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Mini Review

Pheromones as Component of Integrated Pest Management

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ABSTRACT

During the seventies and the eighties, environmental and social side effects of synthetic pesticides led to the development of Integrated Pest Management (IPM) programs. The concept of manipulating pest behavior for insect control has been known for centuries through the practice of trap cropping. Food lures and baits treated with a poison have also been used for more than a century to control household pests. Currently, pheromones and other semiochemicals are being used to monitor and control insect pests in large farms. The advantages of using pheromones for monitoring insect pests include lower costs, specificity, ease of use, and high sensitivity. Different types of insect pheromones exist viz., Sex pheromones, Alarm pheromones, Aggregation pheromones, Trail pheromones, and Host marking pheromones. Sex pheromone is the most successful insect pest management strategy among these all especially on insect pests of pome, grape, cotton and tomato. Such pest management methods are sustainable and environmentally safe to the broad-spectrum insecticides, either as monitoring or management tools of critical IPM programs

Keywords: Pheromone; Semiochemicals; Allelochemical; Insect pest; IPM (Integrated Pest Management)

INTRODUCTION

Resistance development to the existing insecticides became an important issue in insect pest management [1,2]. Outbreaks of secondary pests are common from overuse of insecticides [3,4].

Pest behavior manipulation as pest management has been known for long especially the practice of trap cropping [5]. Food lures and baits treated with a poison have also been used for more than a century to control household pests [6,7] defined 'manipulation of pest behavior' as 'the use of stimuli that either stimulate or inhibit a behavior and thereby change its expression'. Manipulation of insect behavior involves detection of signal chemicals known as semiochemicals [8], and also referred to as info-chemicals [9].This paper is therefore, aimed at reviewing on use of pheromones in pest management.

LITERATURE REVIEW

History of use of pheromones as component of IPM

During the seventies and the eighties, environmental and social side effects of synthetic pesticides led to the development of integrated pest management (IPM) programs in different parts of the world such as USA and Asia since which many IPM strategies have been successful worldwide [10].

Historically, the role of sexual pheromones in insect mating was demonstrated in the late 19th century [11]. The characterization of the first insect sex pheromone was established in 1959 and was isolated from female Bombyx mori (Lepidoptera) which the first step to replace synthetic insecticides with pheromone products [12-14]. Integration of chemical ecology in IPM was a new science discipline emerged from manipulating insect behavior [15-17].

Pheromones and other semiochemicals are now used to monitor and control pests in millions of hectares of land [18]. Pheromones are cheap, specific, easy to use, and are highly sensitive [19-22]. Monitoring pests using pheromone lures can

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benefit management decisions such as insecticide application timing.

SEMIOCHEMICALS

Naturally, the chemical cues produced by either plants or animals can elicit behavioral or physiological responses in other organisms [23-25] defined 'semiochemical' as 'signaling compounds mediating interactions between organisms', which are of two types viz., Pheromones and allelochemicals based on the source of the chemical. Pheromones mediate interactions between two individuals of the same species, while allelochemicals is interactions between two individuals of a different species [13,26].

TYPES OF INSECT PHEROMONES

There are different types of pheromones according to the response they induce on the perceiving individuals [16,13].

Sex pheromones

These chemicals have a number of useful attributes to attract or annihilate method, including specificity, eliciting long-distance responses and longevity in the field that have been identified largely from Lepidoptera [27-30].

The release of sex pheromones are influenced by factors such as time of day, weather, and the availability of host plants [31].

APPLICATIONS OF SEX PHEROMONES IN IPM

Monitoring

The synthesis of copies of insect attractants and their release in controlled devices enabled pest monitoring [32-39].

Mass trapping

Mass trapping is the application of semiochemicals-baited traps for capturing a sufficient proportion of a pest population prior to mating, oviposition or feeding so as to prevent crop damage. The practice in IPM programs has been very limited as the technique is density dependent [40-45] and only few success reported [46-48].

Mating disruption

Mating disruption is one of the most successful applications of insect sex pheromones for direct pest control which is designed following the mating behavior of insects [18,49]. The density of the chemical influences the success in Table 1 [50,51].

Insect pest	Crop	Sex pheromone
Codlimg moth (*Cydia pomonella*)	Pome fruit	(E, E)-8, 10-dodecadien-1-ol (major component)
Oriental fruit moth (*Grapholita molesta*)	Pome fruit, Stone fruit	(Z)-8-dodecenyl acetate, (E)-8-dodecenyl acetate (95:5 ratio) and (Z)-8-dodecen-1-ol
Leaf rollers (various spp.)	Pome fruit	Δ Δ-11tetradecenyl acetate and Δ Δ-11tetradecenyl alcohol (common components)
Grapevine moth (*Lobesia botrana*)	Grape	(E, Z)-7, 9-dodecadienyl acetate, (E, Z)-7, 9-dodecadienol and (Z)-9-dodecanyl acetate
Pink ballworm (*Pectinophora gossypiella*)	Cotton	(Z, Z)-and (Z, E)-7, 11-hexadecadenienyl acetate (1:1 ratio)
Tomato pinworm (*Kaiferia lycopersicella*)	Tomato	(E)-4-tridecenyl acetate

Table1: Successful cases of mating disruption in IPM.

Alarm pheromones

Alarm pheromones are released in response to natural enemies [52]. The alarm pheromones of aphids have been used commercially to increase the effectiveness of conventional pesticides or biological control agents, such as the fungal pathogen Verticillium lecanii [53]. Synthetic alarm pheromones and the increased activity of the aphids in response to their alarm pheromones increase mortality because they come in contact more often with insecticide or fungal spores [54].

Aggregation pheromones

Aggregation pheromones lead to the formation of animal groups near the pheromone source, either by attracting animals from a distance or by stopping ('arresting') passing conspecifics which attract only the opposite sex, aggregation pheromones, by definition, attract both sexes and/or, possibly, larvae [55].

Aggregation pheromones have been used successfully for controlling various Coleoptera, including the cotton boll weevil, Anthonomus grandis, in the United States [56,57] and bark beetles in North America and Europe. Grand lure proved to be an effective monitoring tool with the potential for playing a significant role in the control and eradication program targeted against the boll weevil [58].

Host marking pheromones

This behavior reduces competition between individuals, has also been studied in the related cherry fruit fly (Rhagoletis cerasi) [59-69].

DISCUSSION

Chemical trail communication allows group foragers to exploit conspicuous food sources efficiently, and it is the most prevalent form of recruitment behavior. Trail communication is commonly based on a multi-component system, in which the secretions of different glands contribute to the structure of the trail and regulate different behaviors in the process of recruitment [59-61]. Insects use this pheromone to locate the food [62,63].

CONCLUSION

Serious side effects from the conventional use of synthetic pesticides for routine arthropod pest management have prompted the investigation and development of alternate strategies for the minimization of pest damage. Insect sex pheromones have been proposed as a potential group of alternative control. The use of pheromones for pest control promises to be an important component of the ongoing challenges to develop alternatives that may help to solve major environmental and human health problems associated with chemical pesticide use in agriculture. Sex pheromones will likely continue to be an integral part of IPM programs in agriculture, particularly for monitoring insect pest populations.

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Pheromones and other behavior-modifying semiochemicals are now an integral part of numerous pest management programs and are expected to play an important role in high-tech crop protection of the future. These will help provide a sustainable and environmentally friendly replacement to the broad-spectrum insecticides, either as monitoring or management tools of critical IPM programs.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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