Fending for the natural foe

> *"There's a big opportunity to develop biocontrol measures."*

Technical IPM special

Oilseed rape is a crop that still has a lot to offer if the CSFB problem can be overcome, but many of the growers sticking with the crop this autumn will be hoping fortune favours the brave. *CPM* investigates the role of natural predators.

By Lucy de la Pasture

With the realisation that chemistry no longer cuts it as far as reliable cabbage stem flea beetle (CSFB) control is concerned, all eyes are on the scientific community to help come up with an alternative strategy to keep oilseed rape in the rotation.

Understanding the behaviour of the pest is an important step in developing ways to manage it and in this 17-page special, *CPM* explores IPM in practice and some of the new research into the ecology of CSFB and slugs (page 20), which may help lead to improved IPM practices in the future.

There's still a lot that isn't understood about CSFB, explains Dr Sam Cook, insect behavioural ecologist at Rothamsted Research.

"We know the basic lifecycle for CSFB but not the mechanisms behind each stage. For instance, we don't know how they locate the OSR crop — whether it's visual or an olfactory (by smell) mechanism. We don't know the signals that cue female egg-laying and we don't know where the pest goes to aestivate (a summer diapause) after OSR harvest. Importantly, we also don't know how far CSFB can fly to migrate into crops in the autumn."

Disrupt lifecycle

Once all these things are understood then it'll be possible to work out the most effective ways to disrupt the pest's lifecycle. "There's a big gap in our knowledge at the moment but there's also a big opportunity to develop biocontrol measures," she adds.

Re-establishing OSR as a viable crop to grow is desirable because, as well as a big loss to the rotation, a decline in OSR area is a blow to farmland biodiversity, says Sam. "We've found more than 150 different species make their home in the OSR crop. Insects love it and that's good for farmland birds."

The explosion of CSFB in recent years has been due to a number of factors, which together have created a perfect storm for the pest, believes Sam. "We've now lost control of CSFB, but we were already on the verge of losing control before the neonicotinoids were revoked — even then, adult numbers were already increasing rapidly.

"This rise in the adult population combined with three mild winters, which facilitated prolonged periods of egg laying and larval development, has caused a problem on the scale we currently face," she adds.

Ironically, work was underway in the late 1990s to seek answers to precisely the questions that still remain over CSFB, but ▸

Sam Cook says we need to learn a lot more about the phenology of CSFB so that ways can be found to disrupt its lifecycle.

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▸ the introduction of the neonicotinoids shifted research focus away from the pest and onto pollen beetle, which was deemed a greater threat at the time. Researchers are now playing catch up and, in spite of the importance of the pest, funding for these empirical studies is hard to come by in the UK, explains Sam.

The good news is that some work is now underway and AHDB has recently put out a call for research into the fundamental phenology of the pest. Sam is also co-supervising a research student at the University of Göttingen in Germany, who is researching how CSFB locate crops for his PhD.

But Sam believes a study on the population genetics is also badly needed to find answers to some of the other pressing questions about the pest, which will influence the scale of controls needed to bring its population back under control.

"For instance, dropping OSR temporarily in the rotation in whole areas is being proposed by some but in order for this to be successful, we'd need to know how far they can fly to find crops."

Ground beetles eat the eggs laid by cabbage stem flea beetle in the soil and are harmed by pyrethroids, particularly when sprayed at night.

Likely candidates

There's some excitement about the potential for natural predators to assist with CSFB control and recent work at Rothamsted Research and John Innes Centre (JIC) has discovered some likely candidates for the job.

"We already know big carabids eat the eggs laid by CSFB adults in early autumn. A main focus of the Ecostack project is using camera traps to see what's eating the eggs so we can rank the relative importance of different carabid species," she says.

But it's not just ground beetles that may prove a useful ally. "There's a species of parasitic wasp, *Tersilochus microgaster*, that attacks the larval stages. Unfortunately this parasitoid isn't of much use to the grower as it attacks the larvae and pupates in the soil, so when the parasitized larvae drop off the plant onto the soil the damage has already been done to the crop. But they could have a role in decreasing the CSFB population on the farm in the following year," she says,

Cabbage stem flea beetle migrate into newly planted OSR crops in the autumn, but it's not known how far they can fly to find the crop.

adding that to establish the significance of this, it'll again be necessary to understand the distances adults can migrate.

Another parasitic wasp, *Microctonus brassicae*, was first identified by Rothamsted's Andrew Ferguson in 1996 but was recently 'rediscovered' and described by Anna Jordan at JIC, says Sam.

"*M. brassicae* lays an egg inside the adult CSFB and, when the larva hatches, it basically eats the beetle from the inside out — eventually leaving its host via its backside once it has completed its final instar, killing the CSFB."

Researchers at JIC believe that once 'infected', the CSFB host is quickly rendered sterile, even though the adult beetle's feeding is unlikely to be affected in the early stages. Potentially

Battering with a blunt instrument?

Pyrethroid resistance in the CSFB population has now reached the level where these insecticides are potentially doing more harm than good if repeatedly applied to OSR crops. Rothamsted PhD student Caitlin Willis is looking at the resistance levels in CSFB adults collected by growers under the tutelage of resistance expert, Dr Steve Foster. She detected 100% resistance at eight sites in England in 2019, which is the first time a population has been discovered to have complete resistance to pyrethroid chemistry.

"We found 100% resistance at sites in the East, South East and another in Yorkshire. On average, 55% of the adult CSFB tested had pyrethroid resistance, which is an increase from 33% in 2018," explains Caitlin.

Pyrethroid resistance used to be confined to the areas where pressure from CSFB has traditionally been highest but Caitlin's analysis shows that it's a problem that has now crept into the North and West of the country.

"We found resistance on some farms that hadn't sprayed pyrethroids at all. Because we don't know how far the adults migrate, it's impossible to predict the degree of resistance present in the CSFB population on any one farm from year to year."

Caitlin is also looking at the resistance mechanisms present in CSFB. "In Europe it's known that there is target site pyrethroid resistance (knockdown resistance (kdr) and super kdr), which is due to a mutation in the sodium channel. While the incidence of this mechanism hasn't changed in the UK population in 2018 and 2019, the degree of resistance in CSFB has, indicating another resistance mechanism is present.

Caitlin Willis has been testing CSFB for pyrethroid resistance and last season she found 100% resistance for the first time and the average level of resistance at 55%.

"We're looking for metabolic resistance in UK populations of the CSFB which involves the upregulation of an enzyme. By looking at the genes we can determine if this is happening."

M. brassicae could offer a biological control for CSFB but very little is known about its prevalence or levels of parasitism in the field. Rothamsted PhD student, Patricia Ortega-Ramos, is seeking to establish this missing information and has been analysing more than 250 CSFB samples sent in by farmers across the UK last harvest.

"Patry's analysis has been delayed by the Covid-19 pandemic but she's found *M. brassicae* present in 70% of sites and with a parasitisation rate of around 7%. To be an effective biological control this needs to be higher, at around 40-80%."

That's not to say *M. brassicae's* potential to assist with CSFB management should be dismissed, believes Sam. "If we can understand how to support parasitoids on the farm then it should be possible to increase their prevalence and efficacy. Patry will also be looking at the agronomy at different sites to see if any particular practices benefit or adversely affect the parasitoids," she says.

Field margins, beetle banks, conservation and wildflower strips may provide a habitat that will support and protect *M. brassicae* and further understanding of its phenology will help determine exactly which measures are most beneficial, adds Sam.

"We're also looking at the resistance of natural enemies to insecticides. One of lthe biggest worries is that growers are resorting to repeated sprays of pyrethroids at night, which is when carabids are most active. I'm not sure there is an awareness yet of just how much harm growers are doing to beneficial insects with these practices." ■

Larva of the parasitic wasp Microtonus brassicae *larva exiting the anus of a CSFB.*

No insecticide policy for OSR

Julian Gold describes his own farming experience as constantly playing golf in the dark — "you hit the ball but are never really sure where it's landed." But even though it's not always easy to get empirical results in his farm trials, that hasn't stopped him from trying new approaches on the 750ha Hendred Estate he manages near Wantage in Oxfordshire.

Like many growers, Julian experienced some failed OSR crops last autumn but doesn't consider CSFB was the sole reason. He believes the pest gets the blame for every crop failure but usually it's a combination of factors working against the crop, with slugs and snails often underestimated and doing their fair share of damage on his farm.

"Last year the crop failure was down to the week it was drilled. Half the OSR went in between 13-20 Aug and was mostly fine, the other half was drilled in the first week of Sept and all failed. It was due to the lack of soil moisture as much as the CSFB pressure at the time."

Julian is abandoning spraying pyrethroids on the farm, with the possible exception of BYDV control in cereals. He firmly believes that it's pointless trying to target CSFB with pyrethroids because more benefit can be had from helping predator numbers build up on the farm in the longer term. When that happens, the pests aren't likely to be as much of a problem as they currently are, he says.

Getting off the hamster wheel is one of the phrases many farmers with a regenerative approach often use. Julian had his 'aha' moment when he first got his own beehive and fully realised the connection between farming and the environment. He describes industrial agriculture as concentrating on the production line without thinking about maintaining the factory. A scenario which means eventually the whole thing will at first leak and eventually come crashing down.

So instead of reaching for the can, he's aiming to safeguard his OSR crops by ensuring good seed to soil contact at drilling, something which isn't always easy on his high calcareous soils.

"It's the nail in the coffin if soil to seed contact isn't good enough, so multiple rolling is likely to be a key part of our strategy. I've been aiming for two passes with the Cambridge rolls for the past couple of seasons but I'm planning on trying to find the time for at least three or four passes this autumn because it also stops CSFB and slug movement."

The farm chops all straw behind the combine and has impressive soil organic matter levels of 5-7%. He's found the quality of straw chop has a huge bearing on the success of OSR establishment, which mostly follows winter barley in a six-year rotation on the farm.

"As soon as it gets damp in the evening then the few mm's difference that makes to the quality of the straw chop is noticeable in the following OSR crop."

The Hendred Estate is one of twenty farms taking part in the ASSIST project, led by the Centre for Ecology and Hydrology, with Rothamsted Research and the British Geological Survey as partners. The aim is to assess the impact of wildflower strips down the middle of fields on natural predators over five years.

Although it's too early to make any conclusions from the work, anecdotally there are already positive signs, with the OSR in the no-insecticide ASSIST trial achieving 100% establishment last autumn.

"Drilling into the data when it's collected will provide a fascinating insight into the measures that could encourage natural predators and bring the farming ecosystem back into balance," he believes.

Wildflower strips through the middle of fields have been planted on the Hendred Estate as part of the ASSIST project with the aim of helping to nurture natural predators.

Julian Gold sees no benefit from using pyrethroid on his OSR crops and will be concentrating on planting conditions to give his crop the best possible chance this autumn.