SAFE, EFFECTIVE, AND HIGHLY TARGETED TOOLS FOR PEST CONTROL

Our goal was to develop socially acceptable, cost-effective, and highly targeted next-generation technologies, tools, and strategies for pest management. The aim was to produce new and better approaches to control invertebrate pests and protect taonga species. All while minimising the cost and risk to biodiversity and agricultural industries.

We started this research looking at a range of possible techniques, but gene silencing eventually became our focus. This method uses artificially produced double-stranded RNA (dsRNA) to stop the production of proteins in the pests. It does not affect the genome of the pest species and can be highly targeted towards individual pest species.

The exemplar pest we chose was the parasitic varroa mite, which beekeepers identify as the leading killer of beehives here in New Zealand and around the world.

A beekeeper placing the treatment into a hive during field trials in 2022. The white pouch contains sugar water plus the dsRNA product. It is easy to apply and non-toxic to the beekeeper.

DOES IT WORK? HOW?

We first used mini hives in the laboratory to understand how dsRNA could affect the varroa parasite. This work showed that mites (and bees!) survived treatments with the dsRNA, but the mites stopped reproducing after treatment. When we analysed their genetic code we found the target gene, Calmodulin, had been successfully been silenced.

We then assessed if any 'non-target' organisms might be affected by this treatment. Experiments with wax moths in the laboratory showed no indication of harm after long-term exposure to the treatment. Our analysis indicated no other organisms, other than species closely related to the varroa mite, would likely be affected by this treatment.

Under permit from the New Zealand EPA (Environmental Protection Authority) and Provisional Registration from MPI, we ran field trials from 2022- 2024. We tested hundreds of hives in the North and South Islands and found that dsRNA can be an effective treatment for beekeepers. Further experiments are currently underway to better define the dose needed for pest control.

WHAT DO PEOPLE THINK?

We presented this technology to beekeepers throughout the country. While most beekeepers we spoke to were supportive, some were more cautious and wanted to see more research before this new pest control method is implemented.

AT A GLANCE

A new method to control the varroa parasite and improve honey bee health.

For decades we have relied on broad-spectrum synthetic chemicals to control pests. These can be harmful to the environment, other organisms, and sometimes even the species we are trying to help.

"A brilliant discovery that I support enthusiastically being developed to combat varroa mites in managed honeybee colonies/hives"

"Great to have new safe alternatives in the treatment of varroa"

- *Beekeepers we spoke to were mostly supportive of dsRNA technology*

Māori beekeepers we interviewed also wanted solutions beyond conventional chemical treatments. Double-stranded RNA appeals to most beekeepers as a new, more targeted control. However, the distinction between other genetic tools is not always clear and interview participants wanted to see further research on its potential effects, as well as ongoing communication and dialogue with end-users.

Māori beekeepers also noted a diversity of other constraints and challenges, including obligations to employ whānau, support local hapū and iwi economies, and concerns about others benefitting from their cultural property, like te reo Māori names.

A bee with parasitic varroa mites. This bee is also suffering from an infection of the Deformed wing virus, which varroa transmits. The mite and virus are the leading cause of honey bee hive loss in New Zealand.

WHAT COMES NEXT? IMPLICATIONS AND OUTCOMES

We are still busy with trials, consultation, and development. But the company we have been working with, GreenLight Biosciences Inc., has just submitted this product for registration in the US. They want to investigate registration for bee keepers to use here in New Zealand over the coming year.

Honey bees feeding on the treatment. Bees don't seem to be affected by the dsRNA, nor do other insects such as bumble bees or wax moths. It is highly specific to the mites.

Double-stranded RNA has real potential as a cost-effective and highly targeted next-generation technology for pest management. We hope that this work will be a model for the enhanced management of many other pests here in New Zealand and around the world.

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Honey bees, Varroa mite, dsRNA. RNAi, Gene silencing, Pest management

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