Detection of Stored Grain Insect

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ABSTRACT

The stored grain insects cause quantity and quality losses in the stored grains. Overall post-harvest losses of grains are about 10–15% of fairly common in many developing countries. For minimizing the stored grain losses, early detection of insects holds paramount importance. Different methods used to detect the storage grain insects aregrain probes and insect traps, Pheromones, Visual lures, Acoustical methods, Electrical conductance, Berlese funnel method, Near-infrared reflectance (NIR) spectroscopy, Machine visionand X-ray imaging. Among all, X-ray imaging appears to have the greatest potential among the insect detection techniques.

INTRODUCTION

All over the globe cereal grains, oilseeds and legumes areimportant food source for humans and most animals. The stored grain insects cause quantity and quality losses in thestored grains. Insects, mites, rodents, birds and microorganisms are attacked by grains so usually economic losses occur. In the above mentioned organisms,insectscause majorgrainlossesnot onlyconsuming grain but also contaminating food with their metabolic byproducts and body parts. The growth of microorganisms and the development of hotspots in grains due to their metabolic activities produce heat and moisture by the insects. Highly infested grains are unfit for seed

purposes and their products are unsuited for human consumption. Overallpost-harvest losses of grains are about 10–15% of fairly common in many developing countries (Lucia &Assennato, 1994).For minimizing the stored grain losses early detection of insects holds paramount importance. So the mainfocus in this article is on the detection methods of stored grain insects.

Detection of storage grain insect methods

(a) Grain probes and insect traps:

- Insect populations in stored grain are often monitored using traps.
- Pitfall and probe traps are commercially available traps that are used for detecting adult insects in stored grain.
- Probe traps are cylindrical tubes with perforations in the upper section through which insects drop into the trap and are unable to escape because of the shape of the receptacle.
- These traps have a pointed tip for easy insertion into the grain. Traps must be removed from the grain bin and inspected periodically to determine the number and type of insects that have been captured.
- Probe traps detect insects when no insects are detected by standard grain sampling methods such as Grain trier method (Barak &Harein, 1982) because they remain in the grain for long periods.

(b)Pheromones

- The most common use of aggregation or sex pheromones is in traps to monitor insect populations.
- For monitoring, chemical attractants usually are impregnated or encased in a rubber or plastic lure that slowly releases the active components over a period of several days or weeks.
- Stored-product insects can be detected with a variety of traps, some using food attractants or synthetic insect pheromones.
- Three stored-product insects that commonly occur together, and for which pheromones are available, are the lesser grain borer, *Rhizoperthadominica*and the red flour beetle *Triboliumcastaneum*(Herbst)which use an aggregation pheromone, and the warehouse beetle, *Trogoderma variabile* (Ballion), which uses a sex pheromone.

(c) Visual lures:

- Visual lures used in insect management fall into the following categories: lights (incandescent, fluorescent, and ultraviolet) that attract insects from dark or dimly lit surroundings; colored objects that are attractive because of their specific reflectance and shapes or silhouettes that stand out against a contrasting background.
- Insect electrocutors can be effective in certain indoor situations, especially in food warehouses and processing plants.
- Electrocutors are placed in dimly lit areas where their light is not visible from outdoors. In such locations the trap does not lure insects into the building, yet it does attract and kill certain flies, moths, and beetles that are pests of stored products or nuisances in food production areas (Gilbert, 1984).

(d) Acoustical methods:

- Insects hidden inside kernels of grain can be detected acoustically by amplification and monitoring of their movement and feeding sounds.

- Hagstrum*et al.* (1988) demonstrated that, sounds of *R. dominica* larvae can be used to estimate larval population densities without removing grain samples.

- Hagstrum*et al*. (1996) detected the presence of one infested kernel in a 650 g of grain. The effective use of an acoustic method to detect insects in grain requires a quantitative understanding of several physical and biological factors that avert sound production, insect distribution, and detection.

- One of the disadvantages of acoustic methods is that they cannot detect dead insects in grain and infestation by early larval stages of insects.

(e) Electrical conductance:

- A single kernel characterization system is commonly used to measure grain kernel weight, moisture content, diameter, and hardness.

- This system works on the principle of electrical conductance and compression force.

- The kernel acts as one resistor in a two-resistor and voltage-divider circuit of the single kernel characterization system.

- Conductance is monitored by measuring the voltage across the kernel. A low voltage measurement corresponds to low kernel resistance, which is typical of high moisture-content kernels. If a live insect is present inside a kernel, there is likely to be a large downward slope in the conductance signal.

- Pearson *et al.* (2003) detected hidden internal insect infestations in wheat kernels using electrical conductance. Their studies showed that the identification accuracies for all wheat samples were 88% for large sized larvae, and 87% for pupae, and there was no sound kernel misclassified as infested.

(f) Berlese funnel method:

- A Berlese funnel works on the principle that insects move away from heat. The Berlese funnels are 49-79% efficient in recovering free-living adults of *Cryptolestesferrugineus* (Stephens) in wheat samples.

- This method is often slow and inaccurate in detecting infestations. It takes 5-6 hr to determine the presence of insects in 1 kg grain samples and during this time, the grain would have been loaded into bins or ships.

- The performance of a Berlese funnel depends on insect stage, size of grain sample, and moisture content of grain (Smith, 1977). Furthermore, this method cannot be used for the hidden infestation in grain kernels.

(g) Near-infrared reflectance (NIR) spectroscopy:

- The NIR spectroscopy has evolved as a fast, reliable, accurate and economical technique available for compositional analysis of grains (Kim*et al*., 2003).

- This technique can be used for both qualitative and quantitative analysis.

- The NIR technique provides information based on the reflectance properties of different substances present in a product. The NIR is based on the absorption of electromagnetic wavelengths in the range 780–2500 nm.

- The concentrations of constituents such as water, protein, fat and carbohydrate

can be determined using classical absorption spectroscopy.

- Elizabeth*et al*. (2002) determined that a NIR system is the best method to detect single kernels of wheat that contained live or dead internal rice weevils at various life stages.

(h) Machine vision:

- In this system individual grain kernels are compared with the photographic print of the representative sample.
- Computerized image analysis has been shown to have great potential for detecting and identifying various non-grain particles and insects in wheat.
- A machine vision system for detecting insects in grains consists of a high-speed integrated machine vision software package used with a monochrome CCD (charge coupled device) camera and a personal computer.
- Zayas and Flinn (1998) detected *R. dominica* adults in wheat bulks with higher than 90% accuracy using structural and colour information.
- Ridgway*et al*. (2002) developed a rapid machine vision method for the detection of adult beetles and determined that detection rates were 89% for commercial samples containing several insect species.
- The disadvantage with this technique is that this method is subjective, time consuming and internal infestations cannot be identified.

(i) X-ray imaging:

- Soft X-ray is the only non-destructive, direct method that can detect insect infestations in grain kernels.
- Karunakaran*et al*. (2003) correctly identified wheat kernels infested by *Sitophilus oryzae* larvae and pupae-adults with more than 97% accuracy from the soft X-ray images. They also identified sound kernels with 99% accuracy and also indicated that in the future an automated line-scan X-ray system could inspect 1 kg grain in about 15 min compared to 5-6 hr using a Berlese funnel.
- Of all the available methods to detect insects in grains, soft X-ray imaging is the only non-destructive and timesaving technique.

CONCLUSION

Insect populations in grains can be generally monitored by several methods. Probe traps can be effective but it is difficult to interpret the type and size of insect catch. Pheromone traps are accepted by several factors like wind speed, temperature and direction. Acoustical methods can detect only live insects while electrical conductance can detect internal insects in grains. The NIR spectroscopy method is very sensitive to the moisture content in samples and the instrument requires frequent calibration. Machine vision systems cannot detect internal infestations. The soft X-ray method is the only non-destructive and direct method to detect insect infestations both by internal and external grain feeding insects. Thus, the soft X-ray is the method that appears to have the greatest potential among the insect detection techniques.

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