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Future of Pheromones in Plant Protection

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Sex pheromones can be employed in survey, monitoring, trapping and mating disruption of insect pests. The design and colour of the trap as well as the type of lure determine the efficacy of trapping. Quite a number of pheromones have been isolated, identified and synthesized. In India large scale testing of pheromones have been carried out for *Spodoptera litura* and *Pectinophora gossypiella*. The other monitoring and mass trapping experiments conducted in the country are for codling moth, gypsy moth, *Heliothis armigera*, *Earias insulana* and *Chilo auricilius*. An important feature is that pheromones are ecologically safe.

Insect rely on sense of smell (odour) and communicate with each other by releasing into air specific chemicals or odours for their selection of food plants, site to lay eggs, location of prey, defence and offence, mate attraction and courtship. These odours or specific chemicals that deliver behavioural messages have been termed semiochemicals and semiochemicals used for intraspecific communication between individuals of a single species termed as pheromones (Karlson & Betenandt 1959). Birch (1974) and Shorey and Makelvevy (1977) defined pheromones as a chemical(s) that is released from one insect to induce a response in another individual of the same species. In short, pheromones are intraspecific chemical messages of insects.

Knowledge of specific pheromone substances in insects has developed very rapidly since the chemical characterization of the sex-pheromone of the female silkworm moth, *Bombyx mori* (L.) (Butenandt et al. 1959). These substances are widely distributed in the insects and have been demonstrated in most of the important economic insect pests. However, for utility in plant protection, the sex-pheromones that initiate and control the mating behaviour are most promising.

Sex-pheromones can be practically employed in survey or monitoring, trapping, mass trapping and mating disruption in the integrated pest management gainfully:

(*i*) *Survey trapping*: This area has got great promise in pest management. The use of pheromone traps is a valuable new tool for effective and less expensive control of destructive insects. Traps baited with pheromone lures can detect presence of insects and can over a period of time, provide insight into insects life cycle. Insect populations can be estimated and new areas of infestation can be detected at an early stage. This information can be used to schedule

control tactics and monitor effectiveness of control programme. With the aid of computers and knowing first effective emergence trap catch data, it is possible to predict population dynamics through each life of a given cropping season. Also, such trapping programme over large areas can help to study dispersal or migration distances. Information of trap catches also indicates which are the key pests and their economic thresholds which is helpful in timing and selection of appropriate control strategies.

(*ii*) *Mass trapping*: Large number of pheromone baited traps can be used to capture males of the newly emerged adult moths and thus reduce the number of males for mating. In such cases, the field has to be flooded with the traps to attract sufficient number of male moths and requires to cover large area to avoid any migration of insects from adjoining areas. For successful mass trapping programme isolated areas, low population density of pests and surrounding crops which are not attacked by same insect pests is of critical importance.

The design and colour of the trap as well as the type of the lures determine the efficacy of mass trapping. Research conducted on traps and lures suggest that selection of proper type of trap and lure is important to achieve a desirable results in trapping as the insect's orientation is very specific. There are different types of traps available like delta, sacuer-pan, funnel type, inverted wire mesh cone, Kiterman, cardboard corrugated box and perforated hollow tubes-probes and that of lures are (*a*) cotton wicks, dental rolls, cigarette filters and elastic bands, (*b*) rubber septa, (*c*) hollow fibrers of celluose or polymeric material and (*d*) three layer polymeric dispenser. While the critical factors that effects traps are colour, shape, design, insect movement, spatial configuration and linearity of plume of various trap design, factors like temperature, structure, components of pheromone and release rates of polymeric materials effectively influence the lures.

(*iii*) *Mating disruption*: Another most effective use of pheromones in pest management is their employment in suppressing mating by confusing male insects. This method exploits the chemical communication system which the male use for locating the opposite sex for mating purposes by permeating the air with synthetic pheromone, the natural sex attractant 'trail' emanating from the female is masked and with disruption of mating egg laying is prevented and thus population increase is reduced.

Recently, a combination of pheromone along with a selective insecticide, has successfully reduced cost which would further help in the developmental strategy of the integrated pest management programme.

Apart from the above uses, pheromone application can also be made for the following purposes:

(*a*) Trapping to collect species that are otherwise difficult to obtain

(*b*) Timing of pesticide treatment, release of parasites and predators can be based on the results obtained

(*c*) Luring to areas that are treated with pesticides or baited hosts or chemosterilants

(*d*) Luring to areas that are treated with pathogens, which can then be spread by the infected individuals to the rest of the population.

For the above versatile uses, the insect pheromones are recognised as the most important part of the so-called third generation pesticides (Jacobson 1975).

Although, pheromones are widely used for different purposes in foreign countries and are commercially available, there is limited and slow progress in our country. In fact, work on pheromones has started of late and yet several Institutions and Universities are confined to the laboratory work having paid

Table 1 *Sex pheromones of important insect—pests of India*

Sl. No.	Common Name	Scientific Name	Important host(s)	Pheromone component(s)	Purpose
	AGRICULTURAL INSECTS				
1.	Gram pod borer	*Heliothis armigera*	Gram, Red gram, Cotton, Tomato, Maize	(Z) 11—Hexadecenal and (Z) 9—Hexadecenal (97:3)	M/MT/MD
2.	Tobacco caterpillar	*Spodoptera litura*	Tobacco, Cotton, Groundnut	(Z,E) 9,11—tetradeca-dienyl acetate (Z,E) 9,12—tetradeca-dienyl acetate (10:1)	M/MT
3.	Greasy cut-worm	*Agrotis ypsilon*	Gram, Vegetables, Potato	(Z) 7—dodecnyl acetate and (Z) 9—tetradecenyl acetate (3:1)	M
4.	Indigo caterpillar	*Spodoptera exigua*	Jute, Sugarbeet, Tobacco, Lucerne	(Z,E) 9,12—tetradeca-dienyl acetate	M
5.	Spotted bollworm	*Earias insulana*	Cotton, Lady's finger	(E,E) 10,12—Hexadeca-dienal	M
6.	Sorghum stem borer	*Chilo pertellus*	Sorghum, Maize	(Z) 11—Hexadecenal and (Z) 11—Hexadecenal (50:50)	M
7.	Pink bollworm	*Pectinophera gossypiella*	Cotton	(Z,Z) and (Z,E) 7,11—Hexadecadienyl acetate (50:50)	M/MD
8.	White striped borer	*Chilo suppresalis*	Paddy	(Z) 11—Hecedecenal and (Z) 13—Octadecenal (3:1 to 7:1)	M/MD
9.	Cabbage looper	*Trichloplusia ni*	Cabbage	(Z) 7—dedecenyl acetate	M
10.	Oriental fruit moth	*Grapholitha molesta*	Citrus	(E,Z) 8—dedecenyl acetate (7:43)	M
11.	Oriental fruit fly	*Dacus dorsalis*	Mango	4, allyl—1,2—dime-thoxybenzene	M
12.	Melonfly	*Dacus cucurbitae*	Cucurbits	4 (P—hydroxy phenyl) 2—butanone acetate	M
13.	Codling moth	*Laspeyresia pomonella*	Apple	(E,E) 8,10—dedecadienol	M/MD
14.	Gypsy moth	*Lymantria obfuscata*	Apple/Apricot/ Forest trees	Z—7,8—epoxy—2—methyl octadecane (7R,8S)—epoxy—2—methyl octadecane	M/MT/MD
15.	Stalk borer	*Chilo auricilus*	Sugarcane	(Z)—7—dedecenyl acetate (Z)—8—tridecenyl acetate (1:1:1:1) (Z)—9—tetradecenyl acetate (Z)—10—pentadecenyl acetate	M/MD

Table 1 (*contd.*)

Sl. No.	Common Name	Scientific Name	Important host (s)	Pheromone component(s)	Purpose
	STORED INSECTS				
16.	Khapra beetle	*Trogoderma granarium*	Stored wheat	(Z) and (E) 14—methyl 8—hexadecenal (92:8)	M/MT
17.	Pulse beetle	*Callosobruchus chinesis*	Stored pulses	"Erection" (Copulation release pheromone) A mixture of several hydrocarbons and a dicarboxylic acid	M/MT
18.	Almond moth	*Cadra cautella*	Stored nuts/Flour	(Z,E) 9,12—tetradeca-dienyl acetate	M/MT
19.	Angoremois grain	*Sitotroga cerealella*	Stored grains	(Z,E) 7,11—Hexadeca-dienyl acetate	M/MT
20.	Indian meal moth	*Plodia interpuctella*	Stored grain	(Z,E) 9,12—tetradeca-dienyl acetate	M/MT
21.	Potato tuber moth	*Pthorimaea operculella*	Stored potatoes	(E,Z) 4,7—tridecadieniol and	
				(E,Z,Z) 4,7,10—trideca-trienol (1:4)	M/MT/MD
22.	Cigarette beetle	*Lasioderma serricorne*	Stored tobacco	4,6—dimethyl 7—hy-droxy nonan—3—one	M/MT

M — Monitoring, MT — Mass trapping, MD — Mating disruption

very little attention in demonstrating the usefulness of pheromones in filed application.

Pheromones which have been isolated, analysed, identified, synthesised and formulated and which are relevent to the Indian context are listed in table 1. So far large scale testings are carried out only for *Spodoptera litura* (tobacco caterpiller) at the Central Tobacco Research Institute, Rajahmundry and *Pectinophora gossypiella* (Pink bollworm) in Punjab by Pest Control (India) Pvt. Ltd. and Directorate of Plant Protection, Quarantine and Storage which have shown spectacular results not only in the output but also improvement in the quality of the produce. The other monitoring and mass trapping experiments conducted in the country are for codling moth, gypsy moth, *Heliothis armigera, Spodoptera litura, Earias insulana* and *Chilo auricilius* insect-pests.

Pheromones are an important tool in Integrated Pest Management in view of the fact that they are essentially non-toxic and ecologically safe. Beneficial insect population both parasites and predators, usually destroyed by broad spectrum insecticidal application, are preserved and therefore assist in control of damaging secondary pests or minor pests. Moreover pheromone application provide relief from chemical stress on the plants and ecosystem.

Although, not yet fully operational as direct control agent in pest management system it really promises as safe, selective and effective control agent in plant protection.

Pheromones have scope beyond our imagination but require understanding and support and it is certain that if at all there is any replacement to PESTICIDES IT IS PHEROMONES.

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