AHDB

Arable research review

2018/19

Foreword

Tim Isaac
Head of Arable Knowledge Exchange

Welcome to our arable research review for 2018/19.

As a summary of research projects, for both AHDB Cereals & Oilseeds and AHDB Potatoes, I hope you find it a useful and valuable reference. Developed for distribution at our winter (2018/19) events, the review includes key findings and next steps. You will also find lists of all the projects, together with information on our wider technical activity, demonstrating the breadth and depth of research we commission for the arable sector.

Further information on both our current and completed programmes can be found on our websites by searching the topic or project number. We also support a number of PhD studentships and Nuffield Scholarships, details of which are also on our websites:

- **cereals.ahdb.org.uk**
- **potatoes.ahdb.org.uk**

This publication was produced as part of our drive to provide stronger and more united resources across the arable sector. Recognising that so many of the key issues are common across the rotation, we combined our knowledge exchange (KE) teams for potatoes and cereals & oilseeds back in April 2018. This is already reaping rewards for our levy payers. We can deliver much better value for money by combining similar areas of research and KE, while at the same time ensuring the levy raised from the individual sectors remains ring fenced for their benefit. Some topics will always be sector specific and these are reflected in the more specialist projects, whereas our work on soils, rotations, integrated pest management (IPM), and so on, is of relevance to all those involved in the arable industry.

A priority for our arable activity, highlighted in AHDB's 'Inspiring Success' strategy, is to accelerate innovation and productivity growth through coordinated research and development (R&D) and knowledge exchange (KE). This can be achieved only through a fully integrated programme, where R&D and KE continually inform and direct each other. While our research reports provide an extremely valuable resource in their own right, there are also many opportunities to see them brought to life through our Strategic Farms, Monitor Farms, Arable Business Groups, technical events and webinars. I encourage you to get involved with these, wherever you are in the country.

It's also important to mention that this coordinated and integrated approach doesn't just apply to AHDB in isolation. We work in collaboration with a long list of industry partners, meaning that levy payers see the added value of combined funding and expertise, and less duplication. Common problems require common solutions and we need to move quickly to address new challenges, so you will also see our partnership approach highlighted further in this review.

If you would like more information on our full range of activity, including the many online tools and resources produced from our R&D work, please take a look at the AHDB website. All publications can be found at **ahdb.org.uk/knowledge-library** and reports, meeting dates and results from on-farm try-outs from the Monitor and Strategic Farms can be found at **ahdb.org.uk/farm-excellence**

Contents

Current projects

Rotations partnership

Dates: April 2016 – March 2021
Project number: 91140001
Lead partner: NIAB CUF
AHDB funding: £1,203,152

This integrated research programme of soils and water aims to optimise the productivity and sustainability of rotations that include potatoes.

The project is rare in that it is a large-scale statistically valid study that examines cultivation strategies, rotation length and composition in the context of whole-rotation productivity and sustainability. This will allow for better quantification of soil quality and resilience.

A Grower Platform has been established to provide data (historical and current) to quantify the linkages between rotational management, soil physical conditions and economic and agronomic sustainability. About 70 crop surveys have been completed, covering a wide range of soils, climatic conditions and rotation types.

Research will develop existing precision farming technologies, imaging systems, models and decision support systems to provide growers, agronomists and land-managers with a 'toolbox' that will help them manage their soil resources in a more effective way.

On-farm trials will also investigate the effects of different rotation types (e.g. length and composition), soil amendments, cover crops and cultivation strategies on key soil metrics and rotational sustainability, for a range of soil types used for crop production in the UK.

Other research aims are to demonstrate how soil management practices (e.g. organic amendments and irrigation) alter soil conditions, root distribution and function and crop performance. In addition, the project is investigating how soil management and genotypic differences in root length distribution interact to determine water use efficiency and yield.

Key findings

Experiments have shown beneficial effects of compost, historic and fresh applications of farmyard manure on potato yield. Direct benefits were measured on yield of cover crops and organic amendments over 2017 and 2018.

Other work demonstrated that both tracked or wheeled tractors caused similar amounts of soil damage; soil compaction could be reduced by reducing tractor tyre pressures during seedbed cultivations.

Next steps

Rotational data will continue to be collated for the lifetime of the programme. Analysis will include the economics of rotations.

Research trials are ongoing for the applications of new technologies to enhance rotations, as well as rotational productivity and resilience, and linking soils, water and roots with crop productivity.

Soil biology and soil health partnership

Dates: January 2017 – December 2021
Project number: 91140002
Lead partner: NIAB, ADAS, SRUC, Fera, GWCT and ORC.
AHDB funding: £858,869
BBRO funding: £140,934

The Soil Biology and Soil Health Partnership will work with the agricultural industry to increase our understanding of soil biology and develop a toolkit to measure and manage soil health.

This five-year cross-sector programme, funded by AHDB and BBRO, is designed to help farmers and growers maintain and improve the productivity of their systems, through a better understanding of soil biology and health. The Partnership comprises eight scientific and six industry partners – this breadth of expertise provides a strong practical and scientific foundation to the programme, ensuring the project is relevant in modern farming rotations.

The first focus was on baselining and benchmarking. By reviewing existing knowledge of how management can affect soil health and drivers of soil biology, indicators that could be used to develop a soil-health scorecard have been agreed. These will be further tested and validated in the rest of the programme of work. Molecular approaches for routine soil-borne disease and soil health assessment have also been reviewed.

Using long-term experimental sites, the impact of soil management will be measured. Research techniques will be used on these sites to understand the interactions between soil management practices, biodiversity and the suppression of soil-borne pathogens.

Working with industry, researchers and farmer/grower groups, the key priority issues of the sector will be confirmed. On-farm monitoring will measure the impact of innovations in soil management on crop yield, quality and soil health using paired field comparisons/split field treatments.

Published reports

Project 1: Translating existing knowledge of management effects on soil biology and soil health

Project 2: Development of soil health card

Project 3: Molecular assessment of soil-borne diseases and soil health

Key findings

A literature review has updated information on the effects of agricultural management options (reduced tillage, adding organic matter etc) on soil biology, chemistry and physics, as well as crop yield.

A pilot visual tool has been developed to present the likely magnitude of the effects of representative management options (reduced tillage; no-tillage; cover crops; carbon-rich or nitrogen-rich organic amendments) on a suite of biological, physical, chemical and economic outputs. This will be updated and developed throughout the programme.

A shortlist of 12 physical, chemical and biological indicators of soil biology and soil health was compiled and a provisional scorecard has been developed; this uses a 'traffic light' system to give a visual overview of the status of each indicator.

Eight farmer groups have been set up to test and validate the soil health scorecard on farm from autumn 2018.

Next steps

The findings are being designed to be accessed, understood and implemented easily by farmers to aid them in the improved management of soil health.

The proposed soil health scorecard will be tested and validated in research trials and on commercial farms, starting in 2018.

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

Integrating control strategies against soil-borne *Rhizoctonia solani* in oilseed rape

Dates: July 2016 – September 2019
Project number: 21140008
Lead partner: University of Nottingham
AHDB funding: £80,000

This project aims to increase knowledge of the soil-borne pathogen *Rhizoctonia solani* in UK oilseed rape. The final output will be the first integrated guidelines for the control of *R. solani*, incorporating targeted seed treatments and varietal resistance for improved disease management and protecting of oilseed rape yield.

R. solani anastomosis group (AG) 2-1 is an aggressive soil-borne pathogen of oilseed rape worldwide; however, the epidemiology and control of *R. solani* AG2-1 have not been extensively investigated in UK oilseed rape, and presently there are no disease-resistant varieties.

The research will provide information on disease epidemiology, genetic resistance to *R. solani* in oilseed rape and yield loss. It will also look into targeted crop protection through the use of low-dose seed treatment against soil-borne pathogens for crop establishment.

A culture of the pathogenic fungus *Rhizoctonia solani*

Key findings

The pathogen *R. solani* AG2-1 is capable of causing establishment and yield loss.

There are genetic differences in resistance to *R. solani* in Brassica species but no resistant varieties are available.

Establishment loss can be recovered by an effective seed treatment.

The seed treatment, inclusive of sedaxane, metalaxyl-M and fludioxonil, is most effective against AG2-1 compared to other standard treatments.

Responses in all commercial varieties to seed treatment result in yield increase under high disease.

Next steps

Field experiments, running in UK, France and Germany will be repeated in 2018/2019, investigating interactions between seed treatments and oilseed rape genotypes.

Studies to determine environment-pathogen interactions and the impact on root system architecture are in progress.

Data collection and modelling from field experiments in the UK and EU is ongoing.

Maximising the benefits from cover crops through species selection and crop management (Maxi-cover crop)

Dates: August 2016 – November 2019
Project number: 21140009
Lead partners: ADAS and NIAB
AHDB funding: £230,000

Cover crop trial

New knowledge on how cover crops can be used to enable deeper, more extensive crop rooting will be published to provide practical science-based information to aid cover crop selection and management.

Ten cover crop treatments (7 straights and 3 mixtures) are being grown to see their effect on soil properties, crop rooting and yield.

Cover crop species include oil radish, spring oats, rye, vetch, crimson clover, buckwheat and phacelia.

In-depth assessments are being done at three large-plot trials, and the impact of the cover crops on the following two cash crops will be quantified.

The effects of different cover crop mixtures and cultivation technologies will be validated in tramline trials on farms, including the Sittingbourne Monitor Farm and previous Monitor Farms in York and Huntingdon.

Key findings

Early establishment of cover crops is essential to ensure good cover and maximum benefits.

Increased rooting in the cover crop may result in increased rooting in the following spring crop, in situations where the spring crop established well.

Cover cropping can result in increased moisture retention in the topsoil, which may impede establishment of the following spring crop.

Single year cover cropping is insufficient to measure impacts: these need to be measured across the whole rotation, including multiple years of cover cropping.

Next steps

The effect of the cover crop treatments at the large-plot and tramline trials established in autumn 2017 will be followed through to the yield of the subsequent spring crop (harvest 2018) and following winter crop.

Soil physical (structure), biological (earthworms) and chemical (organic matter) properties will be assessed at these sites in spring 2019.

The legacy effects of the cover crop treatments at the large-plot trial and 2016 tramline trials will be evaluated (soil properties and the yield of the winter crop).

A cost-benefit analysis for all of the trial sites will be completed.

Disease

Completed projects

Disease monitoring revolution

Dates: March 2015 – February 2018
Project number: 21120002
Lead partner: Rothamsted Research
AHDB funding: £75,000

A revolution in disease monitoring in agricultural crops is about to take place – devices can now detect and alert farmers about the presence of airborne spores before the disease even gets the chance to infect crops.

One such device, the 'DNA auto spore trap', has been developed as part of a recently completed AHDB project. Led by Rothamsted Research, in collaboration with the Burkard Manufacturing Company, the mains-powered trap processes high volumes of air and can collect spores as small as 4µm efficiently. Once gathered, the spores are broken up to release DNA for identification by a series of 'in-trap' laboratory tests. Information on the presence of spores is then beamed wirelessly to a server, thanks to an internal 4G router.

Key findings

New tests have been developed for the following arable diseases: light leaf spot, sclerotinia stem rot, septoria tritici, eyespot and early blight.

The tests can be used in the spore trap, portable assay machines and diagnostic labs.

Researchers have also developed tests to detect for changes to fungicide insensitivity in the pathogen that causes septoria tritici in wheat. The tests, which can identify populations with reduced sensitivity to DMI and SDHI fungicides, can only be used in laboratories at present.

Current projects

Fungicide performance in wheat, barley and oilseed rape

Dates: March 2019 – March 2022
Project number: 21120013
Lead partner: ADAS
AHDB funding: £530,245

Independent assessments, across a UK network of fungicide performance trials, provide information on the relative performance of fungicides against economically important foliar and head diseases.

The trials, which test established, new and 'pipeline' chemistry are set up to reflect changing cropping and disease pressures. For example, the trials have investigated the key wheat diseases – septoria tritici, yellow rust and brown rust – for several years. Recently, trials have also started to assess fungicide activity against head blight and their impact on mycotoxins.

In oilseed rape, the main focus is control of light leaf spot and phoma, while for barley its rhynchosporium, net blotch and ramularia. Trial sites and protocols are designed to test fungicide products under high disease pressures, to provide a good test of the relative power of each product.

Each autumn and winter, results of the trials are published on **ahdb.org.uk/fungicide-performance.**

Key findings

SDHIs are highly active against septoria but there is some evidence of decline in efficacy.

A trend for a decline in activity of Comet on rhynchosporium has been observed.

Reduced sensitivity to SDHIs in net blotch has now been confirmed.

Resistance to SDHIs and azoles in trials against ramularia is now evident.

Tracking septoria tritici's sensitivity to fungicides

Dates: April 2016 – March 2019
Project number: 21120018
Lead partner: Rothamsted Research
AHDB funding: £60,000

Septoria tritici is the most damaging foliar disease of UK wheat, so it's essential it is controlled effectively. AHDB-funded monitoring of fungicide sensitivity has seen significant declines in azole sensitivity and resistance to SDHIs is beginning to develop.

The changes in efficacy and potential implications for field performance are being monitored in a series of AHDB-funded laboratory and glasshouse tests.

Septoria populations are taken from winter wheat fungicide performance trials and commercial crops. Susceptible populations are used to set the 'baseline' sensitivity. This baseline is used to track shifts in performance, including how sensitivity changes following an application of a fungicide.

Key findings

Azole sensitivity shifts are continuing in UK field populations, with increasingly complex strains dominating populations.

Mutations in field populations against SDHIs are now widespread in the UK.

SDHI sensitivity shifts were large in 2018.

Next steps

Further SDHI sensitivity monitoring is required as new mutations have been detected in each year and evolution of highly resistant strains can't be ruled out.

Integrated control of septoria tritici

Dates: August 2015 – March 2020
Project number: 21120007
Lead partner: ADAS
AHDB funding: £155,404

With widespread evolution of resistance to key fungicides for control of septoria, there has been increased interest in the use of cultural control options. Such options can be used to reduce the intensity of fungicide spray programmes, but greater understanding about these approaches is required for them to be used with confidence.

The value of varying sowing date and seeding rate, as well as the use of disease-resistant varieties, is being assessed via a series of bespoke trials. The impact on disease control, yield and margin over fungicide cost are all being quantified

The result will help farmers make strategic decisions on which crops would benefit from intensive or reduced fungicide inputs.

Key findings

Later-sown crops are associated with reduced septoria levels.

Seeding rate has little effect.

More resistant varieties showed little or no response to inclusion of SDHIs.

Next steps

The final year of trials will help validate the findings over a wide range of locations and disease pressures.

Combining chemistry for sustainable disease control

Dates: April 2017 – March 2021
Project number: 21120058
Lead partner: ADAS
AHDB funding: £196,500

New fungicide modes of action (MOA) are increasingly rare. They need to be protected against the development of resistance. Good progress has been made in understanding resistance evolution in a single MOA but where two or more single-site acting fungicides are used in a spray programme, the optimum anti-resistance strategy is less certain. Some aspects of resistance management can even have opposing effects where resistance to two MOA is evolving at the same time, which has proved difficult to reconcile.

A combination of modelling and field trials is being used to calculate the best strategy for deploying fungicides with two or more modes of action to minimise the risk of resistance developing to both simultaneously.

Key findings

Mixtures are better than alternation, except in a few exceptional cases.

Splitting the dose across several treatments may not increase selection when mixtures are used.

Next steps

Trials will continue to confirm the results.

Improved fungicide resistance management in OSR pathogens

Dates: January 2017 – June 2021
Project number: 21120015
Lead partner: Rothamsted Research
AHDB funding: £160,966

When it comes to fungicide resistance, crop pathogens of wheat and barley often grab the headlines. Fungicide resistance is, however, a risk to oilseed rape too. In fact, light leaf spot pathogens with decreased sensitivity to azoles have been identified in the UK already.

Sclerotinia stem rot isolates with resistance to SDHIs have also been reported at low frequencies in Europe and in Australia, azole insensitivity in the phoma stem canker population has also been detected. The widespread use of single-site modes of action in oilseed rape fungicide programmes is a poor anti-resistance strategy.

Compared to cereal crops, however, very little is known about resistance management strategies. This project is developing the evidence base to provide the industry with robust anti-resistance guidance. In the research, current practices are being interrogated and anti-resistance strategies tested. Critically, the work compares solo products against mixtures and alternation strategies to find the approaches most likely to slow selection for fungicide resistance.

Key findings

Pathogens that have more than one life cycle in a season, such as light leaf spot, are at most risk of resistance development.

Pathogens that have one life cycle in the season such as phoma, are at lower risk of resistance development.

All UK light leaf spot isolates tested contain mutations that give them reduced sensitivity to azoles, though field performance is not compromised.

Next steps

How anti-resistance strategies impact selection will be investigated.

UK Cereal Pathogen Virulence Survey (UKCPVS)

Dates: April 2016 – March 2019
Project number: 21120034
Lead partner: NIAB
AHDB funding: £353,986

The UK pathogen population is evolving. In addition to becoming less sensitive to fungicides, disease-causing organisms can also unpick a crop's natural resistance mechanisms.

The UKCPVS was set up to provide an early warning of changes to resistance ratings. Wheat yellow rust, as well as wheat brown rust and cereal mildews, are all monitored by the survey.

Yellow rust

Brown rust

Cereal mildew

Growers, agronomists and trial operators are encouraged to send in infected wheat and barley samples from across the UK. Selected samples are tested on AHDB Recommended Lists (RL) varieties and candidate varieties to look for unexpected results. Further tests are done on pathogen samples of interest to pinpoint changes. Where significant changes are detected, such as a new race, an alert is issued to industry.

Key findings

Significant new wheat yellow rust races, Red 24 and Blue 7, have been confirmed recently.

Both races were present in the UK pathogen population in 2016 and tests suggest they contributed to the major revision of RL disease ratings for the 2017/18 Recommended Lists.

Many varieties are susceptible to infection by Red 24 and Blue 7, according to UKCPVS tests

Further information, including sampling information, is available from: **ahdb.org.uk/UKCPVS**

Quality

Current projects

Eyespot-resistant wheat with an increased grain protein content

Dates: July 2014 – June 2019
Project number: 21130018
Lead partner: JIC
AHDB funding: £62,000

Plant breeders hold the key to eyespot resistance in cereals. The trouble is, they can't use it. The *Pch1* gene is associated with resistance and the chromosome in which it sits is also associated with relatively high grain protein content. The same chromosome region, however, is associated with a yield penalty.

The project will determine the relative position of genes for eyespot resistance, protein quality and yield, so the desirable traits can be selected without the unwanted yield loss trait.

The four-year project aims to facilitate the production of eyespot-resistant varieties of wheat with improved grain protein quality suitable for milling.

Key findings

Increased protein content appears to be associated with a smaller grain size, but no effect on yield has been observed associated with *Pch1.*

Work is in progress to identify the precise *Pch1* genes that confer increased eyespot resistance.

Next steps

The data from additional field trials at several sites will be analysed to gain more information on yield and protein effects.

The results from field trials using unique genetic materials will be evaluated to see the effect of increasing the dosage of *Pch1* on eyespot resistance.

Monitoring mycotoxins and other contaminants in UK cereals

Dates: August 2016 – July 2021
Project number: 21130040
Lead partner: Fera
AHDB funding: £616,582

The incidence and levels of key contaminants in samples of both UK-grown and imported cereals for milling, malting and animal feed will be surveyed.

The data will be used to inform and alert the industry on the safety of their products to provide quality assurance. This will provide customer confidence in UK cereals.

The focus is on monitoring harvested and stored grain samples for mycotoxins, pesticides and metals. Subsets of samples are also analysed for ergot alkaloids.

Key findings

Deoxynivalenol (DON) has been detected most frequently in wheat samples.

Few samples of oats (7%) and no samples of barley contained DON above the reporting limit.

There was a higher incidence of zearalenone (ZON) in 2017 than 2016.

A high incidence of ergot alkaloids was observed; oat feed had 100% and wheat feed had 95% incidence of one or more ergot alkaloids at levels from 48–862µg/kg.

Next steps

Annual analysis of a representative set of commercial samples of wheat, barley and oats and their co-products will continue and data will be reported to EFSA, as requested.

Investigation of high levels of erucic acid in oilseed rape.

Investigation of high levels of erucic acid in oilseed rape

Dates: February 2018 – February 2019
Project number: 21130055
Lead partner: NIAB
AHDB funding: £45,938

High levels of erucic acid have been associated with a risk of congestive heart failure in humans and some animals. High erucic acid oilseed rape (HEAR) varieties contain, on average, 50% erucic acid and are grown for non-food industrial uses. Double low ('00') varieties of oilseed rape, with low seed contents of both erucic acid and glucosinolates, are predominantly grown in the UK for the food market. Currently, the food industry will take oilseed rape at levels of erucic acid of 5% or below. The EC is currently considering the introduction of a maximum limit of 2% erucic acid in 00 varieties.

Rejected and accepted samples of OSR were tested to identify sources of contamination, which may be from farm-saved seed, weed seed, volunteers, cross-pollination from another crop or other seed crop. The investigation will rank the sources of erucic acid elevation in the field. This will then inform the industry of cropping, storage and transport practices to minimise contamination risk.

Key findings

Farm-saved seed carries a risk as it can become contaminated with seed from volunteers. Erucic acid tests should be conducted on all seed sources before drilling.

After harvest, cultivations should be delayed (ideally, by at least four weeks) to allow OSR volunteers to germinate and be controlled.

Fields with OSR volunteers and erucic acid producing weed populations are at higher risk.

Poor segregation of crops increases risk. Double-low OSR must be segregated from HEAR OSR and weed-prone crops at all times to reduce risk of contamination.

Next steps

A DNA-based method of identifying high erucic acid volunteers at, or before, stem extension, will be developed. An estimate of their impact on the eventual erucic acid content in the harvested crop can be provided.

This would allow growers to sample soil from fields in the rotation preceding oilseed rape crops, germinate the volunteers in the weed bank and get those tested to give an early warning of potential problems.

Weeds

Completed projects

Multiple herbicide resistance in grass weeds

Dates: April 2014 – September 2018
Project number: 21120025
Lead partner: University of Newcastle-upon-Tyne
AHDB funding: £280,000

Herbicide-resistance in black-grass now occurs on virtually all farms where herbicides have been used for its control. The urgent call for solutions saw AHDB and BBSRC join forces to co-fund a pioneering research initiative. A £2.8m injection of funding has helped six UK academic institutions combine their weed research expertise in the Black-Grass Resistance Initiative (BGRI).

The work combines state-of-the-art genomic approaches with weed ecology and agronomy, to unravel the major driving forces for the evolution of multiple herbicide resistance and provide new management options.

An in-field rapid diagnostic test (lateral flow device) for non-target site resistance has been developed. It will aid early detection and provide farmers with the opportunity to manage resistance proactively.

Key findings

The relative frequency, importance and interaction of target site and non-target site resistance mechanisms has been demonstrated.

Key agronomic drivers of non-target site resistance have been identified.

Heritable variation in glyphosate sensitivity has been linked to frequency of historical glyphosate use.

Current projects

Herbicide resistance in UK brome species

Dates: March 2017 – February 2021
Project number: 21120059
Lead partner: ADAS
AHDB funding: £218,000

With the first evidence of evolving resistance to glyphosate in UK sterile brome, this work investigates how herbicide resistance develops in brome species to find ways to slow or prevent it. Bromes are competitive weeds capable of causing a significant yield loss and there are currently limited herbicide control options available. There is little data on the current resistance status UK species but herbicide-resistant sterile brome populations have been found in France and Germany.

A combination of field surveys and glasshouse and container-based methods are being used to determine the range of herbicide susceptibility in brome species and whether some brome species are naturally more tolerant to key herbicides and, in conjunction with field surveys, if populations are responding to herbicide selection pressure and becoming less susceptible.

Any potentially resistant populations will be tested through selection experiments to see if these species can be pushed towards herbicide resistance as a result of poor herbicide practice. The best application timing will be determined to identify strategies to help maintain and improve herbicide control while also minimising the risk of resistance evolving.

Key findings

Sterile brome is the most common brome species but other species are more prevalent than previously thought.

Correct brome identification by growers and agronomists is low. Brome problems appear to be increasing.

All cereal growing areas are affected, with the worst affected areas being North, South East, West Midlands and South West.

Next steps

Selection experiments will be done to establish the risk of resistance.

Herbicide timing experiments will be carried out to confirm the optimum application timing for all brome species.

Brome workshops will be arranged.

Retaining the effectiveness of glyphosate for grass weeds

Dates: October 2015 – September 2020
Project number: 21120023
Lead partner: ADAS
AHDB funding: £250,000

Globally, dozens of weed species have developed resistance to glyphosate. No cases had been reported in the UK, until a scientific paper published in 2018 confirmed that some sterile brome populations had reduced sensitivity to the chemical. Increasing resistance to selective herbicides – especially in grassweeds within UK arable cropping systems – and a reduction in available chemistry means the pressure to use glyphosate as a stale seedbed management tool, in particular, is increasing and it is vital to retain its effectiveness.

Accurate management guidelines can help significantly reduce the risk of glyphosate resistance evolving in key grass weed species. In 2015, the WRAG (Weed Resistance Action Group) and AHDB issued guidelines base on four key principles: prevent survivors, maximise efficacy, use alternatives and monitor success. Field and container-based trials are being conducted in this work to validate these guidelines. Specifically, it will provide greater precision on how much glyphosate can safely be used and how often to avoid resistance evolving. A resistance test for live plants to use in season will also be developed.

Key findings

A minimum of two applications of 540g active ingredient glyphosate is required at the correct weed growth stage (<GS14) to control black-grass and Italian rye-grass populations resistant to other modes of action.

Higher glyphosate doses are required for later weed growth stages (>720g a.i./ha)
More variation in consistency of control with Italian rye-grass compared to black-grass.

Next steps

Selection experiments in containers are being done to quantify risk of resistance.

Glyphosate dose, weed size and following herbicide programmes are being investigated to see how resistance risks are mitigated.

Applications at large weed growth stages, simulating between row applications are being tested for resistance risk.

RISQ resistance test (for detecting herbicide resistance) validation continues.

Pests

Completed projects

Precision slug control

Grey field slug (Deroceras spp)

Dates: October 2015 –September 2018
Project number: 11120022
Lead partner: Harper Adams University
AHDB funding: £34,577

Applying slug pellets evenly across a field may become a thing of the past, if the patchy distribution of the pest can be better understood.

AHDB-funded PhD student Emily Forbes has been working for the last three years to map the presence of slugs in commercial fields.

The research uses innovative tagging technology, where a harmless device (about the size of a grain of rice) is attached to slugs to detect where they congregate and how and when they move about the field (even when they are under the ground).

Emily looked at the patterns and influence of environmental factors (e.g. soil moisture, organic matter, pH and soil type) to develop approaches for precision treatment. The work could reduce the amount of control product required and increase the economic viability of non-metaldehyde options.

Many slugs congregate in patches, especially when not foraging. Slugs also have a tendency to follow slime trails made by other slugs, all helping them cluster together. Sustainable management of slugs could be based upon this distribution rather than on the current estimates of average numbers. By targeting pesticides only at the higher density patches, pesticide or bio-pesticide use could be reduced, resulting in more sustainable control.

Key findings

Stable slug patches have been found throughout the growing season.

Targeting pesticides at higher density patches could provide more sustainable control.

Next steps

Soil physical characteristics influence the location of slug patches.

Better knowledge of these characteristics would improve field assessment and provide opportunities for automation.

Wheat bulb fly management

Dates: March 2016 – June 2018
Project number: 21120032
Lead partner: ADAS
AHDB funding: £86,000

Adult wheat bulb fly (© ADAS)

The cereal pest wheat bulb fly (WBF) lays its eggs in the bare ground during the summer. When the larvae hatch during the winter, they enter plants and kill shoots. As the potential yield loss depends on the shoot population in winter, the size of pest population and how much damage an individual larva can cause, this research looked to quantify the relative importance of each one of these factors.

Information on WBF incidence (from the autumn survey), egg viability, the maximum shoot number the crop could achieve by late winter and the number of shoots that a single WBF larva could destroy was used by the researchers.

Modelling work showed that variation in the maximum shoot number had a large effect on the chance of yield loss because crops that produced excess shoots were able to sacrifice them to the pest without affecting yield.

Five winter wheat field experiments, which used combinations of sowing date, seed rate, variety and insecticide treatments, conducted across two growing seasons (2015/16 and 2016/17), were used to test a shoot production model and threshold scheme.

Key findings

A model has been developed to predict the sowing date and seed rate required to reach the target shoot population of 500 shoots/m^2 at GS31.

The preliminary threshold scheme can predict the sow date and seed rate required to achieve a robust crop that will tolerate a range of WBF pressures.

There is evidence that shoot production can sometimes be affected by varietal choice, with Revelation producing more shoots/m^2 than the other varieties under test (Butler, Evolution and Horatio)

Next steps

Although this project concentrated on WBF, it is envisaged that the scheme will also be applicable to other dipterous stem borer pests (fruit fly, gout fly, yellow cereal fly) with minimal modification.

Autumn survey of wheat bulb fly incidence

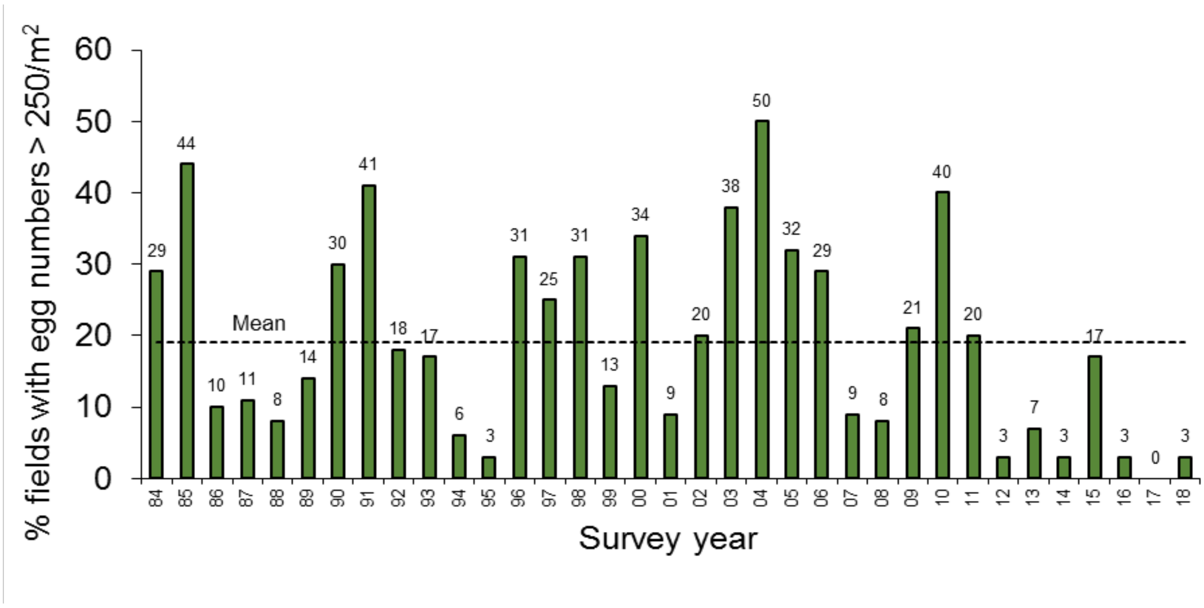
Dates: August 2011 – July 2018
Project number: 21120003
Lead partner: ADAS
AHDB funding: £54,357

All cereals except oats can be attacked by wheat bulb fly (WBF), although damage is most frequently reported in wheat. The pest is most prevalent in eastern England.

Due to recent withdrawals, chemical options for control of WBF are limited to seed treatments. The thresholds for treatment are as follows:

- Early-sown winter wheat crops (before November) are unlikely to benefit from seed treatment, as they have more time to tiller and are better able to withstand WBF attack. Seed treatments also lack persistence to fully protect such crops
- For late-sown winter wheat crops (November to December), seed treatments should be considered where WBF populations exceed 100 eggs/m^2 (moderate risk)
- For late-winter/spring-sown crops (January to March), seed treatments should be considered irrespective of the WBF population size (unless no eggs are present)
- The threshold of 100 eggs/m^2 is, therefore, only relevant to late-sown crops

Conducted by ADAS, the survey involves taking soil samples in September from 30 fields prone to WBF attack (split equally across sites located in the East and North of England) and calculating the number of WBF eggs per square metre. The pest, which has been monitored annually since 1984, has been detected at relatively low levels in the last few years. In 2018, only one site had significantly more than 100 eggs/m^2, which was a potato site in Cambridgeshire (322 eggs/m^2).



Survey results, the report and threshold information can be accessed via the dedicated AHDB web page: **ahdb.org.uk/knowledge-library/wheat-bulb-fly**

Current projects

Aphid flight times

Dates: April 2014 – March 2019
Project number: 21120020
Lead partner: Rothamsted Research
AHDB funding: £605,000

Peach-potato aphids on an oilseed rape leaf

AHDB Aphid News provides information on when aphids are migrating at key times of the year. This information can be used to rationalise the use of insecticides, improve the timing of treatments and reduce harm to beneficial insects.

Suction-traps, managed by Rothamsted Research and SASA, have provided data of value in assessing aphid risk on a regional basis. Yellow water-pan traps have been deployed by Fera to assess risk at a local level on the distribution and abundance of aphids. The project provides weekly information on cereal, oilseed rape, potato, vegetable, pea and other pest aphids present in the growing season and forecasts for the presence of early season aphids.

Key findings

Data gathered shows how major aphid species have developed over the season.

The first autumn migrations of cereal aphids are reported and this information can aid decision-making for best control. The information provides growers with an early warning system of aphid colonisation on a regional basis.

To sign up to receive AHDB's aphid news, visit **ahdb.org.uk/aphid-news**

Cabbage stem flea beetle IPM

Dates: August 2016 – December 2019
Project number: 21120049
Lead partner: ADAS
AHDB funding: £150,000

Cabbage stem flea beetle (CSFB) is a serious pest of oilseed rape (OSR), with pyrethroid-resistant populations confirmed in the UK.

Both the adult and larval stages can cause damage to the crop. An integrated pest management (IPM) strategy is needed to make rational decisions on the need for control.

By investigating the impact of the pest on yield, how agronomics influence damage and inherent tolerance of OSR plants in relation to pest thresholds, growers could more confidently predict the risk of pest damage. Cultural control methods, such as defoliation and trap crops, could be of use in controlling CSFB.

Key findings

Initial variety/seed rate trials found no significant effect of variety on CSFB damage or incidence.

Mowing in December or January significantly reduced CSFB larval numbers and did not negatively impact yield.

Only a small proportion of larvae were able to reinvade OSR plants from mown plant debris.

Leaving a large enough area of volunteer OSR uncontrolled until mid-September might act to draw CSFB adults away from nearby drilled OSR crops.

Next steps

Modelling analysis to identify key risk factors for adult and larval CSFB. Variety–seed rate trials and larval impact trials will be repeated. The volunteer OSR trap crop trial will also be repeated, along with the defoliation trial, which will also include disease assessments.

Nutrition

Current projects

Nitrogen and sulphur for spring barley

Dates: March 2018 – April 2021
Project number: 21140038
Lead partner: ADAS
AHDB funding: £139,980

The careful judgement of nitrogen (N) rate is particularly important in spring barley to ensure that the grain N content is neither too high nor too low for the requirement of the target market.

The increased demand for spring cropping has resulted in more people growing spring barley. Growers with less experience with this crop may find it challenging to achieve the grain quality targets reliably.

Furthermore, spring barley has been grown on light land traditionally but the area is now expanding to heavy land too. This is likely to affect the optimum N strategy to achieve the various grain N% targets. On top of this, some modern varieties yield 12% more than some traditional varieties. The more recent varieties may require more N to achieve potential yield.

Growers are often over-cautious with their fertiliser rates to avoid exceeding minimum thresholds and, as a result, often ‘miss out’ on yield due to sub-optimal N rates.

In spring barley, several factors affect grain N concentration. These include the N supply from the soil, rate and timing of N fertiliser, late foliar N, sulphur fertilisation, grain yield and plant population density.

The aim is to update N and sulphur (S) management guidelines for more reliably achieving grain N% targets with maximum yield for modern spring malting barley varieties.

Key findings

Even after taking into account new trials data, the updated RB209 recommendations only achieve target grain N% in 60% of cases (based on tests against historical trials data).

Nitrogen and sulphur for oats

Dates: August 2018 – May 2022
Project number: 21140039
Lead partner: ADAS
AHDB funding: £120,000

UK oat production has increased substantially over the last 20 years, fuelled by increased demand for oats for human consumption. At present, nutrient recommendations do not take into account oat milling quality.

This project on oats looks at some of the uncertainty associated with N and S rates and timings in oats, including the effect on milling quality.

With S deposition from the atmosphere decreasing in recent years, the project will aim to optimise its application. In addition to yield, quality aspects will be investigated. The work includes the management of S to optimise yield and milling quality of winter and spring oats.

The project will analyse existing data on N and S rates and timing and evaluate the impact of N and S on the milling quality of oats, specifically specific weight, screenings, kernel content and hullability.

Nitrogen and sulphur for wheat

Dates: July 2018 – March 2022
Project number: 21140040
Lead partner: NIAB
AHDB funding: £179,548

Nutrient management in milling wheat crops is the focus of this project. Led by NIAB, the research includes trials on the foliar application of N at the milky-ripe stage.

The work also includes the management of S to reduce the production of asparagine in wheat. Elevated levels of asparagine, which is linked to the production of the processing contaminant 'acrylamide', are known to be associated with S-deficient wheat crops.

LearNing Lessons

Dates: September 2013 – August 2018
Project number: 2160005
Lead partner: ADAS, NIAB, Agrii
AHDB funding: £261,545

Large variations in wheat yields across farms and fields, and even within fields, often make people question their approach to N management.

The AHDB-funded 'LearN' project tested a radical new approach to help farmers work out whether they were applying the right amount of nitrogen (N) fertiliser.

18 highly engaged farmers, who already followed best nutrient management practice, tested their farms' standard N rates in simple tramline trials.

The trials, which ran from 2014 to 2017, tested single replicates of two treatments (60kg/ha more and less than the farm standard rate of fertiliser N) in alternate tramlines.

A yield increase of 0.3t/ha was deemed necessary to pay for an additional 60kgN/ha – based on a wheat price of £140/t and fertiliser costs of £0.70/kg.

Key findings

If nitrogen rates are calculated using RB209 and the nutrient management plan is followed, yield variation is most likely caused by other factors.

The average wheat yield (142 tramline experiments) was 11.43t/ha for the farm standard.

On average, yields were reduced by 0.36t/ha for the minus 60kgN/ha treatment and increased by 0.36t/ha for the plus 60kgN/ha treatment.

There was little, if any, economic incentive to deviate from the standard N rate on these farms.

Across all experiments, none of the farms was applying too much or too little N consistently. This means that the large variation in yield, both across farms and fields, was probably the result of agronomic, genetic, chemical, soil or engineering factors.

Next steps

Key findings from this project will form recommendations/update on N management in AHDB Nutrient Management Guide (RB209) and Nitrogen for Winter Wheat – Management Guidelines.

Current AHDB Cereals & Oilseeds-funded research projects

Project number	Full Title	Topic	Lead contractor	End date	AHDB Funding
21140006	Developing targeted management methods for clubroot through pathotyping and field mapping to establish the impact and spread of the disease in oilseed rape	Disease	SAC Commercial LTD	February 19	£176,832
2140020105	Sclerotinia risk live-reporting system for oilseed rape	Disease	RSK ADAS Ltd	March 2019	£161,400
21120036	Understanding risks of severe phoma stem canker caused by Leptosphaeria biglobosa on winter oilseed rape in the UK	Disease	University of Hertfordshire	March 2019	£120,000
21120045	Investigating a potential new variant of Zymoseptoria tritici, causal agent of Septoria leaf blotch, and implications for UK winter wheat varieties	Disease	National Institute of Agricultural Botany (NIAB)	April 2019	£69,207
21130048	PhD: Barley resistance to Rhynchosporium: new sources and closely linked markers	Disease	James Hutton Institute (JHI)	March 2021	£70,500
21130004	Developing enhanced breeding methodologies for oats for human health and nutrition (DEMON)	Nutrition	Aberystwyth University	August 2019	£157,841
21140023	PhD: Screening and performance of phosphorous-efficient cereals cultivars for future food security	Nutrition	Bangor University	December 2019	£54,000
21120064	Genetic basis of winter oilseed rape resistance to the cabbage stem flea beetle	Pests	John Innes Centre (JIC)	September 2021	£70,500
21130025	Defining the basis for variation in water absorption of UK wheat flours	Quality	Rothamsted Research	March 2019	£180,000
21130013	Improving winter malting barley quality and developing an understanding of the interactions of introgressions with genetic background	Quality	James Hutton Institute (JHI)	March 2019	£106,040
21130005	Developing new types of wheat with good bread-making quality at low protein content	Quality	Rothamsted Research	December 2019	£80,000
21130047	PhD - Understanding components of specific weight in barley grains - opportunities for improving grain quality and processing efficiency	Quality	Scottish Rural University College	March 2020	£69,327
21130024	Developing systems to control male fertility in wheat for hybrid breeding, enhanced pollen production and increased yield	Quality	University of Nottingham	September 2020	£896,624
21130040	Monitoring of contaminants in UK cereals used for processing food and animal feed	Quality	Fera Science Ltd	July 2021	£871,600
21130012	PhD: Identification of Fusarium resistance within UK oat breeding lines	Quality	Harper Adams University	September 2021	£20,000

21140024	Soil and Cover Crop Associations Developing Rhizo-biological Efficiency	Soil	University of Cambridge	January 2021	£35,250
91140002	Soils & Water Research Partnership: Rotations	Soil	NIAB CUF	March 2021	£858,869
21120035	PhD: Understanding interactions between Ramularia collo-cygni and barley leaf physiology to target improvements in host resistance and disease control	Weeds	SAC Commercial LTD	January 2019	£54,000
2140012101	PhD: Variable rate application of plant protection products - investigations to establish the feasibility and potential cost benefits	Weeds	Cranfield University	July 2020	£54,000
21120023	Managing the resistance risk to retain long-term effectiveness of glyphosate for grass-weed control in UK crop rotations	Weeds	RSK ADAS Ltd	September 2020	£250,000
21120062	PhD: Developing guidance for fungicide resistance management: a case study for SDHIs and generalisations for the future mode of actions	Weeds	Rothamsted Research	September 2020	£35,250
21120059	Investigating the distribution and presence, and potential for herbicide resistance of UK brome species in arable farming	Weeds	RSK ADAS Ltd	February 2021	£218,000
21120058	Managing resistance evolving concurrently against two or more modes of action, to extend the effective life of new fungicides	Weeds	RSK ADAS Ltd	March 2021	£196,500
21120015	Maximising the effective life of fungicides to control oilseed rape diseases, through improved resistance management	Weeds	Rothamsted Research	June 2021	£160,966
212000110	AHDB Recommended Lists for cereals and oilseeds 2016-2021	Varieties	AHDB, British Society of Plant Breeders (BSPB), Maltsters' Association of Great Britain (MAGB) and National Association of British and Irish Millers (nabim).	March 2021	£7,953,359

Potato storage

Completed projects

Sustaining expertise in potato post-harvest physiology

Dates: February 2015 – September 2018
Project Number: 11140003
Lead partner: Natural Resources Institute at the University of Greenwich
AHDB Funding: £150,126

Tuber quality and, in particular, sugar content is a key component to monitor during storage, as it is directly linked to fry colour requirements from the processing market. Sugar (sucrose and glucose) content is used as a measure of chemical maturity at harvest and provide an indicator of the storage potential of harvested crops.

Additional measures that can provide insight into chemical maturity of a crop at harvest include fructose, dry matter, mineral and antioxidant content, tuber porosity and respiration during storage. This helps inform which field consignments are at a higher risk of developing quality problems during storage. It can also help provide tools to more accurately predict the storage behaviour of potatoes.

Alongside the research and capacity building work, this fellowship will also train an early career scientist in potato physiology and biochemistry, with a specific focus on those processes that occur during storage. It will, therefore, build upon the previously completed PhD studentship on senescent sweetening (11140014).

Key findings

Respiration rates change over time and vary between varieties. They could be a possible predictive marker for processing quality.

Application of phosphate (300 kg/ha) increased phosphate content of Markies and Pentland Dell tubers at harvest ,in one year out of two, when grown in a field at P index 1.

High phosphate application reduced the sucrose concentration of tubers at harvest.

Next steps

The use of real-time respiration of tubers in store using SafePod technology will be investigated across a wider range of varieties and temperatures.

PhD: Novel metabolic markers for potato dormancy

Dates: October 2014 – September 2018
Project Number: 11140007
Lead partner: University of Sheffield
AHDB Funding: £8,600

Potatoes remain dormant for a period of time after harvesting. When they break out of dormancy, physiological and biological processes occur that induce sproutings, such as the mobilisation of storage reserves and cellular changes that trigger the emergence of tuber eye buds.

Advances in the analysis of small tissues, such as germinating eye buds, can now help the understanding of how non-specialised cells develop into eye bud cells. Chemical markers relating to the different stages of dormancy break will be determined in this project. This will ultimately further the understanding in optimising storage and breeding for varieties with a long dormancy.

Key findings

Chemical analysis of tuber buds induced to sprout indicates that the same metabolite products consistently accumulate during the first 72 hours.

These products are involved in the tricarboxylic acid (TCA) cycle, a process in which cells release stored energy needed for cell division and multiplication. Buds that are more likely to sprout show altered levels of TCA.

Carbon going through the TCA cycle at the onset of dormancy break is diverted from reserve storage to plant growth.

Next steps

Identification of the chemical markers that can be used to assess the tendency for sprouting under commercial storage conditions.

PhD: Persistence, transformation and the fate of CIPC

Dates: October 2014 – September 2018
Project Number: 11140006
Lead partner: SUERC (Glasgow)
AHDB Funding: £91,963

Most potato stores in the UK use CIPC for sprout suppression. Following application as a hot fog, CIPC is retained in the fabric of buildings and persists in the flooring of stores many years after the final application.

As a result, potato stores that have used CIPC cannot store other products such as cereal grains, fresh vegetables or seed potatoes due to the unintentional risk of cross-contamination. At present, little is known about the fate of CIPC and its main breakdown product 3-CA, in the fabric of potato stores.

This project addresses these issues by quantifying the persistence of CIPC and 3-CA in potato stores, the factors involved in cross-contamination of non-potato crops, and the strategies for the decontamination of stores.

Key findings

Sampling and analytical methods were successfully developed to detect CIPC in concrete and in grains.

CIPC persisted in all stores tested, regardless of total quantity applied and timing of final application.

The route of cross contamination is a complex process involving physical and chemical factors.

The extent of contamination is influenced by (i) direct contact with flooring, (ii) headspace directly above the concrete surface and within the store itself and (iii) presence of CIPC-containing dust particles in store environment.

Next steps

Recommendations can now be made on the re-use of potato stores previously treated with CIPC, and direct store-specific decontamination strategies can be developed depending on the stores future end use.

Current projects

PhD: Mechanisms of senescent sweetening

Dates: October 2016 – September 2019
Project Number: 11140024
Lead partner: James Hutton Institute
AHDB Funding: £69,327

Maintenance of tuber quality during long-term storage is essential to meet the processing market's requirements. One key factor for potatoes destined for processing is the prevention of sugar accumulation during storage. Excessive sugar levels arising from physical processes, like senescent sweetening, can lead to unacceptable fry colours and increased levels of acrylamide in processed products.

This project aims to gain further understanding of the physiological, biochemical and molecular mechanisms involved in senescent sweetening and, as a result, identify key factors controlling this process. Tubers from two varieties were studied, one susceptible and the other resistant to senescent sweetening.

Key findings

Experiments have identified an increase in sugar content after approximately 30 weeks of storage, with significant differences in glucose and fructose levels between the two varieties. A dark fry colour of crisps is associated with the accumulation of sugars over time.

No significant differences in stress-related chemistry between varieties were seen, indicating that it may not be linked to senescent sweetening.

Chemical profiling showed that the 'susceptible' variety is quicker at converting glucose into sucrose than the 'resistant' one.

Breakdown and storage of starch were identified as potential traits linked to sweetening resistance.

Quantifying effects of potato seed multiplication systems and storage practices on ware production

Dates: September 2016 – March 2022
Project Number: 11140032
Lead partners: NIAB CUF & Sutton Bridge Crop Storage Research (SBCSR)
AHDB Funding: £578,156

Seed health and performance are significant factors in ware production and meeting market requirements. At present, there is limited understanding of how different environmental factors affect seed performance and ultimately ware production, both during multiplication and storage. As a result, unpredictable and poor seed performance can sometimes lead to ware failure and increased wastage.

Integrating agronomy and storage data will provide a better understanding of the effect agronomic and environmental factors have at the different stages of seed and ware production. Ware growers will benefit from having access to seed with more predictable performance, which will make meeting market requirements easier.

Multiple stocks of the seed of the varieties Royal and Maris Piper are currently being monitored through several generation cycles in commercial and experimental systems. The stocks represent relevant agronomic and storage practices, including crops grown in different regions, subject to contrasting systems of production, grading, storage and transport. Novel seed storage techniques are also being investigated at a smaller scale. Tuber (seed and ware) physiology and pathology will be monitored in storage and during successive multiplication cycles.

Key findings

Small differences appeared in emergence, ground cover development, number of stems at a common seed weight, tuber populations and yield between seed stocks and storage regimes.

On average, the incidence and severity of a number of diseases, notably gangrene and skin spot, were greater following commercial storage than from storage at SBCSR.

High incidences of gangrene and skin spot were associated with incomplete emergence and low ground cover respectively.

Next steps

Further tests on a wider range of stocks at different stages of multiplication are required for full characterisation of seed performance variation.

Integrating CIPC alternative sprout suppressants for the processing sector

Dates: October 2017 – September 2020
Project Number: 11140043
Lead partner: Sutton Bridge Crop Storage Research (SBCSR)
AHDB Funding: £199,950

The potato processing sector is particularly reliant on CIPC for sprout suppression, since tubers are stored at relatively warm temperatures (6-13°C) to maintain commercially acceptable fry colour in processed products. The active substance is up for registration renewal and the European Food Safety Authority (EFSA) has recommended no further renewal following a review. With no decision yet reached, CIPC's future in the sprout suppressant toolbox is uncertain. Evaluating alternatives to CIPC is therefore crucial.

This project builds on previous research work undertaken at SBCSR that explored ethylene as a suppressor of sprouting in tubers destined for the processing market. The sprout suppressants to be evaluated in this project are maleic hydrazide (MH), spearmint oil, ethylene, 1-4 dimethylnaphthalene (DMN) and CIPC. Their efficacy in controlling sprouting in synergy are also being explored.

The varieties Innovator, VR808, Royal, Performer and Maris Piper are stored at 9 °C and assessed for sprouting and frying colour at 3, 6 and 9 months intervals.

Key findings

The effectiveness of individual treatments were, in increasing order of efficacy: untreated, ethylene or spearmint oil, CIPC or DMN.

Combinations of different treatments were more effective than either treatment alone. A single dose of either DMN or CIPC increased the efficacy of other treatments.

Sprouting was significantly delayed for all varieties with MH treatment, although the use of different stocks in the trial affected comparison across treatments.

Next steps

The trial has been extended for two further years as part of the AHDB's enhanced sprout suppression research and KE initiative. A parallel trial for the fresh market was added in summer 2018, which will last three years.

As the future of CIPC is uncertain, combination treatments will include ethylene and spearmint oil, both suppressants known to be available in the UK in 2019-21.

Latent infection of tubers during storage and transit

Dates: September 2016 – March 2022
Project Number: 11120028
Lead partners: SASA, Sutton Bridge Crop Storage Research & University of Warwick.
AHDB Funding: £63,423

The Scottish seed potato industry is exporting an increasing number of seed potatoes to non-EU destinations, which have stricter phytosanitary regulations than the EU market. While very few seed lots are rejected, economic loss and wastage resulting from re-export and disposal can be detrimental to the industry. Diseases, in particular those with latent infection, are the main reason behind official rejections.

This project will determine the importance of latent infection in seed lots destined for export and identify those at risk of quality deterioration prior to dispatch. The effect of storage and transit journeys on the maintenance of seed tuber quality will also be quantified.

Project data will provide valuable insight into disease development and tuber quality during export transits to formulate effective management strategies for growers and exporters. Ultimately, these strategies will ensure that customers receive high-quality seed tubers; increasing the demand for Scottish seed.

Key findings

None of the seven seed potato consignments failed inspection at the export destinations, so were cleared for entry.

Conditions during transit can have an effect on tuber quality, since disease symptoms were observed for two tuber samples post-export. No rots were observed in any of the examined stocks during pre or post-export assessments.

Large variations in temperature, relative humidity and dew point were observed before and after transit via cargo hold, indicating that additional controls may be required during this period.

Independent variety trials

Dates: April 2015 – July 2019
Project number: 11120013
Lead partner: SASA
AHDB funding: £136,797

All potato varieties must be placed on the official National List (NL) of an EU Member State.

Part of the NL testing in the UK focuses on evaluating varietal performance for susceptibility to diseases, pests and some tuber quality characteristics, and is undertaken within the AHDB Potatoes-funded Independent Variety Trials (IVT) programme.

Testing is undertaken for variety resistance to foliar late blight, skin spot, silver scurf, black dot and potato mop-top virus. Since 2016, the database has also included varieties where information has been supplied by breeders/agents. Final data from the NL and IVT trials are published on the AHDB Potato Variety Database.

In 2015, tests were conducted on 12 varieties, which had completed UK NL tests, and 8 Common Catalogue varieties. In 2016, tests were conducted on 9 varieties, which had completed UK NL tests, 6 varieties, undergoing their second year of UK NL testing, and 15 Common Catalogue varieties. In 2017, tests were conducted on 5 varieties, which had completed UK NL tests, 3 varieties, undergoing their second year of UK NL testing, and 17 Common Catalogue varieties.

Spatiotemporal analyses of potato late blight in Great Britain

Dates: September 2017 – August 2019
Project number: 11120032
Lead partner: James Hutton Institute
AHDB funding: £100,000

Current methods of late blight management are effective; however, there is a heavy reliance on expensive chemical products (up to £72M). There have been dramatic changes in the genetic make-up of the GB late blight population over the last ten years. Newer, more aggressive strains continue to appear, with uncertain implications for disease development and control.

This project aims to empower agronomists and growers with a new understanding of the epidemiology of late blight in GB and provide new visual aids to facilitate improved decision-making.

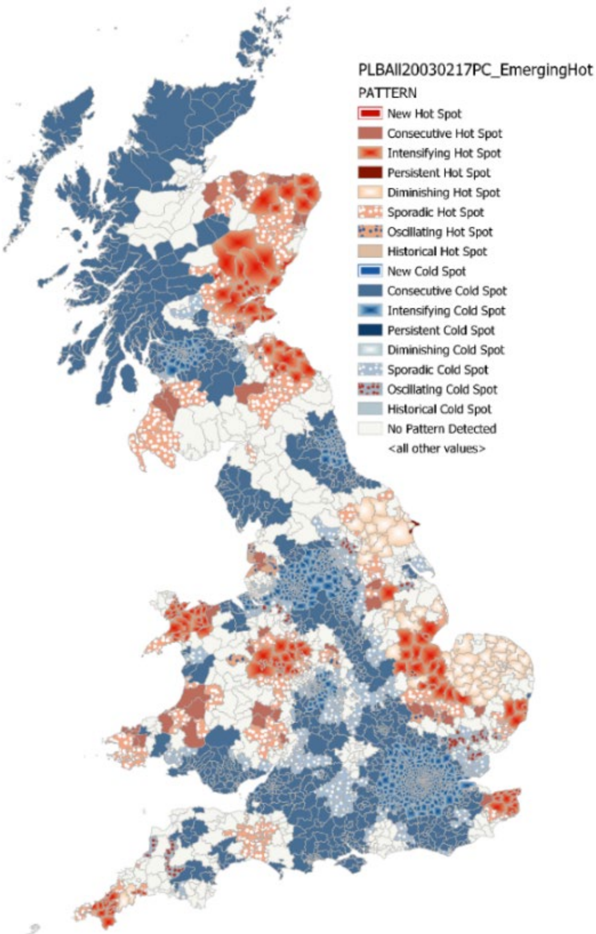
This project examines the data from AHDB Potatoes ‘Fight Against Blight’ database using an array of statistical and geographic information system (GIS) analysis methods.

Key findings

Specific geographic areas where late blight occurs each season have been identified.

Characteristics of early outbreaks and hot spots have been analysed, looking at how previous-season outbreaks relate to early outbreaks the following season.

The new blight genotype 37_A2, was found in hotspot regions in Shropshire and East Anglia, and had moved north towards Sheffield in 2018.



Analysis of emerging hot spots using all potato late blight outbreak data

Next steps

Outbreak and hotspot tracking will be developed, linking the movement and dominance of previous genotypes (e.g. 6_A1) with new genotypes (e.g. 37_A2) to try to establish risk of spread.

Met office weather data will be overlaid to determine when populations increase and the drivers of migration between hotspots.

Potato production and management

Current projects

Alternative approaches to the production of healthy mini-tubers

Dates: December 2016 – May 2019
Project number: 11140031
Lead partner: SASA
AHDB funding: £77,902

Mini-tubers are the first tubers in the potato production chain and preservation of their high health status is very important to the industry.

At present, mini-tuber production in Scotland mainly relies on peat-based growing media, which is largely considered to be free from pathogens. However, there is a Government policy-led drive to reduce peat use by professional growers by 2030, to address environmental concerns. This has resulted in a need to find alternative growing media that are suitable for producing healthy mini-tubers, in order to safeguard the future of the industry.

Experiments were conducted to see whether pathogen-free potato micro plants could be grown in a range of commercial peat-based and peat-free growing media. Pathogen-free micro plants of two potato varieties (Hermes and Maris Piper) were transplanted into containers with one of seven different commercial peat products or one of six different peat-free growing media. The peat-free growing media included two products based on sheep's wool and two products derived from pine bark, together with coir and wood fibre.

Plants were grown for 12 weeks and tested for the presence of a range of fungal pathogens (*Polyscytalum pustulans*, *Colletotrichum coccodes*, *Streptomyces scabie*s, *Spongospora subterranea* and *Verticillium* spp) using molecular diagnostic methods.

Key findings

Plants grown in the commercial peat products or the wool-based peat alternatives grew well.

Growth of micro plants in coir, wood fibre or pine bark products was variable.

Molecular tests confirmed that none of the roots grown in peat or in the wool-based media was positive for the seven pathogens tested.

Next steps

Investigations on other peat alternative growing media.

Improving nitrogen recommendations for potatoes through estimation of determinacy

Dates: March 2017 – September 2020
Project number: 11140044
Lead partner: NIAB
AHDB funding: £122,073

Understanding the nitrogen (N) determinacy group of new varieties is essential to understanding the appropriate N application rate for a given season length and soil N supply. Determinate varieties stop leaf production after they have initiated the first flower, while indeterminate varieties continue to produce leaves and flowers.

Determinate varieties typically need twice the amount of N as indeterminate, but calculating the determinacy group of a variety currently requires years of time-consuming and expensive field testing. This can mean that during initial commercialisation of new varieties, the recommended N rates is estimated incorrectly, leading to increased production costs, yield loss, poor crop quality and increased wastage.

This project aims to produce simple objective measurements to reliably allocate varieties to determinacy groups without the need for extensive field experimentation. These measurements include integrated ground cover, main-axis above ground nodes, and harvest Index at around 55 days after emergence.

Key findings

From the first year of experiments, the number of main-axis, above ground nodes is the best indicator on determinacy.

In well-replicated experiments, there was good correlation between the measurements and they are likely to produce reliable estimates of N grouping.

Next steps

Repeat experimentation to assess if the measurements continue to be a good indicator of determinacy.

Define which measurements may be more suitable than others under different circumstances.

PhD: Soil management and irrigation interactions affecting root-to-shoot signalling and yield of potato

Dates: October 2017 – September 2020
Project number: 11140035
Lead partner: Lancaster University
AHDB funding: £70,500

Unfavourable weather limits UK potato production. Future conditions, such as drought and excessive rainfall, are difficult to predict when potatoes are sown and, therefore, varietal choice (e.g. selecting drought-tolerant varieties) may not always be the best strategy.

Irrigation techniques in potatoes can also affect soil properties, but the mechanisms by which soil management and irrigation interact to affect crop yields are poorly understood. If the mechanisms regulating plant stress responses can be better understood, this will help predict crop behaviour in distinct environmental conditions and will inform better crop management leading to greater, more stable yields.

This project examines how potatoes sense their root environment and how they translate this into signals that are transmitted to the above-ground plant parts to regulate performance, development and tuber yields. It uses both greenhouse pot experiments and field experiments.

Key findings

Both drought and soil compaction limited shoot growth, restricting leaf area expansion.

Plants exposed to these stresses maintained water status, even though growth was limited, suggesting growth is regulated by root-to-shoot signalling.

In field trials, soil compaction reduced shoot growth and drought stress also limited yield

The impact of both stresses combined did not differ significantly from that of the individual stresses.

Next steps

Experiments will look at combinations of drought and compaction stress and measure their effect on early plant development.

A model will be developed to relate penetrometer resistance to soil bulk density, water status and depth.

Current AHDB Potatoes-funded research

Project number	Full title	Topic	Lead contractor	End date	AHDB Funding
11120032	Fellowship: Spatiotemporal analyses of potato late blight in Great Britain	Disease	JHI	August 2019	£100,000
11120046	PhD: Application of machine learning to blackleg prediction	Disease	JHI	March 2020	£71,400
11140044	Estimation of determinacy: Improving nitrogen recommendations for potatoes through estimation of determinacy of varieties	Nutrient	NIAB	September 2020	£122,073
11140048	PhD: Sulphur recommendations and acrylamide potential	Nutrient	NIAB CUF	March 2021	£83,093
11140031	Alternative approaches for the production of healthy mini-tubers	Production	SASA	May 2019	£77,902
11140035	Soil management and irrigation interactions affecting root-to-shoot signalling and yield of potato	Production	Lancaster University	September 2020	£70,500
11140054	Investigation of the potential for precision soil and crop growth mapping to improve tuber size distribution at harvest	Production	Harper Adams University	September 2021	£71,400
91140001	Rotations Partnership: Management of rotations, Soil Structure and Water	Soils	NIAB CUF	March 2021	£1,203,000
11140043	Integrating CIPC Alternative sprout suppressants for the processing sector	Storage	Sutton Bridge Crop Research	September 2019	£199,950
11140024	PhD: Mechanisms of senescent sweetening - Elucidating the Mechanisms of Senescent Sweetening in Stored Potato Tubers to Improve Storage Regimes and Identify Candidate Genes	Storage	James Hutton Institute	September 2019	£69,327
11120031	Improved seed management to minimise losses due to Pectobacterium Species	Storage	James Hutton Institute	July 2020	£204,884
11910057	Integrating alternative suppressants for the fresh market	Storage	Sutton Bridge Crop Storage Research	June 2021	£264,000
11910059	CIPC contamination of stores	Storage	Sutton Bridge Crop Research	September 2021	£63,580
11140039	PhD: Mechanism of cell cycle repression in tubers	Storage	University of Sheffield	September 2021	£8,600
11910058	Understanding dormancy in potato	Storage	Sutton Bridge Crop Research	September 2021	£75,000
11120028	Latent infection of tubers during storage and transit	Storage	SASA, Sutton Bridge Crop Storage Research & University of Warwick	March 2022	£63,423
11140032	Quantifying effects of potato seed multiplication systems and storage practices on ware production	Storage	NIAB CUF & Sutton Bridge Crop Storage research	March 2022	£115,000
11910056	Maleic Hydrazide: Optimisation as a sprout suppressant	Storage	Sutton Bridge Crop Storage Research	June 2021	£100,000
11120013	Independent variety trials	Variety	SASA	July 2019	£136, 797

Contacts

Alice Sin
Resource Management Scientist – Soils
T: 024 7647 8785
E: Alice.Sin@ahdb.org.uk

Amanda Bennett
Resource Management Scientist – Soils
T: 024 7647 8951
E:Amanda.Bennett@ahdb.org.uk

Catherine Garman
Crop Protection Scientist – Diseases
T: 024 7647 8598
E:Catherine.Garman@ahdb.org.uk

Charlotte Rowley
Crop Protection Scientist – Pests
T: 024 7647 8973
E:Charlotte.Rowley@ahdb.org.uk

Dhan Bhandari
Cereal Product Quality Specialist
T: 024 7647 8750
E:Dhan.Bhandari@ahdb.org.uk

Sajjad Awan
Resource Management Scientist – Crops
T: 024 7847 8787
E: Sajjad.Awan@ahdb.org.uk

Paul Gosling
Crop Protection Scientist - Weeds
T: 024 7647 8757
E: Paul.Gosling@ahdb.org.uk

Sue Cowgill
Crop Protection Senior Scientist - Pests
T: 07768 177 596
E: Sue.Cowgill@ahdb.org.uk

Further information

Publications can be found at **ahdb.org.uk/knowledge-library**

Reports, meeting dates and results from on-farm try-outs from the Monitor and Strategic Farms can be found at **ahdb.org.uk/farm-excellence**

AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

T **024 7669 2051**
E **info@ahdb.org.uk**
W **ahdb.org.uk**
@AHDB

POTATOES
CEREALS & OILSEEDS