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AHDB

from theory to field

Following the slime trail

A new insight into the behaviour and movement of slugs begs the question whether overall molluscicide treatments are sometimes more than what’s actually needed to suppress pest numbers. *CPM* explores where this research may lead in practice.

By Lucy de la Pasture

You could say changes to management practices to control slugs have been about as sluggish as the pest itself — with very little in the way of innovative applied research for decades. An AHDB-funded project underway at Harper Adams University has bucked that trend and is investigating the basis for a much more targeted approach.

The foundation for the project was a PhD which confirmed that sluggy patches in fields were stable, explains Charlotte Rowley, who manages pest research at AHDB. “The initial work opened up the possibility of a more precise approach to slug control which would help safeguard ferric phosphate and increase the viability of options associated with higher treatment costs, such as biological control.”

Author of the PhD, Dr Emily Forbes is very much a part of the follow-on work at Harper Adams University, with colleague and principle investigator Prof Keith Walters. She explains that the aim of her original research was to investigate the potential for targeting the specific areas with high densities of slugs using a reduced overall amount of molluscicide, while still maintaining control.

Practical system

Keith stresses that right from the outset, the aim was to produce a practical system that will be useful to farmers which means it has to take any commercial constraints and practices into account. “Our work has been guided by industry rather than the just biological interest. That’s fine-tuned the directions the research has taken in order to find workable and acceptable solutions that fit into normal farm practice.”

To test the feasibility of a precision approach to slug control, the first big question to answer was whether the patches are stable in time and space, he explains. “This is important because if the patches where the slugs congregated weren’t stable then the area that needed treating would have to be redefined for every molluscicide application — this would be unfeasible.”

Emily explains that a lot of the literature says that the slug population isn’t uniformly distributed within a field, yet there’s little research evidence to show this. “To look at this scientifically, we undertook repeat sampling of refuge traps set up at 10m intervals on a 10 x 10m grid across the field. We found that in different fields and ▸

Keith Walters says the use of RFID tags has revolutionised the understanding of slug behaviour.

▸ in different seasons that slug patches within fields had the same pattern of stability," she says.

Keith highlights that the design of the grid was critical to the success of the work. "If the traps were too far apart then hotspots would be missed but if they're too close, then more monitoring would be undertaken than needed for the research. Mathematical modelling, in association with the Universities of Leicester and Birmingham, has helped speed up the project by assisting with the design."

Slug management techniques haven't evolved much over the past few decades but this new research hopes to deliver a more precise approach.

The second question to address was whether the patches of slugs were large enough to target with treatments. "Many growers already patch treat but we wanted to establish whether treating the large patches gave sufficient suppression of the slug population or if there were other, smaller patches which collectively also require treatment," he explains.

Mapping technology

This is where working with industry has proved invaluable, adds Emily. "Mapping technology has been used to identify the sizes of patches to be treated and we've found that it's feasible to treat the smaller ones using a conventional pelleter."

Our extensive field work has shown that slug patches within fields come and go — they're not detectable all of the time, so the third aim was to find why this is, explains Keith.

Emily explains slug behaviour explains this observation because slugs aren't always present on the soil surface. "Slug activity is dependent on weather, with mild and wet conditions favouring activity. When it's very cold, hot or dry then slugs are less likely to be found on the soil surface. This isn't an issue for patch treatments as they can be targeted at times when slugs are actively feeding, so patches don't really come and go, they're just not always active. The important thing is when they are detectable, they are always in the same places."

Slug damage is known to often occur in patches within the fields, but this study is the first time that research has sought to understand why this is.

Revolutionary study will challenge thinking

Clive Blacker has been a champion of precision farming for the past 20 years, first introducing practices on his own farm in 1998 before setting up the speciality company, Precision Decisions in 2004.

He describes current methods of slug pellet application as a bit 'hit and miss' so he's enthusiastically supporting the work at Harper Adams to develop a more accurate method for defining areas in the field where there's high slug density and help engineer the treatment solution.

Even though the trend is for farm machinery to get larger and many pelleters now have the capacity to achieve a 24m spread, accuracy is often wanting, he notes. Targeting smaller areas where there are slug patches will require a little more finesse and this is where Clive's expertise in using data to manage variability on the farm comes to the fore.

"It's not beyond the wit of man to put section control or enable smaller spread widths to treat certain areas of the field," he comments. "This new slug work is putting some science into how we approach slug treatments and as we understand the findings, it will help us improve the efficiency of molluscicide application and farm profitability.

One of the most fascinating areas of the study is the insight into slug movements that the RFID tagging has brought to light, says Clive. "It's incredible to have this better understanding of slug movement, especially when they're beneath the soil surface. It turns out that they're not as nomadic as we thought they were."

Precision Decisions specialises in remote sensing and precision soil mapping to generate the data to help growers manage variability on the farm. This is then interpreted into usable and easily deployable solutions, such as variable seed or fertiliser rates. The company's collaboration in the project means that it's possible to deal with practical problems as they arise and Clive sees it as a big opportunity to find a better solution to slug control and challenge the current thinking.

"It's still early days in trying to understand the relationship between soil characteristics and slug population. We've supplied Emily with Electroconductivity (EC) data which is providing an insight into the textural variation within fields and we're able to look at this at different depths — the soil surface and the sub-surface layers. It will be interesting to see how this correlates with slug populations," he comments.

In time, Clive believes the findings of the project will enable growers to map fields specifically for the risk so that high risk areas will be known before planting, when the slug problem is often unseen.

"There are many contributory factors we'll want to assess before a system is in place. These will include the effect of local conditions such as soil moisture, tillage, compaction and seedbed condition," he adds.

Clive Blacker says EC data gives an insight into the textural variation in the soil at different depths which may correlate with slug populations.

"Growers have shown immense support for this project and have helped by providing trials sites. We're all finding it exciting to work with a bright, young scientific mind and the enthusiasm Emily has brought with her in using new techniques to study slug populations.

"By helping us understand where the biggest risk and scale of slug damage is going to be in a field before it happens will allow us to monitor better and to be more proactive about treating slugs — allowing us to get on top of the problem before it becomes one."

The aim of the research is to develop criteria which can be used to produce GPS maps of areas within fields that are at risk of slug damage.

Up until this point in the research, the science applied by the researchers provided explanations for phenomena which have been anecdotally noted in fields by farmers and agronomists for years. But the researchers had a real eureka moment when they started to ask why patches were stable in fields for long periods of time. New technology was to provide an insight into the behaviour of slugs that's never been possible before.

"We needed to understand the behavioural mechanisms that caused slugs to congregate in one area without dispersing. Following slug movement is tricky because they go underground, but we were able to utilise radio frequency identification (RFID) for the first time and tag individuals to follow them," explains Emily.

Although RFID has been used in larger species, this sort of work hasn't been possible in species the size of the grey field slug (*Deroceras reticulatum*) until very recently, when tags the size of a grain of rice have become available.

It turned out that slugs weren't very adventurous after all. "After initial lab work to make sure the tagging didn't change the slug's behaviour, we moved into the field to track tagged slugs over two five-week periods, in autumn and spring. This involved using a RFID scanner, with which we swept the ground in a very similar way to a metal detector, and we found 80% of slugs stayed very close to their release point," she says.

Slugs were tagged with tiny RFID tags and their movement was monitored day and night to discover where they moved, both above and below the ground.

This 80:20 rule has been noticed in a range of animal species, adds Keith. "In a semi-discrete population, there has to be some mixing with other populations to maintain genetic diversity — so this may be why 20% of slugs wander further than the others."

The tagging work has since been followed by some modelling to dig into the detail of why patches are stable and has involved releasing slugs singly and in groups.

Shorter distances

"We found that those released in groups moved more slowly and shorter distances, and with a strongly biased distribution of turning angles. This was due to their interaction with other slugs and helps makes a patch in the field cohesive," he explains.

"There are a number of such interactions that may contribute. We know from another study, many years ago, that slugs will follow a fresh slime trail. Grey field slugs only seem to do this very infrequently, less than 10% of the time. Where slugs exist in a higher density then this happens more often and can make a difference to the rate a patch spreads in the field.

"These conspecific (between same species) reactions increase our confidence by suggesting biological reasons for why patches are stable," comments Keith.

The next important step was to find out whether sufficient economic savings were possible to make patch treatment worth considering. Through collaboration with industry, the researchers found that in some fields a 30-40% reduction in pesticide, labour and fuel was possible. They also found that monitoring the slug population using refuge traps (much as is done currently) would be an effective way of triggering a threshold for treatment, if the new system were able to target exactly where the patches are likely to occur in fields.

Refuge traps were placed at 10m intervals on a 10m x 10m grid across fields to monitor slug populations.

"And that remains the $64,000 question and it's the final stage of the project to work out how to determine where the patches are in fields and, critically, where the edges are to these patches," adds Keith.

Emily explains she started to look at various soil characteristics during her PhD and found some may be linked to slug location. The AHDB project is expanding on this early work to determine which of these characteristics can provide a precise way of locating potential problem areas in fields.

"We're currently analysing samples from last year and looking at EC scans, as well as other soil characteristics that are commonly mapped. In the coming season we'll be using soil characteristics to predict where slug patches will occur within fields," she says. ■

Research roundup

To get further insight on how to 'plug the slug', visit *ahdb.org.uk/slugs*

AHDB Project No. 21120078 'Development of a commercially viable and environmentally sustainable approach to slug control' is led by Harper Adams University and runs from Aug 2019 to April 2021 at a cost of £120,000.

AHDB Student Report 42 (PhD) 'Utilising slug distribution to develop precision application' ran from Oct 2015 to Sept 18 and was funded by a contract from AHDB for £34,000.

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