Agri Express: **02** (01), ***Article No***. V02I01.42 ***E - ISSN No. 2584 - 2498***

BEES FROM POLLINATOR TO EXPLOSIVE DETECTORS

Shaik Sulemaan, M. Pravalika and A Niharika

ITM University, Gwalior

Corresponding author: sulemaan032@gmail.com

ABSTRACT

This article speaks about using bees to find explosives, which is quite innovative. It explains how scientists train bees to detect explosives by rewarding them with sugar water when they sense the smell of Explosives. The bees stick out their tongues when they find an explosive, which is called Proboscis Extension Reflex (PER). The process involves cooling and loading the bees into special containers. Monitoring cameras and devices help track their reactions. Using bees for this job has advantages like quick training, low cost, and safety. The article also mentions new ways to make bee training better and how technology can help. Although there are challenges, like tracking bees accurately, using bees for detecting explosives seems promising for making things safer.

Keywords: Bees, Explosives detection, Proboscis Extension Reflex (PER), Training, Technology

INTRODUCTION

You are about to know something Fascinating about bees, bees are more than pollinators, Honey producer, what if I told you Bees can be used for Explosive Detection. You are about to witness the amazing role of honey bees in detection of explosives which is far more thousand times better than sniffer dogs used by the Cops.

This concept of Honey bees for Explosive Detection was pioneered by a research scientist Jerry Bromenshenk & his team at University of Montana in the late 1990's. This Idea was developed through Classical Conditioning, which acted as foundation for further research in this field. The methods used in this are Active method, Passive method, electronic system for bees' activity monitoring by all these Results of Experiment is seen.

This Process starts by taking honey bees from hive. Bees are collected for the hive by a Suction device making sure it wouldn't harm the bees. Later the bees are cooled in refrigerator to cool them down. The bees are placed in refrigerator for 30 minutes in a calm Environment. After cooling them down, the bees are loaded in a cylinder or cartridge manually. Of course, it is a tough task for the technician, but some labs do have automated bee loading machines. In Lab like visual communication Unit at Rothamsted Research, they have this automated bee loading machine.

Working Principle

The Working Principle of a sniffer dog & bees detecting is similar with few considerations. The Basic principle behind training a sniffer dog is Dogs start salivating in anticipation of food that is coming to it with a ring of Bell or whistle. If you replace the smell of food with Narcotics or Explosives, the dog will start salivating every time to it.

Similarly, Honey bees don't salivate but they do have a proboscis (tongue) as an indicator. The Antennae of honey bee acts as vapour sensors having sensitivity threshold in a trillion, Similar to a Dog.

Honey bees are collected randomly, & they need to pass a qualification test before training. The bees stick out their tongue when presented with sugar water swab. The bees Stick their tongue out called as Proboscis extension Reflex (PER). The bees are exposed to explosive vapour for 6 seconds. They are rewarded at the last 3 seconds. After the 4th round, the bees are ready to get into the field. Besides Looking are the bees visually, how can you monitor their response? There are two ways you can do about it, one is with camera, the other is bees are placed on 6 cartridges & loaded in a monitoring device. The camera inside the device reads the bees in close up. The bees act similarly when they are exposed to the explosive scent. There is an Infra-red Led In front Each Bee. It can tell whether the bee has it tongue out or not. If the monitoring screen is showing 36 green squares, shows that bee has not responded yet & it's a go. If Bee extends its tongue the squares corresponding to it turns red. Something Cool about it is, Bees on Every cartridge can be trained on different-different substance.

After few days bees are sent back to hive. All these things are involved in training of honey bee in explosive detection which can create a miracle with low cost of investment & maintenance. It would create an effective difference if equated.

What Species of Honey Bee can be Used

The most commonly Utilized bee is the Species of ***Apis melifera***

Training of Bees

Bees are trained by a method called "Pavlovian Conditioning". In the famous Pavlov's experiment, he observed that dogs would salivate as a response for presence of food. They are trained by rewarding the bees with sugar water. When they sense the scent, they extend their Proboscis in anticipation of Reward.

Experimental Setups & Monitoring

Researchers use controlled environment for conducting experiments by trained bees. The setups may include Containers or chambers where bees can interact with the sugar syrups. Monitoring tools may include Video cameras or sensors to track bees' responses which includes the changes in Physiological or behavioural changes. This data plays a crucial role for assessing the efficiency of bees as detectors & refining the protocols of training.

Common Devices Used for Explosive Detection

1. Explosive Trace detectors- This Samples the air or surfaces to trace explosive by using techniques such as IMS (Ion Mobility Spectrometry) or MS (Mass Spectrometry).
2. Chemical detection sensors
3. Nuclear Quadrupled Resonance Devices
4. Under Vehicle Inspection Systems (UVIS)
5. Handheld Detectors
6. Biosensors
7. Standoff Detection system
8. Canine (K-9) units
9. Standoff detection System

Why Bees when we have Dogs?

- ✓ It takes short period of time to train bees when compared to dogs.
- ✓ Besides for detecting Landmines, the dogs may trigger the Landmine to Explode. Where the bees can be monitored by drones & it will outsmart the landmine.
- ✓ Low Investment & low-cost maintenance.
- ✓ Safer than Sniffer Dogs in many cases of explosives & narcotics.

Application in Security & Beyond that

Trained bees can be deployed at borders, airport & other sensitive location. Their agility & efficiency makes them well-suited for aims such as cargo searching or detecting concealed explosives.

Advancements in Bee-Based Detection Technology

In recent years, significant studies have been made in developing the capabilities and reliability of bee-based detection systems. These advancements encompass various aspects of the detection process, including training methodologies, experimental setups, and monitoring techniques.

Training Optimization

An area of focus in enhancing bee-based detection technology is developing the training process to improve detection accuracy and efficiency. Scientist are exploring innovative training protocols that helps to seek from behavioural psychology to enhance the learning results of bees. By refining conditioning techniques and stimulus-response, scientists aim to achieve greater consistency in bee detection performance across different environmental conditions and substances which are in target.

Automation and Robotics

Automation plays a vital role in scaling up the deployment of bee for application in real world. Development in robotics and automated handling systems will enable efficient bee loading, training, and monitoring. Robotic platforms equipped with sensors can simulate naturalistic environments for bee training while providing real-time feedback on performance matter. Integration with AI algorithms further develops the adaptability and responsiveness of automated systems, allows dynamic adjustments based on requirements of evolving detection

Sensor Technology Integration

Incorporating state-of-the-art sensor technologies into bee-based detection platforms enhances the sensitivity and specificity of detection capabilities. Miniaturized chemical sensors and microelectronic devices enable real-time monitoring of volatile organic compounds (VOCs) emitted by explosive materials, complementing the bees' olfactory senses. Integration of multisensory data fusion algorithms enables synergistic information processing, where inputs from bees and electronic sensors are combined to enhance detection reliability and reduce false positives.

Bio-Inspired Algorithms

Bio-inspired algorithms draw inspiration from the collective behaviours and decision-making processes observed in ecosystem, such as colonies of bees. By emulating the swarm intelligence by bees, these algorithms regulate detection planning, route planning, and resource locating in dynamic and environment which is uncertain. Swarm robotics approaches helps decentralized mechanism of control to coordinate drones or multiple robotic agents in collaborative detection missions, mirroring the coordinated feeding behaviours of colonies of bees.

Miniaturization and Wearable Technology

Development in miniaturization technology has helped the development of wearable bee-mounted sensor platforms for application of on-body detection. These compact and lightweight devices facilitate communication without wire and harvesting of energy technologies to enable seamless integration with colonies of bees. By

equipping individual bees with special sensor, researchers can bind their capabilities of natural sensing and expand the range of detectable substances. Wearable sensor networks enable distributed sensing and aggregation of data, allowing for real-time monitoring of conditions of environment and potential threats early detection.

Cross-Disciplinary Collaboration

The interdisciplinary nature of bee-based detection research fosters collaboration between experts of many departments like in entomology, materials science, and robotics and computer science. By helping insights from diverse disciplines, researchers can tackle complex concerns associated with bee training, sensor integration, and data analytics. Cross-disciplinary collaboration Enhances innovation and improves the development of holistic solutions that address the multifaceted aspects of detection of explosives.

Cons of Using Honey bees in Explosive Detection

The main concern of using honeybees for landmine detection is the lack of a method for their precise localization and tracking of bees during flight which can be solved up to an extent by use of Drones The other thing would be Training & Reliability which demands a significant time & effort, depending on their consistency might be challenging. Some people may have Ethical considerations especially if the bees are exposed to a potentially harmful substance.

False Positives/Negatives, Honey bee may produce False Positives/Negatives results which can cause inaccurate results while detecting the explosives.

CONCLUSION

Use of Honey bee for the detection of explosive is a Promising Alternative to the traditional methods. While the research is still in development stage, this method has shown a strong potential approach in application of security, monitoring environment & humanitarian effort in landmines detection. Further research will enhance reliability & efficiency. This method is contributing to safer & effective explosive detection.

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