# Computer vision boosts pest control efficacy via insect sterilization

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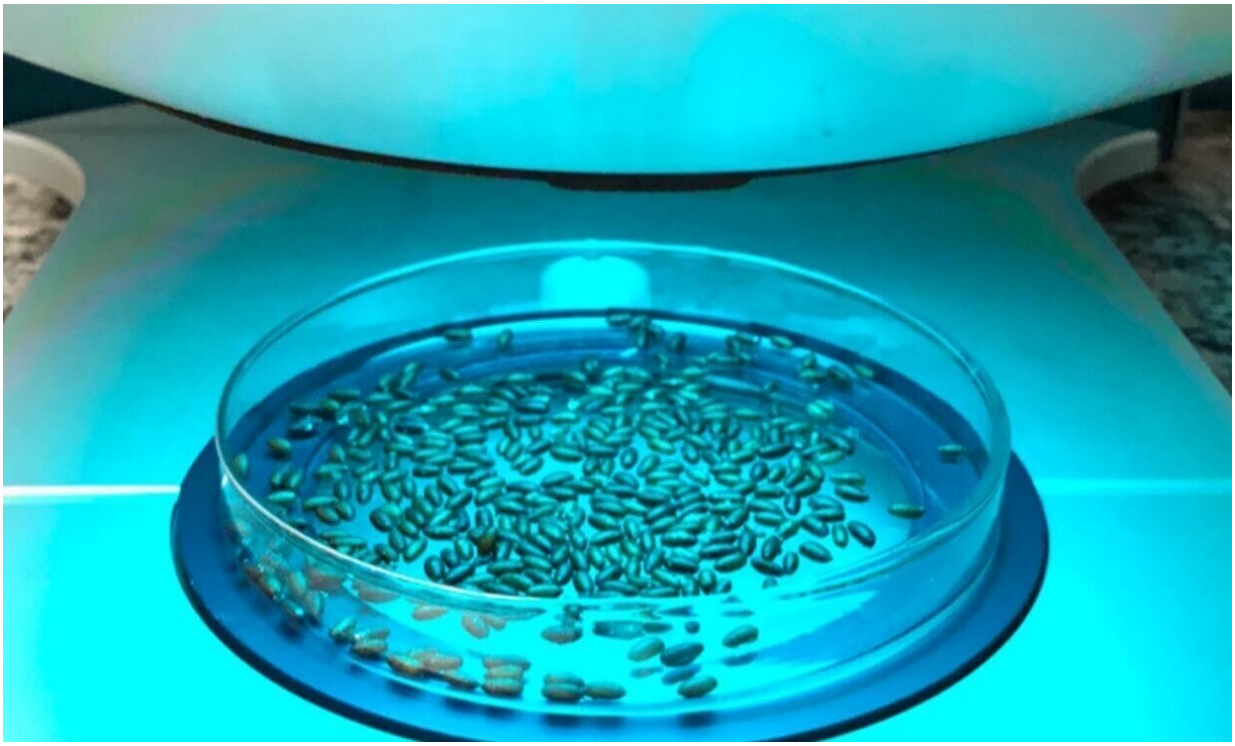

Picture of VideometerLab equipment performing reflectance imaging analysis on pupae of Anastrepha fraterculus. Credit: LRA /CENA-USP

One of the strategies used for biological control of the South American fruit fly Anastrepha fraterculus is sterilization of males by X-ray or gamma-ray irradiation. The aim of the procedure is to bring about a decrease in the wild population of these insects.

A. fraterculus is a major crop pest in the South Region of Brazil, mainly affecting apple and peach orchards. Sterilization is considered an affordable alternative to the use of insecticides and toxic bait. Before irradiation, the pupae—the immature form between larvae and adults—are submitted to a quality control process to identify and discard dead and low-quality insects.

The problem is that this inspection is performed manually and is based on morpho-physiological analysis, but it is difficult to distinguish empty or dead pupae from healthy pupae with the naked eye. Color differences, for example, are subtle and may go unnoticed.

"The problem can impair the efficiency of biological control because low-quality pupae don't develop into sterile flies," said Clíssia Barboza da Silva, an agronomist affiliated with the University of São Paulo's Center for Nuclear Energy in Agriculture (CENA-USP) in Piracicaba. "The margin of error in manual inspection is about 10%," she added.

Barboza da Silva has been working on a way to optimize the process based on a secure and precise method of pupa analysis in the context of mass production. She and her team use VideometerLab, a multispectral imaging instrument developed by a Danish company, to analyze pupae. Multispectral images capture light from an object over a range of wavelengths across the electromagnetic spectrum. The technique accurately identifies alterations in sample quality.

Purchased for approximately BRL 400,000 (now approximately USD 92,000) with funding from FAPESP's Multiuser Equipment Program, the VideometerLab is about the size of a single-serve coffee maker. It sits on the laboratory bench and is easy to operate. In this case, the researchers place the pupae in a Petri dish and analyze them in five seconds. Manual analysis takes hours.

"Thanks to its multispectral camera, the device provides several kinds of data at the same time—physiological, sanitary and genetic, for example, in addition to data on chemical composition," Barboza da Silva said. The device has 19 LED strobe lights, each of which emits a different wavelength from infrared to ultraviolet. The main analytical technique is reflectance imaging. Reflectance is measured by shining light on a sample and calculating the ratio of reflected to incident light.

Images of pupae produced by VideometerLab show different color patterns. The bluer the image, the greater the reflectance and the higher the quality of the sample. According to Barboza da Silva, phenotypical traits such as color and weight are used to detect dead or empty pupae in the conventional inspection procedure.

"The problem is that to the naked eye, empty pupae are almost the same color as high-quality pupae," she said.

Barboza da Silva is co-author of an article published in the *Journal of Applied Entomology*, which presents the positive results of the use of multispectral imaging to control the quality of A. fraterculus pupae.

In addition to providing a complete analysis of various physical and biochemical properties of the pupae, the device also functions as a computer vision system, a type of artificial intelligence that extracts data from images by simulating human vision.

"It generates data and graphics that help monitor pupa quality over time," Barboza da Silva said, adding that since last year, the technology has been used to control the quality of sterile insects sent to supply producers in Vacaria, Rio Grande do Sul, in the far south of Brazil.

The Brazilian Agricultural Research Corporation (EMBRAPA) has a temperate fruit experiment station in Vacaria and is partnering with

CENA-USP in the Moscasul project, launched in 2013 with the Brazilian Apple Growers Association (ABPM).

"A biofactory is being set up in Vacaria, but CENA-USP is producing the sterile fruit flies until an irradiator is acquired to sterilize the pupae," said Thiago de Araújo Mastrangelo, an agronomic engineer and researcher at CENA-USP. The pupae irradiated there are flown to Vacaria in foam boxes chilled to 15 °C about three days before the adult flies emerge.

At EMBRAPA Vacaria, the pupae are placed in larger boxes with access to water and food (usually sugar or honey). Days later, following adult emergence, the sterile males are released into orchards, where they mate with wild females. If the sterile males vastly outnumber the fertile wild males, the wild fly population quickly dies out. The pilot biofactory at CENA-USP currently produces 150,000 to 200,000 insects per week.

According to Mastrangelo, without sterilization or any other control method, the economic impact of the pest could reach 40% of the income from production. "The fly multiplies in areas of native vegetation and then invades nearby crops, such as orange groves in São Paulo [Southeast Brazil] or apple farms in the South."

To date, there is no evidence that biological control of A. fraterculus has had adverse ecological or environmental impacts of any kind in the region, Mastrangelo added. "Recent studies conducted in Mexico show that no harm is done to the food chain of which this insect is part. In tropical environments, even if the species were to become locally extinct, others could take over its ecological niche," he said.

Barboza da Silva noted that potential applications of the VideometerLab extend well beyond insect pupa quality control. "It's being used worldwide in several fields, including medicine, pharmacology, and new

materials. Ours was acquired as multiuser equipment, so we want other researchers in Brazil to start using it too," she said.

Barboza da Silva took a training course in Denmark in 2018 to learn how to operate the device now installed at CENA-USP. This is the only unit currently available in Brazil. She and her team also use it to analyze tomato, carrot, physic nut (Jatropha curcas) and peanut seeds in search of optical imaging patterns that characterize alterations in quality. The study is supported by FAPESP (São Paulo Research Foundation ).

"Conventional tests of seed quality are destructive. Moreover, as with pupae, the results are subjective because they depend on the analyst's training. They are also time-consuming and require a support structure. With the VideometerLab, which uses artificial intelligence, one can analyze the quality of a seed sample noninvasively, objectively and precisely, producing a detailed diagnosis of its physical, physiological, genetic and sanitary characteristics and saving time and money. That's a very significant advance," Barboza da Silva said.

**More information:** Thiago Mastrangelo et al, Multispectral imaging for quality control of laboratory-reared Anastrepha fraterculus (Diptera: Tephritidae) pupae, *Journal of Applied Entomology* (2019). DOI: 10.1111/jen.12716

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