Session 9

Integrated Pest and Resistance Management

Star Wars in food stores – automated detection, determination and laser elimination of insect pests

Cornel Adler[1*], Gunnar Böttger[2], Christian Hentschel[3], Dirk Höpfner[3], Kirko Große[3], Peter Kern[1], Jan Zorn[2]

[1]Julius Kühn-Institut, Federal Res.Inst. f. Cultivated Plants, Inst. for Ecological Chemistry, Plant Analysis and Stored Product Protection, Königin-Luise-Str. 19, 14195 Berlin
[2]Fraunhofer Institute for Reliability and Microintegration IZM, Berlin
[3]Brandenburg University of Technology, Cottbus - Senftenberg, Chair of Communications Engineering,
*Correspondin author: cornel.adler@julius-kuehn.de
DOI 10.5073/jka.2018.463.212

In a project supported by funds of the German government (PT BLE), we test a mobile camera system, scanning surfaces in storage warehouses or food processing industry. If insects are detected they are compared with morphological data in store to decide if the detected individual is a target pest. In case a target pest is determined with high probability, a laser beam is directed to the target to eliminate the insect by heat. The concept is to develop a system that is able to learn and identify more and more different species over time. First aims of the project are to improve reliability of species detection and identification in contrast to the grain with different light spectra and camera parameters. Reaction tests under different light conditions of the two exemplary insects grain weevil *Sitophilus granarius* (Col., Curculionidae) and Indianmeal moth *Plodia interpunctella* (Lepid., Pyralidae) will be carried out. Further the project will investigate laser beam wavelengths and intensities not damaging surfaces and items beneath or next to targets. The system could be utilized to support IPM in well-sealed structures for storage or processing of food and feed stuffs.

Keywords: camera insect surveillance, light, laser control, Sitophilus, Plodia.

1. Introduction

Stored product insects may be found in a given premise for three different reasons:

1. The insects came with infested raw materials, palettes or machinery.
2. The insects have been present for some time and developed in residual products accumulated in unattended areas of the building or within the machinery.
3. The insects found a way to enter from outside, attracted by light, temperature, moisture or volatiles.

In any case it is worth-while to determine the cause why insects can be found inside a storage or food processing facility in order to improve the situation and to reduce the frequency of insects as potential contaminants of food. If insects invaded a premise in infested raw materials, packaging materials such as card-board boxes, tarpolin, palettes, or in infested machinery an improved inspection of all goods prior to bringing them in would be advisable (Adler 2015).

A residual infestation in the building can be detected by regular inspection or by heat-treatments when insects start leaving their favorite hiding spaces. To prevent the immigration of insects from outside one needs to check the seal of windows and doors, the quality of gaskets between frames and movable parts. The air movement could be important, too, as around openings to the outside a reduced pressure in the building could prevent the development of a gradient of attractive odours and thus the orientation of stored product pests (Adler 2016). However, no preventive measure except low temperatures can keep premises permanently insect-free. If insects entered in spite of preventive strategies, they should be detected and controlled as early as possible. One study developed a laser system called "photonic fence" to identify, track, and shoot down small flying insects in the wild (Keller 2016).

Our project outlined here aims to test an automatized camera surveillance of surfaces, combined with a determination of insect genera and a method of pest control using laser beams as a physical control device. Such an automated surveillance could be used in the reception of raw products and storages of finished products, in areas without laborers or at hours when there is no production. Ideally, an insect could be detected and controlled prior to oviposition or other damage.

Questions to be answered are:

1. At which wavelength and light intensity stored product insects are not disturbed in their normal activity but can easily be detected by camera surveillance?
2. Can the utilized optical system detect and determine stored product insect genera with sufficient accuracy?
3. Is the coordination between optic detection and laser control sufficiently fast and accurate for pest-control?
4. Can laser beams be used for insect pest control without damaging goods or surfaces next to the target?

2. Materials and Methods

In a first study the following species resembling crawling beetles and flying moth are tested:

Granary weevil *Sitophilus granariu*s (L.) (Col., Curculionidae)

Indianmeal moth *Plodia interpunctella* (HÜBNER) (Lep., Pyralidae).

We test at which wavelengths and light intensities insect movement is not influenced by a sudden flash from a certain angle, critical wavelengths and light intensities will be determined. Specimens for testing come from our own laboratory culture at defined conditions and on defined substrates. All experiments will be carried out in a stationary testing environment. Later on, a mobile camera detection unit will be used.

The principle of the recognition software is based on pattern analysis (Deep learning) and is illustrated in figure 1. The motion patterns of insects on grain surface, under the different light wavelengths and intensities are recorded in high resolution pictures and videos. The comparison of the pictures results in a probability value for a certain pest insect. The image acquisition of the grain surface and pattern matching are running permanently, creating an automated surveillance system. If a pest insect is determined with a minimal probability of 80 %, laser control is initiated and the process is also transmitted via a data interference to a central pest monitoring center. Is the pest insect on the image not in the database, a new species connected with image and video data can be entered and saved as specimen for the new species. Hence, the pest insect database can be extended.

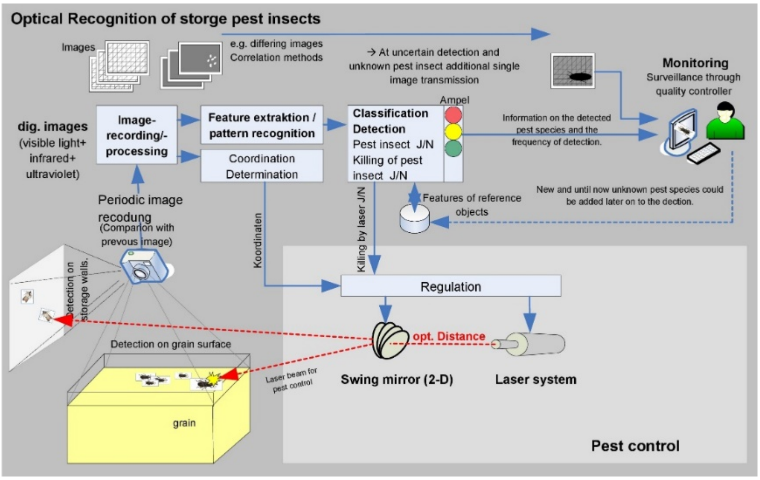

Fig. 9 Scheme of the complete system with detection and pest control

3. Outlook

This study will evaluate the probability of the early detection and pest control and will be a foundation to develop a prototype system. The detection of pest insects facilitates the installation of a model database under diverse environmental conditions and camera angles. The database will be improved if the information of different capture systems (storages) with diverse conditions and will be saved here altogether. With this detection unit a centralized monitoring can be established to lower the personnel costs for inspections and to facilitate a prompt action. Industry partners are integrated early on, starting in the development stage, to guarantee the incorporation of commercial demands. With the results of this study, an industry partners can develop a suitable scanner (light source & camera) in the evaluated spectral region. Preprocessing of video data could be implemented in the camera hardware, hence the transmission of big data amounts (video data) could be minimized drastically.

References

ADLER, C.S.; NDOMO-MOUALEU, A.F.; BERGMANN, J.; MÜNZING, K. 2016: Effect of vacuum storage of wheat (*Triticum aestivum*) grain on the granary weevil, Sitophilus granarius and wheat quality. : 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products, 278-290 P.

ADLER, C.; NDOMO-MOUALEU, A.F., 2015: Pest-proof storage structures prevent the infestation of bulk grain. In: Trematerra, P.; Hamel, D. (eds.): Proceedings of the 10th Conference on Integrated Protection of Stored Products, June 28 - July 1 of 2015, Zagreb, Croatia. Pp: 177-184.

KELLER, M. D., LEAHY, D. J., NORTON, B. J., JOHANSON, R., MULLEN, E. R., MARVIT, M., MAKAGON, A 2016. Laser induced mortality of *Anopheles stephensi* mosquitoes. Scientific Reports **6**: 20936.

Web-Based Phosphine Fumigation Monitoring with Active Sensor Validation Confirms Lethality in Stored Grains

D. Glennon[1*], A. Caravello, S. Ottmar, C. Sweet

[1] Spectros Instruments, Inc., 17D Airport Rd, Hopedale, MA 01747 USA
*corresponding author: dglennon@spectrosinstruments.com
DOI 10.5073/jka.2018.463.213

Abstract

The predominant measurement technologies for fumigation gases over the past 60 years include colorimetric tubes, photoionization detectors, and electrochemical sensors. Their limitations and inaccuracies are well documented. Spectros Instruments has shown non-dispersive infrared monitoring (NDIR) to be a superior analytical tool for the practical measurement of fumigation gases as shown in Table 1. Any compliant fumigation