

# A complex picture

## Technical Forward-thinking farmers

*Zymoseptoria tritici* has always been a challenging pathogen to control, partly because of its latent phase but also because of its shape-shifting ability to evade fungicide modes of action. *CPM* explores how molecular chemistry is both clarifying and adding complexity to understanding the septoria pathogen's resistance evolution and its development in the field.

By Lucy de la Pasture

It's reassuring to know when you fly on a Rolls Royce powered plane, the engine performance data is continuously being 'snapshotted' back to technical experts on the ground. Not only has it allowed the engine manufacture to improve reliability but also develop a 'preventative' health programme, where potential mechanical defects are identified before they become a serious concern.

“It's worth noting how quickly septoria took off after favourable weather late in the season.”

highlights Rosalind. “It reinforced how environmental and cultural factors influence disease pressure, particularly shifting weather patterns.”

An early indication of what lay ahead occurred in Scotland, where Bayer's Grant Reid partnered with two neighbouring farms in Perthshire. “In early March at Middlebank Farm in Errol, LG Skyscraper (5.1) wasn't particularly troubled with septoria, despite its 8 September drilling date — the cold putting pay to that. But a few miles up the road at Keillor Farm, septoria DNA levels rose rapidly in the emerging leaves of LG Sundance (7.9), reaching a notable 21,857 ng/ul by the middle of the month,” he explains.

Grant put it down to prolonged snow cover in the field at higher altitude and he expected that varietal resilience would eventually ‘kick in’ as plants matured. It did, and by the middle of June Sundance was carrying significantly less infection than Skyscraper, with leaf four at 3.483 ng/ul and leaf three negligible. But to see septoria levels rise quickly in a resilient variety early on did surprise him.

When wetter, warmer, arrived in late May then the season really turned. Those areas that received the worst of the weather saw higher infection levels, with the recorded ng/ul rocketing at some sites, says Rosalind.

At Middlebank Farm the Skyscraper succumbed, with leaf three returning a score of 32.105 ug/ul. Other factors probably played a part, she says, but the weather was certainly one.

“Mid-June testing at R H Mason's farm in East Riding saw an October-drilled crop of KWS Kerrin set the seasonal high with a leaf

The same intensive screening isn't quite there yet with cereal disease diagnostic technology, but it's moving in that direction, says Bayer's Rosalind Martin. After a successful pilot in 2020, Bayer extended its Rapid Disease Detection initiative under the banner of ‘National Snapshot’.

“It's an extension of Bayer research evaluating various technologies to improve disease diagnosis and refine fungicide use and compliance which started in 2014,” she says.

### National snapshot

Fifteen farmers teamed up with their respective Bayer technical manager in 2021 to track septoria and yellow rust progression in commercial wheat fields across the UK and Ireland to gain the national snapshot.

“The growers selected two varieties with contrasting disease ratings and qPCR testing measured the pathogen's DNA in ng/ul in the emerging leaves and the upper canopy for the first six months of the year.”

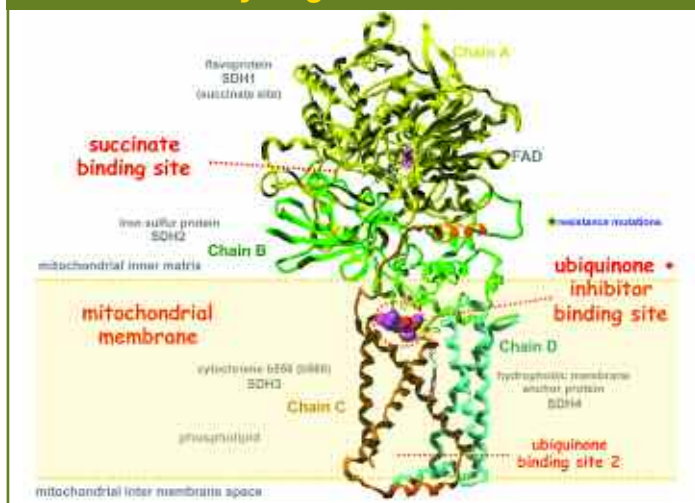
By recent standards the spring weather was cool, with April and May below the 1981-2010 long-term average. With plentiful reports of septoria and yellow rust early on, disease soon dried out — posing the question, what value would the initiative offer?

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## Succinate dehydrogenase structure



*Succinate dehydrogenase inhibitor (SDHI) fungicides specifically inhibit fungal respiration by blocking the ubiquinone-binding sites in the mitochondrial complex II (shown as the yellow shaded area).*

Source: Bayer, 2017

four recording of 48.287 ug/ul,” highlights Rosalind.

“The Borders region of Scotland also saw of plenty of wet weather, but it stayed noticeably cool. As a result, September drilled Elation fared much better, with leaf four recording 2.055 ng/ul, and leaves three and two below 1.0 ng/ul.”

The 2021 data also revealed how an early drilled crop can be more vulnerable to septoria with

favourable weather conditions later in the season.

At J P Clay’s farm at Fawley in Herefordshire, leaf three in KWS Extase (8.0) carried 30.710 ng/ul by mid-June. On the other side of the country, SY Insector (6.8) at Ovington Hall on the Suffolk/Essex border, saw a high ng/ul in leaves four and three.

Bayer’s East Anglian CTM, Ella Crawford, believes September drilling was a key part — the crop being ‘thick and forward’

from the start.

Compare that with Penryn in Cornwall, where Jason Chapman of Pencose Farm held off drilling KWS Extase until late October. Despite favourable weather, the ng/ul levels recorded were considerably lower — with leaf four, 6.507 ng/ul and leaf three just 1.248.

## Low septoria

At Malshanger Estate in Hampshire, the septoria levels in Extase were even lower than those at Penryn. But the ng/ul levels weren’t high in Skyfall either, despite both fields being drilled in September. Estate manager Ian Margettes and Bayer’s Richard Prankard feel they missed the worst of the late spring weather, a robust T1 of Skyway (prothioconazole+ bixafen+ tebuconazole) plus folpet also helped, especially as 30mm of rain fell the following week.

The J P Clay and Ovington Hall results are slightly ‘stand out’ as generally those varieties with higher septoria ratings corresponded with lower ng/ul counts, highlights Rosalind.

The National Snapshot gave an early warning that all was not well with Firefly. “At Troston Farm



*Grant Reid noted septoria levels rise quickly in a resilient variety early in the season but its resistance later kicked in.*

in Suffolk, qPCR levels built up on leaves four and three during May and June but leaves two and one remained clean,” says Ella.

It was a surprise, she says, and she believes the reason behind higher-than-expected infection levels was due to the Cougar parentage as well as the warmer, wet weather that arrived later in the season. But even here leaves four and three in Skyscraper carried higher septoria infection by mid-June.

“It’s worth noting how quickly septoria took off after favourable ▶

## A fieldman’s view

How did the qPCR testing help when it comes to fungicide applications? Bayer’s technical manager Gareth Bubb looks after the septoria-prone west of the country and he believes the testing will aid the responsible use of fungicides, particular once interpretation of the results has become more defined, providing another step towards a more sustainable system. But it doesn’t tell the whole story, he says.

“A lot of people have been disappointed with their septoria control this year, but rather than being due to poor fungicide performance, I believe it’s sometimes a case of expectations being too high.”

Gareth points out that plenty of wheat was drilled early last autumn when conditions were good but that varietal resistance and the implications on disease pressure weren’t always considered.

“It’s hard to compete with septoria when wheat is early drilled so you could say some crops were

set up to fail as far as fungicide programmes were concerned. With early sown crops you can expect to have to spend more on fungicides and still see disease in the crop.”

The early-drilling problem was compounded by the spring weather, particularly the slow emergence of the flag leaf which had the effect of extending the interval between T1 and T2 to five weeks or so.

“By the time it became apparent a T1.5 would have been a good idea in some crops, it was too late.”

As well as timing issues, Gareth says the eradicator activity of fungicides can’t be relied on. “Eradicator doesn’t mean tackling septoria already showing on the leaf, it means having activity on the pathogen, but that’s only possible in the first half of its latent phase.”

When it comes to slowing any shift in fungicide efficacy, Gareth stresses the importance of using well-balanced mixtures, which means



*Gareth Bubb says when wheat is sown early, you can expect to have to spend more on fungicides and still see septoria in the crop.*

keeping the azole content up with SDHIs but equally matching the efficacy of an SDHI when using new azole chemistry. The temptation to skimp or omit the azole because of a perception it’s not doing much is back to front thinking born of a misunderstanding about shifts in sensitivity and how to counter them, he adds.



*The varieties monitored at Malshanger Estate in Hampshire both escaped much septoria, despite both fields being drilled in September, says Ian Magrettes.*

## Forward-thinking farmers

With robotics, gene mapping and molecular markers, digital technology and bio-chemistry it is a dynamic time for anyone involved in agriculture.

Challenges lie ahead for UK agriculture, such as improving productivity while minimising its environmental footprint. But farmers have always had to deal with change, and adopt new ideas and technology.

Bayer is at the core of these agricultural advances, working with farmers throughout the UK and further afield to trial and develop new

diagnostic tools and evaluate different farming strategies, coupled with exciting plant breeding and product development programmes. It will help us develop innovative solutions and services to assist farmers achieve profitable and sustainable agronomic practices.

Despite the challenges facing UK agriculture there is much to look forward to. This series of articles focuses on how innovation and partnership between farmer and industry will help us face the future together.



► weather late in the season. And this is not the first time this has been seen in Bayer qPCR testing,” explains Rosalind.

“In 2019, leaf two tests on a range of varieties revealed low levels of septoria in ug/ul ahead of GS39, even in Kerrin. But

again, wet weather in late May and early June saw a rapid acceleration in susceptible varieties.” ■

## March of the mutants

The advent of molecular science has revolutionised the understanding of fungicide resistance, with multiple mutations now detected at both SDHI and azole fungicide's target sites in some *Zymoseptoria tritici* isolates. On the other hand, the discovery of so many septoria mutants has done little to clarify what the implications of the pathogen's evolution may be in the field.

Bayer's fungicide resistance expert, Dr Andreas Mehl, believes 'resistance factor' is a helpful way of looking at evolution in the septoria population. The company has adopted an approach to monitoring which focuses on the single isolate level and genotyping to identify the mutations present. It's not the same as resistance testing results presented by other companies but Andreas believes it provides a good overview of what is happening within the septoria populations being monitored across Europe.

“EC50 's are commonly used when sharing fungicide resistance monitoring data but the EC50 only measures a change in fungicide sensitivity, it's not a gauge of resistance,” he explains.

Instead Andreas prefers to take the mean EC50 of a reference range of key isolates and then express the sensitivity of tested isolates as a quotient of this figure, which gives its 'resistance factor'. Only when this resistance factor

reaches 30 or 40 has fungicide sensitivity shifted to a level where it's a concern, he suggests

“What really matters is how far an isolate has shifted from key reference isolates — the 'baseline'. A resistance factor is the sensitivity deviation from this.”

Resistance factor scores for bixafen from 2018 and 2020 show the shift has been small, he says. “In 2020 resistance factor scores for the UK ranged from 3-26, though the sample number was much lower due to COVID. That is higher than in 2018, but still below the 30 threshold where we see reduced sensitivity.

“In testing, bixafen is showing lower resistance factors than other SDHIs which are closely related. They are all showing a drift but perhaps not as much as the AHDB's fungicide performance results are suggesting, which are under extreme conditions using single actives,” he adds.

Furthermore, he points out that in the field actives are not applied as straights so individual active resistance factor scores don't give the whole picture.

Andreas talks about mutants as either being 'soft' — they're present but not reducing sensitivity to bixafen significantly — or 'tough guys', such as C-H152R, which do have a marked effect on fungicide sensitivity.

It's a similar picture throughout

Europe. Unlike the UK situation, some 'outliers' were found in Ireland, Germany and the Netherlands, indicating more 'moderate' or 'tough guys' were at large. But Andreas attributes this to a range of factors and isn't alarmed.

“When we look at the small number of results where bixafen has a high resistance factor, these strains typically have a fitness penalty. Tough strains we see in the lab struggle to thrive when exposed to the elements and plant defence mechanisms.”

His comments are based on competitiveness studies in a greenhouse, where the tough mutants have been shown to be outcompeted over time by wild types and softer mutants when placed into a situation more akin to nature.

“I believe the fitness penalty may be related to the G143A mutation which confers resistance to the strobilurins (QoI). Both target sites (SDHI and QoI) are enzymes in the respiratory chain, so if the C-H152R and G143A occur together then this would lead to reduced functioning of both target site enzymes, leading to a reduction in adenosine triphosphate (ATP) production and result in a fitness penalty,” suggests Andreas.

While UK results showed resistance factor scores in the 20s with bixafen, these were much lower for fluopyram, ranging from 2-13.

“We still see the same pattern, with higher scores for Ireland than



*Andreas Mehl says that where resistance factors are raised for bixafen, fluopyram remains consistently strong – confirming incomplete cross-resistance.*

the UK, but the range is much lower. In the Netherlands where we see some particularly high resistance factor scores for bixafen, but with fluopyram they are still low, ranging from 4-9.

“We consistently see that where resistance factors are raised for bixafen, fluopyram remains strong with a low resistance factor which confirms incomplete cross-resistance between the two SDHIs.”

It's also why bixafen and fluopyram complement one another so well, he says. “Even though fluopyram is intrinsically less potent against septoria than bixafen, their different chemistry gives them an entirely different relationship with the septoria pathogen meaning that when one is shifting, the other isn't under the same degree of pressure.”