Putting the 'breaks' on

Technical
Disease control

It might be tempting to focus most fungicide firepower on T2. But with unpredictable weather and disease risks, is this shutting the stable door after the horse has bolted? *CPM* finds out.

By Rob Jones and Lucy de la Pasture

Few of us need reminding how unpredictable yellow rust has become over recent seasons — including growers in the west where yellow rust hasn't historically been that much of a problem. *Septoria tritici* also has a history which shows it's becoming more difficult to control.

Seasons such as the washout summer of 2019, when sudden weather changes exposed any weaknesses in earlier fungicide inputs, have provided some harsh lessons. So while the flag leaf remains the biggest yield contributor in winter wheat, it's no longer possible to rely on a robust T2 to rectify things if disease has already got out of hand. Instead, a good T1 has become increasingly important for keeping a lid on infection earlier, says Harry Fordham, new farming technology lead at Syngenta.

Disease firebreak

"Think of T1 as a disease firebreak. Although the primary spray target for T1, leaf three, only contributes about 8% to yield — compared with 23% for leaf two and 43% for the flag leaf — its strategic importance goes well beyond this.

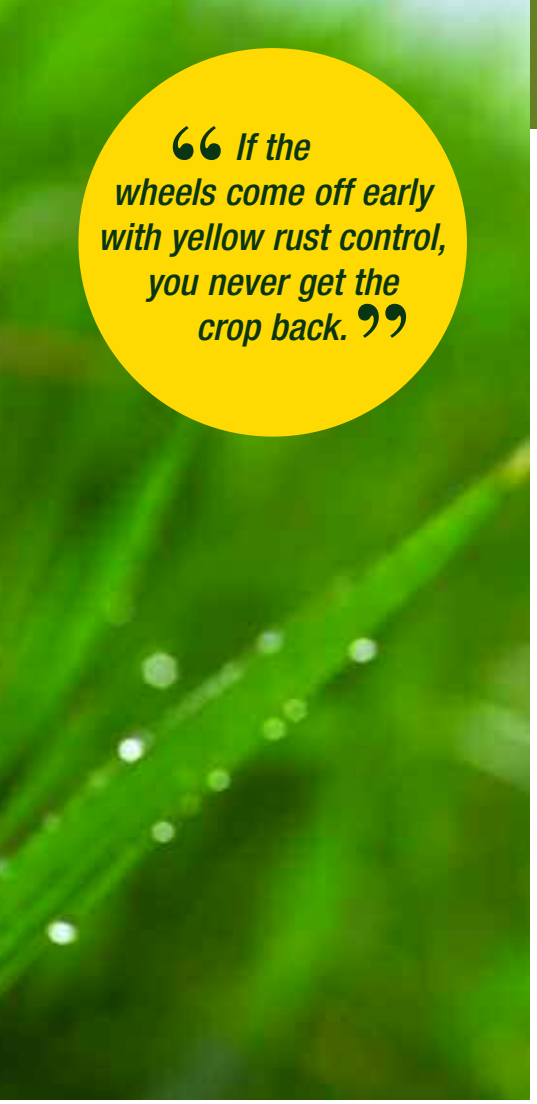
"By keeping leaf three clean with an effective T1, it's essentially 'sanitising' a stepping-stone that otherwise facilitates disease transmission up the plant. It's important because the tip of the flag leaf emerges from below leaf three and it becomes even more so if you haven't got on top of disease at T0."

A big temptation at T1 can be to trim fungicide inputs if disease levels appear to be low at the time of spraying. But that's a huge gamble, Harry stresses. "The impact of future weather on disease development at that point is still unknown. Rusts cycle very quickly in favourable conditions," he notes.

"This season there's been a wide range of drilling dates, with yellow rust found before Christmas and it's been a mild winter. Later drilled crops may be at lower septoria risk, but they can be hit hard by yellow rust because they're so small."

Paul Gruber, regional technical manager for agronomy firm ProCam, agrees T1 provides a crucial disease 'firebreak'. He says the aim of an effective T1 when leaf

At T1 plants are growing more upright so you want the spray to penetrate down into the crop, says Harry Fordham.



three is emerged is to minimise latent infection on leaf two above it, so that the T2 spray can be applied to a clean flag leaf, to deliver its best results.

“Get T1 right and there shouldn’t be a need for a T1.5 spray between T1 and T2, apart from in exceptional cases,” says Paul. “But get it wrong, and that’s when you end up chasing your tail.

Varietal resistance

“If the wheels come off early with yellow rust control, you never get the crop back. Early yellow rust prevention has become even more pertinent, given how quickly we’ve seen varietal resistance ratings break down.”

Paul says that for septoria, curative ability may potentially be improved with new fungicide chemistry, but even with this, he believes keeping crops in a preventative situation is still better than a cure.

“The more we expose new chemistry to established disease, the sooner it will break. The cleaner we keep the crop, not only the better the yield protection, but the longer the new chemistry will be preserved.”

Allied to this, he says persistent disease

Paul Gruber believes in keeping crops in a preventative rather than curative situation when it comes to disease.

prevention is also important at T1. “By keeping the lower canopy disease-free for longer, there’s less of an infection source to move upwards. This also gives some reassurance if there are delays to the T2. We talk about maintaining a maximum three-week interval between spray timings, but we don’t always know if the weather will allow this.”

Trials at ProCam’s main hub at the Stockbridge Technology Centre in Yorkshire have shown T1 to T2 intervals vary widely depending on variety and ▸

By achieving effective control at T1, latent infection on leaf two will be minimised so that the T2 can be applied to a clean flag leaf.

▸ drilling date. And while brown rust is considered a later season disease, he says pressure can be building between T1 and T2. For persistence and rust control he rates the SDHI Solatenol (benzovindiflupyr) highly at T1.

"If there's a hot spell between T1 and T2, brown rust soon gets going. There are plenty of varieties relatively tolerant to septoria but not to brown rust. Solatenol is inherently strong on yellow and brown rusts and is persistent in its control."

Practical considerations

These are the biological arguments for effective T1 disease control, but what about the practical considerations? With other inputs such as growth regulators, herbicides and foliar nutrition also potentially going in the spray tank, Paul says good tank mixability of the T1 fungicide is crucial.

"Opt for a fungicide that doesn't move up the leaf rapidly and accumulate in the leaf tip, which is what can cause scorch," he suggests.

Additionally, with the shape of the plant changing at T1 from its flatter T0 shape, and chances of catchy weather, Harry says pay close attention to application, not only to get the maximum spray on the target, but also to achieve timely spraying.

"Spray too early and the base of leaf three won't have emerged fully, so it won't be fully protected and there's an increased risk the treatment will run out of steam before T2. Spray too late and you can miss the boat when it comes to maintaining preventative control.

"You can aid spray timeliness by using drift-reducing nozzles to maximise spray windows. At T1 plants are growing more upright so you also want the spray to penetrate down into the crop."

To these ends, for most situations Harry advocates Amistar nozzles for both T1 and T2 sprays. As well as being 75% drift-reduction nozzles, he says their slightly rearward-facing spray pattern counters the sprayer's forward motion, so droplets travel more vertically into the canopy for more even coverage on the front and back surfaces of upright leaves. The coarser droplets they produce also aid canopy penetration, he notes.

"Although the primary target at T1 is leaf three, a coarser droplet also helps get spray down to leaf four and leaf five, which can boost the firebreak effect. In normal conditions, our guidance is to ▸

More than just disease control?

Even in disease-free conditions, Tudor Dawkins found that flag leaf greenness was boosted following an earlier application of the SDHI Solatenol at GS31.

The argument for investing at T1 may be convincing. But what happens if it turns into a low disease year? According to Paul, ProCam trial plots showed that even in the low disease year of 2018, when T2 fungicides gave only a modest yield increase, adding SDHI plus strobilurin to a T1 base treatment of azole plus multisite fungicide still boosted yield by 0.65t/ha, to 10.25t/ha.

"At £165/t for wheat, that's worth an additional £107/ha, so a significant return on the extra investment. Being a dry year, this yield uplift was unlikely to have been due to disease control, but more likely physiological effects — maybe increased rooting or better tolerance to drought," he suggests.

The physiological benefits of an early-season SDHI fungicide in disease-free situations has also been researched by Dr Tudor Dawkins at the University of Warwick over the past two years. A former agronomist, he's well aware of the temptation to cut back at T1 if disease pressure looks low, so was keen to understand what fungicides do in addition to disease control and to identify any predictable and measurable effects.

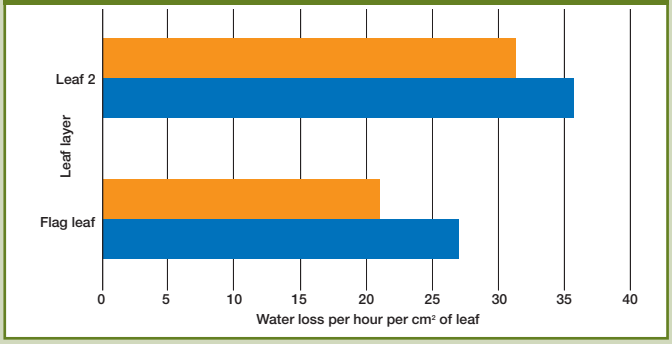
Using a SPAD meter to measure leaf greenness in disease-free glasshouse conditions, he found the chlorophyll content of flag leaves was boosted by about 5% following an earlier application of Solatenol at around the T1 timing (GS31).

A further disease-free experiment also showed less water loss from the flag leaf and leaf two in plants treated with Solatenol at GS31, compared with an untreated control. This was backed up by field results in the low disease year of 2020 in a crop under drought stress, where there was also less flag leaf rolling following a GS39 Solatenol application.

"SDHI fungicides are very effective at inhibiting processes in fungi, but the same pathways occur in plants," explains Tudor. "This work has demonstrated non-disease control benefits from Solatenol. It indicates that SDHI chemistry may help plants to conserve water, which could be important in water stress situations.

"The practical consequence is to help the grower and agronomist choose products that can exhibit non-disease control properties to augment the returns from disease control that fungicides offer, should disease not develop."

Effect of SDHI on water loss



Reductions in water loss (mg water/hr/cm²) from flag leaves and leaf 2 following application of Solatenol at GS 31.

Source: University of Warwick, 2021

Fungicide choice a factor in yellow rust control

Agronomist reports last season about the difficulties controlling yellow rust was put down to a combination of late drilling, winter weather and changes to the pathogen. But research by Bayer at the Cawood trial site in Yorkshire suggests that fungicide choice might have been a factor.

A single application of various fungicide treatments were applied to JB Diego and followed up with disease assessments approximately one week and one month after application. The trial confirmed what had long been suspected — that there are few 'all-rounders' in the yellow rust fungicide armoury, with most actives ideally suited to protectant or curative situations, but rarely both.

How these curative and protectant fungicide properties differed was quite marked. Strobilurins stood out for their curative properties but proved to have limited persistency. Some strong protectants offered little against established disease, says Bayer's Rosalind Martin.

It all comes down to fungicide formulation and the speed of active on the pathogen, she says. "It's common practice to include a strobilurin in a fungicide mixture to boost yellow rust control, but their movement on and through the leaf means they are short-lived on leaf surfaces. Our first assessments showed only small differences in disease levels between pyraclostrobin, epoxiconazole, tebuconazole and prothioconazole treated plots. But second assessments, one month after application, revealed high disease levels in strobilurin treated plots.

"Strobilurin speed is an asset where the disease is established as the fungicide acts quickly against the pathogen. But for a fast-cycling disease like yellow rust it leaves plants exposed to new infection," says Rosalind.

While strobilurins were at the bottom of performance tables when it came to persistency, Elatus Era (prothioconazole+ benzovindiflupyr) came out at the top of the list, offering protection over multiple-cycles, she says. However on established disease Rosalind believes a strobilurin or fast-moving azole is probably the best option.

In addition to highlighting differences between actives, the trial also confirmed the importance of formulation. Bayer-formulated Folicur (tebuconazole) was compared to Toledo (tebuconazole) and the first assessment, just one week after application, found the Toledo-treated plots had 5% more yellow rust infection compared with the Folicur-treated plots. This confirmed that SC (suspension concentrate) formulations don't act as fast as Bayer-formulated tebuconazole, she says.

Bayer trials illuminate the differences between speed of activity in knocking down yellow rust and persistence.

Bayer-formulated Prosaro was also compared with a generic prothioconazole+ tebuconazole formulation. While they both performed well at the first assessment, the later assessment revealed 5% more yellow rust in the generic plots, demonstrating its limited persistency compared with Prosaro.

"Given the uncertainties and unpredictability of factors affecting yellow rust, both tebuconazole and prothioconazole proved themselves as the best all-round actives against the disease, delivering a good balance of persistency and curativity, particularly when well formulated," she concludes.

Tailoring disease control to risk

Understanding risk based on early cropping decisions, like variety or drilling date, and in-season monitoring of crops are key to using Integrated Crop Management (ICM) successfully. Many farmers may already be taking these steps without fully realising it, says Dave Howard, head of ICM at Hutchinsons.

"ICM doesn't require a drastic change from the norm, in fact many ICM principles have already been taken up over the years due to the positive effect they can have on disease management. It's simply a more strategic approach when planning which crops and varieties to grow, assessing where risks lie and then adapting management and inputs in response to changing weather patterns and disease levels — or visualizing risk," he says.

"This can be more complicated than it sounds. Over the past two years growers have juggled with a spectrum of drilling dates and varieties across their farm, which makes assessing which crops are at higher risk more complicated. And that's without the extremes of weather to consider throughout the season."

So to make this process much simpler Hutchinsons has developed a Wheat Disease Risk Forecasting model within Omnia. The model automatically calculates which crops are at the highest risk from disease, taking into account all of the factors affecting disease developing in the crop and allowing the user to tailor a fungicide approach accordingly.

"It's about being better informed to plan a strategy. The job of the model is not to tell us that disease is present, but rather to plan for what disease will be more likely to develop in a particular variety/field etc. This allows the user to temper that risk as much as possible, not eliminate it, by tailoring a planned fungicide approach accordingly."

The model takes into account the data already entered into Omnia, like variety and drilling date, alongside the climatological data provided by the Omnia Climate module. The output is a visual risk map across the farm, illustrating which fields pose higher risks and where that risk is coming from, he explains.

"Users can allocate specific fields and are presented with a sliding scale to access visual representations of crop growth and certain growth stages. Likely spray days are then predicted and as the weather patterns change, the calculated risk constantly evolves, allowing fungicide programmes to be planned more effectively."

Dave Howard explains that a new disease risk forecasting model within Omnia can help justify fungicide applications.

The risk is recorded though the season to provide a record for justification purposes which is something that is becoming increasingly important, he adds.

The Omnia team are developing a similar model for barley and a lodging risk model for wheat, which are both being trialled this spring at Hutchinsons' Helix farms.

Brown rust can build between T1 and T2 so in susceptible varieties it's wise to use a fungicide with both good preventative activity and persistence.

▸ use Amistar nozzles at a water volume of 100 l/ha and 12 km/h forward speed. In an especially thick crop, a higher water volume won't harm, but don't simply increase the pressure to achieve this — the finer droplets produced won't penetrate and will be more prone to drift.

"In conditions when drift reduction becomes even more important, consider 90% drift reduction nozzles but use a minimum of 200 l/ha of water to maintain coverage. Nozzle height should be 50cm above the target, but remember the target is higher than at T0.

"Overall, it's well worth investing in getting T1 right. You still need to do a good job at T2, but it may be possible to use a less expensive T2 fungicide because of reduced need for curative control." ■

Biofungicides can take pressure off chemistry

Disease control is all about prevention these days and this is where early use of the elicitor-based biofungicide, Iodus (laminarin), provides an added dimension to septoria control strategies, says Greg Hanna, trials manager at UPL.

"When used at 0.75 l/ha, Iodus triggers the self-defence mechanisms within the wheat plant. Normally it takes 48 hours for these defences to be activated after a pathogen has invaded plant cells, but Iodus causes them to be 'switched on' in advance of a fungal attack so the plant is already prepared to fight it."

Laminarin, the active ingredient in Iodus, is a natural metabolite extracted from a special species of seaweed, Laminaria digitata, found in the North Atlantic Ocean. "Laminarin is a protein which mimicks a protein found in dead fungal cells and this tricks the plant into thinking that a pathogen has invaded," explains Greg.

"The plant responds to this elicitor action in three ways. It increases the thickness and lignification of cells walls to provide a barrier to invading fungal hyphae. The plant also produces phytoalexins which circulate in the vascular tissues and bind to pathogens, inhibiting their development — producing a vaccine-type effect.

"As well as phytoalexins, the plant produces pathogenesis-related (PR) proteins in response to cell-to-cell signalling as part of the systemic acquired resistance (SAR) response. This is maintained for about 10 weeks and helps protect new and developing plant tissues."

The difference between a conventional T0 and an elicitor is 'same time, different place' — the target is leaf four but the Iodus provides systemic protection for the whole plant, including the leaves yet to emerge, explains Greg.

"Traditionally a fungicide applied at the T0 timing aims to protect the basal leaves that have just emerged and can contribute up to 5% of the crops yield. Iodus provides protection to the basal leaves along with a reduction in the inoculum that would spread upward, but also confers benefits to the upper canopy that isn't present at the time of application. This 'priming' of the upper leaf layers against subsequent disease can help reduce the pressure on the T1 and T2 fungicide programmes."

In trials Iodus has reduced the incidence of septoria by a similar level to both folpet and chlorothalonil, with an average yield response of 0.3t/ha across the trials which is comparable with the multisites. Greg emphasises that as an elicitor, the biofungicide isn't actually acting on the pathogen so is a parallel product to multisites, providing another tool for managing disease.

The reduction in disease burden that Iodus brings to the party is something that Greg believes can play a key role in supporting other fungicides as they come under increasing pressure due to the evolution of resistant pathogens. Currently only approved in wheat, a registration for barley is anticipated in the future after trials have shown promising reductions in net blotch, rhynchosporium and ramularia.

Sticky sulphur

Sulphur is something that's been used for decades for its fungicidal activity. It's now available as biofungicide Thiopron, a liquid formulation with enhanced sticking capabilities due to its formulation which includes Xanthan gum. It also has good compatibility with other fungicides.

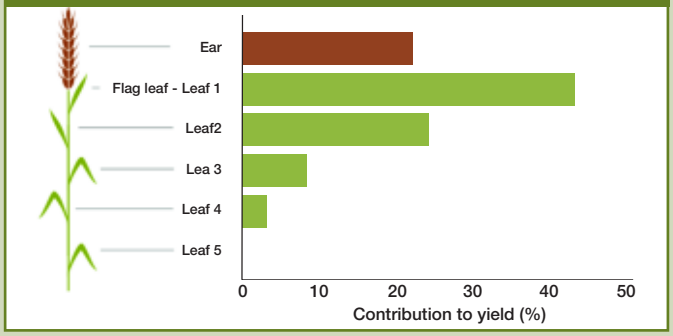
Elemental sulphur is effective when formulated as a fungicide due to a process known as sublimation, the transition of a solid substance to a gas state without passing through a liquid phase, explains Greg.

"Atmospheric hydrogen binds with the sulphur active and forms Hydrogen Sulphide (H_2S) gas in a surface layer on the leaf. This gas layer is toxic to fungal pathogens, providing curative effects but also toxifying the surface of the leaf to prevent the future establishment of spores."

In trials Iodus has reduced the incidence of septoria by a similar level to both folpet and chlorothalonil, providing another tool for tackling disease, says Greg Hanna.

Thiopron can be used as an alternative multisite at T1 and T2 and in trials provides equivalent levels of control to folpet when used at 2-3 l/ha. On the label approval is for powdery mildew but Greg says trials have provided good efficacy data for septoria in wheat and for rhynchosporium and ramularia in barley, where it has a particularly good fit because of its disease profile.

Main contributors to yield



Iodus switches on the plant's systemic acquired resistance pathways so protects leaves yet to emerge.