GENE EDITING

A NEW FORM OF INSECT PEST CONTROL?

Gene editing of wax moth eggs.

Imagine an aphid that can no longer transmit its virus when feeding on crops. Or a toothless caterpillar that can no longer create havoc among maize and sorghum fields. A brand-new genetics-based pest control method could do just that.

Researchers: Dr Gudrun Dittrich-Schröder, Department of Zoology and Entomology, and Professor Bernard Slippers, Department of Biochemistry, Genetics and Microbiology, both associated with the Forestry and Agricultural Biotechnology Institute (FABI).

Pest management in the agricultural and forestry sector has been seriously threatened by a rapid increase in pests in recent years. A report[1] by the Food and Agricultural Organization (FAO) of the United Nations stated that, due to the impact of climate change, plant pests that ravage economically important crops are becoming more destructive and are posing an increasing threat to food security and the environment.

FAO estimates that annually up to 40% of global crop production is lost to pests. Each year, plant diseases cost the global economy over US$220 billion, and invasive insects at least US$70 billion.

A new possibility for insect pest control

Current methods of pest control, such as the use of natural enemies of the pest (called biological control), the application of chemicals or the manipulation of the environment (such as removing a host plant), are either struggling to cope with these rising numbers of pests or have serious negative side-effects on the environment.

A new, potentially powerful and environmentally friendly approach is emerging.

The discovery of Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR), awarded with the Nobel Prize in Chemistry in 2020, has revolutionised gene editing for various organisms, including pest insects.

This mechanism, whereby specific DNA bases are identified with precision and subsequently cut, can be harnessed by scientists to make precise changes in an organism. Gene editing using CRISPR/Cas9 can be conducted in almost all genes and in a wide range of living organisms, including humans, animals and plants. The technology enables genes to be disrupted, added or replaced with another sequence using specifically designed CRISPR sequences and the enzyme Cas9. By altering genes that, for example, affect the reproduction of insect pests, their impact can be reduced.

Opportunities for Africa

"Gene editing as a means of pest control holds much promise for food security on the African continent," says Dr Gudrun Dittrich-Schröder, a research fellow in the Forestry and Agricultural Biotechnology Institute (FABI) and the Department of Zoology and Entomology at the University of Pretoria (UP). "In insects, microinjection is typically used to edit genes relating to fitness, reproduction or insecticide resistance. This technique, conducted under the microscope, makes use of a minute needle to inject the CRISPR/Cas9 enzyme and DNA site-specific product into the embryo of the insect eggs. To optimise the various steps of this technique, initially genes with a visible alteration are targeted to confirm success of the method. Thereafter, genes crucial for pest control are targeted."

This can all be done at UP, says Professor Bernard Slippers, Director of FABI and professor in the Department of Biochemistry, Genetics and Microbiology.

"FABI houses one of the few certified quarantine facilities for research on invasive insect pests and insect-rearing facilities in Africa, and houses state-of-the-art equipment enabling the editing of insect genes through microinjection," he says.

Gene editing in insects is an emerging field in the Global South, placing South Africa and UP at the forefront of new developments with regard to the integration of population genetics, genomics and genome editing for pest management in Africa. Current gene-editing projects target key pests and both forestry and grain crops.

The release of gene-edited insects could add one more option – a powerful and environmentally safe one – to the toolbox when it comes to managing harmful pests. Such an approach could benefit all farmers, irrespective of the size of their operations, as the impact will be across a landscape.

Reference:
1. https://www.fao.org/news/story/en/item/1402920/icode/

"Key to implementing these technologies is a step-wise approach that considers capacity development and quality research, consideration of environmental and ecological implications, effective communication with potential stakeholders and a clear governance framework," Prof Slippers says.

An opportunity exists for all regions in the world to explore this new technology, but this is perhaps even more urgent in Africa to realise the continent's development objectives.

Why is this research important?

Pest control plays a vital role in securing the livelihoods of both large-scale and emerging farmers, as well as food security for whole regions. Cutting-edge technology can edit genes to reduce the harmful effect that insects have on global crop production each year.

40%
Percentage of crops that are lost to pests worldwide.

US$220 billion
What plant diseases cost the global economy

US$70 billion
What invasive insects cost the global economy

Photo Credit: G Dittrich-Schröder

Source: https://indd.adobe.com/view/a356c00d-9aa4-4a3c-a442-d0807193d149