

Out of sight, out of mind

“Soil-borne disease needs a more integrated approach.”

AHDB
AGRICULTURE & HORTICULTURE
DEVELOPMENT BOARD

*from theory
to field*

The importance of soil-borne pathogens may be underestimated in OSR crops. CPM finds out the very latest research findings and how these may eventually help growers achieve better yields.

By Lucy de la Pasture

Foliar disease often steals the limelight but soil-borne diseases in oilseed rape are equally important and are often overlooked, believes Dr Amanda Bennett, AHDB resource management scientist.

OSR is the most popular break crop grown in cereal rotations which gives it the rank of being the third most widely grown crop in the UK. Although large improvements have been made in breeding and agronomic practices, yields have remained static in recent years.

One of the main reasons for the

discrepancy between potential and actual yield is thought to be a build-up of pathogens as a consequence of the increased growing intensity within the rotation. Much less is known about the range of soil-borne pathogens that may be responsible for yield decline than their foliar counterparts, she points out.

Slightly different

“We need to think about soil-borne pathogens in a slightly different way to foliar pathogens. Symptoms of attack are hidden under ground, the pathogens can be difficult to detect and control options aren’t as well established as for foliar diseases.

“Soil-borne disease needs a more integrated approach. As the awareness of soil health grows and the understanding of soil biology gets better, it becomes obvious that management practices are likely to influence soil-borne pathogens just as much as the beneficial microbes that are desirable in soils,” she reasons.

One soil-borne pathogen, clubroot, has historically been more of a problem in northern England but has been nobbling OSR crops in areas throughout the UK in

recent seasons. The onward march of clubroot has been a potential ‘car crash’ that scientists have seen coming for a long time, says Professor Fiona Burnett, SRUC plant pathologist.

“Clubroot is a massively significant disease, with previous AHDB work showing that 50% of land in the North is infected. It’s a very resilient disease, having the ability to persist in soil for 15-20 years, and results in large crop losses.

“Because current weather patterns are giving us warm autumns, conducive to continued clubroot infection, problems are now often showing up much earlier in the season,” she explains.

Soil treatments with lime, calcium or boron give partial control, but strategies such as raising field pH to over 7.5 aren’t practical over whole fields in the context of arable rotations, as other crops within the rotation might be severely compromised, she points out.

“Targeted treatment of affected patches offers a potential approach and will be more cost effective than treating whole fields.”

The easy solution to managing clubroot has been utilising resistant OSR varieties

but there have been incidences where reliance on resistance has been over-used, says Fiona Burnett.

“Clubroot-resistant varieties, such as Mentor, Mendelson and Cracker, all have the same resistance mechanism (the Mendel gene), which is also found in swedes. The clubroot pathogen has multiple strains and only some of them are controlled by this resistance mechanism, so when planting a resistant variety, selection occurs for the strains which aren’t controlled (resistance-breaking strains),” she explains.

As part of her research, Fiona Burnett is attempting to understand the prevalence of these resistance-breaking strains by typing populations in the UK and comparing the results with populations in other countries.

“Screening for Mendel-breaking strains will give growers prior warning where a resistant cultivar won’t supply them with a ‘get-out-of-jail-free card’ where clubroot is concerned.”

Yield mapping

By mapping fields for clubroot, it should be possible to attribute yield loss figures to clubroot patches by linking the clubroot areas to yield mapping. This should help growers with their decision-making and delivering more targeted solutions to the problem, she believes.

“More sustainable solutions could include not drilling patches infected with clubroot, use of resistant varieties and targeted liming. We’ve found that infected patches don’t spread much, they’re often around gateways and stretched along the lines of cultivation. It follows that precision farming techniques open up new avenues for clubroot management and we’re working with

As part of her research, Fiona Burnett is attempting to understand the prevalence of resistance-breaking strains by typing clubroot populations in the UK.

Soil Essentials to evaluate the possibilities,” she explains.

As part of the quest to improve understanding of soil-borne pathogens in OSR, Alex McCormack has been carrying out a survey for the potential causes of yield decline as part of his AHDB-sponsored PhD research at Harper Adams University.

“The effects of soil-borne diseases such as sclerotinia, clubroot and verticillium wilt are reasonably well understood. My research is concentrating on the lesser ▶



Alex McCormack’s research indicates that different isolates of AG2-1 may have different pathogenicity in the field.

Advert removed



Rumiana Ray has screened several commercial OSR varieties and identified differential responses to *R. solani* in controlled environment and in-field studies.

► known pathogens to evaluate their importance and to study their epidemiology," he explains.

With detection all-important, the survey hit a stumbling block before it even started when it became apparent that PCR-assays weren't available for these more minor or lesser-known pathogens. He overcame the problem by using cutting-edge technology, next generation sequencing.

"I found *Rhizoctonia solani* was common, being present in 60% of samples. Its presence was completely unrelated to any agronomic or geographical factors," he adds.

Using real-time PCR to quantify the pathogen, he went on to discover that a small amount of the pathogen was capable of causing disease and having

Clubroot test available

AHDB Horticulture and AHDB Cereals & Oilseeds has funded work to develop a qPCR test to quantify clubroot resting spores in soils. The test has been trialled with a wide range of UK soil types with no reduction in efficacy. The test shows 92% accuracy in predicting the risk of clubroot development compared to grower observations at harvest.

The test is available from Eurofins and PGRO laboratories.

a potential effect on yield.

"I looked at the different *R. solani* anastomosis groups (AGs). AG2-1 was the most prevalent in OSR (60% of sites) with other AGs at lower levels. In vitro work shows there is also some variation in the pathogenicity within AGs, which indicates that different isolates of AG2-1 may have different pathogenicity in the field," he explains.

Poor establishment

So what effect does the rhizoctonia pathogen have on OSR? Alex McCormack has discovered its main influence is damping-off, both pre and post-emergence, so the pathogen likely plays a role in poor establishment that's often attributed to other causes.

Better management of *R. solani* in OSR is the ambition of a further three-year



Amanda Bennetts explains that soil-borne pathogens can be difficult to detect and control options aren't as well as established as for foliar diseases.

research project (ICAROS) being led by Dr Rumiana Ray, associate professor in crop pathology at the University of Nottingham, and is partly funded under the Government's Agri-tech policy.

"It seems that OSR selects for *R. solani* AG2-1, a pathogen that's very aggressive to seedlings causing damping off. Control of rhizoctonia diseases in OSR is currently only possible through the exclusive use of fungicides, which increases input costs and is an unsustainable crop management practice in the long term," she explains.

"Furthermore, there are currently no seed treatments registered in the UK for use against *R. solani* in OSR, highlighting

Integrated approach may improve yields

Syngenta's involvement in the ICAROS project came as the result of an earlier PhD carried out at University of Nottingham and funded by the company, explains Syngenta's Michael Tait.

"The PhD found that AG2-1 was associated with close rotations of cereals and OSR, and as a result is commonplace in UK fields. This particular anastomosis group of *Rhizoctonia solani* is very pathogenic and aggressive to OSR.

"That raises the question whether the damage being caused by the pathogen is being underestimated. Is the effect it has on establishment more of a problem than growers and agronomists are noticing," he asks.

The possibility that a previously overlooked pathogen may be in part responsible for previously unknown yield effects in OSR is something that caught Syngenta's attention.

"By looking at the genetics of OSR to establish whether there's any tolerance to the pathogen, and combining these traits with effective seed treatments, it may be possible to develop an integrated strategy that can ultimately increase OSR yields," says Michael Tait, who's involved in bringing Syngenta's new seed treatment chemistry to the marketplace.

"It's very early days, but the project has already identified variability in the OSR gene pool. It's too soon to tell if this will be useful to breeders but some varieties do seem to have a greater degree of tolerance than others," he explains.

Within the Syngenta portfolio is a recently registered seed treatment for use in many cereal crops, Vibrance Duo, which contains the SDHI sedaxane and old stalwart, fludioxonil. Although not approved for use in OSR, sedaxane



Sedaxane seed treatment has proven to give effective control of damping-off caused by *R. solani* in the ICAROS project.

treatment has proved to give effective control of damping-off caused by *R. solani* in the project.

"We have other products containing sedaxane in the development process, so chemistry is already in the pipeline for future use on the OSR crop," he adds.

the lack of information on yield loss and contribution of the disease to current establishment losses — estimated at £30M in the worst years.”

The ultimate economic impact of the project will be to mitigate loss in establishment or yield due to the disease through improved control strategies, she continues.

“The identification of novel resistance or tolerance traits and genes in OSR against *R. solani*, AG2-1, will provide an essential alternative to fungicide inputs and will allow integration with more targeted crop protection approaches, such as low dose seed treatment. These are both factors this project is investigating.

Search for traits

“We have screened Brassica genetic diversity sets of more than 400 lines and we’re proceeding with genome-wide association studies in the search for traits. We have also screened several commercial varieties and we can identify differential responses to *R. solani* in controlled environment and in-field studies,” she says.

“We have also quantified an approx. 40% increase in establishment after treatment with sedaxane, the SDHI seed treatment from Syngenta, in the absence of an insecticide. Increase in vigour was also observed and those responses were varietal-specific.”

Even though it’s still very early days in the project, some important findings have been made, believes Rumiana Ray.

“We’ve identified differences in varietal responses to *R. solani* in field-grown commercial varieties, and our analysis also suggests that there may be genetic differences, so we may still discover resistance/tolerance genes against the pathogen.

“The fact that a seed treatment



In studies, *R. Solani* AG2-1 was the most prevalent in OSR crops, with more than 60% of soils infected.



R. solani AG2-1 is a pathogen that’s very aggressive to seedlings, causing damping off and poor establishment, as seen in the ICAROS project trials. Photo courtesy of John Alcock.

containing sedaxane is very effective against *R. solani* (AG2-1), means in the absence of commercially available resistance, losses due to the pathogen can potentially be mitigated by the use of a seed treatment,” she explains.

There may be other ways to compensate for *R. solani* reductions in plant establishment, she adds, and adjusting seed rates is one of the management strategies being tested within the project.

Many gaps still remain as this disease hasn’t yet been well researched, she highlights. “We need to understand better the interaction with soil properties and the host in order to design good control strategies for the disease. Exactly how the pathogen interacts with the host within

soils with different characteristics, and how the activity of seed treatment is affected by the soil environment, is something else we’re working hard on.”

Summing up the importance of the three projects currently underway, Amanda Bennett believes they’ll ultimately help give growers a better understanding of how soil-borne pathogens can affect OSR production and provide tools to manage soil-borne diseases. better

“The ultimate output of the ICAROS project will be the first integrated guidelines for the control of *R. solani*, incorporating targeted seed treatments and varietal resistance for improved disease management and protection of OSR yield,” she comments. ■

Research round-up

AHDB Project No. 20123790 – ‘Soil-borne pathogens of oilseed rape: assessing their distribution and potential contribution to yield decline (PhD)’, ran from Oct 2014 to Sept 2016. The PhD was researched at Harper Adams University with industry partners, The Morley Agricultural Foundation and The Felix Thornley Cobbold Agricultural Trust, costing AHDB £18,750.

AHDB Project No. 21140006 – ‘Developing sustainable management methods for clubroot through pathotyping and field mapping,’ runs from Aug 2015 to Jan 2019, costing AHDB £176,832. The project aims to develop cost-effective treatment of clubroot through an understanding of the prevalence of resistance breaking strains of *P. brassicae* present in the UK, and by targeting the use of resistant

varieties and soil treatments to regions and field patches where they are needed and likely to be effective.

AHDB Project No. 21140008 – ‘Integrating Control strategies against soil-borne *Rhizoctonia solani* in oilseed rape (ICAROS)’, runs from July 2016 to July 2019. ICAROS is a joint-funded by BBSRC, AHDB, Syngenta and Innovate UK at a cost to AHDB of £80,000 (total funding £619,000). The project aims to discover novel traits for resistance to *R. solani* in OSR; increase the knowledge of disease epidemiology and yield loss; improve exploitation of targeted crop protection through the use of low dose seed treatment against soil-borne pathogens for crop establishment and understand trait/treatment interactions in relation to root health and yield of OSR.