Project advances quest for sustainable slug control

Slugs are a perennial headache for growers, while efforts to improve the sustainability of the pest's management have been lacking until a recent industry collaboration took the mollusc by the tentacles. *CPM* reports on findings from the first two years of work.

By Rob Jones

By unlocking the secrets of slug behaviour and harnessing the power of predictive modelling, a research project aims to arm growers with tools to manage slugs in a more targeted and sustainable manner.

Back in 2023, a research proposal landed £2.6M from Innovate UK to come up with Strategies Leading to Improved Management and Enhanced Resilience against Slugs, known as SLIMERS.

Led by the British On-Farm Innovation Network (BOFIN), it combines expertise from organisations including the UK Agri-Tech Centre, Harper Adams University, the John Innes Centre, artificial intelligence (AI) specialist Fotenix, and precision farming firms Farmscan Ag and Agrivation.

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Slug expertise

Harper Adams University's Professor Keith Walters, has been running SLIMERS experiments, primarily aimed at improving the understanding of slug behaviour within arable systems.

established that patches of slugs were spatially and temporally stable, but there was still plenty to learn about the underpinning biology driving patch formation and location.

Furthermore, Keith says it's well-known that slugs are typically found in damp environments and thus move down the soil profile in dry periods. But, they also shy away from conditions with high pH levels, while preferring certain soil textures and plenty of organic matter, which not only provides food but also helps to maintain soil moisture.

"Nobody had taken all of these factors and quantified how they nteract to influence where the higher density slug patches occur," points out Keith.

SLIMERS has also involved farmers across the country, who set up 1ha blocks of slug traps in fields spanning different soil types, and took weekly slug counts along with photos of any crop damage.

INDICATING TRENDS

Keith says the vast data set collected showed some interesting trends. "You start with slugs distributed across the field all moving randomly. When they get to areas that are more favourable, they tend to slow down and stay there.

"Some will leave and move to a less favourable area, but a lot of those return when they realise what they've done. Others just resume random movement," he explains.

After discovering broadly where slug patches are likely to occur, Keith and the team wanted to know what makes them stable. Keith says firstly, the molluscs react to the presence of other slugs, so when encountering each other in favourable areas, they slow down and stay together, further increasing the density of the patch.

They then often switch to a circular movement pattern, with some turning right and others turning left. This spiralling keeps them in the same area and increases the likelihood of encountering and breeding with other slugs, further increasing the density of the patch, he adds.

The final piece of intelligence gathered on slug biology, has been their response to waterlogging, as seen during the two years of data collection. Despite their love of moisture, slugs can drown, so when soils become saturated all the patch-creating behaviour is overridden by a fight for survival as they scatter to drier areas.

"It really goes against the patch formation theory, but our farmers suggested they wouldn't go out and treat in such wet conditions, so it doesn't affect treatment decisions

Making a difference

Why one grower decided to work with scientists to address his farm's slug problem

For grower David Fuller-Shapcott, the key driver for involvement in SLIMERS was the chance to help shape a better and smarter way of controlling slugs.

Farming 369ha near Kelso, of which around 325ha is combinable crops, David also grows peas and oats for a local AD plant, and has 21ha of hemp this year. A move towards direct drilling and reduced soil movement had raised concerns regarding slugs in cereals after oilseed rape, and subsequently led to a rise in slug pelleting.

"Climate change also means that our clay soils are generally wetter during the autumn period when slug risk is most extreme which is making it harder. Being able to work with scientists to understand the issue and get better and smarter at managing it seems the appropriate thing to do," explains David.

He says he's also worried about the limited choice of treatments, with ferric phosphate pellets applied every time thresholds are met. "There's nothing much we can do preventively and if something was to happen that meant we can no longer use pellets, we have a serious problem."

Rising slug pressure
A move towards direct drilling and reduced soil movement at David Fuller-Shapcott's farm raised concerns regarding slugs in cereals after oilseed rape, and subsequently led to a rise in slug pelleting.

David is one of many farmers who have been collecting data for SLIMERS, including feeding into the AI model currently in development. He hopes the model will enable him to apply pellets through a GPS-controlled applicator and reduce overall use.

"Most of us know which areas of fields are worse for slugs already, and the chances are that the model will tie in with that this year. If it does, we can be much more confident about where we do and don't treat, and then it really starts to look interesting from a cost and a sustainability point of view."

He also hopes that resistant varieties will play their part, having observed that slugs don't appear to like Elsom's soft feed wheat Blackstone. As such, SLIMERS will be looking at this further.

anyway," notes Keith.

The dedication of participating farmers to deliver data through all weathers has led to the creation of two AI models that predict slug risk and aid management decisions. One is based on slug numbers and behaviour along with physical factors, but requires more data to train it and will be subject to further feasibility testing.

The second and more immediate option, uses biological data on soil type and environmental conditions to predict where slugs are likely to exceed thresholds, displayed as a slug risk map. For this, the user can adjust the threshold for treatment, for example, setting it slightly lower in fields with a history of significant crop damage and vice versa.

SOIL DATA

One of the key questions during the development of the models was how to feed accurate soil type data into the system. Consequently, developers have incorporated electroconductivity (EC) scan data which is often collected for other husbandry purposes, such as fine-tuning nutrient applications, seed rates or soil management.

With encouraging results so far, the model will be tested this autumn, with farmers involved to provide feedback on its performance.

Keith says the aim is to quickly create a digital risk map to automate patch treatment, with the GPS system switching the applicator on and off as it moves across the field. Perhaps importantly, equipment manufacturers have already indicated that existing systems could be tweaked to work in this way.

Such a valuable decision support and patch treatment system is a major step towards designing a solid integrated pest management (IPM) strategy for managing slugs, adds Keith. It's also hoped that patch treatment will make biological slug control methods such as entomopathogenic nematodes more viable.

For another layer of robustness, the smart technology has the potential to be underpinned by varietal resistance to slugs – in wheat at least – after the project has helped to maintain momentum in breeding efforts at Norwich's John Innes Centre (JIC).

A decade or so ago, JIC researchers screened material from the Watkins Landrace Wheat Collection for slug resistance using lab-based tests and found encouraging lines. Planting that material in the field at Morley research farm appeared to confirm the lab results, however, there was a hiatus until BOFIN pushed things on.

JIC's Dr Simon Griffiths, who leads the Delivery Sustainable Wheat (DSW) programme, has been working on slug resistance within SLIMERS. He says the project has facilitated more farm-scale trials of the material with resistance, which have shown consistent results in the field. But, this doesn't tell researchers anything about the nature of the resistance or how it might be used in breeding programmes in the future.

This has led researchers to produce around 90 recombinant inbred lines derived from backcrossing the Watkins resistant variants and the UK spring wheat, Paragon. By observing the segregation of traits within this material, researchers can associate resistance or susceptibility to slug damage with specific genetic markers.

Simon says they're now confident they have two genes – or Quantitative Trait Loci ▶

(QTL) – that are conferring slug resistance. This breakthrough will enable breeders to select for these genes, accelerating the development of slug-resistant wheat cultivars.

The pre-breeding process that introduces the genetics into commercial lines will start immediately and take around four years, with candidates then going into commercial trials, he adds. “Those varieties will initially be off the pace in yield and other important characteristics so there’s no quick fix, but we’re delighted with the progress so far.”

Simon comments that he’d like to see existing commercial wheats screened for variation in slug resistance and that his preferred long-term route would be to have the trait recognised on the Recommended List, similar to orange wheat blossom midge (OWBM).

“It’d give growers and agronomists another tool to use in risky situations, such as on heavy soils, in reduced tillage systems, or following oilseed rape or other brassica crops.

“You’re helping to keep the pressure as low as you can with the genetics, use ferric phosphate pellets to control hotspots, and in time, potentially spot spray nematodes when it’s economically viable,” he says.

SUSTAINABLE CONTROL

Certis Belchim’s Nathan Whitehouse says the developments coming out of SLIMERS are encouraging for sustainable slug control, something the company has been involved in for some time. Working in partnership with German manufacturer Neudorf, the firm has optimised the efficacy of ferric phosphate baits through the development of more durable, high-performance pellets that last in wetter conditions.

He adds that this is largely down to the best ingredients such as a pasta-based pellet, food-grade anti-mould agent, and EDDS chelating agent which is unique to Sluxx HP formulations. The chelating agent gets ferric phosphate into the gut of the slug to deliver the lethal dose while the EDDS technology is less prone to leaching of the active substance from pellets in wet weather, explains Nathan.

“After all of the effort and investment in developing a successful product like Sluxx HP, it’s vital that it’s used appropriately and in a targeted way to avoid overreliance on a single active substance.

“Tools like risk prediction models, patch treatment and resistant varieties are all welcome additions to slug management strategies, and will help to ensure the long-term efficacy and availability of ferric phosphate.”

Varietal resistance
Having undertaken extensive new work, John Innes Centre’s Dr Simon Griffiths says he’s confident two genes have been identified that confer slug resistance.