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

Informe

Información del proyecto

AGRISCENTS

Identificador del acuerdo de subvención:
788949

Sitio web del proyecto

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Proyecto cerrado

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Este proyecto figura en...

Periodic Reporting for period 4 - AGRISCENTS (Scents and sensibility in agriculture: exploiting specificity in herbivore- and pathogen-induced plant volatiles for real-time crop monitoring)

Período documentado: 2023-03-01 hasta 2024-02-29

Resumen del contexto y de los objetivos generales del proyecto

The ERC project AGRISCENTS studied the specificity of volatile blends that plants emit in response to insect and pathogen attack, with the ultimate objective to employ sensors that detect these volatile compounds and identify the attacker. It is envisioned that the sensors will be installed on robotic rovers and will permit real-time monitoring of the agricultural pests and diseases, enabling farmers to apply crop protection treatments at the right time and in the right place. The knowledge generated by the project and the technologies under development will drastically reduce the need for pesticides. But we are also developing a more sustainable alternative to pesticides, in parallel to the sensor part. We have developed a novel gel-based formulation for the application of entomopathogenic nematodes (EPN) that can serve as biological control against insect pests. With field trials in Rwanda we demonstrated that this environmentally harmless formulation can be just as effective in killing a major caterpillar pest as a commonly use pesticide. The application of EPN is usually considered too expensive and not cost effective. The combination of a robotic device that is equipped with an odour sensor and can apply EPN on plants that carry insects could be part of a novel, cost-effective pest control strategy without any need for pesticides.

Trabajo realizado desde el comienzo del proyecto hasta el final del período abarcado por el informe y los principales resultados hasta la fecha

Overall, the project was a success, and we achieved our main objective. Some details are listed below.

Work package 1 focussed on deciphering the plants' odorous vocabulary to create a complete inventory of "odour-prints" for a wide range of herbivore-plant and pathogen-plant combinations. We first evaluated the efficiency of various sorbents in trapping volatile organic compounds (VOCs) with the traditional dynamic headspace volatile collection system, followed by analysis with GC-MS. With the most efficient trapping filter selected, we collected and compared the emissions induced by various plant pests and diseases. Our model plant is maize, but we were also including cotton and bean plants in some of the studies. We were not able to obtain all insects and pathogens that we had planned to test, but we were able to create a nice overview of the variation in volatiles emissions that are released by important crop plants in response to different antagonists. This work continues in the context a follow-up Horizon Europe project named "PurPest".

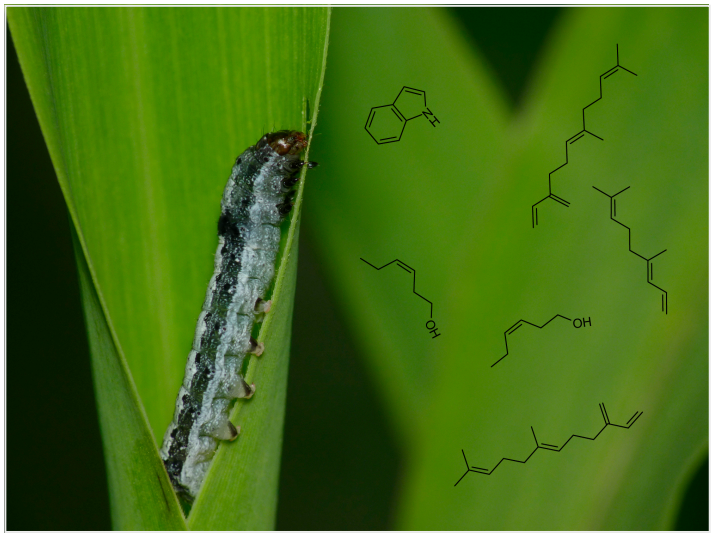
Work package 2 concerned the evaluation of sensor technologies for the detection of specific plant volatile mixtures. We mainly used two different approaches, one based on membrane-type surface stress sensors (MSS) and the other one on proton-transfer-reaction time-of-flight mass spectrometry (PTR-TOF-MS). In a laboratory assay, these sensors were astonishingly well at distinguishing the odorous signals from maize plants subjected to two caterpillar pests and one pathogen. Particularly impressive were the results obtained with the state-of-the-art PTR-TOF-MS, which we purchased for the project. It allows for real-time detection and quantification of volatiles blends and it was readily able to distinguish between the odours of plants that are under attack by different pests. Importantly, it was not only able to make this distinction under laboratory conditions but also outside, using deep learning, it could distinguish between healthy maize plants and maize plants with simulated caterpillar damage with high accuracy.

Work package 3 aimed to genetically manipulate maize plants to release a unique blend of easy-to-detect volatiles (aldoximes and nitriles) upon herbivory on the roots. We identified two maize genes that are specifically expressed in the leaves when the roots are damaged by rootworms. The promotors of these genes were coupled to two poplar genes involved in the biosynthesis of aldoximes and nitriles. The process of genetic transformation was successful, but it did not result in the envisioned odour emissions from the leaves of plants that were attacked by rootworms. However, we did find that some maize varieties, without genetic transformation, would emit volatiles from their leaves when their roots were subjected to insect damage. This implies that our sensor approach could also work to detect an important root pest that is currently invading Europe. We will be part of another European initiative to use odour sensors to detect pest and hope to further explore this possibility of odour-based root pest detection.

Avances que van más allá del estado de la técnica e impacto potencial esperado (incluida la repercusión socioeconómica y las implicaciones sociales más amplias del proyecto hasta la fecha)

• Demonstration that odour sensors can be used under field conditions to monitor herbivore attack of individual plants, in real-time.
• Prove-of-concept for the development of odour sensors that can be installed in robotic devices to monitor crops. The technology will provide farmers with real time information on the presence of pests

and diseases in their fields.
• Novel gel-based formulation that contains entomopathogenic nematodes. This formulation can be used for the biological control of leaf-feeding insect pests, as an alternative to harmful pesticides.



A Spodoptera littoralis caterpillar on a maize seedling and structures of plant volatiles released

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Permalink: https://cordis.europa.eu/project/id/788949/reporting/es