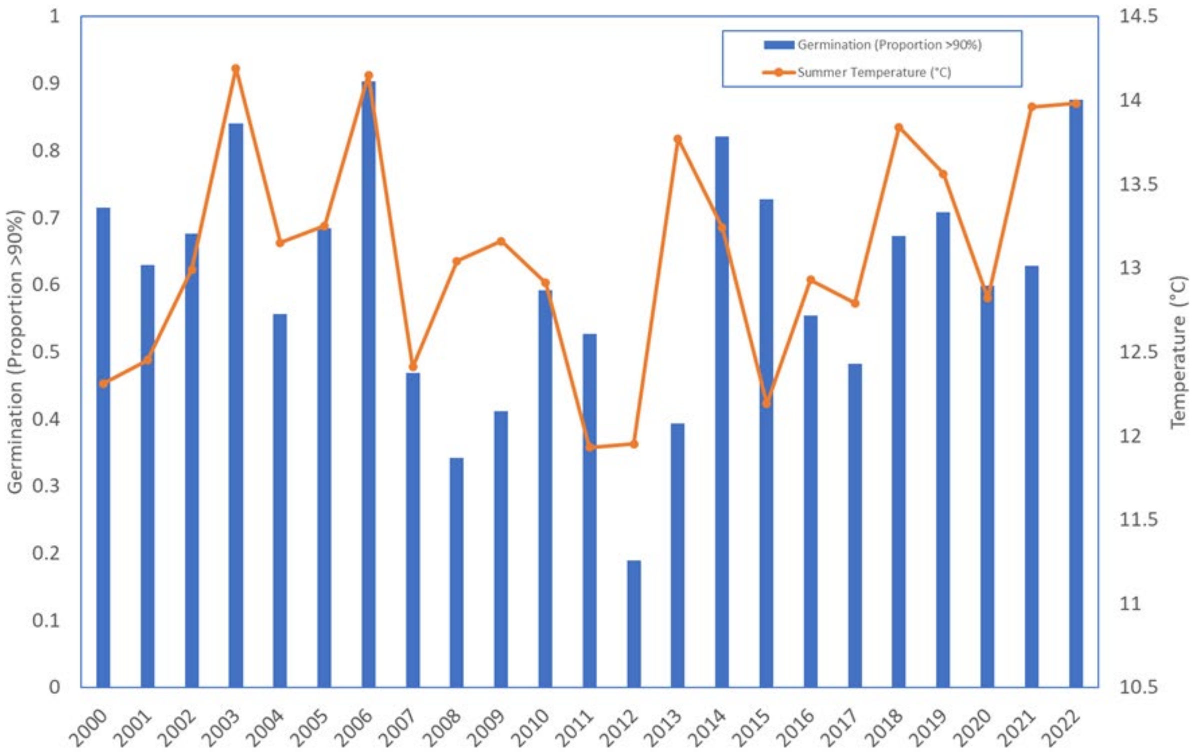

Fig. 2. The relationship between germination of wheat seed (the proportion of results that are over 90%) and mean summer temperature (°C) in Eastern Scotland between 2000 and 2022.

To plough or not to plough?

JACK JAMESON[1,2], KEVIN MCDONNELL[2] and PATRICK D FORRISTAL[1]

[1]*Crop Research Centre Oak Park, Teagasc, Carlow R93 XE12, Ireland*
[2]*School of Agriculture and Food Science UCD, Belfield, Dublin 4 D04 V1W8, Ireland*

ABSTRACT

To plough or not to plough, is an important consideration for most cereal growers. For these growers, there is a continuum of crop establishment systems available to choose from, which incorporate soil cultivation and sowing operations that vary in tillage type, depth, and intensity (Davies & Finney, 2002). In Ireland historically, plough-based crop establishment has dominated, but in recent years, there has been an increase in the interest and use of non-plough systems to establish crops. Growers have turned to these systems to deal with reduced labour availability and increasing crop establishment costs as well as to retain soil carbon and increase work rates.

Crop establishment systems research in drier climates frequently suggests that there are benefits associated with non-plough systems (Triplett Jr.& Dick, 2008; Derpsch *et al*., 2010; Kassam *et al*., 2009; Soane *et al*., 2012; Zarea, 2011). However, limited Irish research has indicated some concerns around the suitability of these systems in wetter climates such as; increases in critical grass weeds and herbicide-resistance development risk e.g.(Vijayarajan *et al*., 2022; Alwarnaidu Vijayarajan *et al*., 2021); inconsistent crop yields (Brennan *et al*., 2014); poorer crop establishment (Byrne *et al*., 2022; Brennan *et al*., 2014); and reduced suitability for spring cropping (Brennan *et al*., 2015).

Crop establishment systems in addition to incorporating differences in tillage practice can include differences in residue management, rotation, cover cropping and traffic management. Researching these systems by means of conventional replicated field experiments is limiting, as it's difficult to replicate the combination of treatments at a small plot level and to determine what aspect of the system may be contributing to any recorded differences. Many growers and grower groups have suggested the need to monitor the performance of alternative crop establishment systems at a farm level, where previous history, field scale operations and individual management practice are all allowed influence the results.

This paper will present results from a current research project examining crop and economic performance of first wheat crops established using different crop establishment systems. To address the limitations of grower field studies and of conventional replicated trials, the project incorporated both elements in studies carried out over three seasons (2020/21 to 2022/23).

The replicated field studies were incorporated as part of a long-term experiment studying tillage systems (deep plough, shallow plough, min-till and direct drill) and rotation in combination on a site which had some of these establishment systems imposed for more than 20 years. The crop establishment plot size was 30m x 30m, which were replicated four times, and had rotation crops grown in 5 meter wide strips, allowing first wheat crops (succeeding oilseed rape) to be monitored each year. Data collected included crop establishment, growth, yield and yield components and all of the management data (including input use).

The multiple case study carried out on commercial farms comprised seven each of farms practicing plough, min-till and direct drill establishment systems across a number of different soil types. First wheat crops were monitored on these farms; necessarily in a different field each year. Similar to the replicated plot studies, data on crop establishment, growth and yield were collected, as were grower inputs for these fields (fertiliser, disease, weed and pest control and machinery operations). Whilst the multiple case study approach doesn't provide the opportunity to statistically compare systems on commercial farms due to the variation in soils, weather conditions and management, it does allow us to characterise the crop and economic performance and its variability, with these establishment systems as practised on a number of farms. This addresses an information deficit.

The data presented will include crop performance and yield information from both the replicated field experiment and the survey of 21 growers' fields. A standard costing methodology will be used to indicate relative production margins from both the field study data and the replicated field experiments.

Currently, results from studies conducted in different climates than our own and anecdotal evidence is guiding growers' decision making around the adoption of non-plough systems. It's hoped these research findings will provide more appropriate information from our climate, allowing growers to make more informed decisions in the future.

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Grieves house tillage trial: What have we learnt from six years of transition to no-tillage cultivation

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ABSTRACT

Reducing inputs into arable farming is a primary method for mitigating the greenhouse gas outputs from these systems which are helping to drive climate change. One way to reduce inputs is to transition from traditional inversion tillage practices to reduced tillage thus reduce fuel and labour inputs. This transition has benefits such as potentially reducing soil erosion, especially if combined with winter or cover cropping, but may also cause issues such as increased run-off or soil capping. No-tillage systems can also be heavily reliant on herbicide usage to control weeds and remove cover crops. Recent research has shown that some cultivars of barley (through yield) are more adapted to non-inversion tillage vs inversion tillage. There are therefore knowledge gaps in how we adapt farming to these lower input managements systems.

Grieves House Tillage Trial is a long-term fully replicated trial following the transition from inversion tillage to non-inversion tillage in spring cropping and winter cropping rotations. We evaluate the changes in soil structure that have occurred during the transition and through the investigation of the root phenotypes of inversion tillage vs non-inversion/no-till adapted cultivars we look at the impact the transition to reduced tillage cropping will have on the crop cultivars we breed for the future.

Grain sustainability challenges: A scotch whisky perspective

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ABSTRACT

The Scotch Whisky industry is a mature, but still expanding, part of the UK manufacturing base representing 26% and 77% of all UK and Scottish food and drink exports respectively. This success is underpinned by the use of primarily UK grown cereals with approximately 90% of barley sourced from Scotland itself. As such the future sustainability of the UK cereal supply chain is a priority for the Scotch Whisky industry to guarantee a local supply of cereals can be reliably sourced over the long-term. As well as quantity, the cereal needs to be of distilling quality for sustainable distilling operations and to maintain the rich flavour diversity which defines the Scotch Whisky category – both of these being a major focus of SWRI research. The immediate twin challenges to be faced are to reduce the carbon footprint attached to cereal production and ensuring crops are resilient to the changing climate impacts. To meet these challenges collaboration across the supply chain and with government is essential with common shared interest driving positive partnerships. For example, the BARIToNE Collaborative Training Partnership on barley sustainability is creating a versatile cohort of crop scientists to help solve future challenges in the coming decades.

Optimise your nitrogen programme using new endophyte technology from Syngenta – introducing Nuello iN & Vixeran

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ABSTRACT

Nitrogen is an essential building block for yield but synthetic nitrogen production and use in agriculture significantly contributes to greenhouse gas emissions. Introducing Nuello iN and Vixeran – two new environmentally sustainable endophyte technologies from Syngenta. The endophyte bacteria in the two technologies can colonise and live within a wide range of agricultural crops and in return fix atmospheric nitrogen to improve crop nitrogen use efficiency. There are many situations where it is not possible to meet the nitrogen demand of a crop (dry weather, delayed nitrogen applications, soil type, leaching etc). Having a "back-up generator" running in the plant for when nitrogen and other nutrients are limiting is a solution provided by these endophytic bacteria.

Nuello iN contains the bacterial strains Pseudomonas siliginis and Curtobacterium salicaceae and is applied as a seed treatment while Vixeran contains Azotobacter salinestris and is applied as a foliar spray in the spring. In cereal trials the two endophyte technologies have been shown to improve crop health and resilience, have given clear yield benefits and are a great insurance policy and real benefit in times of nutrient stress. As part of an integrated nitrogen management strategy the endophyte technologies can enhance yields with standard nitrogen applications especially where access to nitrogen from the soil is limited and, if synthetic nitrogen input reductions are planned by the grower, the endophyte technologies can be used to help maintain yield targets. Cereal trials have shown the endophyte technologies can replace up to 30 kg N ha^{-1} on average and both products can be used in a wide range of crops.

Investigating the impact of different cultivation systems on crop performance in cereal crops

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ABSTRACT

Climate change and the pressure to reduce greenhouse gas (GHG) emissions are driving changes in cultivation systems throughout the UK. By reducing the level of cultivation, there is an opportunity to reduce the emissions associated with arable cropping. With increasingly drier spring and summer months it is becoming increasingly important for crops to access water through deeper rooting systems, to ensure water limitations do not compromise yield potential. Using reduced tillage systems has been shown to improve soil health and structure which can lead to deeper rooting (Ellis, 1979), as well as providing cost savings for farmers. It is crucial that yield effects of reduced cultivations are considered, to determine the impact on final gross margin achieved.

This paper looks at a series of field-scale cereal trials in Fife, Scotland over 3 seasons. Each trial compared minimum cultivation, direct drill, and ploughed treatments for two varieties, and were performed in winter wheat, winter barley and spring barley crops. Assessments included plant and tiller counts, root trait measurements (at growth stage 31), harvest index and grain nutrient analysis. Yield maps were analysed using the ADAS Agronomics methodology to determine significant differences between varieties and cultivation treatments. Significant interactions were observed between treatments and establishment, root traits (particularly root angle and width) nutrient uptake and yield. Differences in treatment effects were also noted between crop type (winter wheat, winter barley and spring barley) and season. This paper will primarily discuss cultivation effects on measured plant growth parameters and how they may have contributed to final yield and gross margins.

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Multiplex digital droplet PCR assay for the detection of barley pathogens

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ABSTRACT

Barley is most widely grown cereal crop in Ireland and 2nd most important crop in the UK. However, the crop faces substantial yield losses annually due to airborne, seed-borne, and soil-borne pathogens. Ramularia Leaf Spot, leaf scald and net blotch, caused by *Ramularia collo-cygni (Rcc), Rhynchosporium commune* and *Pyrenophora teres* respectively, are three important disease of barley, responsible for up to 40% yield loss in Europe annually. Owing to the seed borne nature of these diseases, seed screening is hugely important for pest management and to prevent transboundary spread of pathogens. Digital droplet PCR (ddPCR) is a third generation of quantitative PCR, relying on sample partition into thousands of droplets with each droplet acting as a reaction unit, enabling the precise detection of DNA sequences. Here we demonstrate the combination of two ddPCR assay for the detection of above mentioned pathogens. In the first assay, a multiplex ddPCR assay, provides the capacity to detect *R. commune*, *Rcc* and *P. teres* in a single reaction. Samples positive for *P. teres,* are further analysed in a subsequent assay to distinguish between two forms of *P. teres i.e. P. teres f. maculata* (Ptm) and *P. teres f. teres* (Ptt) causative agents of net and spot form of net blotch respectively. The assay relies on conventional TaqMan probe chemistry providing highly specific and sensitive detection of the pathogens. In order to validate the specificity of the assay, the system was challenged with various barley pathogens. Additionally, the efficiency of the assay was demonstrated by testing 100 historical seed samples of winter and spring barley varieties with variable susceptibility to the different diseases.

Fusarium spp. from Irish cereals: Contributions towards the development of a decision support system to minimise mycotoxin levels in cereal produces

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ABSTRACT

Mycotoxins are secondary metabolites produced by fungi during the growth of a crop or transportation, processing, or storage. Once ingested, these compounds have an acute or chronic cytotoxic, carcinogenic, mutagenic, or immunosuppressive effect, even at low concentrations.

Based on the production of such mycotoxins, *Fusarium* represents one of the most economically important genus of fungi, their mycotoxins in cereals causing major health problems in animals and humans worldwide. Currently, the genus comprises about 150 species, and the most common mycotoxins produced by pathogenic *Fusarium* species in wheat (*Triticum aestivum*), oats (*Avena sativa*) or barley (*Hordeum vulgare*) are deoxynivalenol (DON), zearalenone (ZEA), T-2 toxin, and HT-2 toxin.

Due to a growing concern about the health impact of emergent, modified and combination of mycotoxins present in cereals, the EU is considering imposing new limits for the mycotoxins commonly found in oats. Unlike other crops such as wheat and barley, in oats, mycotoxin contamination can occur in the absence of visual symptoms of fungal contamination, often making it more difficult to assess.

In Ireland, previous surveys showed that T-2 and HT-2 are the most frequent mycotoxins detected in oats, and have occasionally been detected levels above the EU recommended limits (De coli *et al.*, 2021; Kolawole *et al.*, 2021). However, these levels vary from one year to the next and are dependent on weather conditions and different agronomic factors (Kolawole *et al.*, 2021). High levels of T-2 and HT-2 were associated with *F. langsethiae* in oats, this species being particularly found in Northern and Western Europe.

To obtain a broader knowledge on the spectrum of mycotoxins present in Irish cereals, particularly in oats, and the *Fusarium* species responsible for their production, field-based surveys of Irish cereal crops are been conducted for three consecutive years (2022–2024). The *Fusarium* species isolated from the grains are being characterised and included in a *Fusarium* biobank that will be characterised from fungicide sensitivity perspective. In parallel, field based studies are being conducted to determine specific influences current agronomic practices may on both *Fusarium* development and mycotoxin contamination, again specifically in oat crops.

For the first year of the study, a traditional approach was used to develop the *Fusarium* biobank and establish the level of *Fusarium* species found in the grain

samples. This approach consists of cultivation-based assays on agar media and identification based on species-specific morphological characteristics, followed by molecular confirmation of the species (Leslie & Summerell, 2008). However, this approach is tedious, time consuming and imprecise, as it requires high taxonomic skills. Therefore, for the following the first year of the project, a new approach consisting in the high-throughput sequencing of the DNA directly extracted from the grain samples has been undertaken. For this approach the translation elongation factor 1-α gene (*EF1α*), known to be efficient for species discrimination within *Fusarium* genus has been sequenced using the nanopore technology to assess *Fusarium* diversity in Irish cereal crops (Karlsson *et al.*, 2016).

These outcomes, combined with information on the levels of the most common *Fusarium* species and mycotoxins detected in the Irish cereal grains, provide the Island of Ireland Food Safety Authorities with the baseline data regarding the risk of current and emerging mycotoxins to the Irish cereal grain industry and processors. Using this strategy, the knowledge of the impact of different cropping systems and agronomic parameters on the occurrence and levels of *Fusarium* mycotoxin contamination of cereals will be minimised, allowing us to deliver safer, sustainable, and traceable food.

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Mycotoxin contamination in Scottish oats and potential mitigation strategies for growers and processors

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ABSTRACT

Oats are frequently contaminated with *Fusarium* mycotoxins including type A and B trichothecenes and zearalenone, and their glucoside conjugates have also been reported. Agronomy practices, cereal variety and climate conditions have been suggested to play a role in driving *Fusarium* infection in oats. Removal of outer husks during processing has been suggested to remove large portions of mycotoxin contamination.

The current study investigates levels of free and conjugated *Fusarium* mycotoxins in Scottish oats collected over four years and assess the mitigation potential of organic production, cereal rotation and de-husking. Cereal samples were collected from Scottish farms and as part of the long-term field trials at the Aberdeenshire Cropping Experimental (ACE) Platform. Oat samples were analysed for 12 *Fusarium* mycotoxins (type A trichothecenes T-2-toxin, HT-2-toxin, diacetoxyscirpenol; type B trichothecenes deoxynivalenol, nivalenol; zearalenone and their respective glucosides) using LC-MS/MS. The prevalence of type A trichothecenes T-2/HT-2 was highest (95–100% of conventional oats, 50–83% of organic oats) whereas type B trichothecenes were less prevalent and zearalenone was rarely found. T-2-glucoside and HT-2-glucoside were the most prevalent conjugated mycotoxins in oats and co-occurrence between type A and B trichothecenes was frequently observed. Organic oats were contaminated at significantly lower average concentrations than conventional oats, and husks contained higher levels of mycotoxins than de-husked kernels. Cereal intensity within the crop rotation was identified as a significant factor driving mycotoxin contamination.

Our results clearly indicate that free and conjugated T-2- and HT-2-toxins pose a major risk to Scottish oat production and that organic production, low cereal intensity rotation and de-husking offer potential mitigation strategies.

This work was supported by funding from the Scottish Government (RESAS).

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Daud N, Currie V, Duncan G, Filipe J A N, Yoshinari T, Stoddart G, Roberts D, Gratz S W. 2023. Free and Modified Mycotoxins in Organic and Conventional Oats (*Avena Sativa L.*) Grown in Scotland. *Toxins* **15**(4):247.

Tillage, season, management and crop history all affect yield ranking. Which is more important for resilience assessment?

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ABSTRACT

A few cultivars of cereals show adaptation to different types of tillage, mainly inversion compared with non-inversion. This can be shown in changes in variety yield rankings between tillage treatments in small plot field trials (Newton et al., 2020; 2021). However, other factors also affect relative yield rankings such as the season or year, the crop agronomy or management, and the previous crop or crop rotation. Each of these factors in turn can interact with each other and with soil tillage. Are some of these factors more important than others in identifying cultivars that are likely to be resilient and deliver reliable on-farm yields?

We examined the yield ranking of up to nine cultivars across three pairs of trials comparing 1) non-inversion and inversion tillage only, 2) tillage and contrasting management/agronomy, and 3) tillage and crop history or rotation type (winter vs. spring). We identify cultivar interaction effects on yield ranking for all these comparisons, but also some cultivar trends across all the comparisons that may be indicative of on-farm resilience.

These trials and observations have informed our choice of germplasm and the nature of controlled experiments to identify the specific traits that contribute to cultivar adaptation to on-farm conditions, and root traits associated with tillage adaptation in particular.

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Monitoring the sensitivity of *Zymoseptoria tritici* populations to the azole fungicides

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ABSTRACT

Septoria tritici blotch caused by *Zymoseptoria tritici* continues to be the most economically damaging disease of winter wheat throughout north-western Europe. Control is heavily reliant on the application of fungicides, including the azole family of fungicides. Unfortunately, the development of resistance in European *Z. tritici* populations towards these fungicides threatens the viability of the sector. As part of integrated control programmes monitoring for the presence or changes in fungicide resistance is vital to aid the development of strategies that both ensure disease control but minimise fungicide applications. As part of the EURORES network established to enhance fungicide resistance research in *Z. tritici* European monitoring studies have been conducted in 2019 and 2022. These have confirmed the continued increase of key fungicide resistance alleles, specifically CYP51-S524T in the European *Z. tritici* population. In addition, detailed sensitivity analyse has been conducted focusing on the novel azole mefentrifluconazole. Differences in sensitivity were observed amongst European populations in their sensitivity to mefentrifluconazole prior to its launch. Focusing on the Irish population post commercialisation, differences in sensitivity between field populations could be explained by differences in CYP51 haplotype frequencies, in combination with the presence/absence of inserts in the pathogens MFS1 gene associated with enhanced efflux. Combined the findings provide an overview of the current status of azole sensitivity in European *Z. tritici* populations.

Potential for control of ramularia leaf spot

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ABSTRACT

Since the 1980's, barley production across many regions in the world, has been facing challenges posed by the fungus *Ramularia collo-cygni,* which causes Ramularia leaf spot (RLS). The fungus causes substantial yield losses ranging from 20% to 70% and reduces grain quality. The appearance of fungicide resistance in *R. collo-cygni* populations to a number of fungicide actives, together with the lack of known genetic resistance in widely grown barley varieties, indicates limited options to control this disease in the medium to long-term (Havis *et al*., 2015). This highlights the importance of investigating the potential for genetic control of RLS and gain an improved understanding of the host/pathogen interaction.

A subset of the identified spring barley cultivars was tested in field trials in both Scotland and Germany between 2021 to 2022. The results on disease development during both seasons, suggest an interaction between host genetics and an increased resistance to RLS. This was further supported by results from controlled inoculation experiments in a subset of spring barley seedling experiments. Results at both the adult and seedling stage of barley found that *R. collo-cygni*-DNA did not correlate with symptom expression, suggesting that endophytic colonisation by the fungus may not always lead to the appearance of symptoms.

The observations from previous studies and the field trial in 2021 of this study, have linked the appearance of RLS symptoms late in the season to monocarpic senescence. Therefore, this study examined the role of senescence during RLS development and fungal colonisation in studies where *R.collo-cygni* infection was controlled. Results obtained in experiments suggest that host senescence is prematurely induced by *R. collo-cygni* in various spring barley genotypes differing in suceptibility to the fungus. Moreover, results have indicated that senescence is induced both in partially resistant and susceptible barley genotypes. These results indicate that other factors may contribute to the fungus transitioning from its endopythic phase to a necrotrophic lifestyle. Indeed, further experiments on barley in which leaf senescence was delayed showed that RLS symptoms and fungal DNA increased, whereas during early senescence whilst RLS symptoms were reduced, fungal colonisation was increased. These findings suggest that other factors may also contribute to disease development.

Increased resistance to R. collo-cygni in barley plants in controlled inoculation experiments was also found post foliar treatment with the ethylene precursor 1-Aminocyclopropane-1-carboxylic acid (ACC). Furthermore, gene expression analysis of barley ethylene response factors in this study, indicated that one ethylene response factor associated with the QTL on chromosome 4H was upregulated in response to foliar ACC treatment. Altogether, these results suggest a putative ET-mediated disease resistance to RLS.

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What is happening with the regulation of new breeding techniques in Europe?

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ABSTRACT

The development of breeding techniques has accelerated in recent decades with the exploitation of sequencing data and the application of genomics-based techniques. While the generation of novel diversity is the cornerstone of breeding, making the breeding process quicker and more specific is critical at one level to reduce production costs but at another level to respond to the challenges that exist. Indeed, there is no shortage of challenges, be they legislative or environmental. At an EU level, the removal of specific chemistries (e.g. chlorothalonil) has narrowed disease management options and increased reliance on a smaller number of chemistries. This in turn has increased the risk of resistance to remaining active(s). In parallel, the diversity of climates in any given growing season compromises yield potential (and/or quality) and threatens grower profitability. The pace of variety development must be accelerated and the availability of new genomic techniques (NGTs) as breeding tools has begun to demonstrate the potential of these approaches when included in tailored IPM-based strategies. For example, Kessel *et al.* (2018) reported the impact of cisgenically engineered potato to reduce the average fungicide input in potato by 80–90% without compromising control efficacy. Since then, the application of gene editing has further developed the potential of existing varieties with one or more specific agronomically important traits (reviewed by Tiwari *et al.*, 2022). At an EU level, the regulatory landscape has regrettably not kept pace with the development of breeding techniques and the current authorization process for modified plants is not fit for purpose. However, the publication of a new draft regulatory system for NGT derived plants in 2018 by the European Commission provides the possibility for new breeding techniques to be deployed in breeding programmes under certain criteria. In the months ahead, this proposal will be voted on and if delivered in its current format will facilitate breeders to deliver varieties with enhanced traits to meet both legislative requirements and facilitate climate adaptation for crop production systems.

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A National Potato Innovation Centre for the UK and beyond

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ABSTRACT

Potato is a major crop in the UK and throughout Europe and is key in government strategies worldwide (including in China, India and Sub-Saharan Africa) to attain food security by ensuring a reliable and sustainable supply of healthy food. The climate and biodiversity crises require rapid development of crop cultivars adapted to warmer environments to be grown in low input sustainable systems.

We are proposing to establish a National Potato Innovation Centre (NPIC) at the James Hutton Institute in Dundee, which will comprise a state-of-the art innovation facility managed in partnership with stakeholders across academia, industry and government, both nationally and globally. The NPIC will be part of a creative cluster that will deliver solutions for industry, generating new findings, innovative products and high skilled jobs in new industries.

We are meeting with academic partners, industry and government to identify major industry challenges where science can offer a potential solution, both now and in the future, the outcomes of which will be outlined in the presentation.

Some provisional areas are outlined below:

1. Discovery and breeding

Recent breakthroughs in breeding technologies have greatly facilitated the process of potato breeding allowing faster integration of key traits to address climate, disease and quality issues and allowing the full genetic gain of potato to be realised. New facilities in NPIC will enable much faster production of new cultivars.

2. Resilient production systems

Develop sustainable, climate resilient production systems using precision agri-tech tools such as robots, drones, below ground phenotyping, AI and modelling, controlling disease, managing waste and contributing to net zero farming systems.

3. Innovative potato products

Investigate novel uses of potato: using waste tubers, peelings, haulms as raw materials for extraction of bio-actives for medicine, modified potato plants to produce plant-based medicines (e.g. opioids and vaccines), and new alternatives to plastic. Production of new functional foods from nutritious high quality potato proteins (a rapidly growing world market).

Impact of a changing pathogen population on efficacy of control measures for potato late blight

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ABSTRACT

Potato late blight, caused by the oomycete pathogen *Phytophthora infestans*, remains a significant threat to potato crops in the UK and worldwide. The population of *P. infestans* is dynamic, evolving over time in response to management practices such as fungicide application or host resistance deployment. The implications of population change are twofold: new populations have traits that differ from the previous population (e.g., aggressiveness, virulence and fungicide resistance) and therefore influence blight management, and there is risk that both pathogen mating types interact to form long-lived soilborne inoculum (oospores).

Effective blight management relies on knowledge of the source of inoculum and conditions under which disease occurs, the efficacy of fungicides and host resistance.

Given recent significant changes to the population of *P. infestans* and the potential for increasing pathogen diversity in the future, integrated pest management (IPM) strategies must continue to take account of the traits of the contemporary population.

Here we describe how our data from genetic fingerprinting of *P. infestans* is being used, in combination with studies of host resistance and pathogen traits such fungicide resistance, to improve decision making and effective disease management. Twelve different active ingredient groups are currently listed for late blight control (Fungicide Resistance Action Group [FRAG-UK], 2018). This range of fungicides, in addition to limits on the number of applications of a single active, enables management strategies that mix or alternate active ingredients across the season to minimize the risks of resistance developing in the population of *P. infestans*. However, resistance to Metalaxyl-M or mefenoxam has previously been reported in the EU13 genotype of *P. infestans,* and more recently to fluazinam in isolates of the EU33 and EU37 genotypes (Schepers *et al*., 2018) and to mandipropamid in genotype EU43 (Abuley *et al*., 2023). Concerns about further emergence and spread of fungicide insensitivity in 2019 led to the systematic testing of dominant UK genotypes reported here. A range of commonly used fungicides (cyazofamid, fluopicolide, mandipropamid, propamocarb, oxathiapiprolin, amisulbrom and mancozeb) were tested over three or four consecutive seasons (2019–2022). Additional fungicide sensitivity testing of genotypes EU43 and EU41, known to cause control problems in mainland Europe was also carried out. Resistance to foliar late blight in potato varieties carrying a range of resistance genes was carried out using the same selection of *P. infestans* genotypes to identify differences in response relating to local pathogen populations.

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Potato cyst nematodes and the future of potato production in Scotland

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ABSTRACT

The UK is the 5th largest potato producer and exporter in Europe with an industry worth approximately £928 million farmgate value and many billions in downstream industries. 77% of seed potatoes used in Great Britain originate from Scottish farms. However, this industry is under threat from potato cyst nematodes (PCN) which have been spreading across many UK potato growing areas for decades. These endoparasitic roundworms drastically reduce yields and, due to the complex relationship with their host, are extremely difficult to control. Legislation in Scotland prevents seed potatoes from being grown on land where PCN have been detected and PCN are already present in almost 21,000 ha of Scottish soils. Current market varietal requirements and a lack of control options for growers mean that PCN is continuing to spread. Recent predictions suggest that PCN will cause the end of the Scottish seed potato industry by 2050, potentially only 5 rotations away.

Following a report in 2020, a Scottish Government PCN working group was initiated under the management of Scotland's Plant Health Centre. This group, consisting of over 50 government, academic and industry partners are collectively working across 9 key work packages. In addition to core research, the group has proposed new policy changes, created new tools to help growers with PCN management and recommended incentives for improved PCN management to SASA. The working group is currently in year 3 of 5 and this presentation will provide an update on current progress.

Potato storage research capabilities in the UK

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ABSTRACT

UK research capacity in potato (and other horticultural and fruit crops) was significantly reduced with the closure of the AHDB Sutton Bridge Crop Storage Research facility. This presented an urgent problem, but also an opportunity, to create capabilities for crop storage research that are designed and flexible to meet the needs of the sector going forward.

CHAP developed a business case for Storage Research in Horticultural Crops arising from 4 short listed options developed and discussed at Stakeholder workshops – with representatives from across the potato and horticulture sector. A partnership between CHAP, ADAS, Natural Resources Institute (NRI), James Hutton Institute (JHI) and SRUC/SAC Consulting led to capital investment secured by CHAP with funding from UKRI: Innovate UK. This funding has led to Crop Storage and Post-harvest Solutions (CSPS) facilities hosted at the Advanced Plant Growth Centre at JHI in Invergowrie; by ADAS, located at ADAS Boxworth, Cambridge, and at the NRI which hosts the Produce Quality Centre based in East Malling, Kent. Additional funding at the ADAS site came from ADAS, and at the JHI site from the Scottish Government. The funding at NRI has been used to expand an already existing University unit.

These facilities offer the capability to simulate supply chain environments with accurate control and monitoring of potato storage conditions; temperature, humidity and atmospheric composition (e.g. CO_2). The CSPS facility network will focus on further increasing the resilience of food supply chains by reducing food waste, increasing shelf-life and optimising the food value chain from primary production through to retail.

The CSPS network is now available for commercial and R&D projects and collaborations for all interested stakeholders in key areas such as: development of sensors, tags and bioindicators for produce quality management; testing innovative methods for post-harvest control of microbial decay and spoilage; understanding and controlling the biology that influences food storage and shelf-life.

As a consortium CSPS brings together scientists with a wide range of complementary and multi-disciplinary expertise, as well as technology transfer and knowledge exchange. Finally, and perhaps most significantly if looking to the longer term, CSPS can provide a training ground for the new post-harvest specialists of the future.

Further details can be found at https://chap-solutions.co.uk/capabilities/crop-storage-post-harvest-solutions/ and visits to the facilities can be arranged through local contacts or *via* CHAP.

A proactive approach to managing aphid-vectored viruses in seed potato production

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ABSTRACT

Scottish seed potatoes have a global reputation for high virus health. This reputation has arisen from a combination of favourable climatic conditions, geographic isolation of seed crops, and the professionalism of Scottish producers. However, over the past few growing seasons a rise in the frequency of seed potato crops displaying virus faults within the Seed Potato Classification Scheme (SPCS) has caused concern in the industry. In particular, occurrence of viral infections within crops entered at Pre-Basic grades (i.e. early field generations) threatens the industry's reputation.

Seed potato producers are reviewing their production systems and control programmes in light of this challenge to better safeguard against aphid vectored viruses. The issue is complex, and solutions will only arise via a combination of policy changes, coordination between ware potato and seed potato producers, and better use of Integrated Pest Management (IPM) approaches. Aphid vectored viruses in seed potatoes are a substantial challenge for IPM due to the very strict tolerances for faults and the high transmissibility of viruses such as PVY (Dupuis *et al.*, 2017).

This presentation outlines the recommendations from recent industry wide summits, and an appraisal of grower's views in relation to aphid vectored virus management as collected from a recent *Plant Health Centre* funded project (Cresissen *et al.*, 2023). The project also included participatory workshops with industry stakeholders. Several field trials with infector plant rows have also been conducted in Scotland between 2020-present to explore the efficacy of integrated strategies on reducing transmission of PVY and PLRV. The results of these trials inform revised guidance for producers.

Following the participatory workshop priority scores were calculated (Young *et al.* 2022) to rank key areas for attention. There is consensus amongst stakeholders around some key priorities such as effective groundkeeper control, early haulm destruction, and great attention to the quality of input seed. Growers share similar priorities but hold mixed views about some integrated methods which evidence from trial work suggests are effective, such as the use of mineral oils and straw mulches.

Several growers have requested clearer guidance on use of plant protection products within an integrated management approach, and data from SASA's Pesticide Usage surveys (Davis *et al.*, 2023) indicate an over-reliance on insecticides of the pyrethroid class (which are relatively broad spectrum and have well documented resistance issues) with perhaps sub-optimal usage of other available active ingredients (See Fig. 1).

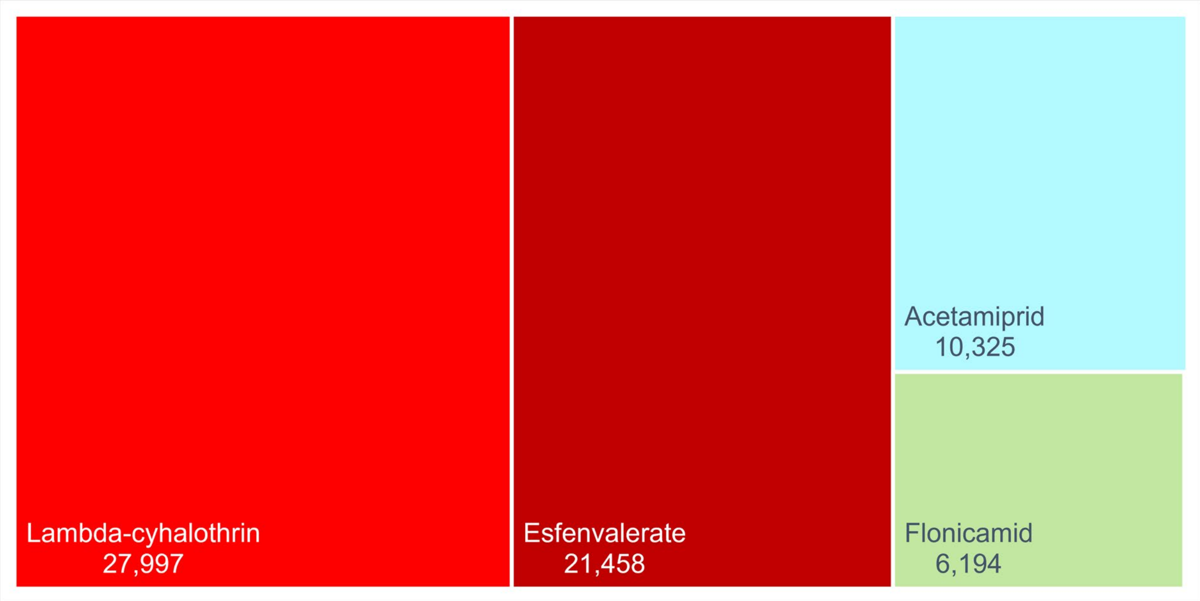

Figure 1. Estimated Treated Hectares in Scottish Seed Potato Crops in 2022 for key actives used in the management of aphid vectored viruses as reported by SASA's Pesticide Usage Survey. Spirotetramat was used on 68 treated ha in 2022.

Growers and industry stakeholders reported two key barriers to greater use of IPM approaches for management of aphids in seed potato production: (1) a lack of producer confidence in the efficacy of IPM methods and (2) lack of experience of implementing such measures within seed potato production systems. This presentation concludes with recommendations on participatory approaches to increasing IPM uptake and focused knowledge exchange measures that will contribute towards meeting the challenge of rising aphid vectored virus incidence.

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Patterns and predictors of potato viruses in Scotland

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ABSTRACT

Potato viruses are an ongoing and increasing challenge to the Scottish seed potato industry, yet little is known of their epidemiology at the landscape-scale. In this study we analysed georeferenced data on the occurrence of ten different potato viruses from the Scottish seed potato classification scheme. A co-occurrence analysis found that 12 virus species pairs occurred together more often than expected by chance, and the bacterial disease potato blackleg was positively associated with eight potato virus species. ArcGIS Pro was used to analyse the spatial and spatiotemporal distribution characteristics of the three most prevalent viruses (PVY, PLRV, and PVA), and this revealed striking geographic differences in disease outcomes across the country. Interpretable machine learning techniques were then used to develop a model to predict patterns of PVY incidence in space and time, and investigate the influence of key crop, management, and environmental factors. The results showed that features related to the health and management of seed stocks were among the most informative predictors of incidence, together with variety resistance, crop location, density of potato production, and temperature variables. The model could serve as the basis of a decision support tool for improved virus management.

The potential contribution of potassium phosphonate to the control of potato late blight in northern Britain

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ABSTRACT

The challenge of controlling potato late blight to the very high level required increases substantially each time resistance to another FRAC target site is detected in *P. infestans* and the frequency of resistance becomes significant. In the last 10 years on the continent the following resistant genotypes have been detected and have rapidly spread to other countries:

- 37_A2, resistant to fluazinam, detected in 2013;
- 43_A1, resistant to CAA fungicides, detected in 2018;
- genotype not yet declared, resistant to oxathiapiprolin, detected in 2023.

The approval in late 2023 of the first potato blight control product to contain the active ingredient potassium phosphonate, which is classified by FRAC as an inducer of host-plant resistance and has a new target site, is therefore very timely. In advance of the 2024 growing season is an opportune time to convey to the potato industry the substantial efficacy of potassium phosphonate in northern Britain.

The oral presentation will only include results from field trials (from SRUC's late blight testing site). These will be from 2017 to 2023. In addition the level of performance under Scottish field conditions of potassium phosphonate properties that are more specific, e.g. curative activity and the impact on tuber size distribution, will be communicated.

Psyllid behavioural studies help understand the risk posed by "*Candidatus Liberibacter solanacearum*" to UK potato and carrot production

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ABSTRACT

The phloem limited bacterium "*Candidatus* Liberibacter solanacearum" (Lso) is associated with disease in Solanaceous and Apiaceous crops and has caused significant economic losses worldwide. Vector-borne transmission is key to its impact, and the main threat to UK crops is incursion of the psyllid vector in potatoes *Bactericera cockerelli* (Tomato-potato psyllid), which is a GB Quarantine pest and EPPO A1 listed pest. It is estimated that if *B. cockerelli* were to invade Europe the effects of Lso damage on potato and tomato across the EU would cost 222M EUR per year and the estimated negative impact of social welfare could cost an estimated 114M EUR (Soliman *et al*., 2013).

Previous research has demonstrated that at least four haplotypes of Lso, vectored by at least four psyllid species, are already present in the UK without any observed economic damage to crops (Sumner-Kalkun *et al*., 2020). This highlights that emergent pathogens can be very closely related to benign native populations (which may be unknown or poorly studied if considered harmless) and illustrates the depth of understanding required when legislating against new threats.

Survival, transmission and feeding studies were carried out to better understand how these resident populations interact with their native habitat and nearby crops, to provide further evidence that the newly discovered Lso haplotypes and vector species in GB pose no threat to crop production. Two species identified previously as present and carrying Lso in GB were investigated in detail. The Nettle Psyllid, *Trioza urticae*, was chosen as it is by far the most ubiquitous and numerous psyllid found in field margins across GB. The other species chosen was Cow Parsley Psyllid, *Dyspersa pallida,* which was only recently found in GB and its distribution appears to currently be limited to Morayshire. This psyllid's main host is Cow Parsley, but adults, eggs and immatures have been found rarely on carrot plants in the field. Other psyllid species which are infected with Lso and found in GB were not investigated during this experiment either due to extremely low numbers found in GB (such as *Dyspersa apicalis*) or difficulty rearing and limited evidence of presence in crops (such as *Craspedolepta* spp.).

The first study focussed on comparing survival and reproductive rates of each psyllid species on three plant species - their native host, and carrot and potato. Individual psyllids were held in position on the leaves of uninfected plants using clip cages and checked every three to four days for 60 days in total. Survival, eggs laid and hatched immature psyllids were recorded at each check. At the end of the experiment the plants and psyllids were tested for the presence of Lso. The results of this experiment

improve understanding of the comparative suitability of crop plants to the insect's main host and the likelihood that psyllid populations could develop and transmit Lso to that crop.

Electrical penetration graph (EPG) experiments were then used to ascertain the feeding behaviour of psyllids, again on their known host plant, and crop plants of interest (carrot and potato). EPG techniques allow visualisation and recording of feeding behaviour of insects with piercing mouthparts (such as psyllids) by connecting the insect and plant to an electrical circuit. Individual psyllids were connected to the EPG system, placed on a connected plant, and monitored for 24 hours using a Giga-8dd DC EPG recording system. Waveforms were collected, analysed, and results were interpreted to assess feeding behaviour on plants. Analysis of waveforms allows comparison of feeding behaviours between individual psyllids and plant treatments, and characterisation of xylem feeding and phloem feeding. Xylem feeding can be common on non-host plants but is considered low risk compared to phloem feeding which is necessary for Lso to proliferate within the plant.

Initial analysis of these survival, reproduction and EPG experiments suggest that both Cow Parsley Psyllid and Nettle Psyllid do not pose a risk to potato plants due to reduced survival, lack of phloem feeding and no reproduction on this plant. Cow Parsley Psyllid is able to reproduce, transmit Lso and phloem feed on carrot plants, however, factors outwith these experiments (such as plant choice, Lso genetic type and phenology of crops) seem to limit the ability of this Lso-psyllid combination to cause disease in carrot crops. Nettle Psyllid was not able to feed, reproduce or transmit Lso on carrot or potato but adults did not exhibit reduced survival on these plants within the 60-day study period.

These factors will be considered in detail within the wider BBSRC funded Caliber project, which will be reported later this year. The results of Caliber will be used to support accurate assessment of the risk of Lso or psyllids causing economic losses in GB crops through the introduction of a new psyllid species, changes in the status of native Lso haplotypes or psyllids, or major changes to land use and agricultural practice.

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P1
Improving aphid and BYDV monitoring

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ABSTRACT

Aphids are a major insect pest, reducing both grain yield and quality via direct feeding or vectoring plant viruses. The most economically important aphid vectored virus in cereals is barley yellow dwarf virus (BYDV), causing up to 80% yield losses. Managing aphids is becoming increasingly difficult due to; reduced insecticide availability, insecticide resistance, lack of robust thresholds and climate change. To navigate these challenges it is critical to implement robust monitoring techniques that account for the spatial and temporal distribution of aphids are essential. Monitoring aphids is a valuable tool in managing aphids, allowing for informed insecticide application decisions to be made. Monitoring tools are applied for different scales; Visual assessments at plant level, Water traps at field level and suction tower at region levels. One caveat to the application of monitoring tools to manage BYDV is that the viral risk of a single aphid is unknown. The presence of an aphid however does not necessarily mean BYDV is present, thus the severity of BYDV infection is linked to both the number of aphids and the proportion of which are viruliferous. This project has established a national aphid-trapping programme in Ireland, to validate the use of monitoring tools to forecast aphid populations and BYDV outbreaks. To achieve this all aphids caught in this survey were tested for the presence of BYDV as were plants within the fields. The first of three years of this survey has been completed across 17 winter barley and 20 spring barley fields in Ireland.

P2
Influence of grazing winter cereals with sheep on agronomic factors including crop pathogen and weed pressure

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ABSTRACT

The UK has witnessed a series of extreme weather events in recent years, and projections indicate an increasing frequency of such occurrences in the future. This has raised concerns among farmers about their ability to provide sufficient forage for their sheep and cattle, particularly during the winter months. Simultaneously, some arable farms are keen on incorporating livestock into their systems to enhance soil health, residual nitrogen levels, and organic matter content through animal manure and urine return. Grazing of winter cereals has potential to offer a mutually beneficial relationship by providing winter grazing for ruminants and at the same time providing arable farms with an additional income stream whilst still maintaining acceptable yields and improving crop resilience against weeds and diseases.

We present some of the results from a recent series of controlled field experiments and farmer-led demonstrations in Northeast Scotland. The primary objective was to test the hypothesis that grazing winter cereals can offer valuable winter feed for ruminants without significantly compromising crop yields or adversely affecting factors such as weed prevalence and disease incidence. We find that winter wheat, winter barley, and winter oats can withstand relatively heavy grazing without clear negative consequences for the crops in terms of yield or impact of weeds and disease pressure. Moreover, analysis of these crops' feed value during the grazing period, typically spanning late November to mid-March, consistently revealed impressive results.

In summary, the grazing of winter cereals presents a promising approach to address the challenges faced by both livestock and arable farmers in the UK, fostering a mutually advantageous partnership that supports food production, soil health, and resilience to environmental stressors.

Acknowledgment

This work was funded by the EU Horizon2020 Research and Innovation Programme - MIXED Project (No.862357) and also receiving support from Rural and Environment Science and Analytical Services Division of the Scottish Government (SRUC-D3-1).

P3
An evaluation of the potential for Bokashi manure treatment in the UK

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ABSTRACT

Bokashi is the Japanese word for "well-fermented organic matter". The organisms responsible for the Bokashi fermentation process thrive in anaerobic (oxygen-free) conditions and for that reason, the process occurs inside sealed bags or vessels. It is similar to the process used to create silage. Bokashi manure treatment involves spraying animal bedding with a liquid mixture of microorganisms (known as Effective Microorganisms or EM®) which gradually colonise the bedding and dung mixture in animal housing. These organisms begin to break down the bedding and dung during the housing period. Once the animals have been removed from the housing, the bedding and dung are taken out, mixed and covered with an impermeable membrane (usually plastic) and left for at least 6 to 8 weeks. The resulting dung can be used in the same way as dung produced by other means (e.g. outdoor stacking, covered stacking and turning or composting). Literature review has shown that the following benefits have been reported following Bokashi treatment of solid manures:

- Improved health of housed animals;
- Lower odours;
- Drier bedding;
- Reduced incidence of flies;
- Reduced nutrient losses from the finished manure and improved carbon and nutrient retention;
- Reduced manure management costs;
- Reduced carbon footprint associated with manure management.

The potential for Bokashi manure treatment is clear, but practical trials in a UK context will be required to determine whether the benefits can be realised in the UK. A 3-year project funded by Innovative Farmers is now underway, with trials on two Scottish farms to determine the potential for the technique in housed cattle.

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P4
Varietal resistance as an IPM tool for Scottish barley crops

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ABSTRACT

On a global scale, barley is the fourth most important crop. One of the most devasting foliar diseases of barley is Rhynchosporium leaf scorch (causal agent *Rhynchosporium graminicola*). In high disease conducive environments fungicides are relied upon heavily to maintain grain yield and quality. Adoption of IPM strategies requires reliable information on the contribution of varietal resistance for plant disease management.

Environmental conditions, such as temperature and rainfall, can alter the relationship between pathogen and host and hence affect disease levels, which can influence the efficacy of pest management tools and techniques. Unless the grower is confident that combining chemical and non-chemical management techniques will reduce the fungicide requirement and protect the yield for that crop, then pesticide usage practices are unlikely to change.

Selecting varieties based on their disease resistance rating has long been regarded as a cornerstone of IPM. However, for growers to be able to use varietal resistance as a means of reducing fungicide inputs they must be know when and how to do so and be confident in their decision-making ability.

This study examined the effectiveness of variety resistance in the management of barley leaf scorch across years and sites in the UK. More disease was observed in more susceptible varieties but the value of variety resistance was far more pronounced under high disease pressure, driven by high temperatures and rainfall over the winter months. In these situations, clearly varietal resistance is an important tool in managing disease, reducing the need for fungicide, and maintaining yields of high-quality grain. Therefore, these weather parameters and varietal resistance ratings (AHDB Recommended List) should be factored into any IPM programme.

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P5
IPM information on social media: Using large language models (LLMs) and keyword extraction to identify trends on YouTube data

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ABSTRACT

Background

Integrated Pest Management (IPM) represents a cornerstone strategy in sustainable agriculture, yet synthesizing practical insights from diverse information sources such as YouTube remains challenging. This research pioneers a hybrid methodological framework, leveraging advanced machine learning techniques for the extraction and categorization of IPM-related content from video descriptions.

Objective

The study aims to utilize BERT topic modeling to systematically identify and categorize IPM themes from YouTube, enhancing the clarity and accessibility of this valuable information for researchers and practitioners.

Methods

We implemented an innovative text analysis pipeline that integrates Python's 'Transformers' and 'TensorFlow' libraries for generating BERT embeddings, with R's 'tidyverse' and 'tidytext' for data preprocessing and 'kmeans' from the 'stats' package for clustering. This approach capitalizes on BERT's transformer architecture, which adeptly captures the subtleties of context within language, surpassing traditional language models in discerning semantic nuance.

Our analysis utilized the Python 'Transformers' library's 'BertTokenizer' and 'TFBertModel' to prepare and process the textual data into contextually enriched embeddings. The embeddings were then analyzed using Kmeans in R, which segmented the data into distinct clusters through a systematic determination of optimal k-values, highlighting the inherent thematic structures.

Results

The BERT-based embeddings were clustered using the 'kmeans' algorithm, underscoring its utility in grouping complex language data. Five topic clusters were

identified. The effectiveness of the approach was further enhanced by custom stop-word filtering via regular expressions in R, eliminating prevalent but non-informative language specific to YouTube. The interpretability of our findings was facilitated by ggplot visualizations, which provided a compelling graphical representation of the data's clustering, and PCA plots that distilled the essence of high-dimensional data into comprehensible two-dimensional space.

Conclusion

This study's novel methodological blend of Python's neural network prowess with R's analytical and visual capabilities sets a new standard for extracting thematic insights from video platforms. By demonstrating how BERT embeddings can be effectively clustered to uncover thematic structures in IPM discourse on YouTube, we provide a template for future investigations into educational and informative content within large-scale digital media platforms that can influence IPM behavior.

P6
Risk perception in relation to crop health decisions

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ABSTRACT

The implementation of IPM practices in agriculture is influenced by farmers' risk aversion. Risk-averse growers are more likely to use conservative and risk-reducing agricultural practices. They may spend more on crop protection products, such as pesticides or fungicides, to ensure a more predictable and stable yield. Their goal is often to minimize the potential for crop failure and financial losses. These producers are expected to require a larger financial incentive to make them reduce or minimise pesticide or fungicide use. In contrast, risk-loving or risk-tolerant producers, who are individuals with a higher tolerance for risk-taking, may be more willing to adopt cost-reducing measures, which may involve having a lower pesticide or fungicide use. They might take calculated risks in the hope of optimizing their returns, even if it means accepting a higher level of uncertainty. These farmers are expected to require a smaller financial incentive to make them reduce or minimise pesticide or fungicide use.

Risk aversion may influence the implementation of other IPM practices. For example, risk-averse producers are expected to have a larger propensity to monitor and scout crops more regularly than risk-loving producers. In other words, risk-averse producers are expected to prefer a management strategy that favours the mitigation of a disease or pest outbreak than a management strategy that favours the control of the outbreak. By being proactive in pest management, risk-averse producers can minimize the uncertainty associated with pest outbreaks. Risk aversion may also influence the implementation of cultural practices, such as crop rotation. These practices disrupt the life cycles of pests and diseases, reducing the risk of widespread crop failure. By promoting stability in crop yields, risk-averse producers are expected to implement cultural practices that minimise yield variability.

We run a project aimed at identifying the effect of risk aversion on farmers' willingness to reduce fungicide use in barley. There is more potential to reduce pesticide (fungicide) use in spring barley as profitability is less likely to be heavily impacted by a reduction in use. This potential variability in pesticide use allows for investigations into risk aversion behaviour amongst spring barley producers. Spring barley producers in Scotland traditionally apply fungicides twice during the growing season to protect the crop from foliar fungal pathogens such as Rhynchosporium. A

producer's decision to apply fungicides twice is likely driven by a risk-reduction approach to crop management. Requesting a barley producer to reduce their fungicide application introduces a new risk scenario during the growing season. This barley producer now faces a higher likelihood of disease outbreaks. Depending on the degree of risk aversion of the producer, a request to reduce fungicide application may be seen by the producer as a benefit. If the perceived risk of disease is lower than expected, reducing fungicide applications may be a reasonable decision if it also reduces the costs of production. However, if disease probability is high, the producer may face increased risk of crop losses, which can be interpreted as more important than the reduction in the costs of production. In this new situation, the overall risk scenario for the barley producer involves a trade-off between cost reduction and the potential increase in the risk of disease outbreaks.

The spring barley producer needs to weigh the potential cost savings against the increased risk of crop losses due to reduced disease control. This decision-making process reflects the complex interplay between risk aversion, cost considerations, and the uncertainty associated with changes in fungicide application practices. We can employ this risk scenario to determine the level of risk aversion of a barley producer. By requesting the barley producer to provide us with the monetary quantity that they are willing to accept to play the risky lottery of making one fungicide application instead of the normal two applications, we can compute his/her risk aversion employing the concept of certainty equivalence. The certainty equivalent is the monetary amount that an individual would consider equivalent to a risky situation. In this case, it would be the compensation that makes each producer indifferent between the risky scenario (reduced fungicide use) and a certain outcome (no disease outbreak), which is assumed to occur when the producer makes two fungicide applications during the growing season (at least, this is expected to be true in his/her mind).

If a producer is risk-averse, the financial quantity requested will be larger than the difference between the expected value of the risky scenario and the value of the sure scenario. This reflects their preference for a guaranteed amount over taking a chance with uncertain outcomes. On the other hand, if a producer is risk-loving, the financial quantity requested will be lower than the difference between expected value of the risky scenario and the value of the sure scenario, indicating a preference for the uncertain possibility of higher returns.

The results of this project show that there is plenty of room for the development of methods that capture farmers' risk aversion. We presented a model for barley where risks scenarios were limited to two and only involved consideration of yield reductions due to disease outbreak. We show that risk aversion influence farmers' decisions about the use of IPM practices. There is a need for more advanced methods to capture risk aversion in contexts where quality is also a variable to consider in the analysis. In the latter case, the financial compensation to reduce fungicides that is likely to be requested by farmers is affected by considerations of quality.

P7
Control of barley diseases using integrated control measures

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ABSTRACT

Barley remains the fourth most important crop on a global scale but has more significance in Scotland where high-quality barley supports a multi-billion pound whisky industry and a significant animal production sector (Scottish government, 2019). Following the introduction of EU 2009/128/EC on the sustainable use of pesticides all of the member states signed up to make Integrated Pest Management schemes National Policy. These polices remain in place despite recent changes to the GB status within Europe. IPM policies require growers to take a holistic approach to disease management.

A series of trials were undertaken at SRUC sites, in order to evaluate the potential of alternative plant protection products and biostimulants to control disease in a number of barley varieties. One set of trials looked at the disease control from Laminarin (Iodus®), *Bacillus subtilis* (Serenade®) and amino acids (Amino Flo®). The products were tested on their own and in combination with a reduced fungicide input at ¼ manufactures recommended doses. Commercial fungicides were azoxystrobin (Amistar®), mefentrifluconazole + fluxapyroxad (Revystar®) and folpet (Phoenix®). Alternative products were applied at T0 spray timing (GS 24) (Zadocks, 1974) and T1 (GS31) and commercial fungicides at T1 (GS 31) and T2 (GS 45). Two varieties of spring barley were used in the trials. Laureate is approved for malting and is the dominant variety of spring barley grown in Scotland and England. In 2023 it accounted for 32% of the area of spring barley grown (AHDB, 2023). Fairing is a specialist grain distilling variety with excellent resistance to Rhynchosporium (AHDB 2024). Disease levels were assessed in the plots and the trials were taken to yield.

Results from 2022 and 2023 indicated that control of disease from the alternative products was variable. In the Fairing trial in 2022 the combination of alternatives with low-rate fungicides gave a significant reduction on Ramularia leaf spot but this did not translate into a significant yield response. Results for Laureate for 2022 were more variable with no pattern observed. In 2023 at the Borders site in Laureate the combinations gave small but non-significant increases in yield over the control. This was also observed in the fairing plots, except for the biostimulant programme, which failed to give a yield increase over the untreated. At the Lanark site although Ramularia leaf spot was reduced in the Fairing plots there was again no significant yield impact. In the Laureate plots disease control was more variable but small non-significant yield effects were observed.

A series of small plot trials were also undertaken looking at the effect of a wider range of alternative plant protection products and biostimulants both on their own and in combination with low rate fungicides. These trials were not yielded but frequent disease observations were taken. Three varieties were used in the trials. In the 2022

trials a number of treatments significantly reduced levels of Rhynchosporium in cv Laureate compared to the untreated control. These were a sulphur product (Microthiol®), Laminarin in combination with a low fungicide dose (azoxystrobin followed by fluxapyroxad + mefentrifuconazole + folpet). Another elicitor product (superphite plus®) in combination with low dose fungicides also reduced levels of Rhynchosporium. There were no significant reductions in disease in the other varieties. In 2023 the disease pressure was very different and no Rhynchosporium was observed in the plots. There was no significant response to any of the products in controlling disease.

The implications for future disease control are discussed in the accompanying poster.

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FIGURES

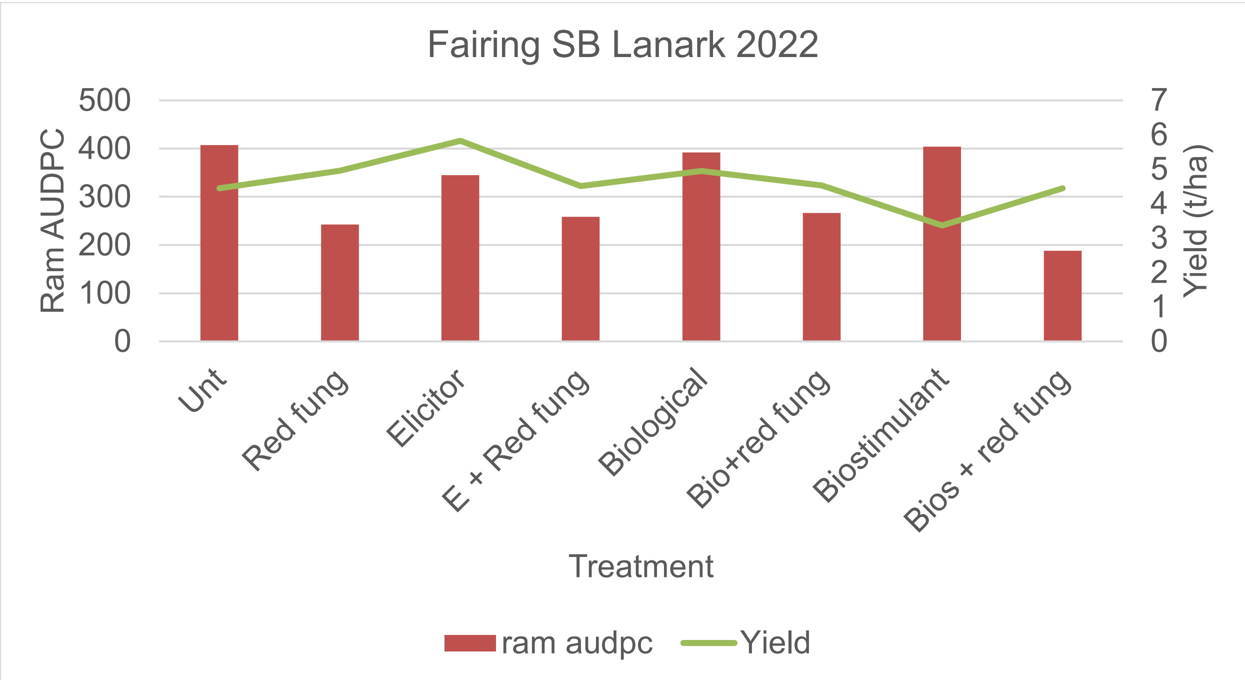

Figure 1. Disease control and yield in cv Fairing in 2022 yielded trial.

P8
Why and how government should support IPM

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ABSTRACT

Agriculture can play a lead role in tackling the twin crises of biodiversity loss and climate change whilst also achieving food security. Integrated Pest Management (IPM) practices aim to maintain or increase farm productivity and profits whilst minimising negative impacts on the environment. However, there is much debate on the best approaches for encouraging further adoption of IPM practices. Industry may offer greater market access for food produced in systems based on IPM principles. Government may offer support, either financial or advisory, for farmers wishing to further adopt IPM practices and reduce the risks associated with pesticides. The question is which practices to support and how?

We summarise here work in several projects to gather evidence on which IPM practices should be supported, under England's Sustainable Farming Incentive (SFI) Scheme, and the best way to support them. Literature reviews were conducted to identify IPM practices likely to: (i) provide effective pest control and hence deliver a reduction in risk associated with pesticide use, and/or (ii) offer benefits to biodiversity. Some of these practices will incur a cost to the farmer/grower and therefore to ensure wide uptake, Government financial support will be necessary.

Farmer/grower workshops were conducted in winter 2022 to identify which IPM measures should be supported and how, from a list of candidate 'paid actions' for SFI. The work also identified the extent to which possible paid actions were already being implemented on farm. The most important outcome of the workshops was that flexibility in selecting IPM options is key. IPM options are unlikely to be adopted as set bundles of actions, as crops are produced in different systems and environments meaning a one size fits all approach is not appropriate. Incentives to increase crop diversity (increasing the number of crop types in rotation) were favoured by arable farmers but not by horticultural producers who often rent/lease land on a short-term basis. Some practices, such as growing disease resistant varieties, were heavily supported in the literature as being effective, but issues arose when discussing approaches to including them as a paid action in a support scheme. The only option that was supported by all types of farmers/growers was payment for IPM planning.

Scotland's Agriculture Bill comes into effect from 2025. If IPM actions are to receive financial support in the new Bill, then we need to identify which practices are going to deliver for food security and biodiversity.

P9
Ramularia – prediciting disease outbreaks

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ABSTRACT

Barley production is threated in the UK (Havis *et al*., 2015), Argentina (Carmona *et al*., 2013; Pereyra, 2013) and across the globe by the Ramularia leaf spot (RLS) caused by the fungus Ramularia collo-cygni (Rcc). RLS results in both losses in yield (Havis *et al*., 2018) and reduction in the grain quality. The pathogen has a long latency period, and the occurrence of RLS is highly dependent on the weather conditions (Havis *et al*., 2015). Currently, the disease is managed through the application of foliar fungicides (Havis *et al.*, 2015, Erreguerena *et al*., 2017, 2021). With the reduction in the availability of pesticides, there is increasing interest in IPM strategies. Thus, there is a need to be able to forecast the likelihood of the disease occurring in any given year and location. Previous models had proven to be lacking in precision across seasons (Mulhare *et al.*, 2021).

In Argentina, RLS can be predicted by investigating the water balance available to the crop during tillering and stem extension. A study was undertaken to determine if accumulated precipitation and accumulated mean temperatures between GS21 and GS39 could serve as proxy variables for the prediction model. A further objective of this study was to test the applicability of this model to northern hemisphere conditions. Results from AHDB spring barley recommended list trials in 2017 suggested a relationship between rainfall between GS21 and GS 39 during the rapid crop growth phase and final RLS levels in the crops. The study will be expanded to cover data sets from Ireland and across the UK in other years.

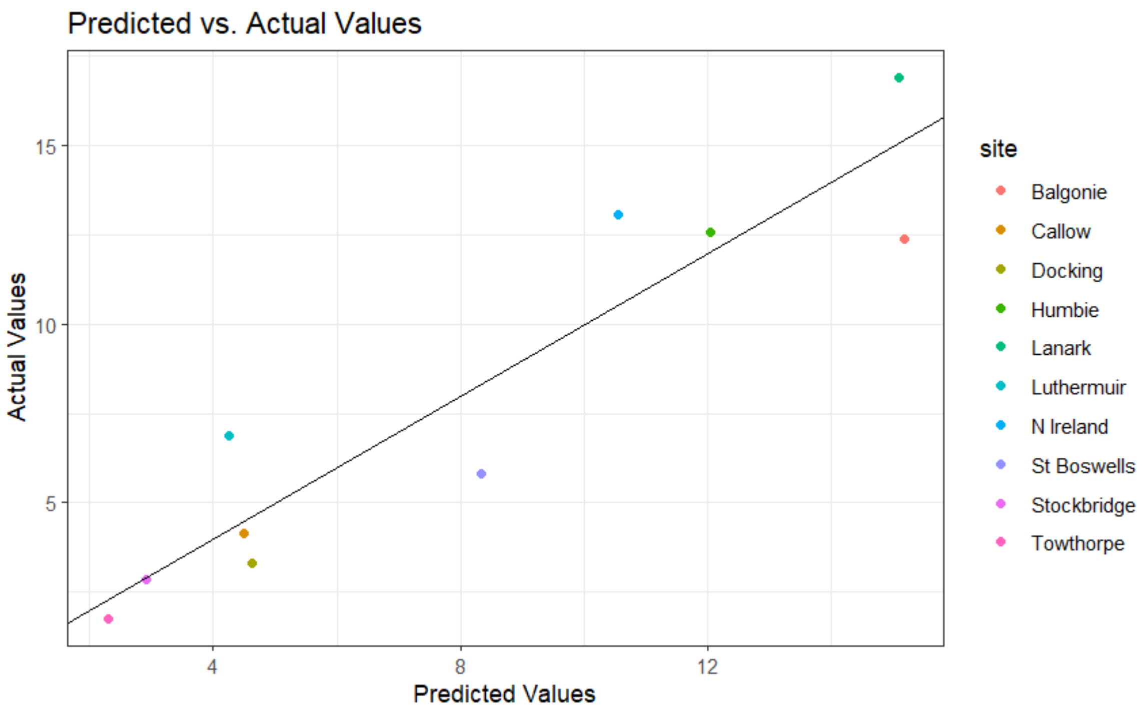

Fig. 1. Prediction model for UK sites (2017) based on rainfall (*P*=0.0008).

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P10
Integrated Pest Management Plans – Plan development and analysis of data 2021–2023

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The poster presents a brief history of the Voluntary Initiative (VI) and highlights some of our prominent work streams in best practice use of plant protection products (PPP's). These include the National Register of Sprayer Operators (NRoSO)(currently with 21K members) and the National Sprayer Testing Scheme (NSTS)(annually testing 18K+ agricultural sprayers and associated equipment). The poster also mentions work in the water industry (the "Think Water" campaign) and BeeConnected (a scheme that connects Beekeepers and farmers to inform beekeepers of potential insecticide applications). But the focus of the poster highlights the development of the VI / NFU and Scottish Plant Health Centre (PHC) Integrated Pest Management (IPM) Plans.

Based on the work of Creissen *et al.* (2019), the Plans were developed, using both agronomic and social scientific input, to aid IPM decision makers through the process of creating an IPM action plan. The plans provide a baseline for the farm which can be assessed via a metric based on expert opinion which gives farmers an IPM score (Creissen et al. 2019) out of 100. Targets can then be set for the individual farmer and these targets can also be used at a regional or national level. Issues or topics requiring further research and knowledge exchange activities are also identified. The plans not only investigate technical barriers to IPM but also identify some of the social barriers to IPM uptake on an individual, personal or business basis. With over 17.5 thousand plans completed since they were launched in 2021/22, we look at some of the trends seen in data from completed arable, grassland and horticultural/potato plans and highlights some of the differences between the different sectors.

The results are helping develop the VI, PHC and SRUC strategy for the furthering the adoption of IPM, particularly in parts of the industry where adoption has hitherto been lower than others. Subsequent IPM Plans have been developed to satisfy the requirements of the Defra IPM SFI Standard under Action 1: IPM1. We hope the introduction of the IPM SFI Standard in England and the proposed introduction of similar policy in the devolved nations will advance IPM uptake across the UK. The VI, PHC and SRUC continues to work with Ministers and government officials to further best practice of PPP use and an integrated approach through implementation of IPM.

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