Meet the rust buster

CPM travels to Denmark to meet the team of scientists who are leading the fight against the world’s number one yield robber.

By Tom Allen-Stevens

It’s likely that few UK growers lose much sleep over yellow rust. Compared with other cropping challenges, the I-know-it’s-there-but-I-have-the-tools-to-manage-it approach is the show of bravado most can comfortably afford to take.

But it is, in truth, an ever-changing, virulent and aggressive pathogen, say experts — a constant threat to global wheat yields — and this relaxed approach may be attributable, in no small part, to the work of many researchers across the world, all feeding information into a research institute in Denmark.

One step ahead

The Global Rust Reference Centre (GRRC), part of Aarhus University situated in eastern Denmark, is dedicated to major research and survey activities aimed at staying one step ahead of both yellow rust and black rust. The latter, also known as stem rust, is more of a problem in warmer climates and is reputed to be the biggest worldwide yield robber of them all.

“We can take samples of wheat rust any time, from anywhere in the world,” says Prof Mogens Hovmøller, who heads up the centre. “If there’s a new epidemic taking off, we need to learn why it’s happening in order to prevent future outbreaks.

Rust spores are spread by the wind, but also by travellers — on past experience, a new strain can travel from one side of the world to another in a very short space of time.”

The virulence surveys, carried out in conjunction with researchers and breeders in the UK, Scandinavia and across Europe, form a major part of this work. European wheat varieties on the whole have a good resistance to yellow rust. But the resistance genes are constantly challenged by new mutant strains of the pathogen.

“These [mutations] can occur...”

“...One single change in a pathogen can completely switch its virulence, so a resistant wheat variety can suddenly be rendered susceptible.”

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**Virulence and aggressiveness**

Assessment of both virulence and aggressiveness of new strains form a key part of the work the centre carries out. Virulence is the ability of a new strain to grow on a variety previously thought to be resistant, while aggressiveness gauges the damage the disease does to the plant.

“Mutations occur constantly in the field, but only the most fit are likely to survive the natural selection that takes place.”

With a generation time of only 10-15 days in summer, it doesn’t take long for a new aggressive race to become evident, and these are the ones sent in to the centre.

“When we get a new race, we try to assess how aggressive it is. But it’s very time-demanding work, so we don’t do this on a routine basis,” notes Mogens Hovmøller. But the level of monitoring the centre maintains is essential for growers to adapt control strategies and keeps breeders informed of developments, he believes.

And there’s one recent development that’s causing concern in northern Europe, says Mogens Hovmøller. “A number of resistant wheat varieties in the UK, France, Germany, Sweden and Denmark suddenly became susceptible as a new race appeared in 2011. In the UK, it’s referred to as the ‘Warrior race’, while in Scandinavia it’s called the ‘Ambition race’.

“We believe it’s the same strain, but this hasn’t yet been finally confirmed through the lab tests we’re carrying out.”

So-called because it was recorded first in UK crops of Warrior, the new race can attack some of the varieties currently categorised on the UK HGCA Recommended List as having a good level of resistance to yellow rust.

“To me it doesn’t look like a single mutation — it’s a very different race. When we grow it, and see how it behaves, I’m suspicious — it has a number of traits we haven’t seen before. It’s also been found over such a wide area of Europe and affects such a wide range of varieties.

What’s more, it’s particularly aggressive on many of those crops.”

Newly emerged crops in Nov were also infected, and in Scandinavia, the pathogen survived the harsh winter through until March. “This was particularly worrying, especially because we found it in triticale, which is also thought to be resistant.”

**Yields plummeted**

In 2008-09, another race had swept through triticale crops in Scandinavia, recalls Mogens Hovmøller. “Resistant varieties went from 0% to 100% infection overnight, and yields in untreated crops plummeted from a good average of 8.4t/ha to just 1t/ha — it was a disaster for organic growers. We subsequently had to assess the implications for wheat.”

In that case, testing showed the new strain wasn’t an immediate threat to wheat, he says. “It can certainly infect the crop, but currently grown varieties are resistant.” Results from testing of the Warrior race, along with updates of the presence of yellow rust races in Northern Europe, can be found on www.eurowheat.org (see chart).

This website is run by the centre in Denmark in collaboration with scientists from the UK, France, Germany, Poland, Sweden, Italy, Hungary and Switzerland.

**Rust recombination**

So what’s causing these new virulent strains? One theory, yet to be substantiated, is that recombination of yellow rust strains may be taking place. Rust generally reproduces asexually — the spores released have identical DNA and traits to the host pathogen that infected the plant. But where two races are present on a wheat leaf late in the season, new races may be formed due to exchange of nuclei in these strains — a kind of asexual recombination.

“In contrast, sexual recombination will require the presence of a so-called ‘alternate host’ — common barberry for example. For sexual recombination to complete its cycle, the pathogen must produce a series of different spore forms, ending with aeciospores on the secondary host that then infect a wheat crop the next year.

“The new recombinant strain can have a very different genetic make-up, which could affect its virulence and aggressiveness.”

Such genetic divergence could then have serious implications for disease control, although the requirement of a secondary host means sexual recombination is rare, notes Mogens Hovmøller.

Recombination and its consequences form another area of research at GRRC. “We’ve a rust collection dating from the 1950s, stored in liquid nitrogen. There are over 10,000 samples in total, so we can learn from what happened in the past.”

In the UK, it’s the Cereal Pathogen Virulence Survey that feeds information into the centre in Denmark. Dr Rosemary Hovmøller and started earlier this year, aims to give growers all over the world an early warning system on rust, to help prevent epidemics.

“You can be certain that your neighbour’s rust will soon be with you,” notes Mogens Hovmøller. “Rustfight provides a web-based surveillance tool. Information can also be uploaded to the server from anywhere in the world.”

Scientists involved in the project are hoping to:

- Get an insight into the mechanisms behind shifts in aggressiveness and virulence of yellow rust
- Provide early warning systems to prevent epidemics
- Pin-point the genetics behind resistance and bring durable disease control in wheat
- Ensure epidemiology information is up-to-date and global via its web-based platform.
- For more, go to www.wheatrust.org/rustfight

A five-year project, led by Mogens Hovmøller and started earlier this year, aims to give growers all over the world an early warning system on rust, to help prevent severe epidemics.

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Tests on the Warrior race of rust are currently underway to determine if it’s the same strain as one that has appeared all over Europe.
Bayles of NIAB TAG leads much of the monitoring work and advises on variety diversification to minimise the impact of yellow rust.

“In Denmark and across northern Europe, wheat varieties grown have a high resistance to yellow rust, but UK varieties on average are more susceptible,” she notes.

Over the last 20 years, a new and particularly virulent race has appeared once every 2-3 years. Notable recent events have been the Robigus race in 2004, Solstice in 2008 and the Warrior race identified last year. “Sometimes it starts in the UK and spreads to Europe, but the recent one appeared all over Northern Europe at the same time, which is unusual. The centre provides a valuable early warning — if a new race has been picked up somewhere else in Europe, it’s almost bound to turn up in the UK too.

“We’re trying to answer the question of where these new races start from, to get a better understanding of why the mutations occur. Often a new race will disappear very quickly as it has no selective advantage. Even a sexual recombination has no predisposition to be aggressive.”

**Information for breeder**

Apart from providing an early warning of an imminent rust epidemic, the other benefit the centre brings is information for wheat breeders. “We’re after more durable, long-lasting forms of resistance, but this is getting tougher to breed into varieties.

“The races of rust we now have in the UK are more virulent than they were just a few years ago — whereas before they challenged just three or four resistance genes in a plant, now they’ve the potential to attack seven or eight. To combat this, breeders can use molecular markers to stack resistance from a number of different sources.”

An important way forward is to use the most recent, multi-virulent races of local origin for selecting durable resistance in the breeding programs, and information from the rust centre is now helping breeders develop quantitative resistance, explains Rosemary Bayles. “This provides a more durable type of resistance, where a variety can exhibit the disease, but at a low level. This slows down the speed and vigour at which an isolate will develop in a crop.

“We can’t stop new races developing, but we may be able to prevent them from being a problem.”

The rustfight website provides access to up-to-date information on new strains and threats.

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The information from GRRC is helping breeders develop a more durable type of rust resistance, says Rosemary Bayles.
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