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Innovations in Insect Pest Management: Interventions Using Insect Derived Volatiles

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Insects release volatiles known as semiochemicals which include intraspecific volatiles (pheromones) and interspecific volatiles (allelochemicals which include kairomones, synomones and allomones). The pheromones are secreted by the individuals of the same species, either males or females or both or even the developing instars. These pheromones are used successfully for the management of insects on various crops.

Material and Methods

The pheromones especially, sex pheromones are usually secreted by females from their glands located in their last abdominal glands or aggregation pheromones by males from thoracic glands. Usually these glands are tweezed out and their chemical profiles are created. Electrophysiological instruments such as electroantennogram (EAG), Gas chromatography coupled electroantennogram (GC-EAD), Gas chromatography coupled single sensillar recorder (GC-SSR) and analytical instruments such as Gas chromatography mass selective detector (GC-MS), Nuclear magnetic resonance (NMR) and Fourier Transformed Infra Red Detector (FTIR) are used for the isolation, identification and structural elucidation of the pheromonal compounds. The identified compounds are synthesized using organic synthesis process and their efficacy was confirmed through behavioural assays using wind tunnel, olfactometers and field cages. Dispensers were used for sustained release of pheromones at the dose simulating natural the field releases from the individuals.

Results and Discussion

Pheromones are of different types such as alarm pheromones, brood pheromones, contact sex pheromones, defense substances, marking pheromones, recognition pheromones, trail pheromones, sex pheromones and aggregation pheromones. Among them sex pheromones and aggregation pheromones are widely used in the insect pest management.

Several species of insects are monitored by keeping the pheromones in the field or green houses/net houses. The catches in monitoring traps will help in decision making process such as the application of insecticides or release of biological control agents. Effective monitoring of the pests is achieved through the use of appropriate dispensers containing the exact blend of the pheromone compounds, placed in optimum quantities of traps, which are spread one to two per acre at appropriate places in the fields (Witzgall *et al*., 2010; Colazza *et al*., 2007). Quarantine monitoring of invasives such as fruit flies are effectively done using parapheromones such as methyl eugneol or cue lure. Monitoring of spread or dispersal and social auditing of the effectiveness of weed biological control agents are also done using the pheromones.

The use of pheromones for mass trapping has led to reduction in the pest load of rice infesting viz. *Scirpophaga incertulas* (Walker), (Cork *et al*., 2005). In the management of brinjal, installation of 25–30 traps/ac, containing a blend of E-11-hexadecenyl acetate and E-11-hexadecenol (100:1) along with insecticidal sprays such as neem, effectively managed *Leucinodes orbonalis* (Guenee) (Cork *et al*., 2005; Rath and Dash, 2005).

Mating disruption is accomplished by inundating the whole field with the pheromones that results in the confusion of males in locating and mating with the females which drastically reduces the egg load in the fields. Commercial formulations such as PB-ROPEL, Isomate M Plus, Isomate M 100, Isomate OFM, RAK1+2 dispensers, or RAK1+2R Isonet and Biodegradable dispensers are a few examples of pheromone dispensers used for successful mating disruption in species such as *Cydia pomonella* and *Cydia moelsta* (Denis and Schiffermüller) (Angeli *et al*., 1999; Molinari *et al*., 2000). Mass trapping and mating disruption can easily be integrated with insecticides, biological control, and are pollinator friendly.

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Polymorphic geographical populations of pests like *Helicoverpa armigera* (Hubner) which exhibit various blend ratios do exist within short geographical ranges, necessitating discovery of appropriate blends of pheromone.

Aggregation pheromones are secreted from the thoracic glands, mostly in coleopteran and heteropteran insects. These are effectively used in attracting both the males and females and thus reducing the population levels. Mass trapping of coffee stem borer, *Xylotrechus quadripes* (Chevr) and red palm weevil, *Rhynchophorus ferrugineus* Olivier was done using their aggregation pheromone. The number of traps used in mass trapping are usually more and both the sexes were normally trapped, for eg, 10 traps per acre each containing 75 mg of pheromone was used for successful management of *X. quadripes*.

Several species of beetles use antiovipositing pheromone which release message to the conspecific females to avoid those trees oviposited by the females. Verbanone is one such substance which was commercially exploited to reduce the infestation by *Dendroctonus ponderosae* Hopkins (Fettig, 2013). Frontalin at higher doses and methylcyclohexanone (MCH) (3-methylcyclohex-2-en-1-one) also act as antiaggregation pheromones and are used for species such as *Ips pini* Say (Miller, 2001; Ross *et al*., 1996).

The natural unsaturated hydrocarbons present on the cuticle of several lepidopteran insects comprise of compounds such as octacosane, pentacosane, hexacosane, tricosane, hexatriacontane, and docosane which increased the activity of egg parasitoid, *Trichogramma* spp. (Paul *et al*., 2002; Paramasivan *et al*., 2004; Yadav *et al*., 2008).

The alarm pheromone (β-farnesene) and sex pheromone of aphids [(+)– 4aS, 7S, 7aR) nepetalactone] are involved in cross-talk with aphid predators or parasitoids (Micha and Wyss, 1996; Powell *et al*., 1993; Hardie *et al*., 1991). β-farnesene is commercially used as attractant for lady bird beetles.

Conclusion

In India, the use of pheromone in pest management is rather very less and farmers are to be educated on the importance of pheromones in management of pests. Pheromones may be incorporated easily in the integrated pest management and accordingly package of pest management to be revised. Semiochemicals comprising of pheromone and kairomone act as important tools in the conservation biological control and these technologies need to be commercialized.

Electronic nose or electronic sensors need to be developed which should be able to identify the presence of calling females in the fields which makes the management practices easy.

Technologies need to be refined with the use of state of art dispensers and environment friendly precision traps for the economical use of pheromones.

Pheromones for insects of Indian origin (such as cashew stem borer, *Plocaederus ferrugineus* (L.) and mango stem borer, *Batocera rufomaculata* De Geer) need to be isolated, identified, and synthesized for commercialization. Pheromones for sucking pests such as leaf hoppers, aphids, mealybugs, leafminers also need to be identified and exploited for monitoring purpose.

Several alien pests such as coconut borer *Brontispa longissima* (Gestro) are expected to invade India in the future, it will be appropriate to isolate, identify and synthesize and share with the countries where the potential of invasion looms over.

Infrastructure facilities need to be strengthened and shared between ICAR and agricultural universities for the semiochemical research for the meaningful development of semiochemical technologies.

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