# Application of Insect Pheromone in Agricultural Insect - Pests Management

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## ABSTRACT

Insect pheromones are specific natural compounds that meet modern pest control requirements, i.e., species-specificity, lack of toxicity to mammals, environmentally benign, and a component for the Integrated Pest Management of agricultural pests. Therefore, the practical application of insect pheromones, particularly sex pheromones, have had a tremendous success in controlling low density pest populations, and long-term reduction in pest populations with minimal impact on their natural enemies. Mass trapping and mating disruption strategies using sex pheromones have significantly reduced the use of conventional insecticides, thereby providing sustainable and ecofriendly pest management in agricultural crops.

## INTRODUCTION

Sex pheromones are chemical signals emitted by an organism that elicit a sexual response in a member of the opposite sex of the same species (Seybold *et al.*, 2018). Since the structural characterization of the first sex pheromone of the silkworm moth Bombyx mori in 1959, more than 600 species of lepidopteran pheromones have been identified. Their main features, e.g., species-specificity, non-toxicity to mammals and other beneficial organisms, their activity in minute amounts, and rapid degradation in the environment were soon envisioned to be promising tools for controlling insect pests, estimating pest populations, detecting the entry and progress of invasive pests, and preserving endangered species. In fact, in recent years the most successful practical applications of sex

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pheromones in integrated pest management (IPM) have been the monitoring of pest populations, mass trapping, mating disruption, and push-pull strategies (Tewari *et al.*, 2014). Sex pheromones are mainly produced by females and used as attractant compounds to show the presence of potential mating partners and their reproductive status. Sex pheromones comprise sex attractant pheromones, which induce upwind oriented movements to the conspecific individual, and courtship pheromones, which elicit a variety of close-range responses in the insect partner.

| Pheromone/Pheromone Components | Insect |
|---|---|
| (*E*)-11-hexadecenal, (*E*, *E*)-10,12-hexadecadienal | *Diaphania glauculalis* (Lepidoptera: Crambidae) |
| (*E*)-10-hexadecenal, (*Z*)-10-hexadecenal, (*E*)-10-hexadecenol, (*E*, *E*)-10,12-hexadecadienal, (*Z,Z,Z*)-3,6,9-tricosatriene | *Conogethes pluto* (Lepidoptera: Crambidae) |
| (*Z*)-11-hexadecenyl acetate, (*Z*)-11-hexadecenal, (*Z*)-11-hexadecenol | *Trichophysetis cretacea* (Lepidoptera: Crambidae) |
| (4a*S*,7*S*,7a*R*)-nepetalactone, (1*R*,4a*S*,7*S*,7a*R*)-nepetalactol | *Hyalopterus pruni*, *Brachycaudus helichrysi* (Hemiptera: Aphididae) |
| (*E*, *Z*)-3,13-octadecadienyl acetate, (*Z*, *Z*)-3,13-octadecadienyl acetate | *Synanthedon vespiformis* (Lepidoptera: Sesiidae) |
| (*E*)-11-tetradecenyl acetate, (*E*, *E*)-9,11-tetradecadienyl acetate, (*E*)-11-tetradecenol, (*E*)-11-hexadecenyl acetate | *Epiphyas postvittana* (Lepidoptera: Tortricidae) |
| (*Z*, *E*)-9,12-tetradecadienyl acetate, (*Z*)-9-tetradecenyl acetate, (*Z*)-11-hexadecenyl acetate, (*Z*, *E*)-9,12-tetradecadienol, (*Z*)-9-tetradecenol, (*Z*)-11-hexadecenol | *Spodoptera exigua* (Lepidoptera: Noctuidae) |
| (*Z*, *Z*)-3,13-dodecadienolide | *Parcoblatta lata* (broad wood cochroach) |
| (*R*, *R*) -(*Z*)-3,7,11,15-tetramethyl hexadec-2-enal, (*R,R*)-(*E*)-3,7,11,15-tetramethyl hexadec-2-enal | *Dociostaurus maroccanus* (Moroccan locust) |
| (4,5,5) -(trimethyl-3-methylenecyclopent-1-en-1-yl) methyl acetate | *Delottococcus aberiae* (Hemiptera: Pseudococcidae) |

**Classification of Pheromone:** According to the effects they produce, pheromones are divided into two groups

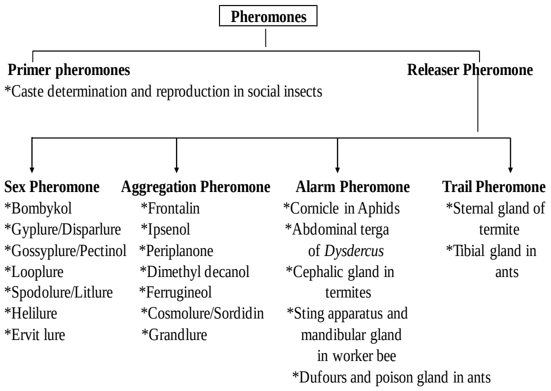
1. Primer effect pheromones

2. Releaser effect pheromones

**1. Primer effect pheromones:** They trigger off a chain of physiological changes in the recipient without any immediate change in the behaviour. They act through gustatory (taste) sensilla. e.g. Caste determination and reproduction in social insects.

**2. Releaser effect pheromones:** These pheromones produce an immediate change in the behaviour of the recipient. They act through olfactory (smell) sensilla. e.g. Sex pheromones, aggregation pheromones, alarm pheromones, trail pheromones.

**1. Sex Pheromone:** Sex pheromone are produced by one sex only and trigger behavioural pattern in other sex that facilitate in mating. It is mostly produced by female and are highly specific for species. Butenandt and Carlson (1959) coined the term pheromone, and they first reported the isolation and identification of sex pheromone from silkworm. There is some exceptional case in insect viz., *Danaus gilippus, Trichoplusia ni, Ceratitis capitata Galleria mellonella* and *Anthomonas grandis* which males are producing sex pheromones. Sex pheromone is received by olfactory sensilla in male antennae. In female lepodopteran insects there are eversible gland produce sex pheromone, located in the tip of abdomen. In male insects' aphrodisiac glands, scent brushes, andraconia produce pheromone. Practical use of sex pheromones and feeding attractants for pest management usually requires that specific active chemicals be isolated, identified, and produced synthetically. The synthetic attractants-usually are used in one of four ways:




(1) As a lure in traps used to monitor pest populations.

(2) As a lure in traps designed to "trap out" a pest population.

(3) As a broadcast signal intended to disrupt insect mating.

(4) As an attractant in a bait containing an insecticide.

**Example of Insects:**

| S. N | Name of the pheromone | Insects |
|---|---|---|
| 1. | Bombykol | *Bombyx mori* |
| 2. | Gyplure/Disparlure | *Porhtesia dispar* |
| 3. | Gossyplure/Pectinolure | *Pectinophora gossypiella* |
| 4. | Looplure | *Trichoplusia ni* |
| 5. | Spodolure/Litlure | *Spodoptera litura* |
| 6. | Helilure | *Helicoverpa armigera* |
| 7. | Ervit lure | *Earias vitella* |

**2. Aggregation Pheromone:** Aggregation pheromone induces aggregation or congregation of insects for protection, reproduction and feeding.

**Example of Insects:**

| S. N | Name of the pheromone | Insects |
|---|---|---|
| 1. | Frontalin | *Dendroctonus frontalis*/Spine beetle |
| 2. | Ipsenol | *Ips confuses* |
| 3. | Periplanone | *Periplanata americana* |
| 4. | Dimethyl decanol | *Tribolium* |
| 5. | Ferrugineol | *Rhynochophorus ferrugineous* |
| 6. | Cosmolure/Sordidin | *Cosmopolites sordidus* |
| 7. | Grandlure | *Antonomus grandis* |

**3. Alarm Pheromone:** It is the antipredator device of insect which elicit escape. Released by cornicles in aphids, abdominal terga of in *Dysdercus cingulatus*, cephalic gland in termites, Sting apparatus and mandibular gland in worker bee, Dufours and poison gland in ants.

**4. Trail Pheromone:** It is the path making pheromone. Produced by sternal gland in termites and tibial gland in ants.

**Uses of pheromones in IPM: -**

- Monitoring of insect pests.
- Control of pest by mass trapping or male annihilation technique.
- Control of pest by mating disruption.
- Control by "Lure and Kill" method

**Advantages of insect pheromone: -**

- Minute quantities of pheromones are needed to attract & kill large no. of insects & so they are economical.
- They are non-pollutant & ecologically acceptable.
- They are species specific.
- They offer easy means to monitor built-up of pest population.

**Disadvantage of insect pheromone: -**

- Pheromones for all the numerous pests are not yet known.
- Sex pheromones can attract only one sex, the other sex could still be there to do the damage.
- Quick results cannot be obtained from pheromones, so they cannot be employed in short term control measures.
- The pheromonal control method demands high skilled labour & maximum input.

## CONCLUSION

The excessive use of synthetic chemical insecticides causes pollution, pest resurgence, and resistance problems. Sex pheromones are natural insect behavior regulators that serve as suitable chemical agents in sustainable agriculture. They have the advantages over the hazardous chemicals of not killing the pest, but reducing the number of male adults, their reproduction rate, and guiding the timely application of insecticides. In the last two decades, studies have been mainly focused on the identification of new sex pheromones, characterization of sex pheromone perception mechanisms, and integration of these new advances in pheromone research to IPM programs. Mating disruption is probably the semiochemical-based technique most successfully used in IPM (Stelinski *et al.*, 2014). So far, studies on MD mechanisms have been focused on male moths almost exclusively, but studies on pheromone autodetection by females have determined that modelling MD mechanisms will increase in complexity (Miller *et al.*, 2006). The actual effects of the different female behaviours on MD largely remain to be understood, but their knowledge should prove useful for evaluating the potential of this strategy in pest control.

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