Arable review 2021–22

Contents

Photography credits:

Cover image © Richard Billingham – ID 216870052, Dreamstime.com. Page 2 and 3 © Dmitry Naumov – ID 112844064, Dreamstime.com. Page 4, 6, 7, 8 (top), 10, 11, 12, 13, 15 (top), 16 (top), 17, 18 and 20 © AHDB. Page 5 © Andrei Shupilo – ID 107752423, Dreamstime.com. Page 8 (bottom) © Debbie James. Page 14 (top) © Mattckaiser – ID 61627011, Dreamstime.com (bottom) © Romthamsted Research. Page 15 (bottom) © Harper Adams University. Page 16 (bottom) © Dominique Dietiker – ID 9704813, Dreamstime.com. Page 19 (top) © Draghicich – ID 64858320, Dreamstime.com; (bottom) © Alan Bennett/Media Imaging Solutions 2014.

Produced for you by AHDB ahdb.org.uk

Foreword

Your levy is ring-fenced for activities that benefit you – growers of cereals and oilseeds. A large proportion of the levy is invested in our research programme, which is targeted at industry-identified priorities.

This review provides an overview of the breadth and depth of current activity. Not every project is summarised, but all current projects are listed on pages 21–23.

Our research provides a foundation for informed decision making. The AHDB Farm Excellence programme helps to bring research-led developments to life and I encourage you to get involved with this activity, wherever you are in the UK.

This year, the Arable review illustrates how research is being put into practice on our Strategic Cereal Farms, with items written by Emily Pope, AHDB Senior Knowledge Transfer Manager.

We always seek to work with others where there are aligned common goals around research, knowledge exchange, skills and marketing. Common problems require common solutions and this benefits from combining funding and expertise (and minimising duplication). Our partnership approach is highlighted throughout this review.

Finally, if you would like more information on our full range of our activity, visit the AHDB website:

- **ahdb.org.uk/knowledge-library** (publications and research reports)
- **ahdb.org.uk/farm-excellence** (Monitor Farm and Strategic Farm meetings and results)
- **ahdb.org.uk/agronomy-focus** (information on our monthly Agronomy Focus e-newsletter)
- **ahdb.org.uk/arable-focus** (our arable journal, which also features agronomy research)

To achieve a sustainable, long-term improvement in farm performance, AHDB continues to be positioned as the UK's leading knowledge exchange partner, disseminating research and innovation at scale across the Cereals & Oilseeds sector.

Richard Meredith
Head of Arable
Knowledge Exchange

Soils

With soil health at the heart of the new environmental land management (ELM) scheme, it is increasingly important to measure and manage it. AHDB Environment Scientists, Amanda Bennett and Alice Sin, reveal how research-based tools can guide soil-management decisions.

As part of the ELM scheme, the Sustainable Farming Incentive (SFI) will introduce a new arable and horticultural soil standard in spring 2022. The aim is to reward farmers who adopt management practices that monitor and improve soil health. Read more about SFI here:

ahdb.org.uk/trade-and-policy/sustainable-farming-incentive

Soil health scorecard

Over the past five years, the AHDB and BBRO Soil Biology and Soil Health Partnership (91140002) has developed and validated thresholds for measuring and monitoring physical, chemical and biological indicators of soil health.

These indicators have been grouped within a soil health 'scorecard'. At the heart of the scorecard is a traffic-light system that shows whether results fall within the expected range for UK soils and climatic regions. Results are flagged as red, amber or green to indicate where values are outside of, close to, or within established threshold values, respectively. A red flag requires immediate investigation, an amber flag warrants closer monitoring. The results, combined with field-level knowledge, can help identify soil-health management priorities.

Scorecard example

Example scorecards, from a long-term rotation trial at Harper Adams University, are shown in Tables 1 and 2. The trial compares bulky organic material (farmyard manure (FYM) and green compost) plots with a control plot. Assessments were conducted in autumn 2017 (at the end of a grass ley) and autumn 2020 (cereal stubble), with samples taken from the same replicated plots.

Table 1. Example soil health scorecard from a long-term organic matter trial. October 2017 – two year grass and clover ley

Attribute	Control	FYM (23 years)	Green compost (13 years)
Soil organic matter (%LOI)	3.0	4.1	4.0
pH	6.4	7.0	7.0
Ext. phosphorus (mg/L)	56	73	60
Ext. potassium (mg/L)	80	311	187
Ext magnesium (mg/L)	44	87	63
VESS score	2	2	1
Earthworms (number/pit)	11	13	11
Potentially mineralisable nitrogen (mg/kg)	23	90	43
CO_2-carbon (mg/kg)	198	228	222

Soil organic matter – comparison to 'typical' levels for the soil type and climate. LOI: Loss on ignition. Ext.: Extractable. VESS: Visual evaluation of soil structure – limiting layer score. Earthworms: Total number of adults and juveniles; >8/pit = 'active' population for arable or ley/arable soils. Potentially mineralisable nitrogen – comparison to 'typical' levels for UK soils.

Table 2. Example soil health scorecard from a long-term organic matter trial. October 2020 – spring barley stubble

Attribute	Control	FYM* (25 years)	Green compost* (15 years)
Soil organic matter (%LOI)	2.7	3.2	3.4
pH	6.3	6.7	6.7
Ext. phosphorus (mg/L)	73	82	72
Ext. potassium (mg/L)	82	212	144
Ext magnesium (mg/L)	33	69	50
VESS score	3	3	3
Earthworms (number/pit)	1	1	1
Potentially mineralisable nitrogen (mg/kg)	24	37	37
CO_2-carbon (mg/kg)	87	111	109

Soil organic matter – comparison to 'typical' levels for the soil type and climate. LOI: Loss on ignition. Ext.: Extractable. VESS: Visual evaluation of soil structure – limiting layer score. Earthworms: Total number of adults and juveniles; >8/pit = 'active' population for arable or ley/arable soils. Potentially mineralisable nitrogen – comparison to 'typical' levels for UK soils. *Organic matter was not added to the plots in 2020 (due to Covid-19 restrictions)

The scorecard reveals how the organic material applications increase soil organic matter (SOM) and key nutrients, such as nitrogen, phosphorus, potassium and sulphur. However, repeat annual applications can result in unacceptably high levels of phosphorus. The scorecard also shows the impact of cereal crop management, with low earthworm numbers recorded and amber flags for the visual evaluation of soil structure (VESS) scores.

Soil biodiversity

The research has also advanced understanding of how management affects soil biodiversity, including earthworms, mesofauna, nematodes and microorganisms. Benchmark threshold values for some biological indicators, such as CO_2 burst (respiration) and potentially mineralisable nitrogen (PMN), have been updated for UK soils and incorporated into the scorecard.

Molecular techniques have been used in an AHDB and AgriFood Charities Partnership PhD studentship (21140024) to investigate how cover crops affect arbuscular mycorrhizal fungi (AMF). Diverse AMF communities may benefit crops in several ways, including increased nutrient uptake, pest and pathogen resistance, drought tolerance and increased yields.

Results show that some AMF species colonise the roots relatively quickly. Further analysis is investigating AMF diversity. In collaboration with Fera's Big Soil Community, the PhD also examines how AMF populations respond to biotic and abiotic factors, such as organic matter and fungicides. Molecular approaches have also been used to explore microbial diversity and to quantify soil organism groups, such as soil-borne plant pathogens, in another project (21140029).

Soil structure

An online compaction-risk tool (Terranimo UK) has been developed by our Rotations Partnership (91140001). It uses UK soil texture information and user-input (e.g. tyre type, pressure and axle loads) data to indicate potential stresses in the soil profile.

The tool also quantifies the potential benefit of various management practices, such as the use of wider, low-pressure tyres or machinery with more axles. It can also indicate the effect of soil moisture. Recent updates include the addition of tracked machines, as well as the potential soil response to multiple wheelings.

Access the tool, as well as guidance on cultivation options, via: **ahdb.org.uk/arable-soils**

Soil organic matter (SOM)

The Rotations Partnership has also validated a model that determines the benefits of organic matter across the rotation. Based on Rothamsted Research's long-term experiments (some going back over 50 years), the model shows that annual application of organic matter for three years can improve yields for up to an additional two years. The applications also have the potential to reduce nitrogen application by 1–15 kg nitrogen/ha (compared to the RB209 optimum), with these benefits over and above the nutrients contained in the organic matter.

The amount of organic matter required depends on:

- The relative value of the crop(s)
- The cost of acquiring and spreading organic matter
- The time it takes for SOM to decay

As part of the project, The James Hutton Institute have developed a way to measure SOM in the field. Using a handheld FTIR (Fourier transform infra-red) spectroscopy instrument, they have established relationships between SOM quality, soil aggregate stability and resilience. In the laboratory, FTIR also accurately predicted soil organic carbon (SOC), in addition to bulk density, which is needed for carbon-stock calculations.

To access all our soil information and resources, visit: **ahdb.org.uk/greatsoils**

Strategic Cereal Farm: cultivating soil health

With climate change set to cause more extreme events, it is important to make cropping systems as resilient as possible. AHDB's Strategic Cereal Farm West has used the soil health scorecard to examine how cultivation systems influence soil health, crop rooting and yield.

A replicated tramline trial on a clay field, which started in 2018, compares the effect of three cultivation depths (5 cm, 15 cm and 30 cm), with a direct drilled treatment added from 2019. At the start of the trial, the soil health scorecard was used to baseline the field, which revealed poorly structured soil and low earthworm numbers.

Trial results

For harvest 2019 (winter wheat), the 5 cm cultivation treatment resulted in significantly greater topsoil penetration resistance, although there was no significant loss of yield. Farmbench was used to analyse the cost of production (COP), with the lowest COP in the 15 cm (£92/t), followed by the 30 cm (£99/t) and 5 cm (£97/t) treatments.

For harvest 2020 (spring beans*), the 5 cm cultivation treatment again delivered the highest topsoil penetration resistance and the lowest yields. Early measurements of spring bean roots showed direct drilled and shallow cultivation treatments had fewer roots, densely concentrated at the top of the soil.

For harvest 2021, the crop (winter wheat) was also sown with a tine seed drill. In April 2021, direct drilled crops had shorter and more compact roots compared to the 30 cm treatment. Above-ground crop biomass and normalized difference vegetation index (NDVI) were uniform across the field.

These results show that no two years or crops are the same and regular monitoring of soil health is important, with a visual evaluation of soil structure (VESS) offering a relatively simple option.

Beetle bonus

AHDB research (PR623) shows that soil conditions influence cabbage stem flea beetle (CSFB) severity. The second year (harvest 2020) of this trial demonstrated this. Initially, oilseed rape crop was drilled in the autumn*. Conditions were dry at drilling. However, minimal cultivation and direct drilling provided sufficient soil moisture. Following deeper cultivations (15 cm and 30 cm), moisture loss resulted in poorer establishment and greater CSFB issues, probably due to slower growth hampering the crop's ability to outgrow feeding damage. However, fewer larvae were detected, which may reflect the egg-laying preference of the pest (which prefers to lay eggs at the base of larger plants), or simply because fewer larvae could occupy the smaller plants.

*All oilseed rape plots were abandoned and re-drilled with spring beans.

Follow the Strategic Cereal Farm story at:
ahdb.org.uk/strategic-cereal-farms

Varieties

Over three quarters of a century have elapsed since the first Recommended Lists (RL) was published. Paul Gosling, who leads the project at AHDB, illustrates how the variety trialling project has moved on, since those early days.

In 1944, a narrative description (by the National Institute of Agricultural Botany) of 16 wheat varieties formed the basis of the RL first edition. Since that time, the variety trialling project has evolved. It now involves more than 400 trials – spread from Cornwall to Aberdeenshire – delivering vast amounts of data for 11 crops each year.

The fuel for the RL is hundreds of potential new varieties produced by plant breeders each year. Varieties that are distinct, uniform and stable – and have value for cultivation and use – are entered onto the UK National List (NL) and can be marketed.

The RL technical crop committees, which are made up of supply-chain representatives, review NL data and select the strongest varieties to enter into RL trials. Only after a further three years of testing can varieties be considered for recommendation.

The evolving system

The latest five-year instalment of work started this autumn, incorporating outcomes of an independent review. For example, various pressures mean that the demand for varietal resistance (to disease and pests) has increased. This has seen breeders and the RL system adapt, with improvements already registering in recommended varieties – such as improved resistance to septoria tritici over the last six years (Figure 1).

The disease-rating system now better accounts for rapidly shifting pathogen populations. Until the RL 2021/22 edition, an average of the last three years' disease data was used to calculate disease ratings. Although this approach is suitable for relatively stable pathogen populations, such as with septoria, it no longer works for the highly changeable yellow rust and brown rust pathogens. As a result, we now give the most recent years' rust data a higher weighting to better account for recent changes in pathogens populations.

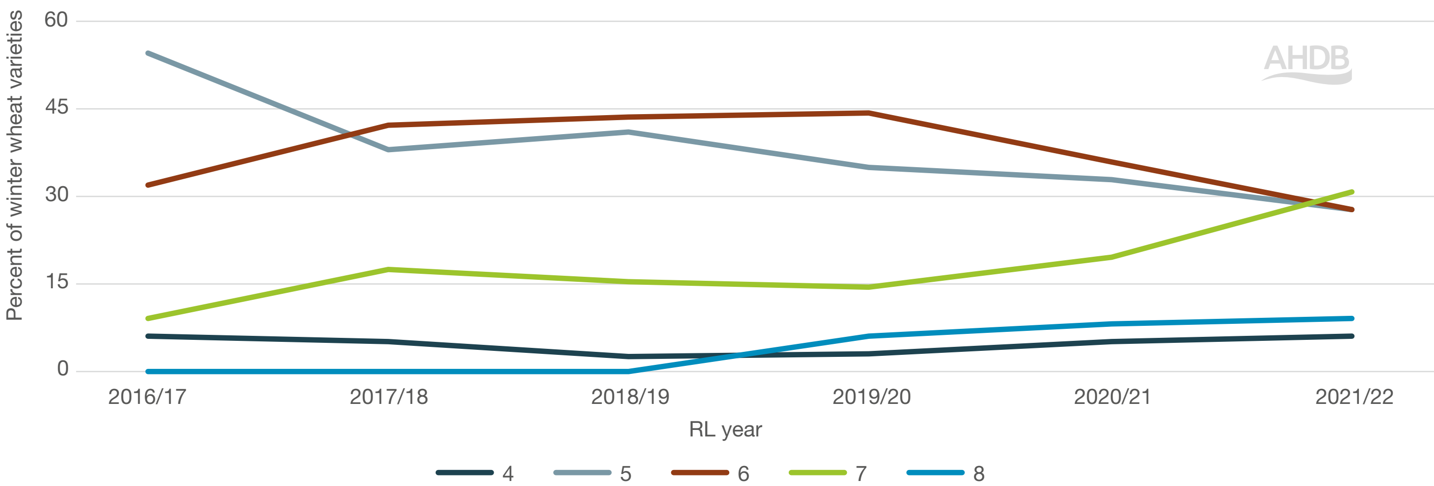

Figure 1. Septoria tritici ratings of winter wheat varieties on the Recommended Lists since 2016/17

RL 2022/23 and beyond

The RL never stays the same. Once again, the 2022/23 edition (due in November) will feature numerous changes – big and small. One of the major differences will be the approach to lodging ratings. As with the rusts, rating scales have become gradually compressed. The next edition will see the scales 'reset' to provide more differentiation, especially at the bottom end.

The latest project phase also sees a greater number of spring barley trials in England, reflecting the increasing popularity of the crop. Also, a greater number of early-drilled wheat trials will be grown in the North, in recognition of changing cropping patterns.

Yield is not king

Yield is no longer the priority for the RL. There is a greater emphasis placed on delivering data to help the industry adopt integrated pest management (IPM) and make the most of changing cropping patterns.

The RL tests the extremes. Treated trials follow a robust fungicide programme to show the genetic potential of varieties – even the weakest (Figure 2). However, the value of untreated trials has increased – with more growers using this data to see how varieties perform under higher disease pressures. As a result, the latest phase of the project sees an increase in the number of untreated trials, in addition to improving information on other characteristics (such as sowing date and lodging with PGR).

Figure 2. Ramularia infection on winter barley in a fungicide-treated trial

Relaunch: The next five years of variety trials

Learn more about plan for the next five years of the RL in the Autumn/Winter 2021 Arable Focus: **ahdb.org.uk/arable-focus**

Strategic Cereal Farm: variety choice and fungicide intensity

A replicated tramline at Strategic Cereal Farm West is comparing fungicide-input strategies on two Group 2 winter wheat varieties (KWS Extase and KWS Siskin), with all other treatments the same.

Building on AHDB fungicide performance results (21120013), the four programmes – each increasing in fungicide intensity – were chosen to create treatment differences (based on in-field observations).

Table 3. Treatment programmes for untreated, low, medium and high input applications

<table>
<tr><th>Treatment</th><th>T1
(26 April 2021)</th><th>T2
(26 May 2021)</th><th>T3
(9 June 2021)</th></tr>
<tr><td>Untreated</td><td>No fungicide</td><td>No fungicide</td><td>No fungicide</td></tr>
<tr><td>Low</td><td>No fungicide</td><td rowspan="3">Fluxapyroxad + mefentrifluconazole 0.9 L/ha</td><td>No fungicide</td></tr>
<tr><td>Medium</td><td>Tebuconazole, 0.7 L/ha
Folpet, 1.5 L/ha</td><td>Tebuconazole, 0.7 L/ha</td></tr>
<tr><td>High</td><td>Bixafen + fluopyram, 0.8 L/ha</td><td>Tebuconazole, 0.7 L/ha</td></tr>
</table>

Disease assessments

ADAS monitored the crop and disease levels. They detected differences in crop development early in the season, with Siskin approaching GS30 in March 2021, while the ear was still at the base of the stem in Extase.

In March and April, disease levels were low, but septoria was seen in both varieties. However, conditions then became favourable for septoria. Disease assessments on 8 July 2021 revealed higher levels of septoria in KWS Siskin (Figure 3). These observations reflect the RL septoria tritici disease ratings: KWS Siskin 6.5 and KWS Extase 8.0.

Overall, the percentage leaf area affected by yellow rust was low, with the highest recorded (2%) on Leaf 1 in the untreated Extase. Levels of brown rust were slightly higher, with the untreated Siskin Leaf 1 recording the highest at 5.75% leaf area affected.

Follow the Strategic Cereal Farm story at:
ahdb.org.uk/strategic-cereal-farms

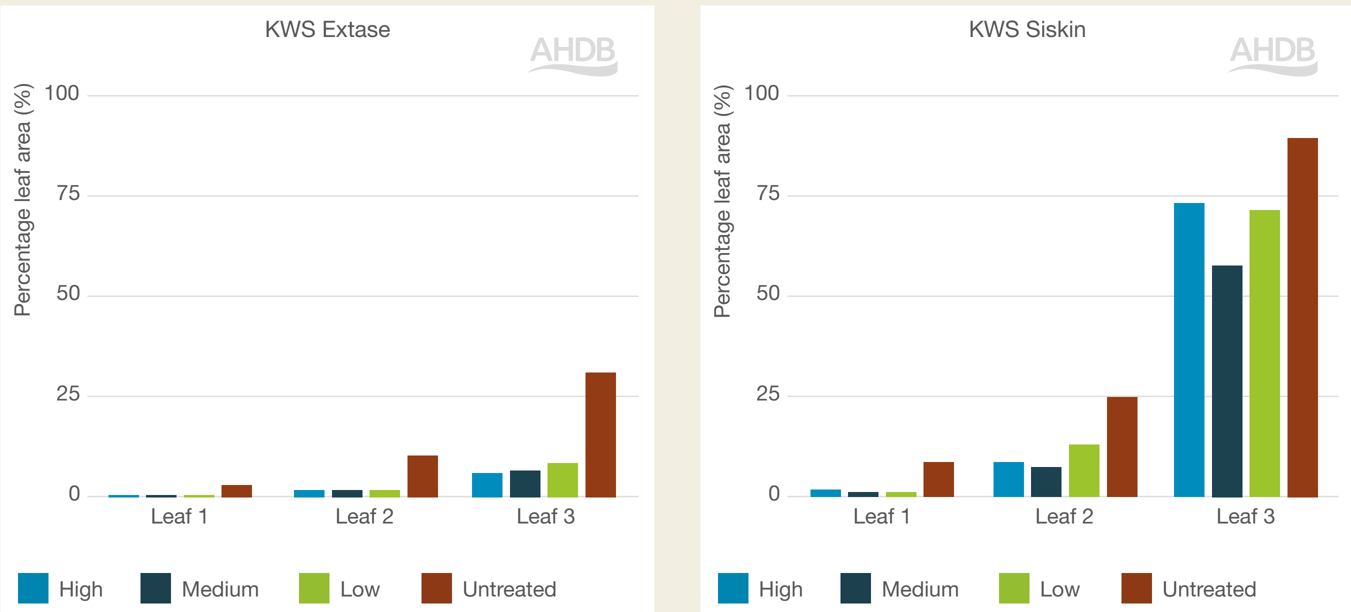

Figure 3. Percentage leaf area affected by septoria tritici in fungicide-intensity trial on two varieties


Yellow rust

Diseases

Working with the Fungicide Resistance Action Group (FRAG) and researchers, AHDB keeps its finger on the pulse of sensitivity of pathogens to new and established fungicides. Robert Saville, Crop Protection Scientist, outlines how the activity can help form the foundation of product and variety choice.

Fungicide performance

The fungicide performance project (21120013) uses high-disease pressure trials to reveal the protectant and curative performance (where applicable) of a variety of fungicide products – in terms of the impact on disease levels and yield.

The project also tests products prior to registration, which allows performance data to be released as soon as products hit the market. For example, this allowed AHDB to issue data on a new wheat product (Univoq) in spring.


Septoria tritici

Monitoring resistance

Another linked project (21120018a) monitors fungicide sensitivity in septoria (*Zymoseptoria tritici*) populations for all key actives, representing various modes of action (MOAs).

Developed as part of the work, DNA-based diagnostics measure the spread and establishment of resistance mechanisms in field populations. This work, together with the outputs from the fungicide performance project, deliver independent data to inform the optimal use of fungicides – regarding product choice, timing, dose and MOA partnering.

Although septoria has become less sensitive to azole fungicides, no significant shifts in azole sensitivity were observed in 2021. Laboratory sensitivity testing shows the shift towards insensitivity has stabilised recently, with only slight changes reported. However, a shift towards SDHI insensitivity continues at multiple locations, as sensitive strains are displaced and resistant genotypes accumulate.

Co-funded research (21120058) and studentship (21120062) projects will also inform the next generation of fungicide resistance management guidance.

Disease resistant varieties

The yellowhammer project (P1701165) aims to identify resistance genes that, when combined, provide durable resistance to multiple races of yellow rust. Trials across UK and Northern Europe are exposing wheat varieties to diverse pathogen populations over several growing seasons. So far, the results confirm the tremendous diversity of the yellow rust population – in both space and time.

Alongside this project, the United Kingdom Cereal Pathogen Virulence Survey (UKCPVS, 21120034) continues to monitor yellow and brown rust populations. The tests and trials reveal which varieties new races infect, helping breeders identify the resistance genes to focus on in breeding programmes.

The UKCPVS relies on growers, agronomists and trial operators to send in their infected leaf samples. Sampling instructions are available via: **ahdb.org.uk/ukcpvs**

How to fortify septoria ratings

Discover how drill date influences disease resistance to septoria tritici in winter wheat in the Autumn/Winter 2021 edition of Arable Focus: ahdb.org.uk/arable-focus

Strategic Cereal Farm: reducing input intensity

FARMEXCELLENCE

AHDB's Strategic Cereal Farm East is testing the cost-benefit of input programmes – at two levels of intensity: 'low' and 'high' – on a hard Group 4 winter wheat variety (Gleam, drilled on 17 October 2020).

The replicated plot trial includes four untreated plots and two replications of seven timing treatments (T1, T2, and T3 combinations shown in Table 4).

Disease assessments

Conditions were not conducive to initial infection and spread of septoria tritici and yellow rust. This was due to a combination of the late-autumn drilling date and weather. Between February and April, rainfall was about half of the long-term average, with temperatures 5°C below average. In early May 2021 no significant disease was detected, with only low levels (<5%) of septoria tritici detected on leaves 5 and above.

In the run-up to T1, weather became more conducive, with septoria found on the lower leaves. By June, an average of 3.7% and 10% of the leaf area was affected by septoria and yellow rust, respectively, in the untreated plots. Across the rest of the trial, the results showed how the T2 timing contributed to the control of yellow rust. Before T3, the low programmes recorded lower green leaf area (GLA).

Follow the Strategic Cereal Farm story at: **ahdb.org.uk/strategic-cereal-farms**

Table 4. Fungicide applications for low and high input programmes

Treatment	Low	High
T0	No treatment	Epsotop (magnesium and sulphur, 8 kg/ha) YaraVita Mancozin (manganese, copper and zinc, 1 L/ha) YieldOn (nitrogen, potash, manganese, molybdenum, zinc, 1.5 L/ha)
T1	3C Chlormequat 750 (chlormequat chloride, 1 L/ha) Firefly 155 (prothioconazole and fluoxastrobin, 1 L/ha) Headland Boron (boron, 0.125 L/ha)	3C Chlormequat 750 (chlormequat chloride, 1 L/ha) Bugle (fluxapyroxad, 1 L/ha) Headland Boron (boron, 0.25 L/ha) Tempo (cyfluthrin, 0.1 L/ha) Tubosan (tebuconazole, 0.5 L/ha)
T2	Epsotop (magnesium and sulphur, 5 kg/ha) Headland Boron (boron, 0.25 L/ha) Verydor XE (fluxapyroxad and mefentrifluconazole, 0.8 L/ha)	Epsotop (magnesium and sulphur, 4.167 kg/ha) Headland Boron (boron, 0.5 L/ha) Verydor XE (fluxapyroxad and mefentrifluconazole, 1.5 L/ha) YieldOn (nitrogen, potash, manganese, molybdenum, zinc, 1.5 L/ha)
T3	Firefly 155 (prothioconazole and fluoxastrobin, 1.15 L/ha)	Bridgeway (amino acid biostimulant, 2 L/ha) Firefly 155 (prothioconazole and fluoxastrobin, 1.5 L/ha)

Note: All other crop applications were the same

Weeds

An over-reliance on a limited group of herbicide modes of action has accelerated the development of resistant grass weeds. Robert Saville, Crop Protection Scientist, explores how AHDB research is helping to identify resistance risks and improve weed management guidance.

Herbicide resistance in brome

With a rise in brome levels, reported by growers and agronomists, a four-year project (21120059) was commissioned in 2017 to investigate. The work assessed the distribution of brome species, determined the presence and extent of herbicide resistance and helped understand how herbicide resistance develops in UK brome species.

The researchers conducted a UK-wide brome survey and exploited a network of farms, established in the black-grass research initiative (BGRI). The underlying genetic basis of resistance was determined in strains collected as part of the survey. Using resistant strains, container-based trials tested strategies to help maintain herbicide control. Concluding earlier this year, the project's key messages are:

- In all UK regions, brome is more abundant than previously observed
- Bromes are likely to increase in low/no-till situations or as areas under environmental management grow
- Brome resistance to acetolactate synthase (ALS) inhibitors has been confirmed and an increased tolerance to glyphosate reported
- Low doses of some herbicides increase risk of driving resistance
- The optimal timing for ALS herbicides is GS12–13 and GS21–23, with levels of control declining rapidly at GS25

Grass-weed glyphosate resistance risks

There are four key principles for managing resistance development in weeds – prevent survivors, maximise efficacy, use alternatives and monitor success. A five-year project (21120023) set out to determine the impact of each principle in relation to glyphosate resistance risks.

Based on black-grass and Italian rye-grass, the work investigated the two main risk periods of glyphosate application: pre-drilling and post-emergence. It quantified the risks associated with various management practices, including repeat applications during the pre-drilling period, the use of cultivation and post-emergence applications between crop rows. It also looked at how to determine resistance status, through tests on seeds and whole plants.

Earlier this year, the project concluded with the main findings used to update the Weed Resistance Action Group (WRAG) guidelines:

- Reduced doses increase the risk of lower efficacy
- Typically, annual grasses require a minimum of 540 g a.i./ha for seedlings up to 2–3 leaves (GS12–13), 720 g a.i./ha when tillering (>GS21–22) and 1,080 g a.i./ha when flowering
- The temperature at application is important: warmer temperatures promote weed growth and higher glyphosate uptake, thereby enhancing control
- Cultivation of stale seedbed (depth 5 cm) is essential to increase black-grass control
- A maximum of two glyphosate application timings for a stale seedbed reduces the risk of resistance developing in survivors

Crop competition against black-grass

Crops compete with weeds to varying degrees and can contribute up to 25% black-grass control. Crop management, such as high seed rates, narrow row spacing and good seedbeds, can also influence crop competitiveness. However, the impact of variety on weed competition is poorly understood, limiting the potential of plant breeding for increased competition.

A four-year studentship (21120187) commenced in October 2020 to test the competitiveness of wheat against black-grass, under controlled conditions, to identify beneficial genetics. Ultimately, the project will allow for enhanced competitiveness to be selected through plant breeding. Additionally, the methods used could be adopted for variety screening, as part of the Recommended Lists.

Strategic Cereal Farm: stubble management and black-grass

FARMEXCELLENCE

Strategic Cereal Farm West has trialled the effectiveness of stubble management strategies in a replicated tramline trial. The 12 ha site features several soil types, from shallow-over-sandstone to heavy clay.

Cultivation treatments

- A power harrow used to a depth of 3–8 cm, with glyphosate applied (farm standard)
- A Duck Foot spring tine cultivator used to a depth of 4–7 cm, with no glyphosate applied
- Väderstad Cultus Quattro cultivator used to a depth of 4–8 cm, with no glyphosate applied

In the two shallow cultivation treatments, soil was moved twice to improve weed control. Treatments were applied before drilling a soft Group 4 winter wheat (KWS Saki).

In September 2020, black-grass levels were relatively low. In fact, it was only found on the headlands, rather than in treatments. Spring barley volunteers competed with the black-grass and may have changed the moisture and temperature of the soil surface. Cleavers were found in October weed assessments. In April 2021, black-grass was found on the heavier soils and cleavers were present in six of the tramlines.

Sticking with the standard

The power harrow produced good tilth and small crumb size. It destroyed the volunteers well by lifting them out of the soil and onto the surface to dry. Although the shallow cultivation treatments kept weed seeds at depth, neither produced a high-quality seedbed or removed all of the volunteer weeds.

Follow the Strategic Cereal Farm story at: **ahdb.org.uk/strategic-cereal-farms** (full trial results available from December 2021).

Black-grass

Grain aphid

Pests

In the face of common challenges, collaboration is key. Sue Cowgill, AHDB Crop Protection Senior Scientist (Pests), examines how the industry has united in the fight against major crop pests.

As part of integrated pest management (IPM) efforts, a suite of new collaborative projects will generate independent evidence on the control options available and how they can be exploited to deliver maximum benefit.

A case in point is cabbage stem flea beetle (CSFB). This year saw the launch of csfbSMART (Sharing Management and Agronomy Research Tools), which connects two research initiatives – an AHDB project (21120185) and a Defra project.

Reducing CSFB impact

The AHDB work (led by ADAS and Harper Adams University), builds on an earlier project that reviewed the factors that affect CSFB feeding, larval infestation and crop tolerance. For the main IPM options, it used a traffic-light system to indicate the level of evidence for their effectiveness.

Sow date delivered greatest impact, with early sowing mitigating the worst effects of adult feeding. Drilling early is likely to produce a more tolerant crop, while late sowing helps seedlings emerge after the peak of beetle flights.

The trouble is CSFB is two pests for the price of one, as larvae also need to be considered. Early sown crops can have the highest numbers of larvae in the autumn and spring. This is mainly because beetles have more time to lay eggs. The warmer conditions also favour rapid pest development. Unfortunately, this means that sow date management alone is not sufficient to fully manage CSFB. Despite this, it is a basis around which to select other management options.

As crops drilled before mid-August are usually more resilient to adult damage, mitigation options should focus on tackling larval pressures. For example, managed winter defoliation is an option to reduce larval load, which was trialled in an Innovative Farmers field lab (91580001).

The main aim of the latest AHDB-funded work is to evaluate combinations of management options. The work also includes laboratory studies to improve understanding of the pest's biology. The Defra-funded work (led by NIAB) tests management methods on a wider scale, encouraging growers to carry out their own trials.

Cabbage stem flea beetle

Crop tolerance to CSFB

Another CSFB collaborative project (21120185) starts this winter. It aims to identify and provide plant breeders with genetic markers to generate new varieties that are less palatable to the beetle.

Such genetic solutions require significant investment by industry. This why the BBSRC is supporting the £1.88m Industrial Partnership Award (IPA), with £60k co-funding from AHDB.

The project, led by the John Innes Centre (JIC), involves Rothamsted Research and seven crop breeding companies. It develops work begun at JIC – including an AHDB-funded PhD studentship (21120064) – and will delve deeper into the beetle's life cycle and feeding preferences.

Aphid/BYDV research

An AHDB-funded PhD studentship project (21120186) at Harper Adams University is using cereal varieties (old and new) to examine aphid feeding preferences (Figure 4). Knowing why aphids prefer certain plants, and the cues involved, can open-up innovative management options. For example, this could include the use of trap crops in crop margins to 'pull' aphids away from the cereal cash crop.

Another project (21120077a) aims to improve decision support systems (DSS) for aphid and BYDV management in cereals. Our BYDV management tool uses weather data to indicate when a second aphid generation is likely to be active – associated with an increased risk of BYDV spread. The ADAS-led work examines other DSS that use a wider range of information sources, including aphid numbers, the proportion of aphids with BYDV, drill date and spray costs. The best DSS elements will be combined in a refined tool, which will be pitted against our current BYDV tool in on-farm tests.

This project will also include assessments of tolerant winter barley varieties, improvements to aphid monitoring and tests of the proportion of cereal aphids that carry BYDV (sampled by the suction-trap network).

In another project (21510015), grain aphids (sampled by the suction trap network) are tested for the mutation that confers moderate resistance to pyrethroids. The annual results are considered by Insecticide Resistance Action group (IRAG) – the group responsible for updating resistance management guidance. In 2020, there were large regional differences in the percentage of grain aphids with the mutation, ranging from 2% in Devon (Starcross) to 71% in Yorkshire (York).

IPM research often requires growers' sites for trials, with opportunities highlighted on IPM Hub: ahdb.org.uk/ipm

Cabbage stem flea beetle larvae damage

Figure 4. Testing aphid landing preferences

Nutrition

As part of AHDB's commitment to the Nutrient management guide (RB209), we invest in research so its recommendations keep pace with modern production systems. Georgina Key, Environment Scientist, reviews the latest developments.

Nitrogen in milling wheat

A current research project is investigating nutrient management in milling wheat (21140040). In conjunction with this work, a project (21140041) is testing ways to accurately predict grain protein content during late stem extension (GS37–39). Such information could be used to decide whether to continue with a milling wheat strategy or to adopt a lower-cost feed-wheat strategy instead.

Two field experiments (Agrii and SRUC sites) were set up by Hill Court Farm Research. Three varieties – Zyatt, Siskin and Skyfall – were grown at eight different nitrogen rates. For the protein prediction test, whole plants (including the root ball) were sampled at GS32 (early May), GS37 (late May) and GS70 (early July) and the nitrogen status of the crop measured.

At GS70, the test correctly predicted that 96% of the plots at Agrii and 75% of the plots at SRUC would remain below 12.5% grain protein. However, the test cannot account for events that happen after sampling – for example, mineralisation of soil nitrogen or adverse weather conditions. In 2020, the growing conditions were difficult. The actual protein measured at harvest was not always closely related to nitrogen applications. However, when nitrogen was not the limiting factor, the test did establish that adding more nitrogen would not significantly increase protein levels.

Digging into HS2 data

During the construction of the High Speed 2 (HS2) rail link, over 800 soil samples were taken (2016–19) along the whole length of the proposed line (London to Birmingham, Birmingham to Crewe, and Birmingham to Leeds). These samples fall into five main areas:

1. Southern: London clay, chalk, clay-with-flints (200 samples).
2. Clay Vales: including gault, Oxford clays, Liassic clays and limestone (150 samples).
3. Midlands: pebbly drift, Triassic (red), sandstones, siltstones and clays (150 samples).
4. Nottingham to Leeds: carboniferous clays, siltstones and sandstones (150 samples).
5. Staffordshire and Cheshire: glacial till, Triassic clays and sandstones (120 samples).

The topsoil, the subsoil and the relationship between them was investigated (Research Review 95). The key findings are presented, below.

Overall, arable phosphorus and potassium levels were found to be more deficient than in routine Professional Agricultural Analysis Group (PAAG) surveys. This is, in part, because the samples were deeper in the HS2 surveys (22–35 cm instead of 15 cm).

Soil texture has a major influence on nutrient levels; phosphorus decreases from light-to-heavy texture, with the contrary trend for potassium and magnesium. In many cases, upper subsoil phosphorus was about half the amount of topsoil phosphorus. However, when above 35 mg/L, the subsoil phosphorus can rise rapidly on lighter soils. Clay soils have proportionately less phosphorus in subsoil, but the levels can vary.

In sandy, light loamy or stony subsoils, subsoil potassium is lower than topsoil potassium, compared to medium or clay subsoils. Subsoil potassium is not totally predictable from texture and topsoil potassium, though usually it is >90 mg/L when topsoil is >150 mg/L. Clay subsoils were rarely lower than 90 mg potassium/L, except carboniferous clays, which have poor potassium status.

Magnesium is higher on clay soils and ultra-high magnesium (Index 6 and 7) was found in some Midlands and carboniferous formations – on these, a low potassium:magnesium ratio was common. Low magnesium occurred mainly in the Southern region and on lighter or stony soils, where the subsoil magnesium was lower than topsoil, which is opposite to what is found in medium and heavy subsoils.

Organic matter (OM) shows a limited increase with clay content: from 3% on light, to 4.5% on heavier soils. There is a need to standardise depth protocols for measuring OM in topsoil and in subsoil. Lastly, the work found that subsoil pH usually exceeded topsoil pH on arable land.

Nitrogen in spring barley

Although traditionally grown on light land, spring barley production has expanded onto soils with a heavier texture. With modern spring barley varieties also likely to affect the optimum nutrient strategy, AHDB research commenced in 2018 (21140038) to help refine RB209 guidelines. The trials tested modern, high-yielding spring barley varieties – Concerto, Laureate, Planet and KSW Irina.

Adjusting nitrogen for yield

RB209 recommendations are based on a ‘typical’ yield benchmark of 5.5 t/ha (spring feed barley). However, the crop is capable of yielding higher. For example, the five-year (2016–20) yield average in Recommended List trials is 7.5 t/ha. Following RB209 nitrogen recommendations, selected experiments hit 7.4 t/ha which suggests that modern varieties can use nitrogen more efficiently.

At present, RB209 suggests that the recommended nitrogen rate is increased by 20 kg for each additional expected tonne (up to 9 t/ha) above the 5.5 t/ha benchmark. The average recommended nitrogen rate was 165 kg nitrogen/ha (across all experiments). However, the measured economic optimum nitrogen rate was 118 kg nitrogen/ha. This means that current recommendations may overestimate fertiliser nitrogen requirements. The researchers suggested two methods to improve RB209 recommendations:

- Increase the yield adjustment
- Calculate fertiliser nitrogen requirement based on crop nitrogen demand and fertiliser recovery

Readjusting nitrogen for grain quality

Across all experiments, reducing the nitrogen rate by 29 kg nitrogen/ha reduced grain nitrogen percentage by 0.1%, which is similar to the current RB209 recommendation (reduce by 30 kg nitrogen/ha). At the nitrogen optimum, the average grain nitrogen percentage was 1.7%. Historic field grain nitrogen percentage and yield data can help guide how much to reduce fertiliser rates by on each farm.

Nitrogen timing

Results from 11 nitrogen-timing experiments largely confirmed RB209’s recommendations, with all nitrogen applied between drilling and early stem extension (with a large timing flexibility in this window). The work also concluded that application of at least 40 kg nitrogen/ha in the seedbed is often beneficial – but should be capped at 40 kg nitrogen/ha, where nitrate-leaching risks are high (e.g. sown before March, grown on a light-sand soil or where high rainfall occurs soon after drilling).

The research also found that current RB209 recommendations for sulphur rates were sufficiently accurate.

Results to nourish spring barley crops

Learn more about this project in the most recent edition of **Arable Focus – Autumn/Winter 2021: ahdb.org.uk/arable-focus**

Updating RB209

AHDB nutrient management research generates recommendations for updating RB209. Such information is reviewed by independent consultants and the UK Partnership for Crop Nutrition – the body responsible for making revisions to RB209. If the evidence for change is robust, RB209 is updated accordingly.

Strategic Cereal Farm: cover crops to catch nutrients

The maxi-cover crop project (PR620) showed that many cover crops take up 30–50 kg nitrogen/ha, with some species even reaching 90 kg nitrogen/ha. AHDB's Strategic Cereal Farm East is investigating the role of cover crops in taking up nitrogen ahead of spring crops in the rotation.

The trials, in four fields (sandy loam and silty clay loam soils) between 2018–21, compared the use of cover crops in a plough and one-pass system with a ploughed-stubble (no cover/bare soil) control. In the first year, a mixture of oil radish, rye and buckwheat was used, with phacelia and sunflowers added to the mix in 2019.

Nitrate numbers

Since 2017, Essex and Suffolk Water has analysed field-drain water samples at the farm. In the first trial year, the ploughed cover crop treatment resulted in the lowest amount of nitrate in the drainage water. In February 2019, the nitrate concentrations were below the threshold for drinking water (50 mg/L) in the ploughed (6 mg/L) and one-pass system (41 mg/L).

In the second year, a combination of reduced soil movement with the one-pass system and cover cropping kept nitrate levels low. However, the nitrate measured in the ploughed cover crop exceeded 50 mg/L in November/December 2019, before returning to below 50 mg/L by January 2020.

Nitrate levels were always lower in the ploughed cover crop compared to ploughed stubble with no cover. The bare soil resulted in nitrate concentrations exceeding the drinking water standard. The highest concentrations were recorded under the plough (280 mg/L) followed by the one-pass system (110 mg/L).

Cover credentials

Across the trials and establishment systems, cover crops produced between 1 t/ha and 1.6 t/ha of dry matter and took up between 25 kg nitrogen/ha and 45 kg nitrogen/ha. Crop establishment was poorer in the plough system compared to the one-pass system, but differences disappeared by spring.

Spring crop yields, following cover crops, were variable. The 2019 spring crop yielded 0.3 t/ha more after cover crops in the plough system. However, 2020 spring barley yields were 2 t/ha lower after cover crops in the plough treatment.

In the one-pass system, the spring crop yield was 0.9 t/ha and 1.7 t/ha lower after a cover crop in the trials. Following this, the under-sown herbage grass' biomass was also low (0.44 t/ha). The autumn above-ground biomass nitrogen content was lower and soil mineral nitrogen was higher. In turn, this resulted in higher concentrations of nitrate in the drainage water.


Phacelia in cover crop mix

Weighing up water with wheat

Although cover crops help reduce nitrate concentrations in water, the cost on crop yields needs addressing – which we are doing, with South East Water and FWAG South East, at Strategic Cereal Farm South.

Taking place across two fields, the trial will measure the impact of species mixtures in a direct-drill system. Cover crops, soil, water and biodiversity will be monitored, with plant health measured. The use of satellite data and in-field measurements will be used to explore the interactions between the soil and the drivers of yield variability after cover crops.

Follow the Strategic Cereal Farm story at:
ahdb.org.uk/strategic-cereal-farms

Unlike over-winter cover crops, living mulches provide more permanent soil cover. AHDB is supporting a group of organic and conventional growers to trial this approach in low-input and no-till systems. Find out more:
ahdb.org.uk/innovative-farmers-field-labs

Quality

In addition to crop genetics, environmental factors influence the quality and safety of cereals. Dhan Bhandari, Cereal Product Quality Senior Scientist, provides an overview of AHDB research on this complex topic.

Flour quality

A major determinant of wheat processing quality is the quantity and properties of grain gluten proteins. A PhD project (21130058) is using replicated field trials, over three years in three different environments, to study such proteins in wheat populations with Malacca (average grain protein content) and Hereward (high grain protein content, high stability) in their parentage.

Tests for grain quality include analysing grain protein composition and measuring metabolites, such as sucrose, maltose and raffinose, which also impact baking quality. The studentship has already identified indicators associated with protein content.

Required for the synthesis of proteins, such as gluten, nitrogen is another key grain-quality component. Because of the high protein content needed for making bread (13%), the requirement for nitrogen applied to wheat may be above the optimum for yield – by up to 50 kg nitrogen/ha. Through an improved understanding of the genetic components of grain quality, it is hoped that this studentship will help plant breeders develop varieties with increased quality stability.

Fusarium resistance in oats

As a result of *Fusarium langsethiae* infection, mycotoxins HT2 and T2 have been identified at high levels in UK winter oat grains, even though the plants display no visible symptoms. Differences in the susceptibility of oats to infection are genetic, rather than cultural. In general, spring oat varieties accumulate less HT2 and T2 than winter varieties, and dwarf varieties tend to accumulate more than taller ones.

A PhD project (21130012), based at Harper Adams University, is analysing the genetics of experimental lines derived from Buffalo (short and susceptible) and Tardis (tall and resistant) parentage. Preliminary results suggest a negative relationship between mycotoxin concentration and height. However, when other factors, such as year and drilling season, are included in the model, height alone no longer influences the HT2 and T2 accumulation. These findings demonstrate further work is required to dissect earliness and height from one another. The project is also developing a robust inoculation method to infect oats with the pathogen.

Monitoring contaminants

AHDB is highly valued for its independent work on monitoring agri-chemical residues and contaminants. Conducted since the mid-1980s in the UK, the results provide customer confidence, quantitative reference points for industry data (obtained with rapid-screening tests) and help the supply chain prepare for new legislation.

In the latest phase of the project (21130040), Fera conducts annual surveys of mycotoxins (e.g. DON, ZON, T2/HT2, OTA and ergot alkaloids) and other contaminants (e.g. pesticides, heavy metals, CIPC and PAHs). Data is collected from representative commercial samples of UK-grown and imported wheat, barley and oats and co-products (wheatfeed and oatfeed).

Based on harvest 2020 results, no samples exceeded the maximum levels for mycotoxins. In many cases, results were lower than the five-year rolling average. Over 400 pesticides and seven metals (including four regulated metals) were analysed, with no maximum residue level (MRL) exceedances detected.

Controlling male fertility in wheat

Crossing two varieties increases yield of the resultant offspring (hybrid vigour). However, the process is challenging, due to the need to ensure effective pollination and avoid self-fertilisation.

A BBSRC LINK project (21130024), led by the University of Nottingham, is developing systems to control and improve fertility in cereal crops. To date, the study has identified key genes in barley and wheat that are critical for pollen development. Of particular interest are observations of how barley male sterility genes affect the crop:

- Thicker anther walls
- Slower degradation of tapetum layer (provides nutrition for pollen)
- Irregular Ubisch bodies (help development of pollen)
- Impeded anther opening and subsequent pollen release
- Pollen-release genes appear to be down-regulated

In addition to providing a better understanding of fertility traits, the project is characterising them in various genetic pools to confirm their consistency. CRISPR gene editing is also being used on a representative gene (HvTF1) to see if the technique can produce plants similar to those modified via conventional methods.

AHDB-funded research

Topic	Project number	Title	Lead contractor	End date	Funding
Soils	21140029	Predicting crop disease from molecular assessment of the distribution and quantification of soilborne pathogens (PhD)	Fera, University of Newcastle	Winter 2021	£25,000
Soils	91140002	Soil Biology and Soil Health Partnership	National Institute of Agricultural Botany (NIAB)	Winter 2021	£858,869 (BBRO co-funding £140,934)
Soils	21140024	Fostering populations of arbuscular mycorrhizal fungi (AMF) through cover crop choices and soil management (PhD)	University of Cambridge	Autumn 2021	£45,250
Soils	91140001	AHDB Rotations Research Partnership	NIAB CUF (Cambridge University Farm)	Spring 2021 (completed)	£1,203,152
Nutrition	21140039	Nitrogen and sulphur fertiliser management for yield and quality in winter and spring oats	ADAS	Summer 2022	£120,000 (total project cost £616,560)
Nutrition	21140040	Nitrogen and sulphur fertiliser management to achieve grain protein quality targets of high-yielding winter milling wheat	NIAB	Spring 2022	£179,548 (total project cost £230,999)
Nutrition	21140041	Early prediction of grain protein content to guide nitrogen management in winter milling wheat	Hill Court Farm Research	Winter 2021	£8,885
Nutrition	21140038 (PR635)	Updating nitrogen and sulphur fertiliser recommendations for spring barley	ADAS	Spring 2021 (completed)	£139,980
Nutrition	21140072 (RR95)	Analysis of top and subsoil data from the High Speed 2 (HS2) rail project	Reading Agricultural Consultants	Autumn 2021 (completed)	£2,700
Quality	21130058	Exploiting variation in grain protein to determine environmental effects on processing quality (PhD)	Rothamsted Research	Spring 2023	£77,300
Quality	21130040	Monitoring of contaminants in UK cereals used for processing food and animal feed	Fera	Summer 2022	£813,368
Quality	21130024	Developing systems to control male fertility in wheat for hybrid breeding, enhanced pollen production and increased yield	University of Nottingham	Spring 2022	£155,992
Quality	21130012	Identification of fusarium resistance within UK oat breeding lines (PhD)	Harper Adams University	Autumn 2021	£20,000
Weeds	21120187	Wheat germplasm for enhanced competition against black-grass (PhD)	University of Leeds	Autumn 2024	£74,100
Weeds	21120059	Investigating the distribution and presence, and potential for herbicide resistance of UK brome species in arable farming	ADAS	Spring 2021 (Completed)	£218,000
Diseases	21120062	Developing guidance for fungicide resistance management: a case study for SDHIs and generalisations for future mode of actions (PhD)	Rothamsted Research	Autumn 2024 (Extended)	£63,959
Diseases	21120034	United Kingdom Cereal Pathogen Virulence Survey (UKCPVS)	NIAB, John Innes Centre	Spring 2023 (Extended)	£599,965
Diseases	21120068	Yellowhammer: a multi-locus strategy for durable rust resistance in wheat, in the face of a rapidly changing pathogen landscape	NIAB	Autumn 2022	£98,002

Topic	Project number	Title	Lead contractor	End date	Funding
Diseases	31120140	Integrated forecasting for diseases affecting multiple hosts exemplified by vegetable brassicas and oilseed rape (PhD)	Newcastle University	Autumn 2022	£71,400 (jointly funded with AHDB Horticulture)
Diseases	21120013	Fungicide performance in wheat, barley and oilseed rape	ADAS, SAC Commercial, NIAB, Harper Adams	Spring 2022	£732,234
Diseases	21120018a	Monitoring resistance to foliar fungicides in cereal pathogens	NIAB	Spring 2022	£90,000
Diseases	21120058a	Managing resistance evolving concurrently against two or more modes of action to extend the effective life of new fungicides	ADAS, NIAB, SAC Commerical, Rothamsted Research	Autumn 2021 (Completed)	£196,500
Diseases	21130048 (SR53)	Barley resistance to rhynchosporium: new sources and closely linked markers (PhD)	James Hutton Institute	Summer 2021 (Completed)	£70,500
Diseases	21120007 (PR634)	Combining agronomy, variety and chemistry to maintain control of septoria tritici in wheat	ADAS, SAC commercial, NIAB	Spring 2021 (Completed)	£155,404
Diseases	21510016 (PR632)	Provision of oilseed rape decision support systems to the UK arable industry (phoma and light leaf spot forecasts)	Rothamsted Research	Spring 2021 (Completed)	£12,817
Pests	21120219	Varietal resistance to feeding (herbivory) by the cabbage stem flea beetle (CSFB) in oilseed rape	John Innes Centre	Spring 2024	£60,000 (total project cost £1,886,025)
Pests	21120186	Improving integrated pest management (IPM) of aphid BYDV vectors (PhD)	Harper Adams University	Winter 2023	£74,100
Pests	21120185	Reducing the impact of cabbage stem flea beetle on oilseed rape in the UK	ADAS, Harper Adams University	Summer 2023	£240,000
Pests	21120163 (91120163)	Testing insecticide resistance management strategies	ADAS	Summer 2023	£138,876 (jointly funded with AHDB Horticulture and Potatoes)
Pests	21120188	Novel approaches to CSFB control (PhD)	Harper Adams University, Certis UK, AFCP	Summer 2023	£36,150
Pests	21120077a	Management of aphid and BYDV risk in winter cereals	ADAS, Rothamsted Research	Winter 2022	£190,000
Pests	21510015	Monitoring and managing insecticide resistance in UK pests	Rothamsted Research	Spring 2022	£42,000 (jointly funded with AHDB Horticulture and Potatoes)
Pests	21120064	Genetic basis of winter oilseed rape resistance to the cabbage stem flea beetle (PhD)	John Innes Centre	Spring 2022	£70,500
Pests	21510022	Autumn survey of wheat bulb fly incidence	ADAS	Autumn 2021	£32,000
Pests	21120078 (PR633)	Development of an environmentally sustainable and commercially viable approach to the control of the grey field slug	Harper Adams	Spring 2021 (completed)	£120,000 (funded with AHDB Potatoes)
Pests	11120055/ 21120080	Pyrethroid sensitivity in UK cereal aphids (2019–20)	Rothamsted Research, ADAS	Spring 2021 (completed)	£15,000 (jointly funded with AHDB Potatoes)

Topic	Project number	Title	Lead contractor	End date	Funding
Varieties	21130028	AHDB Recommended Lists for cereals and oilseeds (2021–26)	AHDB, BSPB, MAGB, UK Flour Millers	Autumn 2026	£8,75,000
Varieties	21130071	A model for wheat cultivars and optimisation for climate scenarios – Sim Farm 2030 (PhD)	University of Sussex	Spring 2024	£74,100 (total project cost £84,1000)
Strategic Farm		Harvest 2022 trials at Strategic Cereal Farms (East, Scotland and South)	NIAB, SRUC	Autumn 2022	£150,000
Strategic Farm East		Calculating marginal land value	NIAB	Autumn 2021	£9,464
Strategic Farm East		Reducing nitrate leaching with cover crops	NIAB	Autumn 2021	£15,714
Strategic Farm East		Flower strips for pests and beneficials	NIAB	Autumn 2021	£15,500
Strategic Farm East		Managed lower inputs	NIAB	Autumn 2021	£8,929
Strategic Farm West		Managed lower fungicide inputs	ADAS	Autumn 2021	£12,015
Strategic Farm West		Autumn black-grass control	ADAS	Autumn 2021	£9,062
Strategic Farm West		Cultivation to improve soil health and crop roots	ADAS	Autumn 2021	£15,491
Strategic Farm West		Benefits of flower strips	ADAS	Autumn 2021	£12,372
Strategic Farm Scotland		Crop heath, soil health, pests and beneficials baselining	SRUC	Autumn 2021	£38,138
Strategic Farm Scotland		Responsive crop nutrition	SRUC	Autumn 2021	£11,500
Knowledge Exchange		Cereal and oilseed yield enhancement network	ADAS	Annual	£17,700
Knowledge Exchange		Oilseed rape establishment contest	ADAS	Autumn 2022	£5,200
Knowledge Exchange		Innovative Farmers: flower power for pest control	Innovative Farmers	Autumn 2022	£18,600 (cash); £3,775 (in-kind)
Knowledge Exchange		Wheat fungicide margin challenge (ADAS/AHDB)	ADAS	Winter 2021	£38,700
Knowledge Exchange		Innovative Farmers: no-till with living mulches	Innovative Farmers	Autumn 2021	£18,600 (cash); £3,775 (in-kind)
Knowledge Exchange		Innovative Farmers: sheep grazing on cover crops	Innovative Farmers	Autumn 2021	£18,600 (cash); £3,775 (in-kind)
Knowledge Exchange		Smart Arable	ADAS, SRUC	Autumn 2021	£15,000

Produced for you by:

AHDB
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

T 024 7669 2051
E comms@ahdb.org.uk
W ahdb.org.uk

If you no longer wish to receive this information, please email us on **comms@ahdb.org.uk**

AHDB is a statutory levy board, funded by farmers, growers and others in the supply chain. Our purpose is to inspire our farmers, growers and industry to succeed in a rapidly changing world. We equip the industry with easy to use, practical know-how which they can apply straight away to make better decisions and improve their performance. Established in 2008 and classified as a Non-Departmental Public Body, it supports the following industries: meat and livestock (cattle, sheep and pigs) in England; horticulture, milk and potatoes in Great Britain; and cereals and oilseeds in the UK. AHDB's remit covers 72 per cent of total UK agricultural output. Further information on AHDB can be found at **ahdb.org.uk**

20021 1022