HGCA

from theory to field

And today's aphid forecast is...

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The UK can lay claim to one of the most sophisticated aphid-alert systems in the world. Recent research has flagged up virus threats and resistance challenges that could soon make monitoring for the pest an everyday farming routine.

By Tom Allen-Stevens

Most growers are probably unaware that aphid movements are tracked to such a degree that an infestation or potential virus outbreak can be predicted with a fair amount of accuracy. For the past 45 years, the Rothamsted Insect Survey (RIS) has used information on aphid movements across the UK to give a valuable indication of the threat to crops. Now, thanks to HGCA funding, it's been made more accessible to growers.

The RIS is a unique programme, says Dr Richard Harrington of Rothamsted Research. "It's the most comprehensive standardised dataset on any terrestrial invertebrate group anywhere in the world. What we have is a fantastic database of aphid dynamics that we can relate to weather data.

"Over the long term, this has shown there's a strong relationship between winter weather and aphid movements. That gives us a good indication of risk to spring-sown crops, while it also gives us good information in relation to those crops established in autumn."

Suction traps

Funded by BBSRC and the Lawes Agricultural Trust, the RIS gathers information from 15 suction traps across the UK (with the four in Scotland managed by Science and Advice for Scottish Agriculture — SASA). Mounted 12m high, these are monitored daily while aphids are in flight — early April until mid Nov — and weekly at other times, with the information collated centrally.

"The height of the traps means we're gathering regional, rather than field-specific, data. Actual numbers colonising a particular crop will depend on the crop and local conditions. But the regional information provides a good general picture of the threat from all of the economically important species."

While the information has a range of fundamental and applied uses, and provides a database of figures valuable for many research projects, its practical application for growers and agronomists was previously somewhat limited, notes Caroline Nicholls of HGCA. So in 2009, a new project, funded by HGCA and others (see panel), was set up to make the information easier to interpret and more widely available.

"The aphid advisory alerts provide really important information about when aphids are migrating at key times of the year. Autumn migrations are picked up first in the alerts and help growers decide about whether to spray against barley yellow dwarf virus (BYDV) and turnip yellows virus (TuYV)," she says.

The information from the trap sites is shown in the alerts as graphs. These display how each species has developed over the season and compares the data

with the previous two years and the 10-year mean. The result is a quick and easy view of the current pest pressure, notes Caroline Nicholls.

"The interpretation of the datasets goes out to agronomists, chemical companies, advisory groups and others to provide regular updates for growers," She says. This includes HGCA's Aphid News, while the information is also displayed on the Rothamsted website at www.rothamsted.ac.uk/insect-survey.

The aim is to rationalise the use of chemical insecticides. "With more growers receiving the information, they can use it to time treatments better, with less prophylactic doses, less harm to beneficial insects and less risk of insecticide resistance."

The aphid advisory alerts have also fed into other HGCA-funded work, she adds. "Aphids caught in the traps have been used for research into aphicide resistance, carried out by Rothamsted, and have also allowed us to provide information on the risk of TuYV, a virus we knew very little about before HGCA-funded work carried out at Rothamsted's Broom's Barn Research Centre."

It's also been a cost-effective route for providing an aphid-alert service to growers, points out Richard Harrington. "The really valuable aspect of this project for growers is that the extra funding builds on a lot of work that is funded from elsewhere, and it capitalises on the long-term nature of this investment."

Over the next year, there are plans to display the data as maps, as well as through the graphs. "It's not a straightforward task, but it's a request we've received from the field and I think it'll add more value for growers.

"I hope we can make this service available to even more people, because it has great potential — we can flag up signs of aphid problems early on, and spot unusual occurrences. We can also keep an eye of resistance."

The aphid advisory alerts make the data more accessible for growers, says Richard Harrington.

Dr Stephen Foster, of Rothamsted Research, has been leading work on sustaining the effectiveness of insecticides against aphid pests. "*Myzus persicae,* the peach-potato aphid, is adept at acquiring resistance to many insecticidal compounds. It feeds on a wide range of plants including brassicas, potatoes and ornamentals, so there's always a green bridge for it. So we have to monitor the level and nature of resistance, as things could change quickly, and this could have very grave consequences for the way we manage this pest."

Neonicotinoid concern

The biggest concern is for the neonicotinoids, he admits. "This is now the most widely used insecticide group in the world — sugar beet growers, for example, have no current viable alternative for controlling *M. persicae* on this crop. It includes many of the popular rapeseed treatments, such as imidacloprid (as in Chinook), clothianidin (as in Modesto) and thiamethoxam (as in Cruiser), and actives such as thiacloprid (as in Biscaya).

"In 2009, strong resistance to neonicotinoids was identified in southern Europe and we needed to know if this was spreading to the UK. MACE resistance to pirimicarb spread to the UK from this region, and this is now widespread."

The UK's network of suction traps provides good data on aphid dynamics.

MACE is a type of target-site resistance where a mutation occurs in the protein in the pest that insecticides normally bind to. It confers strong resistance, with pirimicarb the only insecticide in the UK currently known to be affected. Knockdown resistance, or kdr, can arise through one of two genetic mutations, and is associated with pyrethroids.

The three-year LINK-funded project set out in 2009 to assess and monitor changes in how *M. persicae* responded to newer ▸

Research round-up

HGCA project 3475, Aphid advisory alerts, runs for 48 months from April 2009. Its aim is to collect, interpret and rapidly disseminate relevant data on the numbers of winged aphid pests of cereals and oilseed rape identified in samples from a network of 15 traps. Total cost is £394,554, of which HGCA is contributing £131,518. Led by Rothamsted Research, industry partners are BBRO, BayerCropScience, and Syngenta. The project capitalises on investment from the BBSRC and Lawes Agricultural Trust.

HGCA project 3471 (LINK reference LK 09114), Sustaining the effectiveness of new insecticides against aphid pests in the UK, ran for 36 months and completed in Dec 2011. Its main aim was to maintain effective resistance-management options for improving the sustainability of insecticides, and avoiding ineffective applications. Total cost was £757,321, of which HGCA contributed £17,101. Led by Rothamsted Research with ADAS and Dewar Crop Protection, the project was co-funded by Defra (CRD), HDC, Potato Council, Bayer CropScience, BBRO, Belchim, Certis, NuFarm, and Syngenta.

HGCA project 3498, Strategies to reduce the impact of turnip yellows virus (TuYV) on UK oilseed production, ran for 40 months and completed in April 2012. Its aim was to raise the productivity of oilseed rape in the UK by increasing the awareness of TuYV and developing integrated control strategies. Funded by HGCA, the total cost was £121,536. Led by Broom's Barn Research Centre, project partners were Bayer CropScience, Syngenta and Velcourt.

For more information visit www.hgca.com.

Strong resistance to neonicotinoids has been identified in aphids in southern Europe, notes Stephen Foster.

▸ insecticides, as well as track the status of MACE and kdr mechanisms. The research also included some investigation into the neonicotinoid resistance mechanism.

"Again, this is target site, but acts at a different site in the pest's nervous system. So we now have three different target site resistance mechanisms."

A total of 200 samples were taken all over England, but excluding Scotland. These were reared further in the laboratory and the response of the aphids to the various compounds was assessed.

Subtle shift

"The good news is that none of the UK samples were found to be resistant to neonicotinoids, nor were they resistant to pymetrozine or flonicamid. Sometimes, we saw a subtle shift in susceptibility, but not full-blown resistance.

"We found that MACE resistance to pirimicarb was very common and widespread. 80% of *M. persicae* are resistant, so it's a waste to use this chemical against *M. persicae.* Kdr appears to be on the wane, and there's evidence that there's a fitness cost that's taking away selection pressure."

Aphids that evolve with a resistance mechanism can sometimes carry some other disadvantage, such as less natural defence against predators. If practices change, and there's less use of an insecticide with kdr, natural selection reduces the proportion of the population that's resistant to it.

"But there's a twist. There's another mutation, like kdr, which isn't at the kdr site — a super kdr that's also conferring resistance to pyrethroids. We also have evidence of kdr resistance in grain aphids — Sitobion avenae — that warrants further investigation." This could bring resistant aphids into cereals for the first time in the UK, he warns.

Samples of *M. persicae* aphids with resistance to neonicotinoids, collected from abroad, were tested. "We found there was a lower level of resistance where the aphid acquired the chemical systemically, such as through the leaf. Screening of UK *M. persicae* showed that we are currently

No room for hit-and-miss treatments

Ex Broom's Barn scientist, Alan Dewar, is predicting 2012 will be a bad year for BYDV and TuYV. "There was a late migration of aphids into mid-late Nov — a good three weeks longer than normal. But the chances are that many growers missed the best timing for BYDV sprays — one spray at the beginning of Oct would have been too soon, and a second spray would have been needed last year."

Now an independent consultant, based near Bury St Edmunds, Suffolk, Alan Dewar used to work for both the Insect Survey at Rothamsted, and now monitors crops as part of his advisory role to agrochemical manufacturers and others.

"The regular bulletin's a very useful service. It provides alerts and gives you geographical information about aphid movements. These are compared to the previous two years and the long-term mean, so you can quickly assess whether it's early or late and make the right decision about treatments, based on crop growth stage."

Few growers acted on the late migration of aphids in mid-late Nov, reported through the aphid alerts, believes Alan Dewar.

Autumn 2011 was a case in point, he says. "We had nice, warm conditions, compared with previous years. The late migrations were flagged up in the bulletins and I saw them in the field myself. Subsequently, there was widespread BYDV infection, but many crops weren't treated a second time following an early treatment, or the ideal timing was missed."

Unlike TuYV, an aphid seed treatment for BYDV can be an expensive insurance, he points out. "It's difficult to forecast what the pressure will be six weeks ahead of the best spray timing, that would have been at the end of Oct last autumn. Most OSR crops had a neonicotinoid dressing, but that would have lasted only six weeks, so the crop would have been vulnerable to TuYV infection during Nov."

He believes growers and agronomists should treat the aphid alerts as they do a weather forecast. "I think it's something growers should be clicking into on a weekly basis. We have to get into the mindset of applying products according to risk, and at the right timings — mixing insecticides with an autumn fungicide or herbicide is all too often a compromise, and can be a waste of product."

Many crops weren't treated for BYDV a second time following an early treatment.

More growers and agronomists should use the alerts to feed back actual sightings of aphids, he adds. "It's not easy to do as aphids are tricky to find when they first come into crops, especially in the autumn. But this would build into a very accurate picture of risk in a particular season."

A new feedback form, attached to the alerts, is planned to make the reporting of sightings easier, says HGCA.

Effective use of the service will become more important, stresses Alan Dewar. "There's now evidence of kdr resistance to pyrethroids in grain aphids, while resistance to neonicotinoids in peach-potato aphids is just round the corner. We'll not only need to be monitoring aphids and heeding alerts, but will need to know their resistance status too, so we can make the right product choices."

Turnip yellows virus, evident as a purple tingeing of leaf edges and pods, often goes unnoticed but could be taking 30% of yield.

not selecting for aphids with a potential high level of neonicotinoid resistance, which suggests that either farming practices or the conditions here in the UK don't favour aphids that are genetically inclined to develop resistance."

But the fact that strong resistance to these compounds has been found in southern Europe means it's probably only a matter of time before it spreads here, he warns. "We need to keep monitoring, and growers should look out for aphid alerts and take the appropriate action, and also avoid using pirimicarb for *M. persicae*."

This could have a very important implication for TuYV in oilseed rape over the coming year. This virus, that could be taking 30% of yield, often goes unnoticed. It's hard to spot, and until an HGCA-funded research project on it started in 2009, it was barely recognised as a problem at all.

"One thing the research has established for sure is that TuYV is present and clearly can have a very serious impact on oilseed rape yields," points out Dr Mark Stevens of Broom's Barn.

He's adamant that this is an example of a crop threat that can be minimised through monitoring and a little knowledge of the vector. "The risk of the virus infecting crops is very weather dependent. It relies very much on aphid movements in the autumn and winter."

Again *M. persicae* is the key vector. They colonise crops as they emerge in Aug and Sept and migrate through the crop-growing area until winter sets in, spreading the virus. The infection doesn't show until late spring/early summer, evident as a purple tingeing of leaf edges and pods, easily mistaken for the crop's reaction to cold weather or phosphate deficiency.

Recolonisation of the crop in spring and early summer then carries infection over into the next year, while many weeds are also susceptible, including shepherd's purse, groundsel and chickweed. "But it's not transmitted through seed," assures Mark Stevens.

Virus levels

The project set about establishing the relationship between aphid numbers and potential crop damage. "We not only monitored the level of aphids, both through suction traps and yellow water pans in fields, but also assessed the level of virus they were carrying. Then we related that to virus found in the crop.

"During the project, we found up to 30% of aphids could be carrying the virus, and in 2007, up to 70% of aphids tested contained TuYV."

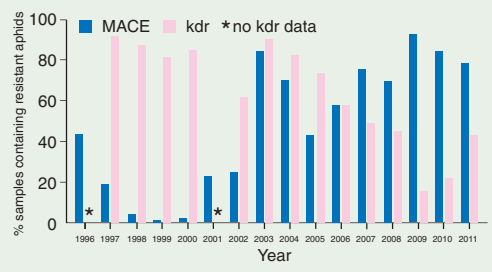
Inoculated trials have assessed varietal susceptibility and the relationship between virus levels and yield loss. "Varieties don't build up the virus to the same level — some contained four times as much virus as others. Yield loss ranges from 12-30%."

But the vital link is the vector itself. In the early autumn, provided the crop has an appropriate seed dressing, it'll be safe from both aphid and virus up to six weeks after sowing. "But seed treatments eventually run out of steam. What we saw last autumn was migrations right up until Christmas. We've levels of TuYV in crops ranging from 10-84% because very few growers went in with a secondary treatment.

Levels of TuYV in crops range from 10-84% this year because very few growers went in with a secondary treatment, says Mark Stevens.

"Of course, product choice is limited in late autumn, as a result of resistance, and it's difficult to know just what the yield impact will be at harvest. But growers who are surprised by yields that are lower than expected may want to pay more attention to aphid alerts this autumn." ■

Frequency of resistance mechanisms in *M. persicae* on field crops



MACE resistance to pirimicarb is very common and widespread, but kdr appears to be on the wane.