***Short Research Article***

**“Integrated Light-Acoustic-Chemical free Trap for Sustainable Crop Pest Management”**

**Abstract**: The present study evaluated the effectiveness of a composite light and sound-based trap system for monitoring and controlling insect pests in fruit orchards. The trap integrated with UV (365 nm and 395 nm), blue light, sticky cards, an electric grid, and an ultrasonic transducer. Results indicated high attraction rates for key agricultural pests including scarab beetles, moths, thrips, whiteflies, mosquitoes, and leafhoppers, with blue light particularly effective against small flying insects. Sticky surfaces and the electric grid enhanced pest mortality. Notably, the ultrasonic component deterred bats, minimizing non-target interference near fruit-bearing trees. Overall, the composite trap functioned as an eco-friendly and multi-functional tool, with strong potential for integration into IPM strategies, offering both pest suppression and ecological safety.

**Key words:** Composite light , Sustainable, eco-friendly, IPM, Multifunctional

**INTRODUCTION:**

In modern farming, insect traps have become an important tool for managing pests in a way that’s both effective and environmentally friendly. Instead of relying only on chemical pesticides, farmers now use a variety of traps like sticky cards, light traps, and pheromone-baited devices to monitor and control harmful insect populations. Hokkanen (1991), was among the first to highlight how trap-based methods, such as trap cropping and attract-and-kill strategies, can reduce pest numbers while protecting helpful insects like pollinators and predators. Shelton and Badenes-Pérez (2006), added that traps are not just for control they also act as early warning systems, helping farmers take action before pests cause serious damage. More recently, Sharma et al. (2019) reviewed how traps have been successfully used in crops like cotton, soybean, rice, and vegetables. Their findings showed that traps are flexible, cost-effective, and easy to include in integrated pest management (IPM) programs. Traps also support the health of the entire farm ecosystem. Using traps can reduce the need for pesticides, protect pollinators, and encourage natural enemies of pests. As agriculture shifts toward more sustainable practices, traps are becoming a key part of pest management strategies, Cavanagh et al., (2009); Wszelaki & Broughton (2013); Shimoda M, Honda, (2013); Nasir and Younas (2025); Ahirwar and Vaishampayan (2022).

**METHODOLOGY: Design**

The present composite insect trap is specially designed to catch a wide variety of crop pests using different kinds of signals and tools all in one device. It combines both attraction and control methods to improve pest capture.

At the center of the device are two ultraviolet (UV) LED lights one at 365 nm and another at 395 nm which help attract insects that are active at night or early morning, since many pests are drawn to UV light. It also uses blue and white LED lights, which make the trap more visible and attractive to several other insect species. To keep away certain flying creatures like birds, bats, or some insects, a 45 kHz ultrasonic transducer is included. The transducer produces high-pitched sound waves that are irritating to them and help repel or confuse them. The trap also uses chemical lures, such as pheromones or food-based scents, to draw in specific pest species more effectively. For passive trapping, the device includes blue and yellow sticky cards, which are known to attract common sucking pests like whiteflies, thrips, and leafhoppers.

Finally, the trap has an electric grid that kills insects immediately on contact. This provides a quick, non-chemical method of control. By combining light, sound, scent, sticky surfaces, and electricity, this all-in-one device offers a practical and eco-friendly way to manage insect pests in agriculture as part of an Integrated Pest Management (IPM) approach. The trap was operated for three hours, from 6:30 PM to 9:30 PM.



**Fig 1 : Installed Composite Trap**

**RESULT AND DISCUSSION**

In the present investigation, the majority of trapped insect crop pests belonged to the order Coleoptera, encompassing a diverse range of beetle families. A total of 14 families were recorded, including Carabidae, Haliplidae, Dytiscidae, Histeridae, Staphylinidae, Scarabaeidae, Elateridae, Meloidae, Tenebrionidae, Cerambycidae, Chrysomelidae, Mordellidae, Scolytidae, and Curculionidae. It was noted that when both UV light sources (365 nm and 395 nm) were used simultaneously, the highest number of beetles attracted to the trap belonged to the family Scarabaeidae, followed by those from the families Scolytidae, Carabidae, Cerambycidae, and Meloidae, respectively.

Scarab beetles are a major agricultural pest, particularly during their larval stage when they appear as white grubs. These larvae live beneath the soil and feed on the roots of crops such as sugarcane, maize, groundnut, and others. Their feeding weakens the plants, leading to symptoms like yellowing, stunted growth, and sometimes total plant collapse. Adult beetles typically emerge with the onset of the rainy season, laying their eggs in the soil. Once hatched, the larvae continue the cycle underground, making early detection extremely difficult. Because of their hidden lifestyle and damaging behavior, controlling white grubs is a significant challenge for farmers. In this context, the composite trap which uses a combination of UV light, sticky surfaces, lures, and electric grids plays an important role. It helps attract and intercept adult scarab beetles before they reproduce, thereby reducing both immediate damage and the long-term pest population.

*Eudocima homaena* and *Achaea janata* are major crop pest of pomegranate. *Eudocima homaena* is a fruit-piercing moth that causes serious damage to pomegranate fruits. The adult moth uses its sharp mouthpart to poke holes in ripe fruits and suck out the juice. This leads to scars, rotting, fruit drop, and opens the fruit to infection by fungi and bacteria. The damage is worse during the ripening stage and can reduce both the quality and quantity of the harvest. *Achaea janata*, damages pomegranates by piercing the skin of ripening fruits with its sharp proboscis to suck juice. This causes scars, fruit rot, and drop, reducing both yield and quality. The pest is active at night, making early control difficult. The adult moths of both species were attracted to UV light at 365 nm, indicating their sensitivity to this specific wavelength.

During the study, leafhoppers, thrips, mosquitoes, and whiteflies exhibited a strong attraction to blue light. Adult showed maximum response when blue and white light were used simultaneously. hrips and mosquitoes showed strong responsiveness to the trap setup. Many individuals were either captured on sticky cards or killed by the electric grid, confirming their high attraction toward the blue and white light.

When the transducer was activated, it emitted ultrasonic frequencies that likely interfered with the bats' echolocation. As a result, the bats stopped flying around the fruit trees and avoided the area entirely. This observation suggests that ultrasound effectively disrupts their navigation, making it a potential tool for bat deterrence in orchards.

Studies by Ramamurthy et al. (2010) and Barghin et al., (2012) showed that shorter UV wavelengths mimic moonlight, guiding nocturnal insects right into traps. Even though insect eyes are most sensitive around green (520 nm), Chitra (2018), found that UV still gets their attention especially below 340 nm. Blue LED light (in the 450–495 nm range) is strong choice. In outdoor tests. Gavhande et al., (2019), found it outperformed yellow light and came close to UV in attracting insects. Chitra (2018) also showed that blue light captures more species variety, making it great for biodiversity tracking. Najiah (2012), built a simple device with white light to repel mosquitoes and flies. In greenhouses, Urairi et al., (2022), tested these waves and pushed away up to 60% of whiteflies in under a minute.

Sticky traps are like cards or panels coated with glue. Lo et al. (2019), found that hot-melt adhesives (HMPSA) worked best, even catching beneficial insects. Nandini et al., (2012), showed that yellow sticky cards are perfect for catching greenhouse pests like whiteflies and thrips. Lasa et al., (2014), discovered that a bait called CeraTrap caught more fruit flies than dry lures, especially females. Ahmad et al., (2023), mixed two scents methyl-eugenol and cue-lure and found the best combo (40:60) to attract *Bactrocera dorsalis*, a common crop pest. Electric grids are classic bug zappers. When an insect flies in, it hits a charged grid and is killed instantly. Stanley et al., (1977), showed how useful these can be for research. More recently, Jobe et al., (2024), pointed out that they work well without chemicals but can kill helpful insects too so modern versions try to be more selective and efficient.

**CONCLUSION:**

Based on field observations, the composite trap system emerged as a highly efficient and environmentally sustainable tool for monitoring and managing pest populations in fruit orchards. The trap’s thoughtfully engineered design incorporated a synergy of UV (365 nm and 395 nm) and blue light wavelengths, which proved exceptionally effective in attracting a wide spectrum of phototactic insect pests. Targeted pest groups included scarab beetles, noctuid moths, thrips, mosquitoes, whiteflies, and leafhoppers, all of which pose serious threats to fruit crop health and yield. The integration of sticky adhesive surfaces and an electric grid added an active suppression mechanism to the system, ensuring that lured insects were not only monitored but also effectively neutralized. This dual-action approach significantly reduced pest populations in the vicinity of the trap and enhanced its utility for real-time pest surveillance. The deployment of an ultrasonic transducer introduced a unique layer of non-chemical pest management. By emitting high-frequency sound waves, the trap successfully repelled non-target organisms, notably bats, from the orchard area. This minimized ecological disturbances and potential damage to beneficial fauna, addressing a common challenge in pest control strategies.

The present composite trap demonstrated considerable promise as a multi-functional, non-toxic, and field-adaptable solution for use in Integrated Pest Management (IPM) systems. Its capacity to attract, capture, and deter across multiple insect groups and non-targets underscores its potential as a cornerstone technology in the pursuit of sustainable and eco-conscious agriculture.

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