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# Improving Performance of Bio-Control Agents through Use of Kairomones

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**ABSTRACT**

Kairomones are interspecific semio-chemicals produced by one species that induce advantageous responses in a different species. They play a pivotal role in entomophagy foraging activities and host location. These chemical cues originate from various sources including host and non-host plants, host insects and synthetic compounds. Major chemical constituents of kairomones include terpenes, flavonoids, terpenoids and saturated hydrocarbons. Insects detect these semio-chemicals through specialized receptors, primarily located on antennae, palps and ovipositors. The host location process in parasitoids involves habitat location, host recognition and acceptance phases, employing visual and volatile cues. Kairomones significantly influence tritrophic interactions in agroecosystems, shaping the foraging behaviour and reproductive strategies of insect pests and their natural enemies.

## INTRODUCTION

Pesticides are the chemicals being used in farming community to control pest & diseases but using pesticides regularly and in huge quantity can cause environmental pollution, health problems or the pest may develop resistance. Keeping in view these problems we need to think about alternative strategies to control pest. Biocontrol agents such as predators and parasitoids play important role in managing the pest.

**Kairomones**

Kairomone are derived from **Greek** words **"kairos- opportunistic or Exploitative''**. Kairomone is an interspecific semiochemical or a mixture of semiochemicals, produced by one species which induces responses advantageous to an individual of a different species perceiving the signal (Dicke and Sabelis, 1988). Entomophages utilize chemical cues for host habitat location, host location and foraging activities.

**1. Kairomone sources**

Kairomones are originated from various sources

- ✓ Host plant
- ✓ Non-host plant
- ✓ Host insect
- ✓ Commercial dispensers of long & short chain saturated hydrocarbons.

- ❖ In case of host- plants, kairomones are derived from various parts such as young leaves, old leaves, stems and flowers at different stages of plants (Baskaran *et al.*, 2018).
- ❖ Non- host plants are also important sources of kairomones (Baskaran and Parthiban, 2017).
- ❖ In case of Host- insects, Kairomones sources are Egg masses, Frass and exuviae and larval & adult of whole-body washes (Maruthadurai *et al.*, 2011).
- ❖ Synthetic long and short chain saturated hydrocarbans play effective role in pest management as well as are derived from various insects and plants.

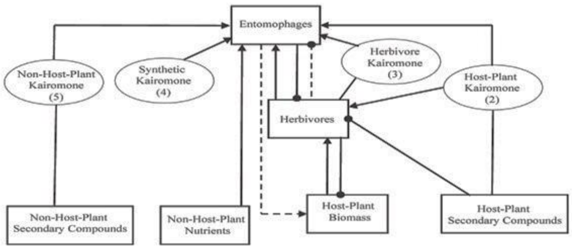



Diagram of Kairomone sources as designated by **"ovals"** in field crop "**plant-herbivore-entomophage"** interactions (designated by rectangles): Solid lines indicate direct effects and dashed lines, indirect effects. Arrows indicate **positive** effects and circle heads, **negative** effects.

- ➢ Herbivores directly benefit from host-plant biomass but can suffer negative effects from toxic host-plant secondary compounds.
- ➢ Herbivores can have direct positive effects on entomophages when providing biomass for sustenance, but can have indirect negative effects on entomophages if they sequester secondary compounds that interfere with entomophage growth.
- ➢ Entomophages have indirect positive effects on host plant biomass by reducing populations of herbivores.
- ➢ In addition, some kairomones that attract entomophages to host plants are attractive also to herbivores.

**2. Major chemical constituents present in the kairomone**

A. Terpenes

B. Flavanoids

C. Terpinoids

D. Saturated hydrocarbons

**3. Steps in locating the host by insects:**

**Step 1:** Plant habitat location

**Step 2:** Plant location

**Step 3:** Host plant acceptance

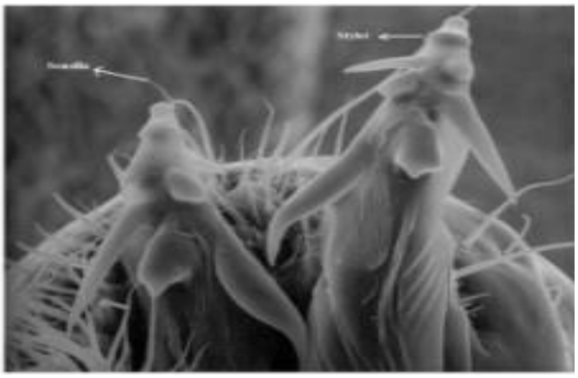
**Step 4:** Host suitability

**Plant defense mechanisms against herbivores and oviposition:**

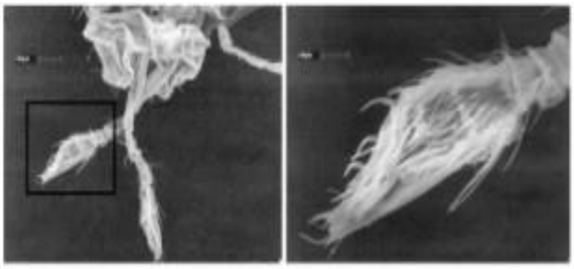
In response to damage caused by herbivore plant develops defense mechanism that is

- **Direct defense:** Reduce the supply of essential metabolites to the herbivore; and the production of compounds that minimize herbivore performance or the production of toxic substances to the herbivore
- **Indirect defense:** Plants can 'cry for help', attracting the natural enemies of herbivores, through the release of HIPVs that are used by natural enemies as cues to find their host (Hilker and Fatouros, 2015).

4. **Kairomone Perception by Insect Natural Enemies:** Insects use their sense of taste or smell to detect the presence of semiochemicals. Specialized receptors may be located anywhere on the body but are especially common on the feet, antennae, palps and ovipositor. Perception of host-related semiochemicals occurs on specialized sensilla on the antennae, rostral tip in the case of predatory bugs, and ovipositor in several hymenopterans. Antennae of parasitic Hymenoptera and predatory Hemiptera play a major role in host/ prey location. Olfactory sensilla play a major role in detecting semiochemicals with low molecular weight that are volatile enough to become airborne from a distance, while the sense of taste (gustation) is used for contact chemoreception– detecting molecules that adhere to a substrate or to the outside of an insect.



**Rostral tip of the carnivorous stinkbug Eocanthecona furcellata with sensilla around the proboscis**



**Antennal sensilla of Trichogramma**

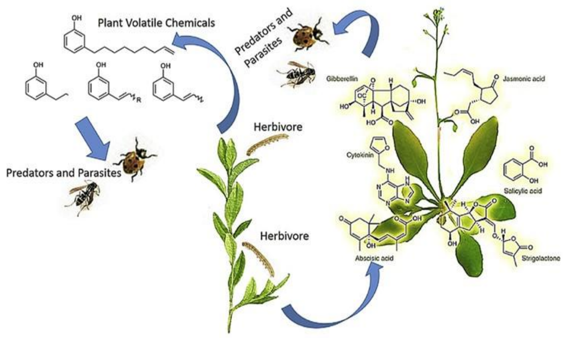



**Fig 2. Schematic representation of how plant response against the herbivore**

5. **Steps in host location in parasitoids**

The process of host location by parasitoids consists of at least 4 phases

- Host habitat location
- Host location
- Host recognition
- Host acceptance

Parasitoids employ visual cues at a distance along with long-range volatile cues emitted by

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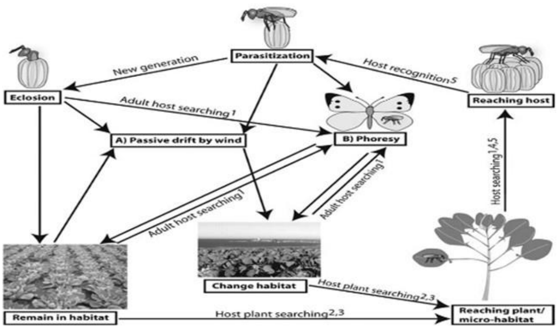
the infested plants in an attempt to locate host habitat. Once landed on a plant, multiple non- or low volatile searching stimulants that are linked to the host are used for retrieval. A number of plant secondary compounds have been identified as non-volatile kairomones of relatively high molecular weight. These are active in modifying insect behavior as arrestants, feeding stimulants, and oviposition stimulants.




**General pathway of egg parasitoids**

The host location behavior of egg parasitoids and the possible infochemicals involved are shown on the basis of a virtual system. After eclosion, an egg parasitoid may choose to remain in the same habitat and search for a host plant or to change to a new habitat.

To reach habitats, the wasp has Two possibilities:

A) By chance and drift passively with the wind or

B) By searching adult hosts for transportation (phoresy).

By using cues of the adult host, either to directly find the host plant and deposited herbivorous eggs or to achieve phoresy, egg parasitoids are shown to rely on the adult host stage more than other parasitoids do.

## 7. Kairomones use in a tritrophic context

The foraging behavior of egg parasitoids is strongly affected by chemical cues from the first and the second trophic level. In an agroecosystem, to feed and reproduce, insect pests and their insect natural enemies depend on volatile cues for inter-species communications. These cues act as a key component in governing tritrophic interaction mechanism in an ecosystem.

**Various kairomones build up different types tritrophic interactions**

1. Plant produced kairomones play role in tritrophic interaction
2. Herbivore-produced kairomones play role in tritrophic interaction
3. Predator-released kairomones play role in tritrophic interaction.

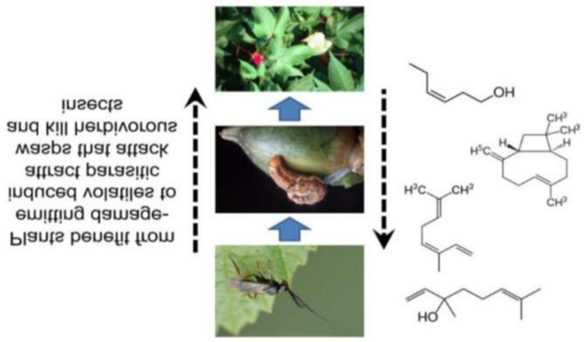


**Fig 5: Interaction between cotton (Gossypium hirsutum), the herbivorous insect Helicoverpa zea and parasitic wasp Microplitis croceipes**

**Summary:**

Kairomones, semio-chemicals produced by plants and insects, play a crucial role in natural pest control. These chemicals can be derived from various sources such as host plants, non-host plants, and host insects. They assist in the location and acceptance of host plants by parasitoids and predators, influencing tritrophic interactions in ecosystems. Studies have shown the effectiveness of kairomone extracts from different sources in enhancing parasitism and predation rates, providing an eco-friendly alternative to chemical pesticides.

## CONCLUSION:

The ecologically viable plant protection strategies like semio-chemical based approaches have been gaining importance to ward-off negative effects of chemical pesticides. Kairomone augmented biological control is being suggested, but their extensive use under field condition is restricted due to non-availability of efficient formulations and dispensers to deliver accurately at required concentrations. Because of the volatile nature of kairomones, slow-release devices need to ensure a controlled release of the biologically active volatile compounds, while providing protection from UV light, oxygen and climate change effects. Developing efficient formulations and delivery mechanisms for kairomones is crucial to advancing sustainable pest management practices and reducing reliance on harmful chemicals in agriculture.

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