NEW ERA AGRICULTURE MAGAZINE

Acoustics techniques in Modern Pest Management

Managayarkarsi S*[1], Nivedha N[2], Logeshvararaj B[3] and Chozhan K[4]

Abstract: -

The scientific study of acoustics examines the production and reception of sounds. This technique has been used since the early 1900s in an array of countries to detect, identify, and monitor certain pest species. A lot of research has been done on using acoustic technologies to either detect or trap insect pests or to change behaviour by inhibiting inter-specific communication. In pest control, common acoustic tools include laser doppler vibrometers, microphones, ultrasonic transducers and various sensors including piezoelectric disks, accelerometers, and acoustic probes, among others. The general acceptance of acoustics as an environmentally friendly and highly effective pest management technique has been hindered by the technology's relatively expensive cost and high expertise requirement. Exploration of advanced technologies in the development of more reliable and cost-effective acoustic devices and their further improvement for easy handling may pave the way for their wide applicability in true sense.

Introduction:

For pest management, legislators, and researchers, acoustic devices offer non-destructive, remote, automated detection and monitoring of hidden insect infestations. A number of factors affect how well acoustic devices detect cryptic insects, estimate population density, and map distributions. These factors include the type and frequency range of the sensor, structure of substrate, interface between the sensor and substrate, length of the assessment, size and behaviour of the insect and distance between the insect and

Managayarkarsi S*[1], Nivedha N[2], Logeshvararaj B[3] and Chozhan K[4]

[1& 2] Assistant Professor in Department of Entomology,*

School of Agricultural Sciences, Dhanalakshmi Srinivasan University, Samayapuram, Trichy,

[3] Field Scientist, Agri Search Pvt. Ltd. Maharashtra*

[4] Dean, School of Agricultural Sciences, Dhanalakshmi Srinivasan University, Samayapuram, Trichy,

sensors. Throughout the years, acoustic recording and playback technologies have been successfully used for insect monitoring and detection (Mankin *et al*., 2011). Acoustic studies in agriculture have mostly focused on attracting and trapping insects for biological studies, sterilization/killing, and pest population surveys. They have also attempted to manipulate insect behaviour or break up intra-specific communication by using sound or vibrational signals that are transmitted within the host plants (Cokl *et al*., 2009).

With their greater sustainability and environmental friendliness, alternative approaches to pest control are being explored more often. The majority of non-chemical pest management techniques manipulate the behavior of the target organism by applying various external stimuli. The current non-chemical solutions call for a labor-intensive, time consuming and error-prone manual procedure. Automatic detection and identification includes acoustic sensing as one of its primary subfields. In addition to being ecologically harmless and having no negative impacts on non-target organisms or the environment, it can identify pests in wood, grain that has been stored, and soil (Liu *et al*., 2017). Acoustic devices often operate in a frequency range that is inaudible to human beings and thus cause no disturbances.

Acoustically-controlled insects

According to Kirkpatrick and Harein (1965), the viability of *Plodia interpunctella* and its progeny were significantly decreased by audible sound waves. Kiruba *et al.* (2009) reported that *Corcyra cephalonica* noises are greatly impacted by triangle auditory waves. Mechanical damage was seen in *T. castaneum* larvae exposed to sine wound waves within the frequency range of 900–1100 Hz (Jinham *et al*., 2012). Pradzynska(1982) reported that the adults of *Sitophilus granarius* were successfully controlled by ultrasonic vibrations within a mass of wheat grains.

A portable acoustic device was created by Sri Lankan researchers Siriwardena *et al.* (2010) to detect coconut palms infested with *Rynchophorus ferruginous*. For oilseed crops, Sisodiya and Singh (2016) devised and developed an ultrasonic and infrared insect detector. The ultrasonic sensor uses ultrasonic signals produced by insect feeding events in crops to identify insect sounds. A Mediterranean fruit fly female acoustic trap was created by Mizrach *et al*. (2005). A bioacoustic method was investigated by Hofstetter *et al*. (2013) for reducing bark beetle reproduction in wood tissues. Kahn and Offenhauser (1949) attracted and captured the male *Anopheles albimanus* by means of loudspeakers. Acoustic devices were eventually used in laboratory and field research to trap *Scapteriscus spp* and other mosquitoes, including the Chironomid midge.

The "Beetle Sound Tube" technique employs perforated tubes inserted in the grain bulk which act as a sizable insect trap for regulating storage pests. They are able to detect all that captured inside the tube because they have a single acoustic sensor at the bottom of tube, right above the trap container. Throughout the duration of storage period, tubes remain in grain and continuously listen for insect sounds without creating any disruptions. An early warning system for pests found in stored products was created using sound to alert storage keepers to an infestation before it became too serious. The "Beetle Sound Tube" system has been altered to work with various storage configurations, including silos, flat storage, and large bags, by utilizing various tube sizes, shapes, and compositions.

Current Technologies for Producing Sound and Vibration

General purpose loudspeakers and other sonic sources with varying dimensions and power levels have been evaluated in behavioral manipulation bioassays, population surveys, and trapping investigations. For example, tuning forks, tiny tweeters, acoustic lasers, and big piezoplastic sheets on foam boards. Airborne sounds generated by harmoniums and MP3 player speakers have been used to elicit vibrations in plants or other substrates harboring specific insects. Behavioral manipulation research have employed piezoceramic actuators, electrodynamics shakers, caged insects, and tethered flying insects to generate noises and vibrations.

Attraction and Trapping Devices

Many devices, such as electrically charged screens, fans or vacuums with collecting bags or cones with nets, sticky cylinders and boards, funnel and bucket traps, or wood-and-screen silt traps, have been used to capture insects of various species that are drawn to sound. The size of the insect and its locomotory behaviors, such as flying or walking up or down a surface, preferences for holes or crevices, rough or smooth surfaces, etc., influence the preferred trap design in part.

Potential Applications for Acoustic Signals: Repulsion/Exclusion, Communication Interference

It has been well documented that many species of insects subject to predation by bats will dive to the ground or move away when they detect ultrasonic signals that resemble echolocation calls. .. In a field of maize that was inhabited to both *Ostrinia nubilalis* (Hubner) and *Heliothis zea* (Boddie), a light trap with an ultrasonic speaker had been established. In order to simulate a range of pulse rates and durations emitted during echolocation screams by nearby insectivorous bats, the speaker produced 1 ms, 25 kHz pulses at rates of 1–10 /s.

It is important to note also that capability to detect ultrasound to ultrasonic signals has evolved primarily in insects that are preyed upon by bats. Consequently, it is not surprising that none of the popularly marketed ultrasonic repellers has ever been shown to be cost- effective against insects such as cockroaches, mosquitoes, fleas and dragonflies that typically are not bat prey. Potential uses of vibrational or acoustic signals include ant repellent, hemipteran insect capturing, and behavioral modification of their communication. Furthermore, there is a chance to manipulate predator-prey behavior and replicate sound through behavior. (Mankin, 2012)

Conclusion

The preceding study has demonstrated that employing auditory communication in pest management can help prevent insects from entering the environment and detect hidden bug infestations early on. Instrument prices will go down as technology advances and more people begin to use them. The examination of diverse monitoring and pest control techniques through the use of acoustics will motivate entomologists to examine the acoustic characteristics of the different pests.

References

1. Alfred PremjithJinham, Solomon Kiruba, Jesudasan Thombi Thanka Kumaran, Sathiadas Sam Manohar Das. 2012. Efficacy of Audible Sound Waves in Inflicting Tissue Damage and Mortality in *Tribolium castaneum* (Coleoptera: Tenebrionidae) Larvae. Agricultura Tropica Et Subtropica, 4o5l/1.,4 352 -(316), 22001122
2. Cokl A, Millar JG. Manipulation of insect signaling for monitoring and control of pest insects. In: Ishaaya I, Horowitz AR (eds.) Biorational control of arthropod pests: application and resistance management. Springer, Dordrecht, Netherlands. 2009, 279-316
3. Hofstetter, R. W.; Dunn, D. D.; McGuire, R and Pottera, K. (2013).Using acoustic technology to reduce bark beetle reproduction.Wiley Online Library. 70: 24-27.
4. Kahn MC, Offenhauser W. The first field tests of recorded mosquito sounds used for mosquito destruction. The American Journal of Tropical Medicine and Hygiene. 1949; 29:811-825
5. Kirkpatrick R.L., Harein P.K. (1965): Inhibition of reproduction of Indian meal moth *Plodia interpunctella*,by exposure to amplified sound. Journal of Economic Entomology 58: 920-921.

6. Kiruba. S., Jinham, A.P., Kumaran, J.T.T., Das, S.S.M., Papadopoulou, S. (2009): Effectiveness of audiblesound waves in reaching *Corcyra cephalonica* Stainton (Pyralidae: Lepidoptera) concealed under flour cover. Entomologia Generalis 31(4): 327-336
7. Liu, H., Lee SH, Chahle JS. 2017. A review of recent sensing technologies to detect invertebrates on crops. Precision. Agriculture. 18:635-666
8. Mankin RW, Hagstrum DW, Smith MT, Roda AL, Kairo MTK. Perspective and Promise: A century of insect acoustic detection and monitoring. American Entomologist. 2011; 57(1):30-44.
9. Mizrach, A; Hetzroni, A; Mazor, M; Mankin, R. W; Ignat, T and Grinshpun, N. (2005). Acoustic trap for female Mediterranean fruit flies. Transactions of the American Society of Agricultural Engineers; **48**:2017-22.
10. Pradzynska A. (1982): The suitability of ultrasound forcontrolling stored pest. II. The effectiveness of treatment with ultrasonic waves on all stages of the granary weevil (*Sitophilus granarius* L.). Prace Naukowe Instytutu Ochrony Roslin 24: 77-90.
11. R. W. Mankin 2012. Review-Applications of acoustics in insect pest management. CAB Reviews (7)1:1-7
12. Siriwardena, K. A. P.; Fernando, L. C. P.; Nanayakkara, N.; Perera, K. F. G.; Kumara, A.D. N. T and Nanayakkara, T. (2010). Portable acoustic device for detection of coconutpalms infested by *Rynchophorus ferruginous.*Crop Protection.**29**:25-29.
13. Sisodiya, K. and Singh, M. (2016).Design and development of Ultrasonic and IR insectdetector for oilseeds crop. International Journal of Electronics & Communication Technology. **7**(4): 2230-7109.