Lure and Kill Strategy: A Promising Safe Approach to Pest Management that Alleviates Synthetic Pesticides Use

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Abstract

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Methods using insect stimuli to manipulate behaviour of pests are discussed. Light is shed on how to combine insect stimuli with other safe means in integrated control strategies to increase the efficacy of these approaches. The main components of these strategies are pest monitoring, semiochemicals, host–plant resistance, trap crops and selective pesticides or biological control agents. These components are combined under the term lure and kill strategy or push–pull strategy. Research should continue to study how insects produce pheromones, how they trigger a response and the influences of these responses.

Key words: Pheromones, stimulants, behaviour.

Introduction

Insects emit different excretions to communicate with individuals of the same species or to modify the behaviour of receptor organisms of other species. These volatile excretions, i.e. semiochemicals are secreted by insects to evoke stimuli, e.g. location of prey, avoidance of predators and signalling to conspecific individuals before mating or during times of danger and many other functions. Such way of communication is known as the chemical language of insects (17). The use of these excretions is growing within the scope of pest management. However, to make the best use of this way of behavioural communication in pest management we have to keep in mind the well known saying "be aware of your enemy's language". This could be achieved by applying lure and kill or push-pull strategies which use semiochemicals combined with other control means into an overall flexible strategy to protect crops. The main components of these strategies are pest monitoring, semiochemicals, host-plant resistance, trap crops and selective pesticides or biological control agents. In case of applying chemical control, pesticides should be used in ways that minimize their negative impact on the ecosystem. Examples of these more elaborate methods include combinations of distinct behaviour, e.g. the attractant and feeding stimulant in toxic baits for olive fruit fly (9).

Principal elements of behavioural manipulation methods

The choice of a stimulus to be used for behavioural manipulation should depend on some desirable attributes (5):

1. Accessibility: The stimulus must be suitable for presentation in a form that the insect can perceive.
2. Definability: The more precisely the stimulus can be defined, the more precisely it can be reproduced artificially.
3. Controllability: The ability to control various parameters of a stimulus, including intensity and longevity, will give greater control in a behavioural manipulation.
4. Specificity: The more specific a stimulus is to a particular behaviour of a pest, the more likely it can be used to manipulate that behaviour.
5. Practicability: Environmental hazards and cost of producing a resource must be within practical limits because chemicals that are persistent and have high mammalian toxicities may protect an edible resource but render it unacceptable for human consumption.

However, manipulation of insect stimuli must be conducted within the context of a method to be useful. A method consists of a strategy for behavioural manipulation and the mechanism that implements the strategy. For example, in the attract-annihilate method, the strategy is to attract pests to a site and remove them from the environment, and the mechanism may be a trap or a surface coated with a deleterious substance such as toxin or pathogen.

Advances in the use of semiochemicals in pest management

Many new advances in the use of pheromones and other semiochemicals in pest management have taken place. However, in choosing examples, methods of practical success as well as methods that have been tested experimentally are included.

A combination of the sex pheromone which attracts males, and a food lure (a mixture of phenethyl propionate, eugenol and geraniol), which predominantly attracts females, has been used against the Japanese beetle, *Popillia japonica*. The combination trapped more males and females than the two attractants did when used separately (12). Visual stimuli are also effective for this pest as the catch of beetles is greater in white traps than those of other colours (13).

Most work on the application of attractants to disrupt a finding behaviour has focused on mate location particularly of moths. Large amounts of synthetic females sex pheromone are applied as a slow release formulation to prevent males from finding females as a method of mating disruption (3). This method has been used successfully for control some pests as the cotton pink bollworm, *Pectinophora gossypiella* and the oriental fruit moth, *Grapholita molesta*, on stone fruits. In addition, an interesting method of mating disruption is used in California to control the pink bollworm: an insecticide, permethrin, is added to the sticker used to attach the pheromone formulation to the leaves of the plant. This combination increases the efficacy of the pheromone formulation (1).

Hose (10) suggested a different technique to prevent mating by auto confusion using electrostatic powders. The pheromone is formulated with an inert carrier in the form of electrostatic chargeable powder (Entostat). The carrier powder has the ability to adhere strongly to the insect cuticle, placing innumerable pheromone-emitting sources on the antennae and other parts of the body. The advantage of this technique is the highly reduced amount of pheromone used.

However, the success of the so-called mating disruption methods depends to a large extent on the potential for emigration of mated females from outside the treated area

(2). The efficacy of mating disruption method is not satisfactory when the treated area is limited in size. Ogawa *et al.* (15) stated that the area-wide use is the most important factor for success of mating disruption.

Cross *et al.* (4) outlined a new method for the control of codling moth, *Cydia pomonella* and summer fruit tortix moth, *Adoxophyes orana* in apple orchard. The method entails luring the adult moth with semiochemicals to auto disseminators where the adults become contaminated with baculoviruses. Once adults are contaminated, the baculoviruses spread between individuals during mating and eggs together with the surrounding area can become contaminated during oviposition.

Interestingly, aggregation pheromones have been used successfully to trap insects of both sexes for controlling various Coleoptera, e.g. cotton boll weevil, *Anthonomus grandis* in the United States (11) and bark beetles in North America and Europe (14). The olive fruit fly, *Dacus oleae*, a major pest of olives in the Mediterranean region, has been controlled effectively as with insecticides by an elaborate mass-trapping method (9). Females of this pest produce a blend of compounds that attract males over a distance. One of these compounds, 1,7-dioxaspiro [5.5] undecane is also produced by males. The (R)-(-) enantiomer of this compound attracts only males and the (S)-(+) form of this compound elicits a response that appears to be aggregation by females (8). The method involves a combination of attractants and stimulants on an insecticide-treated wooden board.

It is worth noting that alarm pheromones are also applied for increasing the efficiency of pest control means against aphids. Many species of aphids produce an alarm pheromone (E)-(B)-farensene, which is normally released when aphids are attacked to increase their mobility and enhances chances of escape from natural enemies. This reaction to the alarm pheromone has been utilized to increase aphid contact with insecticides incorporated in synthetic pheromone formulation (7). Moreover, the alarm pheromones are used to repel the honeybee, *Apis millifera* from oilseed rape before insecticide applications (6, 16). Also, in glasshouses where many aphids are highly resistant to insecticides, synthetic alarm pheromone can be used to improve the efficacy of biological control agents by increasing pick-up of fungal spores and consequently increases fungal infection (18).

It is not surprising that the ingenious use of this strategy is also being applied successfully within the mosquito oviposition pheromone which has recently been used in Kenya to direct mosquitoes to lay eggs in specific pools where the emerging larvae could be destroyed by Juvenile hormone incorporated into the formulation or possibly with overcrowding factor.

Future Prospects

Future research has to develop successful methods, modify and refine the methods to enhance the efficacy of pheromones in pest management. Research should provide knowledge concerning how insects produce pheromones, how they trigger a response and the influences of that response. For example, researchers are beginning to uncover the hormones that trigger pheromones production as well as the binding proteins that bring the pheromones to their receptors. Investigators also are discovering the neurological pathways that pheromones stimulate in a responding insect and the enzymes the insect use to breakdown the pheromone so as to shut off its signalling. This basic research should lead to better ways for using pheromones or other compounds to manage behaviour of insect pests. Moreover, researchers are working to improve pheromone dispensers in the field so that chemicals are longer acting, less costly, more potent and easier to release.

الملخص

رسمي، علي. 2006. الجاذبات واستراتيجية القتل: اتجاه أمين واعد لإدارة الآفات يمكنه الاستغناء عن استعمال مبيدات الآفات المصنعة. مجلة وقاية النبات العربية. 42: 159−161.

يناقش الباحث النهج التي تستعمل محفزات الحشرات للتأثير في سلوك الآفات. ويلقي الباحث الضوء على الكيفية التي يتم فيها جمع محفزات الحشرات مع طرائق أخرى أمينة في استراتيجات المكافحة المتكاملة لزيادة فاعلية هذه الاتجاهات. إن المكونات الرئيسة لهذه الاستراتيجيات هي مراقبة الآفات، الممركبلت الكيميائية، مقاومة النبات العائل، المحاصيل الصائدة والمبيدات الانتخابية و استراتيجية القتل أو عوامل المكافحة البيولوجية/الأحيائية. ويتم دمج هذه المكونات تحت مصطلح استراتيجية الجاذبات والقتل أو استراتجية الدفع والسحب. وينبغي أن يستمر البحث لدراسة الكيفية التي تنتج الحشرات فيها بإنتاج الفيرمونات وكيف تقوم هذه الأخيرة بإحداث استجابة وتأثيرات هذه الاستجابات.

كلمات مفتاحية: جاذبات، محفزات، سلوكيات.

عنوان المراسلة: علي رسمي، قسم وقاية النبات، المركز القومي للبحوث، الدقي، القاهرة، مصر، البريد الالكتروني: ely_rasmy@hotmail.com

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