

“It’s very hard to tell by eye if your crop is infected with TuYV, but it has become the most widespread disease by a country mile.”

Stealth conceals the viral burden

Innovation Inside traits

Sampling results have revealed turnip yellows virus is endemic across UK oilseed rape crops. CPM explores the evolving story of how plant breeders have built in resistance.

By Tom Allen-Stevens

There is now a disease that has become a threat for all oilseed rape growers. It’s a virus that can cause up to 30% yield loss for which there is no effective chemical treatment. Turnip yellows virus (TuYV) is transmitted by aphids and it’s believed around 70% of peach potato aphids (*Myzus persicae*), the most common aphid vector in the UK, carry it.

There is, however, a solution. Look on the AHDB Recommended List and you’ll find no fewer than eight OSR varieties believed to be resistant to TuYV. Five of these are new to the RL this year and sit at the top of the heap. The reason they’re there is reputed to have as much to do with breeding expertise as it does with how the virus itself has spread.

TuYV has done a fairly effective job at becoming pandemic across most of Europe (see panel on p75), but it’s crept up by stealth, notes Prof John Walsh of Warwick University. “In terms of pathogens of oilseed rape, you can see phoma and light leaf spot symptoms quite clearly. It’s

very hard to tell by eye if your crop is infected with TuYV, but it has become the most widespread disease by a country mile,” he says.

“It’s spread by a number of aphid vectors, with *M. persicae* by far the most significant — testing has shown that 70% of the population carries the virus. As well as OSR, the aphid infects various brassica vegetable crops and weeds, so there’s always a green bridge providing a virus reservoir.”

Growing proportion

Neonicotinoid seed dressings had been effective at keeping aphids out of arable crops in the early autumn, when aphid flights threatening OSR can hit a peak. But since their removal from use, the proportion of infected OSR crops has grown from just a few hotspots a decade ago to endemic across much of the UK today.

“Infection of OSR is density dependant



John Walsh believes plant resistance is by far the best way forward for growers to protect crops from the effect of TuYV.

— there’s a clear correlation between aphid numbers and the proportion of infected plants in crops. The weather in the autumn is crucial, and suction trap data provided by Rothamsted Research show warm conditions drive numbers — we’ve



TuYV symptoms showing on susceptible OSR plants at various growth stages as a purple discoloration compared with resistant types.

had many favourable autumns for aphids in recent years," John notes.

Far less is known about exactly what the virus does to a crop. AHDB-funded work conducted by Dr Mark Stevens at BBRO in 2008 found that at an individual crop level, control of TuYV could raise average yields from 3.3t/ha to 4.4-6.0t/ha. "The virus has the effect of reducing both the fresh and dry weight of a crop," John explains. "Infected plants produce fewer side branches,

pods, and seeds per pod. It's confined to the phloem, so potentially robs the plant of resources that would be fed to the roots.

"But you often don't see severe symptoms, which is why TuYV often goes undetected. Plant resistance is by far the best way forward."

Work undertaken at Göttingen University in Germany over two decades succeeded in bringing in genetic resistance. "Researchers recreated OSR, Brassica napus, from its two ▶

Game-changing varieties punch well above their weight

"If you only grow one variety of oilseed rape this year, pick one with TuYV resistance," recommends Hutchinsons technical support manager Neil Watson. "And if you're growing more than one, you should include the trait across at least some of your area."

He recalls the research carried out over a decade ago by Mark Stevens at Brooms Barn, which showed up to 30% yield penalty where levels of the virus were found to be high and where infection occurred early in the crop's life. "At that time, TuYV was found only in one or two hotspots and levels varied considerably year-on-year, so it often didn't manifest itself in a yield penalty at all," notes Neil.

But even then, he felt sure the virus was going to become significant. "Two factors have been game-changers. Firstly, it's become far more difficult to control the early infection without neonicotinoid seed dressings. Getting the timing right for sprays is exceptionally difficult, and that's a recipe for the virus to spread."

The second factor has been the relative rise in performance of varieties with TuYV resistance. "I've been tracking the trials performance of these varieties over the past few years, especially across sites in the



Every OSR grower should pick a variety with TuYV resistance, believes Neil Watson.

South and South West," he says. "Increasingly they have been punching well above their weight."

He notes that TuYV tends only to hit a crop that's stressed. "Where you've succeeded in maintaining crop momentum, especially at the end of the season, the effects of the virus won't be nearly as devastating. But you cannot control the weather which will have the greatest impact, so it makes sense to give yourself the protection of a TuYV-resistant variety."

His favoured hybrid is Aurelia. "It's one of the highest for gross output on the RL, with disease scores of 8 for both phoma and LLS. For growers looking to get a step ahead, RL candidate LG Aviron looks very promising, which builds in pod shatter resistance," he notes.

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TuYV resistance climbs the ratings in southern trials

"There's such a strong argument for growing a TuYV-resistant variety, why wouldn't you?" asks CCC Agronomy's Peter Cowlrick. "When they were first introduced, they carried a yield penalty. But breeders have done a fantastic job at building in other traits, and the mood music on these types has now changed."

He points to trials undertaken by AICC across sites in Suffolk and along the south coast. "The focus has been to sift out OSR varieties with tolerance to verticillium wilt. But it's the TuYV-resistant ones that have been climbing up the ratings in terms of performance," he notes.

Leaf samples taken from the trials have shown levels of infection with TuYV of between 80-100%, he reports. "Within the varieties at the top end of the current RL, we regularly see yield advantages in the trials of 0.5t/ha for those with TuYV resistance, with a range of 0.3-0.5t/ha."

The trials have been carried out on

high-performing sites with control yields above 6.0t/ha, he adds. "They're high input trials with insecticide used to keep aphid populations under control, but there's a high proportion now carrying the virus. It's very challenging to time applications correctly, especially near the coast, and in a crop where the canopy has grown up well and provides its own microclimate for aphids to continue reproducing."

This makes a TuYV-resistance variety a sensible choice, purely from a risk-management point of view, he says. "The first decision then is whether you go for a conventional or hybrid variety. We have a number of growers who have tried Aspire, and while it performs well, it's lacking in spring vigour, so wouldn't be suitable in later-drilled situations or on low fertility sites. But where cabbage stem flea beetle isn't a concern, you can drill it earlier, it has good LLS resistance and doesn't get leggy.



The mood music on TuYV resistance has now changed, says Peter Cowlrick.

"Aurelia and Ambassador are both good hybrid choices, suitable for Sept sowings. Ambassador has the edge on vigour, while Aurelia is slightly shorter and stiffer, suited better to fertile sites," notes Peter.



With 70% of the aphid population now carrying the virus, it's become far more difficult to control the early infection without neonicotinoid seed dressings.

► relatives: *B. rapa*, which includes turnip and Chinese cabbage, and *B. oleracea* — cabbage and cauliflower. Some

B. oleracea relatives appear to have complete resistance to TuYV. One line of *B. napus* from Göttingen University, known as R54, was found to have resistance," continues John.

The pre-breeding research was part-funded by a consortium including major European plant breeders who received germplasm and genetic markers to introduce the trait into commercial lines. "Unlike Rlm7, that confers resistance to phoma, it isn't known whether it's one distinct gene. But the molecular markers are 100% successful in identifying whether a variety possesses the resistance."

The first commercial variety

with TuYV resistance was Amalie, introduced into the UK by Limagrain in 2014. Included on the RL, the variety had a yield penalty compared with others, notes Dr Vasilis Gegas, LG's European portfolio manager.

Nurture genetics

"Sometimes genetics can give us a solution when nothing else can, and we have to nurture that," he says. "To AHDB's credit, Amalie was recognised for its resistance to TuYV, despite being uncompetitive with others on the RL. But genetic resistance is a process that constantly evolves."

The trait had been introgressed across Limagrain's European oilseed portfolio, resulting in open-pollinated Aspire, introduced last year, then three new hybrids on the 2020/21 RL — Ambassador, Aurelia and Artemis. "Like Rlm7, TuYV resistance has become the industry standard — it's a step change for the crop," says Vasilis.

But there's a potential problem — all the varieties with the trait stem from the same initial cross, notes John. "There's currently only this one

source of resistance available commercially, and it hasn't been mapped to a specific gene or subset of genes."

So research at the University of Warwick, funded by BBSRC for four years, identified new genetic sources of extreme and quantitative resistance. BBSRC have now provided two years of follow-on funding of £200,000, bolstered by cash and in-kind contributions from Limagrain, Elsoms, Syngenta and LSPB to bring the genetic markers and plant lines through to the commercial partners.

Vasilis notes that extensive testing across Europe has shown current resistance is holding up well. "But you never know — the more you rely on it, the greater the risk the virus will overcome genetic resistance."

He points out that bringing in new traits from exotic sources is a complex and time-consuming process. "We have to be sure the new material is superior and will deliver the right tools to growers — any deployment is not taken lightly."

But he also has his eyes on the next step — in a further BBSRC-funded project at Warwick, with Limagrain as the sole commercial partner,

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PhD student Shannon Greer has been taking a close look at Amalie and its progenitor species, identifying and mapping new sources of resistance. She's also been assessing the potential

Inside traits

Sustainable agriculture is moving to a new era in which plant genetics play a greater role in the integrated crop management toolbox growers utilise to get the best from their crops. In this series, *CPM* has teamed up with Limagrain to give growers insight into these new tools. Through privileged access to staff and related research these articles look inside the traits, explore the genetics and unlock the secrets of a successful crop. Limagrain started 50 years ago as a farmer-owned co-operative in France, and is now fourth largest seed company worldwide. With an annual turnover of nearly €1.9 billion, 16% of this is spent on R&D. By developing varieties with higher yields, improved resource efficiency and reduced environmental impact, Limagrain is a major contributor to meeting agriculture's sustainability goals.

And this guides the company's *raison d'être*: to cooperate for the advancement of agriculture everywhere, for everyone.



interaction between TuYV resistance and tolerance to verticillium wilt. "Although, far from definite there's now some evidence in support of that," reports Vasilis. "It could be the Holy Grail of genetic resistance or it could just be that the genes that confer resistance to TuYV also make the plant healthier, and therefore more resilient to other pathogens.

"But just identifying this potential coping mechanism is a big step in itself, and could herald the next wave of trait combinations that will bring to the market varieties with increased resilience to soil-borne threats. I think a sclerotinia-tolerant variety within five years, for instance, is an achievable target." ■



TuYV resistance has become the industry standard — a step change for the crop, says Vasilis Gegas.

Limagrain TuYV-resistant List leaders at a glance

	Ambassador	Aurelia	Artemis	Aspire
Variety type	RH	RH	RH	Conv
Gross output (% treated control)	108	108	107	106
Oil content (%)	45.3	45.2	45.7	45.7
Stem stiffness	8	8	8	9
Shortness of stem	6	6	5	7
Earliness of flowering	7	7	6	7
Earliness of maturity	6	5	6	5
Disease resistance				
Light leaf spot	7	8	6	7
Stem canker	8	8	7	6

Source: AHDB Recommended List Winter oilseed rape 2020/21

Virus levels endemic across UK crops

Since 2016, Limagrain UK along with industry partners — Agrii, Openfield and the AICC — have been monitoring levels of TuYV in crops across the UK. It's part of a programme carried out by the breeder across Europe, with leaf samples taken both in the spring and autumn and tested using the Elisa standard test.

"We've mapped the incidence of TuYV from the UK to Ukraine and seen it build over the years," notes Vasilis. "We're getting to a situation where in some locations 100% of crops carry the virus. It's now endemic across Europe, no longer confined to hotspots."

Sampling is carried out twice during the growing season, with an initial small-scale survey conducted in Oct-Nov, followed by extensive testing carried out in early spring.

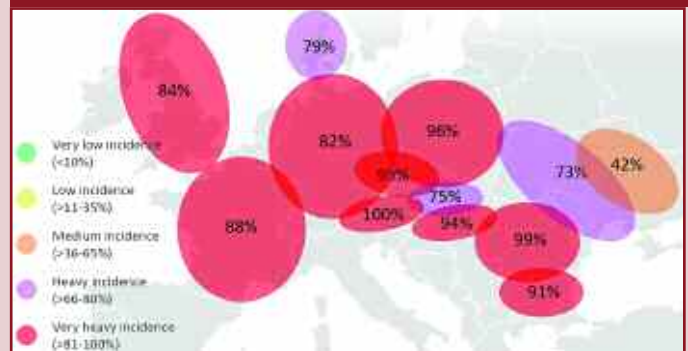
"We now regularly find high to very high levels of infection in UK crops in the autumn, which wasn't the case before," notes Vasilis.

"But it's not surprising considering TuYV incidence reached its highest level ever last season, with an average of 84% of non-TuYV resistant UK crops infected in early spring 2019. Almost all sites had an infection rate between 81-100%."

While incidence was highest in East Anglia and south east England, sites in Scotland and the South West now show very high levels of infection. "Four years ago we wouldn't have seen high levels in the North. But last year we saw 70-75% infection of OSR in Perth and 50-54% in Aberdeen," he points out.

Infection usually occurs in Sept to Oct when aphids are still flying —

TuYV incidence across Europe – 2019



Source: Internal analysis, Limagrain Europe Laboratory, 2019; TuYV incidence in non-resistant varieties per country, 430 locations.

the earlier a crop is infected, the less seeds per pod develop, so the harsher the yield penalty, adds Vasilis.

"Early drilled crops that are more open, corresponding with mild autumnal conditions, are at the highest risk. Once an aphid picks up

the virus, it's infected for life — if an uninfected aphid feeds on an infected plant, the aphid becomes infected and so the cycle continues," he explains.

• For the 2020 results, go to www.cpm-magazine.co.uk