Scents and sensibility in agriculture: exploiting specificity in herbivore- and pathogen-induced plant volatiles for real-time crop monitoring

Results in Brief

Odour sensors could help combat crop-destroying pests

A real-time crop pest monitoring system offers targeted treatments addressing growing threats.

FOOD AND NATURAL RESOURCES

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Plants release odours (volatile compounds) in response to attack by herbivores or pathogens. Thanks in large part to the work of Ted Turlings from the University of Neuchâtel (website in French), it is known that these chemical cocktails are tailored to the nature of the attack.

Turlings had previously found that plants' response to caterpillar attacks is triggered by their oral secretions which release an odour attractive to parasitic wasps.

"Plants actively recognise what is attacking them, then enact a 'my enemy's enemy, is my friend' strategy," as Turlings, coordinator of the AGRISCENTS project, puts it.

AGRISCENTS, which was funded by the European Research Council, wanted to determine if sensors could detect pest attacks based on crops' odours, aiming to eventually attach these sensors to agricultural robots to identify infestations for swift and targeted treatment.

A growing problem

Invasive crop-eating insects are now spreading around the globe.

The fall armyworm first detected in Africa in 2016 has rapidly spread throughout the continent. It is estimated to be causing USD 2-6 billion of damage per year, risking famine for millions of people.

It has since invaded Asia and more recently reached Europe (the Canary Islands, Greece and Romania).

AGRISCENTS concentrated on maize, a particular target of the insect. "Lost maize yields due to pest attacks also have major economic and food security consequences that we can help mitigate," adds Turlings.

Maize is easy to grow and emits its strong protective volatiles quickly, reaching maximum potency in about 8 hours.

Makes sense

AGRISCENTS tested two available sensors.

One works mechanically, using 12 tiny discs coated with different polymers which change the discs' shape on contact with volatiles. While a computer can register this change, not much information is available about the chemical interactions involved.

The second, more sensitive device, is a special mass spectrometer that offers more chemical information in real time by measuring the mass of the target molecules.

"While a great proof of concept, currently this device weighs around 100 kg and costs over USD 300 000, but smaller and cheaper devices will soon be available," notes Turlings.

The plan is to fit more practical and affordable sensors to agricultural robots, which patrol crops. Software would enable the robots to report problems to farm managers and implement treatments in situ immediately, reducing pesticide use to where and when necessary.

Yielding results

Rapid progress on the sensors allowed the team to develop a spin-off strategy using insect-killing nematodes (microscopic worms) that might avoid pesticides. Normally not encountered by the caterpillars, nematodes can kill within 2 days.

The project has developed a special gel containing nematodes which can be injected directly into the centre of caterpillar-infested maize plants.

While this can be delivered by agricultural robots in intensive agriculture settings, in Africa it would probably be undertaken weekly using caulk guns and without sensors, as maize is continuously infested by the fall armyworm.

“Rwandan trials with locally sourced nematodes were as effective as synthetic pesticides, increasing maize yields by one tonne per hectare. While more expensive than pesticides, very targeted nematode application will reduce costs while benefiting health and the environment,” says Turlings.

Planning to protect Europe from priority pests

The fall armyworm has now been designated a ‘priority pest’ by the European Commission which has outlined enhanced measures to prevent its spread around Europe.

While COVID curtailed the project’s aim to build a catalogue of volatiles equating to a wide range of pest attacks, the team is now doing so within the current EU-funded PURPEST project, developing and field-testing odour-based detectors to protect European crops from increased threats.

Keywords

AGRISCENTS, crop, maize, caterpillar, robot, artificial intelligence, fall armyworm, agriculture, volatiles, sensor, pest

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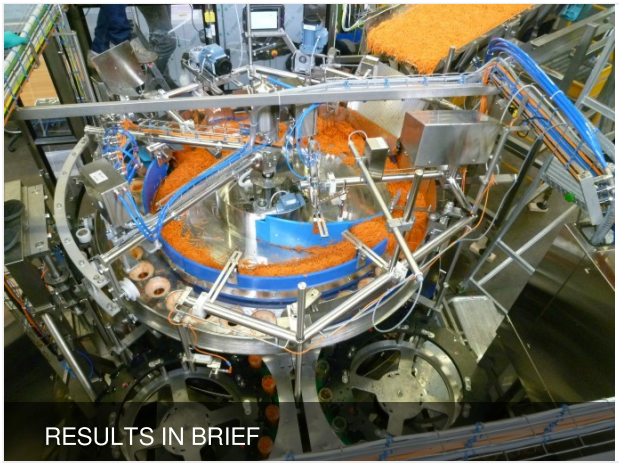

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