> *Three years of data indicates BChV is more common in the UK, which is interesting because it had previously been thought that BMYV was predominant.*

Keeping viruses on the ropes

Virus yellows

The whole world has become very aware of the threat viruses can pose in recent years, including in 2020 when virus yellows pulled no punches. BBRO updated growers on the fast-growing body of knowledge about this decimating disease at its recent BeetTech event. *CPM* reports.

By Lucy de la Pasture

The relatively mild winter probably means a lot of sugar beet growers put a tick in the Cruiser (thiamethoxam) box on their seed order in the hope that the derogation for the seed treatment will be triggered.

Speaking at the recent BeetTech meeting in Newark, Prof Mark Stevens describes virus yellows as the forgotten disease. That was until 2020, when the menace it can be in beet crops was brought home in the most visual of ways and the resulting yield losses started to make sugar beet look like a very unattractive crop to grow.

One year on, a very different winter killed off over-wintering aphids in the months leading up to sugar beet planting in 2021, explains Mark.

Virus forecast

"We had five cold weather events during January and February last year (the months the Rothamsted Research model uses to predict virus risk) and that's the best aphicide there is. As a result it was predicted just 8% of the national crop would become infected with virus yellows, compared with 70-90% in 2020, which was just below the threshold to trigger the emergency authorisation (EA) for Cruiser."

With minds firmly focused on the importance of monitoring for the presence of green wingless aphids in crops, and the timely use of insecticides should numbers reach threshold levels, 2021 was a virtually trouble-free year as far as virus yellows was concerned, says Mark.

"In the vast majority of crops there was little or no virus, some had levels from 1-5% and odd fields reached up to 20%. Overall the national incidence was 2%, with East Anglia the worst affected area."

Reassuringly, aphid monitoring carried out by BBRO indicated that only 1% of aphids caught in yellow water traps last year were carrying virus and that could potentially reduce the inoculum pressure early in 2022, he adds.

At the time of BeetTech the outcome of the virus prediction model was unknown. Mark explains the risk is driven by temperature in the Rothamsted model, with average temperatures of 4.25-4.5°C from 1 January to 28 February required to trigger the threshold level for Cruiser application this season. This has been set at 19% predicted virus yellows infection for 2022, which is an increase in the threshold of 9% set last year. ▸

Mark Stevens outlines some of the cultural measures to help mitigate the risk posed by virus yellows.

Alistair Wright suggests the varieties trialled in Verdes, which show more impact from either of the viruses assessed (BMYV or BYV), may benefit from being sown earliest.

▸ The new EA has restrictions attached and one of those is a maximum seed rate for treated seed of 1.15U/ha. "Where there's a necessity to sow a higher seed rate then there's an opportunity to make this up using untreated seed," he clarifies.

But relying on the neonicotinoid seed treatment to get out of virus yellows difficulties isn't enough, there are lots of other measures that can be taken to reduce risk of infection, highlights Mark.

"Maximising hygiene measures on the farm will help minimise the carry-over of any potential virus, as well as inoculum for powdery mildew, downy mildew and cercospora. But getting the basics right at drilling time is perhaps one of the most important things so the crop gets up and away quickly.

"That means it will be bigger when aphids migrate into the crop and will reach the 12-true leaf stage faster, when mature plant resistance makes it less vulnerable to the virus.

"Some growers have had success using spring barley as a cover crop to disguise the young sugar beet plants from aphids, which are attracted by the contrast between the brown soil and young beet plants. It's important to take the barley out at the right time, before it has a competitive effect on the beet crop," he adds.

Mark also suggests keeping a firm eye on the BBRO aphid migration data so that crop monitoring can be stepped up as aphids fly into crops. Encouraging natural predators is another way to get a helping hand with aphid control but timing is important, with their appearance in crops needing to coincide with the arrival of aphids for best effect, he says.

For the first time in recent years, growers have two fully approved aphicides to fall back on should aphids reach the threshold of one green wingless aphids/four plants. Joining Teppeki (flonicamid) is Insyst (acetamiprid), which can only be used once in crops.

At the time of writing BBRO was awaiting confirmation from CRD that in situations where Cruiser was applied to the seed, Teppeki would have to be used as the first spray to avoid using two neonicotinoids in sequence. It's also hoped that an emergency authorisation will be gained for a third insecticide in the coming weeks, explains Mark.

Complex of viruses

Plant breeders are the most likely saviours when it comes to dealing with the risk from yellowing viruses. BBRO's Dr Alistair Wright has been monitoring cultivars, old and new, in trials and says that breeders are making headway in finding genetic material that's resistant to some, not all,

Aphid migration into crops was much later last season than in 2020, with many crops already nearing the 12-leaf stage, when mature plant resistance kicks in.

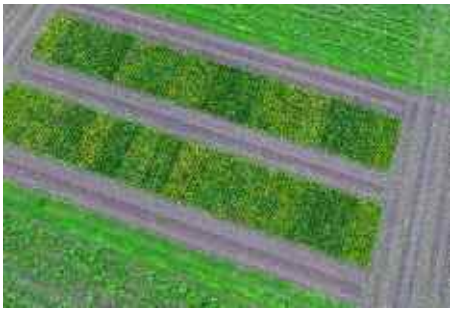
of the three viruses which are responsible for virus yellow.

Two of these are from the same family of viruses known as poleroviruses, he explains. "Beet chlorosis virus (BChV) and beet mild yellowing virus (BMYV) are both poleroviruses. BChV is the least damaging, producing yield losses of around 25%, with BMYV more damaging (30% yield losses).

"Beet yellows virus (BYV) is a closterovirus and is the most severe, with around 50% yield losses," he explains.

Monitoring in BBRO trials is now being conducted over three projects. Goliath is looking at new BMYV and BYV tolerant cultivars; Verde is assessing all the cultivars on the current Recommended List; and Titan is investigating whether tolerance to viruses varies with plant age.

"In project Verde, each cultivar is inoculated with both viruses and the effect on yield is assessed. We're seeing a chequerboard pattern in the plots to BMYV ▸



BBRO is trialling new genetic material from breeders in its Goliath trial and the chequerboard effects shows the differences between cultivars in resistance/tolerance to BMYV and BYV.

Second foliar insecticide receives approval

Insyst (acetamiprid) has been authorised for the reduction of beet yellows virus complex via the control of the main virus vector, peach-potato aphid (*Myzus persicae*).

Following the loss of Biscaya (thiacloprid) growers were down to just one authorised foliar product — Tepekki (flonicamid) — with just one application per crop. Certis product manager Henry Welham says this would be nowhere near sufficient to keep virus out of crops in a high-risk year.

"The authorisation of Insyst adds a much-needed second foliar spray to growers' defences. It provides rapid knockdown, which is very useful early in the season to prevent early virus build up as this has the greatest impact on yield."

The product label permits one application per crop with a maximum individual dose of 250g/ha. Important guidance on the label is that the rate of application shouldn't be lower than specified to ensure good control and to prevent the likelihood of resistance build up, he notes.

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Suzannah Cobb found that virus in beet samples last year was 75% BChV, 18% BMYV and 7% a mixed population of the two.

▸ which indicates there are differences in tolerance between cultivars. We're not seeing this in the plots inoculated with BYV. The trial also confirms that the more yellow a variety goes, and therefore more chlorophyll is lost, the more yield is lost."

Alistair believes the information generated by Verde provides useful information to growers to bear in mind, particularly when it comes to planting time, even though it's one year's data.

"As an example, in line with RL data, we saw Daphna yield the best without virus and Maruscha KWS the least. However, when infested with BMYV, Maruscha's tolerance to BMYV was evident as it maintained over 90% of its yield and Daphna slipped to being one of the worst varieties losing almost 30%."

He stresses that BBRO provides this information as a guide to support variety selection and the order of drilling seed. "Varieties which show more impact from either of the viruses assessed (BMYV or BYV) could be more susceptible to virus damage and therefore may benefit from being sown earliest. As always, bolting risk and seed bed conditions must also be considered."

Similarly, Goliath is showing there are big differences in the pipeline genetic material from breeders which is being tested in the trial. "We're seeing strong differentiation in symptoms between plots, with the majority of cultivars not losing yield when inoculated with BMYV but there's no resistance to BYV yet."

In Titan, beet plants are being inoculated with virus at three different growth stages — in 2021 this was in early March, late March and mid-April.

"The more mature plants (at the time of inoculation) didn't express virus symptoms as strongly and yielded more than the plots inoculated when plants were younger. Some cultivars responded exactly the same, regardless of the age when they were inoculated," he comments.

"There was a similar effect with BYV — some held out better than others, leading to bigger yield impacts."

Virus strains

PhD student Suzannah Cobb is digging a little deeper, looking at the significance of virus strains to assess whether resistant cultivars will hold up in the field.

Using COVID as an analogy, she says she's essentially looking to see if there's a delta variant at play and if so, whether vaccinated beet will be protected.

"The BBRO trials are being conducted using virus originally collected from commercial beet, then maintained and cultured in the laboratory, but is this the same as the wild types in circulation in a field situation?"

Suzannah explains that the BBRO use an antibody-based technique to identify viruses — the same technology as a lateral flow test. "It's possible to distinguish BYV from the poleroviruses (BMYV and BChV) using this technique but it's not possible to identify the two viruses from the same family because they have a very similar structure."

To see whether BChV or BMYV is present requires a PCR test and this is what Suzannah is using in her project.

In 2019 and 2020 the sample size was quite small — 15 and 14 leaves respectively — and PCR showed 64% was BChV, 18% BMYV and 18% a mixture of the two poleroviruses. Last year enabled Suzannah to scale up and collect 338 leaves for testing. This showed 75% BChV, 18% BMYV and 7% a mixed population of the two.

"The three years of data indicates BChV is more common in the UK, which is interesting because it had previously been thought that BMYV was predominant," she says. "That's possibly good news because it's the slightly less damaging of the two."

So what about strains? Suzannah sent samples for sequencing and some genetic differences were found, indicating mutations were present in the field.

"We know the wild types differ from the strain we're using to inoculate field trials but at the moment we don't know whether this is significant. In 2022, I'll be inoculating using the cultured and wild type viruses which will be a world first."

Sharella Schop noted environmental effects had a much larger impact on aphid mortality compared than any genotypic differences.

Mature plant resistance

Sharella Schop is investigating mature plant resistance in her PhD at Wageningen University in the Netherlands.

"When aphids feed on plants with mature plant resistance, a black deposit forms in their stomach and this is the precursor of the aphid's death. We don't know what this deposit is so we're trying to identify it," she explains.

"We're trying to develop fundamental understanding of this mechanism and discover whether there's variation in mature plant resistance between cultivars. If there is then plant breeders will be able to look for a trait."

In climate-controlled experiments, Sharella observed a difference in aphid mortality between plant genotypes. Taking these genotypes into the field, a difference in performance was observed and of note was the high aphid mortality which occurred in July in response to a high temperature event, she comments.

"We saw that the environmental effect had a much larger impact on aphid mortality compared with the genotypic differences. To find out the biochemical pathway underlying mature plant resistance (MPR), we should investigate how the physiology of the plant leaf is affected by the environmental effects that resulted in high MPR."

Sharella has concludes that mature plant resistance is unlikely to be governed by a resistance gene, but she believes the physiological state of the plant is very important. ■


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