BIODEGRADABLE DEVICE FOR THE BIOLOGICAL CONTROL OF AGRICULTURAL PESTS

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RESUM

Researchers from the University of Alicante have developed a device for pest control based on repellent volatile organic compounds (VOCs) incorporated into activated carbon matrices with suitable porosity. The technology enables a sustained release of repellent VOCs over several weeks, reducing dependence on chemical insecticides and the environmental impact associated with conventional plastic dispensers.

The device essentially consists of a carbon matrix, in granulated or pellet form, with the repellent incorporated into it. This matrix is enclosed in a porous and biodegradable container in the form of a sealed bag, facilitating direct field application and ensuring easy and safe handling. Moreover, its versatility allows the active compounds to be adapted to different pest species and crops, offering a sustainable and efficient approach to plant protection.

The technology, protected by a patent application, has been developed at the laboratory and pilot prototype scale, with proven efficacy against the banana weevil (*Cosmopolites sordidus*) and other agriculturally relevant weevils. Companies interested in commercial exploitation are sought.



INTRODUCCIÓ

The exponential growth of the world population has increased the demand for food, which has traditionally led to greater use of chemical pesticides that affect non-target organisms and generate environmental impacts. In response, research is moving toward sustainable pest control strategies based on the disruption of their chemical communication.

In this context, **semiochemicals** are informative molecules that trigger ethological or physiological responses in organisms and represent an alternative or complement to insecticides within Integrated Pest Management (**IPM**). Among them, pheromones stand out for their natural origin, ecological character, and low risk to human health, being used in monitoring, mass trapping, mating disruption, sexual confusion, and push-pull strategies.

Another type of semiochemical is the **allelochemical**, which transmits signals between species. Among these, **repellents** are antixenotic allomones that induce the receptor's avoidance behavior. They are classified into four types: **expulsive** (chemical barrier without contact), **irritant** (avoidance after contact), **deterrent** (alters feeding behavior), and **odor masker** (reduces host attractiveness). Although their use has focused on insects of human or veterinary importance, their agricultural application remains limited. However, volatile organic compounds (**VOCs**) produced by entomopathogenic and nematophagous fungi with repellent effects against pests such as *Cosmopolites sordidus* have been identified.

Repellent VOCs are a promising alternative, although their volatility and instability reduce their effectiveness in the field. To be

viable, they require **dispensers** that release molecules slowly and in a controlled manner, maintaining effective concentrations over long periods, which increases costs and limits large-scale use.

Many of these dispensers use **non-biodegradable plastic matrices**, generating microplastic pollution and contradicting sustainability goals. Moreover, the devices must be efficient and maintain their repellent activity over time.

Within this framework, **carbon-based materials**, such as activated carbons, emerge as ideal candidates. Their porous structure, high surface area, and surface chemistry enable the adsorption and controlled release of molecules while being **biodegradable**. These materials can be obtained from **natural residues**, and their incorporation into soil improves moisture retention and nutrient supply, aligning with the principles of the circular economy.

Although advanced formulations for pheromones exist, their application to repellents remains limited and dependent on plastics. Hence, there is a need for a **biodegradable, efficient, and economically viable solution** capable of ensuring controlled release and long-lasting protection without compromising the environment. The present invention addresses this need, improving upon Spanish patent ES2815148B2, which is based on volatile compounds from entomopathogenic fungi as repellents against the banana black weevil (*Cosmopolites sordidus*).

DESCRIPCIÓ TÈCNICA

Researchers from the University of Alicante have developed a physical device for pest control based on an **activated carbon matrix impregnated with repellent volatile organic compounds (VOCs)** of either natural or synthetic origin. The design combines the adsorption properties of a highly porous material with the appropriate textural characteristics to allow the sustained release of the active compound in agricultural environments.

The core element of the device is a **solid support made of activated carbon**, within whose porous structure the VOC is adsorbed. The incorporation of VOCs into the matrix can be achieved through **vaporization, impregnation, or immersion processes**. Once incorporated into the material, the compounds are retained within its porosity, and thanks to its textural properties, the VOC is gradually released by **desorption** upon exposure to air. The proper selection of the textural characteristics of the carbon matrix ensures that desorption occurs in a **controlled and constant manner** over extended periods.

To ensure stability and facilitate field application, the activated carbon containing the VOC is placed within a **porous and sealed wrapping**. This wrapping prevents premature loss of volatiles and guarantees **simple and safe handling** of the device. It helps maintain ambient VOC levels high enough to induce avoidance behavior in target insects for several weeks, without the need for frequent replacement.

This technology addresses one of the main challenges of modern agriculture: **reducing dependence on synthetic insecticides**, which cause resistance problems, environmental risks, and unwanted effects on beneficial organisms. Volatile repellents have shown great potential as an alternative, but their use has been limited by their rapid degradation and dispersion in the environment. This system provides an **innovative solution** through a **controlled and sustainable release format**, capable of prolonging the effectiveness of the active compound under real crop conditions.

In addition, this approach allows **flexibility in compound selection**, since activated carbon is compatible with both **biological molecules**—for instance, those produced by entomopathogenic or nematophagous fungi—and **synthetic formulations**. This adaptability enables the technology to be applied to various crops and pest species while maintaining the same operational principle.

Overall, the device represents a **significant advancement in the development of volatile-release systems** for plant protection, combining **technical efficiency, stable release**, and a **design aligned with sustainable agricultural practices**.

AVANTATGES I ASPECTES INNOVADORS

ADVANTAGES OF THE TECHNOLOGY

The main advantages of this technology are as follows:

- **Prolonged and controlled release**: The porous structure of the activated carbon enables a sustained release of the volatile compound, avoiding emission peaks and ensuring high efficacy for several weeks without the need for frequent replacement.
- **Environmental sustainability**: The use of activated carbon and biodegradable wrappings eliminates dependence on conventional plastics, preventing waste generation and reducing the environmental impact on agricultural ecosystems.
- **Formulation versatility**: The system is compatible with a wide range of VOCs, both synthetic and microbial in origin (entomopathogenic and nematophagous fungi, etc.), allowing the device to be adapted to different crops and pests using the same basic design.
- **Ease of application and low operating cost**: The device does not require specialized equipment or advanced technical training, resulting in time savings and lower labor costs for farmers.

INNOVATIVE ASPECTS OF THE TECHNOLOGY

This invention introduces a **novel and efficient solution** for agricultural pest control by combining **activated carbon as the main release matrix** with **repellent volatile organic compounds**. Compared to previous developments that focused on pheromones and attractants—mostly using plastic-based or various solid matrices—this technology provides several **innovative elements**:

- **Pioneering use of activated carbon** as a release matrix for repellent volatile compounds in agricultural applications—an approach not described in previous devices focused on attractants or pheromones.
- **Integration of VOCs of biological or synthetic origin** into a porous and biodegradable material, and their use within a **porous, biodegradable wrapping**, enabling the sustained release of the volatile compound under field conditions.
- **A design that overcomes the high volatility and low persistence** of VOCs in field environments, providing an efficient and sustainable alternative that replaces conventional plastics in dispensers.
- **A modular and versatile design**, capable of accommodating different VOCs within the same technical base to adapt to various crops and pest species.

In summary, the key innovation lies in **translating the potential of repellent VOCs from the laboratory to real agricultural applications**, addressing the issues that have so far limited their use: excessive volatility, low persistence, and dependence on plastic dispensers.

ESTAT ACTUAL

The technology has been developed at **laboratory and pilot prototype scale**, with preliminary field trials confirming its viability under simulated environmental conditions.

The tests conducted have demonstrated that the **VOCs** of interest are stably adsorbed within the activated carbon matrices. Their high surface area and specific porosity ensure a **sustained release** of the compounds for periods exceeding **28 days**, maintaining effective concentrations for pest control.

Specifically, the device has been shown to **retain its repellent activity for over 28 days against the banana weevil** (*Cosmopolites sordidus*), confirming its potential applicability against other agriculturally relevant weevil species such as *Rhynchophorus ferrugineus* and *Rhynchophorus palmarum*.

In addition, the design incorporates practical features for future commercialization, such as a **sealed porous bag wrapping** that prevents rapid volatilization losses and facilitates handling, transport, and direct field application. The devices can be produced in granulated or pellet form, optimizing logistics and dosing.

The technology readiness level (TRL) is estimated at **TRL 5–6**, having been tested under both controlled and small-scale field conditions. However, it still requires scaling-up and validation in large agricultural operations. Its thermal stability, absence of premature volatile release, and preservation of repellent activity for more than 28 days confirm the potential of this solution for sustainable and low-impact agricultural applications.

APLICACIONS DE L'OFERTA

This technology lies within the field of **agrobiotechnology**, combining tools from chemistry and materials science to provide an innovative pest control system based on a carbon matrix that adsorbs volatile organic compounds and ensures their sustained release. Its versatile design allows integration into various agricultural contexts, particularly those where reducing the use of chemical pesticides is a technical, economic, or regulatory priority.

The main sectors of application include:

- **Crops sensitive to weevils**: Protection of banana, plantain, cocoa, palm, and other plantations where species such as the banana weevil (*Cosmopolites sordidus*) or the red palm weevil (*Rhynchophorus ferrugineus*) pose critical threats to productivity. The device is also suitable for other crops affected by phytosanitary problems associated with weevil infestations.
- **High value-added agriculture**: Vineyards, citrus orchards, and fruit farms where the demand for sustainable, chemical-free solutions is steadily increasing.
- **Organic and certified agriculture**: Farming systems requiring alternatives to synthetic insecticides, complying with organic production and sustainability regulations.
- **Controlled-environment production**: Greenhouses and hydroponic systems, where the localized and prolonged release of VOCs is particularly effective in maintaining stable concentrations within enclosed spaces.
- **Early crop protection stages**: Preventive application during germination and seedling establishment, critical phases in which early infestations can compromise later crop performance.

COL·LABORACIÓ BUSCADA

Companies are sought to acquire this technology for **commercial exploitation** through the following collaboration models:

- **Patent licensing agreements.**
- **Joint R&D projects** to adapt the technology to specific company needs, including formulation optimization, industrial scale-up, and adaptation to different crops and pest species.

- **Co-development of prototypes or field validation.**
- **Other collaboration modalities** that enable the commercial exploitation of the technology.

In particular, interest is sought from **companies with technical, production, and commercial capabilities** to develop, manufacture, and market repellent VOC-based devices for plant protection.

Target Company Profile:

- Companies specializing in agrochemicals and plant protection.
- Biotechnology companies focused on agricultural applications.
- Multinational corporations or large enterprises in the agricultural sector.
- Companies involved in the commercialization of carbon-based products.

DRETS DE PROPIETAT INTEL·LECTUAL

This technology is protected through a patent application:

- *Patent title: "Repellent Device"*
- *Application number: P202530720*
- *Filing date: July 31, 2025*

SECTORS D'APLICACIÓ (4)

Agri-food and Fisheries
Molecular Biology and Biotechnology
Materials and Nanotechnology
Chemical Technology