International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 04-05-2023, Accepted: 19-05-2023, Published: 03-06-2023
Volume 8, Issue 6, 2023, Page No. 12-15

Semiochemicals communication: A sustainable approach for suppressing insect pests population

Umesh Vishal Mahajan*, Sanket Sahebrao Kawale
M. Sc. Scholar, Department of Entomology, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Abstract
Semiochemicals are the organic compounds which are capable to modify the behaviour of recognizing organism at nano levels. They help in perceiving the information about the environment through olfactory system and are produced by both animal and plant. Semiochemical involved in the intraspecific communication are pheromones and interspecific communication is mediated by allelochemicals. The intraspecific signals in the form of pheromones play significant role in insect communication and may act as attractant or repellent by modifying behavioural pattern at specific time. It affects mating activities, oviposition, feeding, host-habitat resources, avoidance from enemies and also competition among the species. Semiochemicals have great potential in monitoring pest population by altering the behaviour of pest or enemies which are detrimental to the target pest. They can be used widely in pest management due to their feasibility in crop pest protection activities. It can be included in an integrated pest management strategies as they have adverse effect only on target pest, environmentally safer and also less risk of resistance development in the target pest.

Keywords: pest, semiochemicals

Introduction

Semiochemicals, can be defined as chemical markers or signals that relay communication in the act of the same or different species (Komala *et al.*, 2021) [6]. The term semiochemical is derived from the Greek word "semeon" which means mark or a signal that induce a behavioural or a physiological response in other individuals. Semiochemicals affect the behavior of insect pests mainly by: insect-insect or plant-insect interactions (El-Ghany, 2019) [2]. Semiochemicals are organic compounds used by insects to convey specific chemical messages that modify behavior or physiology (El-Sayed, 2015) [3]. The insects use semiochemicals to mediate important behaviour such as mating, oviposition and foraging for resources (Evenden and Silk 2016) [4]. These compounds can be classified in two groups considering whether they act as intraspecific (pheromones) or interspecific (allelochemicals) mediators. Insects use semiochemicals to locate mate, host or food source, avoid competition, escape natural enemies and overcome natural defense systems of their hosts. Semiochemicals have the advantage of being used to communicate message over relatively long distances compared with other insect means of communication such as touch.

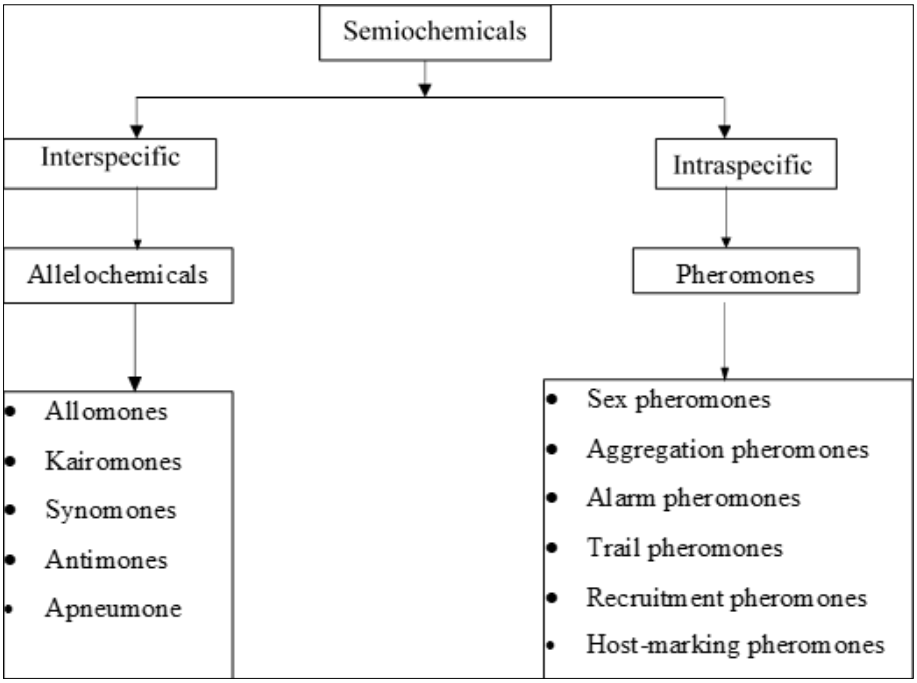

Fig 1: Semiochemicals classification

1. Different type of semiochemical

A. Allelochemicals

Substances which transmit chemical messages between different species, known as allelochemials. The communication is interspecific communication. They have been divided into five categories: allomones, kairomones, synomones, antimones and apneumones.

- **Allomones**
  (From Greek "allos + hormone" = excite others) released from one organism that stimulate a response in an individual of another species. The response is beneficial to the emitter.

- **Kairomones**
  (From Greek word "kairos" = opportunistic or exploitative): emitted by one organism that stimulate a response in an individual of another species. The response is beneficial to the recipient.

- **Synomones**
  A substance released by organism which benefits to both sender and receiver.

- **Antimones**
  A substance produced or acquired by an organism that when it contacts an individual of another species in the natural context, evokes in the receiver a behavioural or physiological reactions that is maladaptive to both emitter and the receiver.

- **Apneumone**
  (From Greek word "a-pneum" = breathless or lifeless). A chemical released by non-living substance that is beneficial to receiver but detrimental to other organism in the substance.

B. Pheromones

A pheromone is a secreted or excreted chemical factor that triggers a social response in member of the same species. The term pheromone was introduced by Peter Karlson and Martin Luscher in 1959, based on Greek word 'pherein' (to transport) and 'hormone' (to stimulate). They are sometimes classified as ecto-hormones.

The pheromones can be classified into 2 group –

- **Primer effect pheromones-**

They trigger off a chain of physiological changes in the recipient without any immediate change in the behaviour. They operate through gustatory sensilla. These regulate caste determination and reproduction in social insects like ants, bees, wasps, and termites are mediated by primer pheromones.

- **Releaser effect pheromones**

These pheromones produce an immediate change in the behaviour of the recipient. They operate through the olfactory sensilla. Releaser pheromones may be further subdivided based on their biological activity into-

- **Sex pheromones**

Interaction between sexes of the same species and are mainly produced by females to attract males. Aphrodisiacs are substances that aid in courtship of the insects after the two sexes are brought together. In many cases males produce aphrodisiacs. Bombykol is first sex pheromone isolated and identified from silkworm in 1959 by A. Butenandt and co-workers.

Table 1: Major differences between male and female produced pheromones

Sr. No.	Properties	Female sex pheromone	Male sex pheromone
1.	Range	Acts at long range. Attracts males from long distance	Acts at a short distance
2.	Role of stimuli	Play less role	Visuals and auditory stimuli play major role
3.	Action elicited in the other sex	Attracts and excites males to copulate	Lowers females resistances to mating
4.	Importance in IPM	More important	Less important

Table 2: Some of the female sex pheromones identified in insects

Sr. No.	Name of insects	Pheromone
1.	Gram pod borer, *Helicoverpa armigera*	Helilure
2.	Cabbage looper, *Trichoplusia ni*	Looplure
3.	Pink bollworm, *Pectinophora gossypiella*	Gossyplure
4.	Gypsy moth, *Porthesia dispar*	Gyplure, disparlure
5.	Honey bee queen, *Apis sp.*	Queen's substance
6.	Tobacco cutworm, *Spodoptera litura*	Spodolure, litlure
7.	Silkworm, *Bombyx mori*	Bombykol

- **Aggregation pheromones**

These pheromones caused to aggregate or congregation of insect for reproduction, protection and feeding habits. They are attractive to both sexes and tend to operate over long range and have the potential of attracting thousands of individuals. They also function as defence against predators, mate selection.

- **Alarm pheromones**

These are antipredator device, a warning the members of the same species to the presence or attack of enemy. These are mostly common in social insects such as bees, aphids and ants.

- **Trail pheromones**

These are used to find mates and distant food source more efficiently. Termites, foraging ants and larvae of some lepidopteran insects produces trail pheromones.

- **Recruitment pheromones**

These are very common in social insects, which are used to maintain order, recruit member in honeybees Nasonov pheromone released by worker bees to orient returning forager bees back to the colony as well as to recruit other workers outside the hive.

- **Recognition pheromones**

Social insects like ants, bees and termites these are used to distinguish colony members from non-colony members. These pheromones are tended to be simple - straight or branched–chain hydrocarbons and are a blend of compounds. The termite egg recognition pheromone (TERP) has been one of the most important pheromones to be identified, which strongly evokes the egg-carrying and grooming behaviour of workers.

- **Host-marking pheromones**

These pheromones reduce intraspecific competition by disrupting landing feeding or oviposition of pests on their host plants. They are one of the few pheromones that serve to repel rather than attract the insects. They are known from a number of insect orders *viz* coleopteran, lepidoptera, diptera, homoptera, orthoptera and hymenoptera.

2. Strategy for use of the semiochemicals in pest suppression

The most successful approach using the Semiochemicals in the pest suppression is to monitor the pest population activity or to determine the number of an insect population to take the necessary control measure. By using the large number of synthetic pheromones are released into the crop to prevent or delay the mating and hence reduce the incidence of an insect in the next upcoming generation. The mass trapping is considered most effective for suppressing and eradicate the low density and isolated pest population. The main purpose of mass trapping is to catch the insect to remove a large number of insect populations from a source before mating, oviposition or feeding and thus preventing damage to the crop.

a. Monitoring

The application of semiochemical used to detect both the presence and density of pest population (Witzgall *et al*., 2010) [14]. Making the decision for control measure to keep the pest population below the economic threshold level. Sex pheromone traps have been widely used for decision making, intervention, using insecticides. It can be done either with kairomones or pheromones baits traps. Kairomones based traps have most commonly used to monitor the biological control agent *Rhizophagus grandis*, a predator of spruce bark beetle *Dendroctonus micans* population (Palial and Nidhi, 2019) [7]. These pheromone traps are used to detect the low-density population and also for monitoring the presence of invasive species and prevent its establishment and spread. Pheromones bait traps especially the sex pheromones are effective in monitoring the insects than kairomones because of its strong attractant and species-specific nature of pheromone attraction. In the stored grain pest, several pheromones in a single trap are a new trapping system for monitoring the behavior of different species. Sex pheromones for Almond moth *Ephestia cautella*, Indian meal moth *Plodia interpunctella*, Khapra beetle *Trogoderma granarium* and aggregation pheromones for flour beetles like *Tribolium castaneum* and *Tribolium confusum* are incorporated into natural food attractant oils for capturing in the trap. The monitoring strategy also used for evaluating the abundance of spruce budworm males *Choristoneura fumiferana* Clemens (Lepidoptera: Tortricidae) based on pheromone-baited traps in Canada (Rhainds *et al*., 2016) [11].

b. Mass trapping

Mass trapping includes the use of synthetic pheromones such as sex and aggregation pheromones and a food and host attractant, bait traps used in the field to capture males of newly emerged moths and reduce the number of adults for mating and it's used to manage wide range of insect pests, typically in dipteran, lepidopteran, coleopteran (Palial and Nidhi, 2019) [7]. The lure should be very effective than naturally occurring attractant. For Lepidoptera, it is essential that males are trapped before mating and it is most succeeded with insects that mate only once. In the Coleoptera, the bark beetle, *Ips spp*. and *Dendroctonus spp*. (Curculionidae: Scolytinae) produce the aggregation pheromones, which attract both sexes about equally and thereby provide an opportunity to reduce the pest population as a whole (Palial and Nidhi, 2019) [7]. Control of the brinjal fruit and shoot borer moth, *Leucinodes orbonalis*, has been achieved due to a combination of a reduction in the pest population and a greater impact of natural enemies, numbers of which increased after cessation of the use of insecticides. (Tamiru and Khan 2017) [12]

c. Mating disruption

Pheromones are used for suppressing mating by confusing male insects. Mating disruption is a strategy which uses species-specific sex pheromones that affect mating behaviour by releasing high level of pheromones so as to achieve sensory adaptation and habituation or provide numerous discrete point sources so as to mask trail following or to create false trail. Four mechanisms of mating disruption are considered:

(i) Competitive attraction (false trail following)- Semiochemical substances draw the attention of the males away from wild females thereby following a false trail.

(ii) Confusion of males (camouflage): confusion occurs due to saturation of the environment with semiochemical substances causing random flight patterns and thereby missing the female position and effectively blocking mating.

(iii) Sensory desensitization- adaptation of the male antennal receptor system or habituation of the central nervous system as a neurophysiological effect processing due to overexposure to semiochemical substances (continuous and high background concentration).

(iv) Sensory imbalance- achieves mating disruption by impeding the male's ability to recognize the female sex pheromone within the treated environment, thereby preventing him from responding to it (El-Ghany, 2019) [2]. Important successes of mating disruption include control of the codling moth, *Cydia pomonella* in pome fruit, the oriental fruit moth, *Grapholita molesta* in stone fruit like peaches and nectarines, the tomato pinworm, *Keiferia lycopersicella* in vegetables, the pink bollworm, *Pectinophora gossypiella* in cotton and the omnivorous leafroller *Platynota stultana* in vine yards.

d. Push pull Strategy

Push-pull strategy represents an important strategy and it also called "stimulo-deterrent diversion tactic". Push-pull is a pest suppression strategy that combines the repellent and attractant semiochemicals to manipulate the pest and their natural enemies (Pickett *et al*., 2014) [8]. It consists in a combination of repellent and attractive stimuli modifying the behaviour of insect pests and/or of their natural enemies. The insects are deterred or repelled away from the crops (Push

strategy). They are simultaneously attracted by lures (Pull strategy) and concentrated in other areas where they are trapped or killed in a controlled manner. This strategy requires a clear understanding of the pest biology, chemical ecology and of the interactions with hosts, conspecifics and natural enemies. (El-Ghany, 2019) [2].

Conclusion

There has been a rapid progress in the utilization of semiochemicals in pest management because of certain unique benefits, these are species specific and do not cause adverse effect on non-target organisms. Many of semiochemicals do not persist or accumulate in the environment and therefore, do not pose any environmental problems. Since they are used in minute quantities and kill a large number of insects, they are economical. The quick results cannot be obtained with semiochemicals, so they cannot be employed in short term control measures. Sex pheromones can attract can only one sex, the other sex could still be there and continue to inflict the damage.

References

1. Agronomy, Society and Environment, 15(3): 459-470.
2. El-Ghany NMA. Semiochemicals for controlling insect pests Journal of Plant Protection Research,2019:59(1):1-11.
3. El-Sayed AM. The pherobase: database of insect pheromones and semiochemicals, 2015.
4. Evenden ML, Silk PJ. The influence of Canadian research on semiochemical-based management of forest insect pests in Canada. The Canadian Entomologist,2016:148(1):170-209.
5. Heuskin S, Verheggen FJ, Haubruge E, Wathelet JP, Lognay G. The use of semiochemical slow-release devices in integrated pest management strategies Biotechnology, Agronomy, Society, Environment,2011:15(3): 459-470.
6. Komala G, Manda RR, Seram D. Role of semiochemicals in integrated pest management International Journal of Entomology Research,2021:6(2):247-253.
7. Palial S Nidhi. The Potential use of Semiochemicals in Pest Suppression. International Journal of Zoology and Animal Biology, 2019:2(3):1-6.
8. Pickett JA, Woodcock CM, Midega CA, Khan ZR. Push–pull farming systems. Current opinion in biotechnology,2014:26125-132.
9. Prasad T.V. Handbook of entomology. New Delhi, 2019.
10. Ramalakshmi V, Dash L, Padhy D, Rout S and Tripathy B. Role of Semiochemicals in pest management, Cuttack, Orissa,2020:209-228.
11. Rhainds M, Therrien P, Morneau L. Pheromone-based monitoring of spruce budworm (Lepidoptera: Tortricidae) larvae in relation to trap position. Journal of economic entomology,2016:109(2):717-723.
12. Tamiru A, Khan ZR. Volatile semiochemical mediated plant defense in cereals: a novel strategy for crop protection Agronomy, 2017:7(3):1-8.
13. Trematerra P. Advances in the use of pheromones for stored-product protection Journal of Pest Science,2012:85(3):285-299.
14. Witzgall P, Kirsch P, Cork A. Sex pheromones and their impact on pest management Journal of chemical ecology,2010:36(1):80-100.