PHERA

pheromones for row crop applications

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>
> ISCA Chief Executive Officer and Founder
> Dr Agenor Mafra-Neto

# NEWSLETTER MARCH 2022

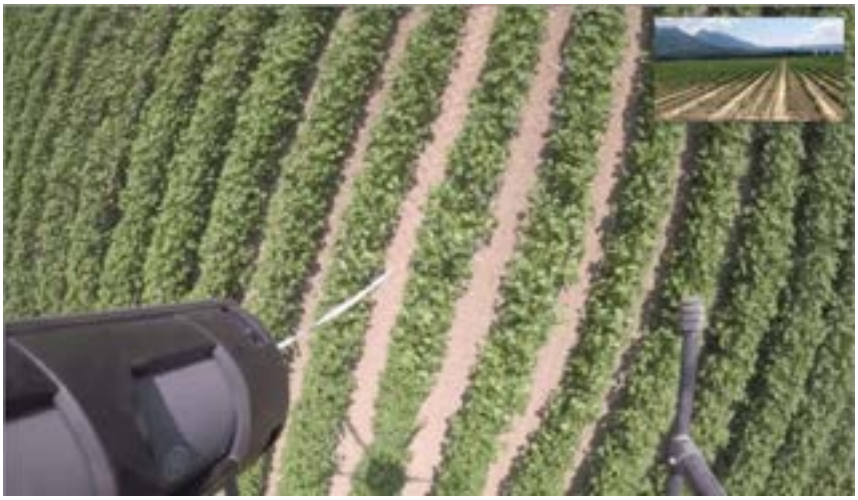
Having successfully demonstrated that insect pheromones can be produced cost-efficiently at an industrial scale using yeast fermentation, the PHERA partners are now testing various pheromone formulations in field trials.

This newsletter compiles the results of these field trials - so far - and also takes a look at the first life cycle assessment (LCA) study comparing insecticides with mating disruption using fermented pheromones.

## Pheromone released by drone controls cotton pest

PHERA partner NovAgrica Hellas experiments with new methods of applying pheromone solutions for pest control in field crops.

Pheromones are traditionally released from stationary dispensers, but NovAgrica Hellas is also developing flowable suspensions that adhere to plants and are endowed with special characteristics to protect the labile pheromone molecules and control their release. Most importantly, they can be distributed by drone, explains NovAgrica Hellas Head of R&D and Co-founder Dimitris Raptopoulos.



A drone releases NovAgrica PheroWax (pheromone formulation) into a cotton field in Central Greece for management of cotton bollworm

"There is a huge push towards making agriculture sustainable, but short of going backwards in terms of agricultural intensity, we need new technologies to drive the development forward, and drones are without doubt one of these exciting technologies," he says.

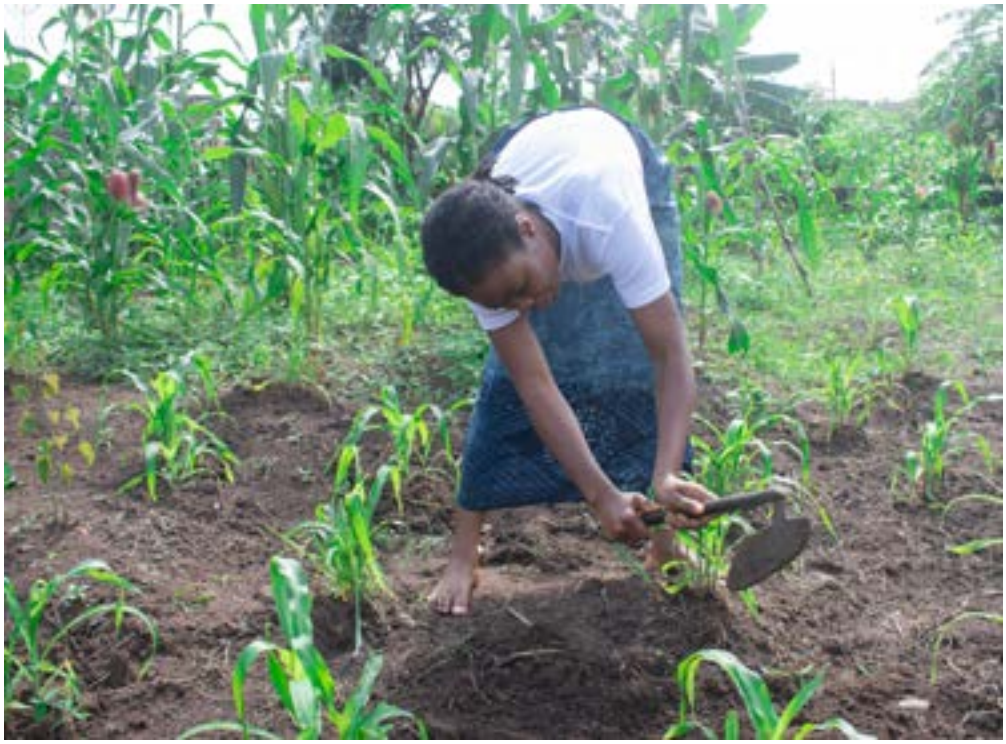
There are several advantages to using a drone. It is faster, cheaper and less weather-sensitive than manual application and more environmentally friendly than mechanic sprayers. In fact, drones are already revolutionising the application of conventional pesticides. Building on advances in camera and GPS technologies for identification and treatment of weeds and pests in a field, drones are seen as part and parcel of precision agriculture in the future.

NovAgrica has now tested pheromone for control of cotton bollworm applied by drone in cotton in Central Greece (picture). The trial demonstrated that pheromone is superior at controlling cottom bollworm compared to the control plot. Equally, if not more important, considering PHERA's mandate, biological pheromone proved as efficient as its synthetic counterpart in doing so.

**NovAgrica Hellas of Greece manufactures Integrated Pest Management (IPM) products with a focus on semiochemicals.**

# Mating disruption controls fall armyworm in Brazil

PHERA partner ISCA Inc. of the US has shown that pheromone-based pest control in maize nearly halves the damage caused by the Fall Armyworm (FAW).



Being able to control the fall armyworm in row crops in a sustainable way will make a big difference to the many people in developing countries whose staple food crops are threatened by this pest

"In these trials we have shown that the Fall Armyworm can be controlled sustainably by using inexpensive mating disruption solutions, bringing hope to the many people around the globe stricken by the impact of this invasive species," said ISCA CEO and Founder Dr Agenor Mafra-Neto.

The FAW is becoming one of the most dreaded pests in the world due to its voracious appetite for maize and many other crops combined with its widespread distribution. Since 2016, this pest has spread out of the Americas to nearly all but the coldest regions of the world. The Food and Agriculture Organization (FAO) has even developed the Global Action for Fall Armyworm Control, recognizing that "sustainable FAW management will preserve the food and nutrition security of 600 million people worldwide". Maize is a staple food in Africa, South-East Asia and Latin America.

The key word here is "sustainable" because the FAW is close to impossible to control by conventional chemical means. The insect is developing resistance to insecticides at an alarming pace. It is therefore widely acknowledged that the FAW can only be controlled using a combination of strategies such as integrated pest management (IPM) with pheromones as an essential component.

ISCA tested four combinations of two of their products – Noctovi and SPLAT FAW. Noctovi is an insect attractant designed to mimic the odours produced by sugar-rich flowers favoured by moths of the Noctuidae species, including the FAW. SPLAT FAW is an attract-and-kill product containing the FAW pheromone and an insecticide. ISCA reduced the use of insecticide by combining it with pheromone-based mating disruption – the art of fooling the FAW male insects into thinking females are everywhere but where they really are by filling the air with the insect's sex pheromone.

"Conventional pest control is really inefficient. It relies on farmers bringing the pesticide to the pest, and they have to cover every leaf of every plant to kill the pest by contact. Pheromone-based pest control, on the other hand, attracts the pest, is efficient when applied in spaced dollops in the field and does not pollute the environment or harm non-targeted species," explained Agenor Mafra-Neto.

The trials were carried out in the Matto Grosso State in Brazil on a total area of about 300 hectares in 2020/21. Not only did ISCA find that the damage of maize cobs was nearly halved, the company also recorded an increase in yield of about 40%.

**ISCA Inc. is an agricultural biotech company that harnesses the power of semiochemicals such as pheromones to offer the next generation of insect control. ISCA means "lure" in Portuguese – fitting because the company uses semiochemicals to manipulate insect behaviour to deter them from destroying crops. The company is based in Riverside, California, with subsidiaries in Brazil, Costa Rica and India.**

# Pheromones for pest control: it's all about timing

Fermented pheromone has outsmarted one of the world's worst agricultural pests. In a field trial in industrial tomatoes in France in July 2021, Russell IPM has reduced the population of Helicoverpa Armigera by about 75% in the centre of the field.

"The significance of these results is immense," explains Dr Shams Usmani, Head of Pheromone Solutions at Russell IPM, one of the PHERA partners, with a reference to the nature of the pest in question.

H. Armigera is feared due to its indiscriminate appetite combined with a remarkable ability to develop resistance to insecticides. Believed to have originated in Africa, H. Armigera is now a notorious pest in nearly all but the coldest regions of the planet. It has been found feeding on over 300 plant species from cotton and tobacco to maize, soybeans, sunflowers and a range of fruits and vegetables, giving rise to common names such as the cotton bollworm and the tomato fruit borer.

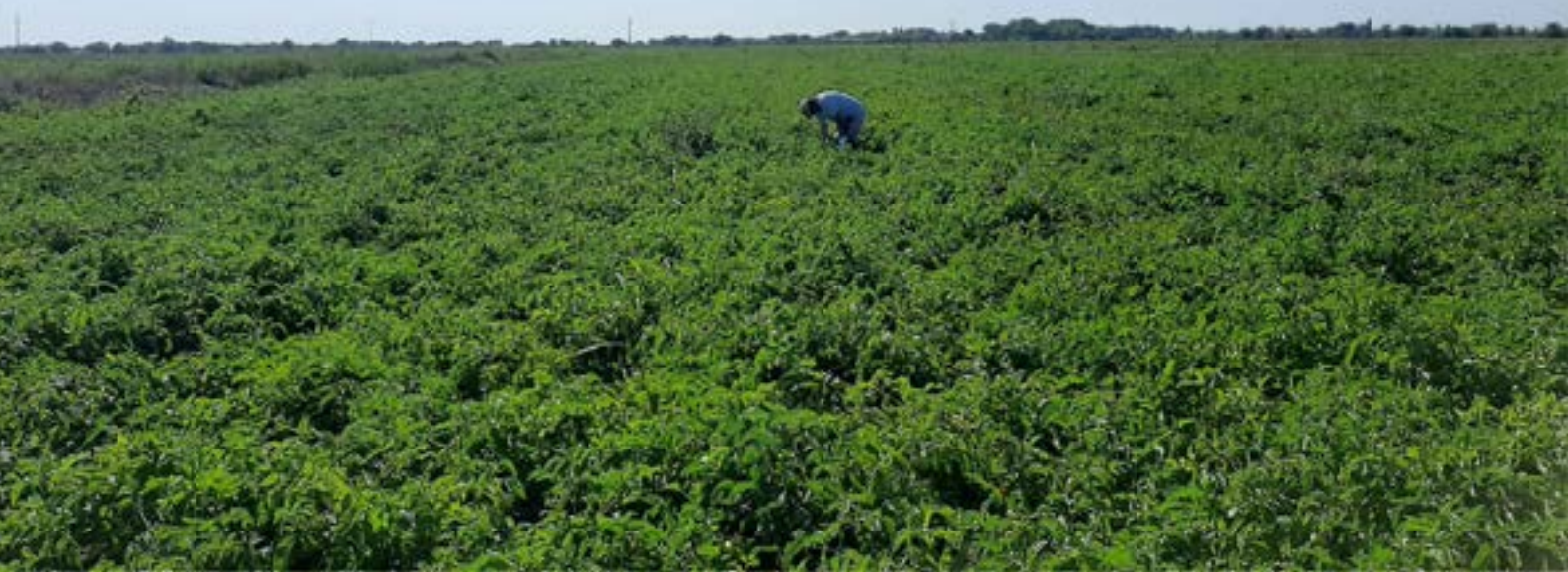
As H. Armigera is increasingly difficult to control chemically, alternatives are urgently needed. This field trial showed that fermented pheromone is one such alternative. The pheromone used is produced by BioPhero of Denmark that has developed a unique fermentation technology to produce a pheromone blend biologically identical to the one used by H. Armigera to attract a mate.

Russell IPM used a slow-release pheromone formulation in this field trial. The formulation was released using extrusion dispensers placed throughout the tomato field, thereby confusing the moths, preventing them from locating each other to mate, lay eggs and produce plant-munching larvae.

The field trial illustrated that pheromones go hand in hand with other integrated pest management (IPM) tools such as manual screening for pests in a field. Despite recording an impressive reduction in the number of adult moths, the researchers still saw some damage of tomato fruits and leaves. A likely explanation is that the trial started after the first emergence of larvae, Dr Usmani explains. Timing is of the essence when using pheromones.

Finally, the field trial showed that it is easier to control insect infestation at the centre of a field than along its boundaries due to migration of moths from surrounding areas.

**Russell IPM is a leading developer of integrated pest management (IPM) technologies. The company sells pheromones, traps and pest management supply across the globe.**

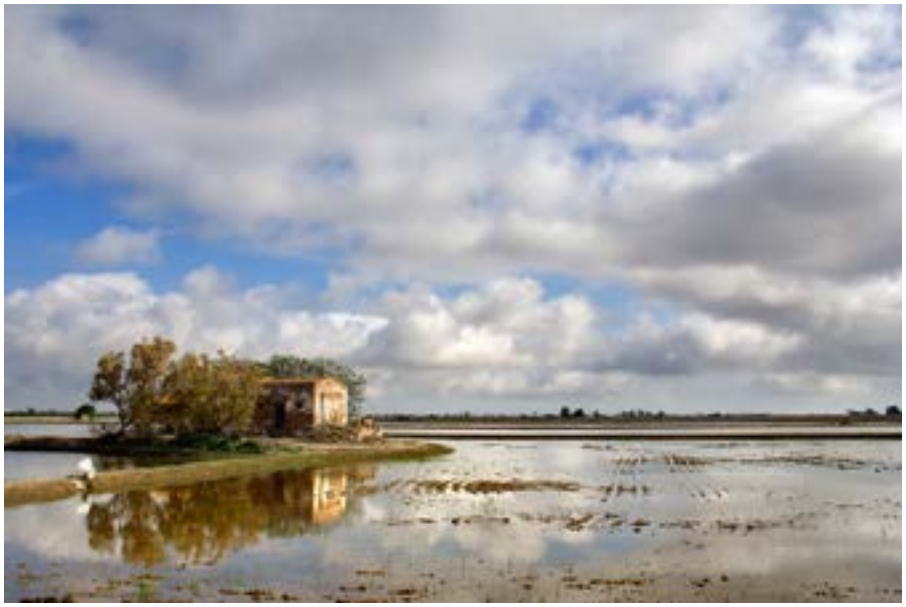


# Pheromone solutions protect conservation area

The Ebro Delta is one of the most important wetlands in Europe. It is well worth protecting. There is just one problem. The Ebro Delta is interspersed by marshes and paddy fields that traditionally are treated with pesticides to kill insect pests. The futility of this biological tug-of-war is clear for all to see. But what to do? Spoiler alert – the solution involves pheromones and PHERA partner SEDQ of Spain.

The Ebro Delta of Spain spans more than 30,000 hectares (320 km2). Its lagoons, marshes, pans and beaches shelter 77 protected plant and vertebrate species. With more than 343 species of birds recorded, it is a haven for birdwatchers. Not surprisingly, part of the area is a designated Natural Park in Spain and protected under the EU Birds and Habitats Directives, the Ramsar Convention and UNESCO.

Unfortunately, the 7,800-hectar Natural Park is surrounded by 22,000 hectares of rice, a favoured crop of the striped rice stemborer (Chilo Suppressalis). This is a pest notoriously difficult to control. On hatching from the eggs, the larvae quickly bore into the rice stem, where they stay until they emerge from the pupae, making them difficult to control with traditional insecticides. As a result, the Ebro Delta was sprayed with hundreds of thousands of litres of aggressive insecticides such as organophosphates in the 1980s and 1990s, killing off pests and beneficial insects alike, along with birds, fish, amphibians and other lifeforms.



Pheromone-based mating disruption has proven its impact in the Ebro Delta

Something had to be done, and that something became the introduction of pheromone-based mating disruption. Pheromones are natural molecules secreted by moths in particular to attract a mate. If a farmer disperses the same pheromones in a field, the insects' I-am-here pheromone trail is veiled, and they can't find each other. No mating means no eggs and no plant-munching larvae.

The transition from insecticides to mating disruption in the Ebro Delta happened gradually in cooperation with SEDQ, a Spanish company specialising in biological pest control solutions based on pheromones. The growers began with mass trapping in 2000, using pheromone-loaded traps to attract the moths, combined with aerial spraying if needed, and only if needed. In 2012, they introduced mating disruption, and by 2015, all 22,000 hectares of rice were cultivated using mating disruption only.

The results speak for themselves. Today, the growers of the Ebro Delta have almost eliminated the use of pesticide – only a few percent of cultivated area need to be sprayed – to the benefit of the area's fauna. Further south along Spain's eastern coastline, one finds the Albufera Natural Park, another important wetland surrounded by paddy fields. Here, the growers were a little quicker at embracing mating disruption, spurred on by an impending ban on aerial spraying by 2009. A study of waterbirds in Albufera from 2009 to 2017 found that the number of breeding pairs had increased by over 40 times.

The pheromone blend used in the Ebro Delta is incorporated into a polymer dispenser together with UV blockers and antioxidants to protect the active ingredient. The growers simply have to place the dispensers on sticks in the field – and only once. Treatment no longer has to be repeated, and the biodegradable canes can be left in the field to decompose. It is easy and more cost-effective than conventional spraying.

**Results like these drive the PHERA Project. This EU-funded project seeks to broaden the scope for pheromones. Although the efficacy of mating disruption has been known for more than 20 years, the cost of pheromone production has been a barrier to its deployment. Pheromones have until now been manufactured synthetically, a complex and expensive process, but the PHERA Project is scaling up a new fermentation method for production of affordable pheromones at industrial scale. The drop in price will make pheromones accessible for use in large-scale row crops.**

The first life cycle assessment of pheromone-based mating disruption versus insecticides is clear:

# The more insecticide we can replace, the better

Replacing insecticides with pheromone-based mating disruption can reduce ecotoxicity significantly. This is the result of a life cycle assessment (LCA) study carried out by Fraunhofer IBP, a German life cycle expert, which BioPhero partners with under the EU-funded OLEFINE and PHERA projects.

The study compared conventional cultivation using conventional chemicals, irrigation and machinery with three Integrated Pest Management (IPM) scenarios, where the insecticide was replaced by pheromone in varying quantity and yield effects.

Integrated Pest Management (IPM) is by many seen as the answer to increases in pesticide use, insect resistance and environmental and human health concerns. The Food and Agriculture Organisation, which promotes IPM,[i] defines IPM as "the careful consideration of all available pest control techniques (…) to grow healthy crops and minimise the use of pesticides, reducing or minimising risks posed by pesticides to human health and the environment for sustainable pest management."[ii]

Ideally, pesticides should be applied to keep pests, diseases and weeds below their economic damage threshold without harming humans and the environment. Pests must be controlled to a level that allows sustainable crop production, but there is no need to kill every single insect in a crop. This is what underpins IPM. By using a combination of biological, chemical, physical and crop-specific (cultural) management strategies and practices, IPM seeks to minimise the chemical component to need-based application of less hazardous pesticides.

The Fraunhofer study found that pheromone-based mating disruption "can eliminate or significantly reduce the ecotoxicity (30-50%) of conventional agriculture through replacement of conventional insecticides". The degree of impact depends on the crop and, hence, the type of insecticide used (the study looked at five different crops in three different countries – corn in the US, soybean in Brazil and brassica cabbages, cotton and grapes in Greece).

The best improvement was observed in US corn sprayed with the commonly used pyrethroid insecticide, Lambda Cyhalothrin. Ecotoxicity was reduced to almost 0, while human toxicity (non-cancer effects) was reduced by 80%. In fact, the toxicity of Lambda Cyhalothrin is so predominant that the impacts caused by other pesticides in the study, including the herbicide Glyphosate and the fungicide Folpet, are negligible. In comparison, the study saw a reduction in ecotoxicity of more than 50% in soybeans in Brazil and almost 30% in grapes in Greece.

In this study it was assumed that the entire amount of insecticide would be replaced by pheromone. In real life, this may not be realistic, but the more insecticide we can replace with pheromones, the better for the environment.

**Fraunhofer IBP is a German research institute rooted in building physics and urban planning with a designated Department of Life Cycle Engineering. Under the auspices of the EU-funded OLEFINE and PHERA Projects, Fraunhofer has used life cycle assessment (LCA) methods to assess the sustainability of the projects' pheromone products and their application.**

[i] https://www.fao.org/publications/card/en/c/CA7179EN/

[ii] https://www.fao.org/pest-and-pesticide-management/ipm/integrated-pest-management/en/

## The first LCA study of its kind

This is the first LCA study comparing insecticides with mating disruption using fermented pheromones.

In the study, Fraunhofer compared the environmental impacts of production and use of conventional insecticide with those of pheromone. Parameters examined included climate change, energy use, acidification, terrestrial eutrophication, photochemical ozone formation and toxicity (freshwater ecotoxicity and human toxicity (cancer effects) and human toxicity (non-cancer effects)).

The research institute quickly ran into limitations of the existing LCA models. Life cycle assessments of pesticides are subject to many uncertainties as pesticides impact the entire environment, not just a target organism. Finding the balance between too simple and too complex is a challenge in life cycle assessments.

The current standard model "USEtox" is recommended by the European Commission for use in Product Environmental Footprint calculations, but with caution.

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