

## Future looks to biology

“Thyme and spearmint oil are lethal to the grey field slug.”

### Slug control

After many years of stagnation, innovation has been reignited in the field of slug research. *CPM* finds out how plant extracts, biologicals and robots could form the basis of control strategies in the future.

By Lucy de la Pasture

**Active ingredients and brands of slug pellets have come and gone over the past forty years but in reality, very little has changed in the way slugs are controlled in field crops. Currently there's just one molluscicide active ingredient being manufactured and pellets have a method of application that's relatively untargeted, the time is ripe to explore alternative, effective and eco-friendly control measures.**

There's been an injection of enthusiasm into applied slug research, particularly since Dr Jenna Ross returned from a recent Nuffield Farming Scholarship which considered mollusc control measures across the globe. One of her conclusions from her travels was that the study of malacology appears to be in difficulty, with no clear succession plan in place, and limited funding to share and develop ideas.

Now a member of the Crop Health and Protection (CHAP) team, Jenna and her colleague Dr Archita Barua have been briefing new life into the subject. With the help of Dr Christopher Williams of Liverpool John Moores University, they undertook a literature

review to assess the biological and biorational strategies that may have potential for slug control in the future.

There are 42 different species of slugs in the UK and over 50% of them are non-native, explains Archita. Because it only needs one slug to breed, there's an ever-present danger of new invasive species smuggling themselves into the country. As the number one pest of arable crops, slugs aren't a pest to be ignored.

### Potential

Of the three main biological control prospects — parasitic nematodes, carabid beetles and sciomyzid flies — Jenna believes there's a lot of potential in nematodes. It's not a new concept — *Phasmarhabditis hermaphrodita* has been on the UK market since 1994 as Nemaslug but has not been an economically feasible option in arable crops. In the UK the cost of Nemaslug is £110/ha and it requires application using a large volume of water. It has other practical issues such as strict storage requirements and a short shelf life.

“When I began my career as a nematologist over fifteen years ago, there were only three nematode species within the *Phasmarhabditis* genus. Years on, and lots of international survey work later, the genus has boomed to 15 species so it's possible that one of these could be better to utilise for slug control. It's an area where there's massive potential for more research and development,” says Jenna.

The review also highlights studies which cast doubts over the pathogenicity of the strain used in Nemaslug, which has now been cultured over a long period of time.

There's a suggestion that wild strains of *P. hermaphrodita* may cause more rapid mortality and feeding inhibition.

“In particular, a better understanding of *P. hermaphrodita* association with bacteria is desirable. The relationship between the cultured nematode and bacteria in Nemaslug is artificially created so there are research opportunities to look for other bacterial species and their virulence on different slug species.”

There are also insect species which could potentially be used as biological controls for slugs in field crops. Sciomyzid (or Marsh) flies are natural enemies of slugs and snails, having larvae that display a wide range of feeding behaviours which include predation and parasitism. Of the Sciomyzids, *Tetanocera elata* has been reported to be a potential slug control agent but lab studies have highlighted some potential hurdles. One of these is that the larvae don't hunt for their



Jenna Ross says there's massive potential for further research to help develop slug controls using biologicals, such as nematodes, sciomyzid flies or carabids.

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*Slug research has been revitalised in recent years and the drive towards more sustainable farming systems means new solutions are being investigated.*

► prey, it's more a case of a chance encounter or starve.

Better known for their penchant for slugs are the carabid beetles, so is there any

potential to extend their role as natural enemy to a biocontrol species?

"There has been some work on the use of carabids within sustainable agricultural practices, but more could be done to focus on their potential for biological control. We believe that carabids are probably best as conservation biocontrol agent, but there remains a research gap between their ecology in conservation headlands, field margins and beetle banks and their biocontrol potential in arable fields," says Jenna.

Other potential future non-chemical options for controlling slugs are natural products containing plant extracts — these come under the 'biorational' title. Perhaps of most interest are essential oils, explains Archita.

Biorational products made from essential oils are already gaining traction in mainstream agriculture; for example, spearmint oil is approved in potatoes for

sprout suppression in the UK, with approval for orange oil in the pipeline.

Essential oils are obtained by the steam distillation of plants and contain the aromatic fraction of compounds present in the plant tissues, many of which are used in plant defence mechanisms.

"In lab and glasshouse experiments, researchers have observed that thyme and spearmint oil are lethal to the grey field slug, *Deroceras reticulatum*, and several other essential oils exhibited low-moderate levels of toxicity," explains Archita.

Their lack of phytotoxicity to plants or restrictions on field use and relatively easy commercial availability make essential oils an enticing area for further research.

"Some essential oils look promising because they can kill slugs, as well as boost plant defences by enhancing their repellent, irritation and anti-feedant properties against slugs. So they may offer all-round plant protection from the pest when control using natural enemies isn't possible to achieve." ►

## Hunter-killer robots progresses to field trials

Robots could one day take over the laborious monitoring for slugs in arable fields and then use that data to spot treat slugs with biological controls. The SlugBot project is being led by Jenna at CHAP in partnership with the Small Robot Company and Devon-based farming enterprise, AV and N Lee. Launched last year, the ground-breaking project is being funded by government through Innovate UK.

"There are so many angles to the SlugBot project," says Jenna. "Monitoring is a real gap in current strategies, where overall, non-targeted treatments are normally applied to fields. Using robots will tell us where slugs are present in the field and this targeted approach of delivering biocontrol could then potentially make biologicals more affordable. As well as precision treatment, there's also the potential

to alter dose rates," she adds.

Phase one of the project has been focusing on developing the artificial intelligence slug detection capability, including with multispectral and Red Green Blue (RGB) imagery. Phase two moves to slug detection using Small Robot Company's 'Tom' robot. This will use imagery and artificial intelligence to detect slugs autonomously.

The project is just about to commence phase three this autumn where SlugBot will enter field trials and proof of concept. These will focus on development of precision spraying, delivering an in-field slug treatment solution prototype.

There's much more at stake than slug control with SlugBot, it could have the potential to revolutionise pest control in field crops, adds Jenna "If the premise works then it could



*Robots have the potential to make biological controls more targeted and cost-effective if they can hunt slugs and apply controls with precision.*

become a model for tackling and controlling other pest species if we can secure additional funding."

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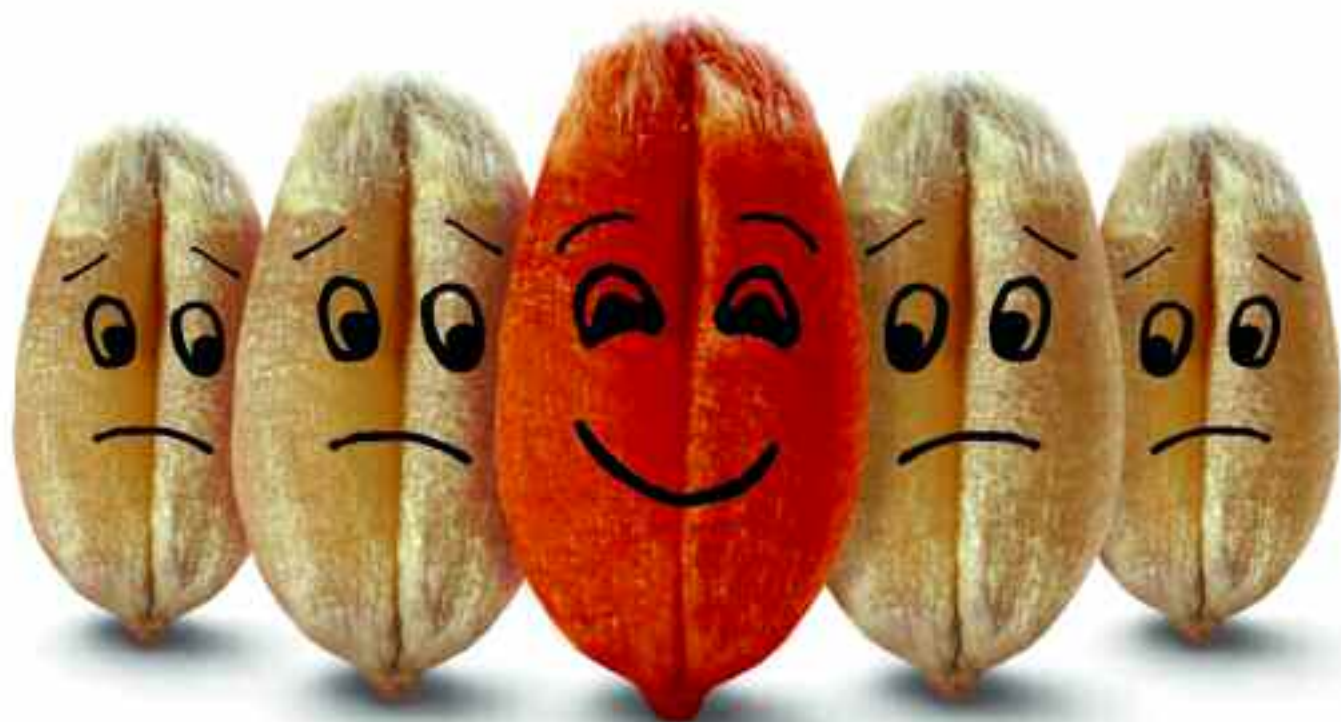
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► At this stage the potential of developing a slug control from essential oils is a theoretical one, but Archita believes there's cause to move research into the field where their effects on slugs and non-target organisms can be studied further.

"Because some oils have nematicidal and insecticidal properties, their use could be harmful to beneficial nematodes and insects so research should be directed to examine these concerns," she says.

Jenna hopes that slug research has been

*Some plant extracts could have anti-feeding properties as well as being lethal to some species of slug, notes Archita Barua.*

revitalised in recent years and she has reignited the International Organisation for Biological and Integrated Control group (IOBC) to bring scientists together.

"The IOBC has become a real hive where we can pool experience and begin to work on a global scale towards developing new slug solutions." ■



## Efficacy holds up in the wet

Back to the here and now, slug pellets are the only tool available to combat hungry molluscs. And if the weather experienced over the past two autumns has proven anything, it's the advantage of having slug control tools that perform well in wet conditions.

The choice of molluscicide active ingredients has been cut to just one by regulation in recent years, with methiocarb banned in 2013 and metaldehyde currently in its grace period. No supply of metaldehyde pellets has been permitted by manufacturers since 31 March 2021, with onward sale by distributors and use by for farmers permitted until 31 March 2022.

As a result, all major pellet manufacturers have been shifting focus to ferric phosphate products, with new brands coming to the market over the past few seasons. Certis was first company to launch a ferric phosphate pellet more than a decade ago. Its SluXX HP brand is a premium pasta-based pellet that offers the key components of a good slug bait — palatability, durability and spreadability — and has given users confidence in ferric phosphate's performance.

As others have entered the market, SluXX is no longer the only pellet that offers a premium wet-processed pasta pellet with these fundamental properties. However, trials

*New research has shown that SluXX HP pellets retain better efficacy than other pellets under prolonged wet conditions.*



commissioned by Certis, and conducted by independent research company i2L, have shown its formulation — used for all the company's pellet brands made with Ferric Field Technology — still outperforms competitors when the going gets tough, says Certis' marketing communications officer, Kate Downes.

She explains the trial was designed to test and compare three of the leading ferric phosphate pellets under extremely wet and challenging conditions, much like those experienced in recent autumns. The trials took place in small arenas containing topsoil, pellets were applied to the soil surface at a typical field dose and then exposed to a simulated weathering process.

This consisted of two applications of 2mm of water every second day and, to avoid the risk of flooding, irrigation was carried out at 3–4-hour intervals. A maximum of five grey field slugs (*Deroceras reticulatum*) were introduced to each arena at 0, 3, 7 and 10 days and discs of cabbage leaf were added as a food supply.

Assessments were then made at 0, 3, 7 and 10-day intervals after the introduction of the slugs and looked at pellet integrity, slug mortality and crop protection (how much cabbage leaf had been eaten).

Kate says that all the pellets in the trial were wet processed pasta-based formulations, all of which maintained relatively similar integrity throughout. This means there was some palatable bait available to the slugs at all times.

However, when comparing mortality of the slugs towards the end of the assessment period, SluXX HP stood out from the rest, she says.

"The point of difference in pellets made with Ferric Field Technology is the chelating agent, a substance that ensures a lethal dose of ferric phosphate can be absorbed into the slug's gut.

"Most pellets use EDTA, but SluXX HP contains EDDS which is not as easily leached from the



*Kate Downes explains that the number of slugs active on the surface is just the tip of the iceberg in relation to the population present throughout the soil profile.*

pellet. When exposed to wet weather it means the pellets are poisonous to the slugs for longer," explains Kate.

This is beneficial because the number of slugs active on the surface is just the tip of the iceberg in relation to the population present throughout the soil profile, she explains.

The presence of this subterranean population has been proven in a recently published paper from slug expert Dr Gordon Port and his colleagues at Newcastle University, which looked at how slug populations recovered after treatment with pellets.

The study showed that in isolated grassland plots, where horizontal migration was blocked, populations returned to pre-treatment levels vertically from within the soil extremely quickly. Although the authors of the paper state there is still a lot to learn about this inactive subpopulation, it helps explain why a pellet treatment with longer efficacy may help keep the pest suppressed and reduce the need for rapid reapplication of bait, believes Kate.

"The most important thing is to monitor slug activity and maintain optimum baiting points throughout the crop's most vulnerable stage. Once that surface population is removed, there are plenty more to take its place," she notes.