CONTROL OF SOME LEPIDOPTERA PHYCITIDAE INFESTING STORED-PRODUCTS WITH SYNTHETIC SEX PHEROMONE IN ITALY*

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Abstract

Research was carried out in Italy in food preparation industries and warehouses, using the sex pheromones of Ephestia cautella, E. kuehniella and Plodia interpunctella (Lepidoptera: Phycitidae). Optimal release doses of some components of the pheromones of these insects were arrived at by preliminary laboratory tests. In particular, it was found in food processing plants that the three species responded well to: (a) a mixture of (Z,E)-9-12-tetradecadienyl acetate (TDA) and (Z)-9-tetradecenyl acetate (TA) at doses of 10 µg + 5 µg (100 ng released daily) for E. cautella; (b) TDA at doses of 2000 µg (13000 ng released daily) for E. kuehniella; and (c) a mixture of TDA + TA at doses of 1 µg + 0,5 µg (10 ng released daily) for P. interpunctella.

These laboratory data were used in tests in infested environments employing the technique of mass trapping for E. kuehniella and P. interpunctella and of mating disruption for E. cautella.

It was shown that it was possible to control infestation effectively with these systems both in warehouses and in the preparation of food from stored products, with a consequent reduction in the usual insecticidal treatments. These treatments are necessary when routine sanitation measures are not undertaken or when infested stored products are brought into the environment.

Introduction

Technical knowledge of the sexual pheromone of Lepidoptera Phycitidae has allowed workers to program control measures against these insects in the food industry and in stored-products. In some cases their use brought about a substantial reduction in chemical treatments.

As is the case with many insects, the female sexual pheromone of these moths consists of a mixture of molecules, differing in their relations with each other according to species. Some of these substances turn out to be responsible for sexual attraction, while others appear to produce an action which is either synergizing or, inibitory. By establishing the exact proportion among the different synthetically reproduced components it is possible to obtain the specific pheromone. Until now, this has not been possible in practice.

Commercial pheromone dispensers generally contain 2 mg (in some case 0.5 or 1 mg) of (Z,E)-9,12-tetradecadienyl acetate or TDA, which is released for a number of days in variable quantities according to the

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material used (rubber, plastic, paper). This results in non-specific capture of Plodia interpunctella Hübner and Ephestia spp., provided TDA is the common molecule. However, this substance is not the best for some Phycitidae.

To optimize the different ways pheromone may be used, it is necessary to specify the exact doses released and not to use TDA exclusively, but to employ a mixture of other components (Bommer and Reichmuth, 1980). Only in this way, is it possible to pass from single monitoring, to more sophisticated methods of application such as 'mass-trapping' and even 'mating-disruption'.

In the past few years, research has been directed to these objectives and results concerning Plodia interpunctella and Ephestia kuehniella (Zeller) have been published (Süss and Trematerra, 1985; Trematerra, 1986).

Knowledge acquired previously is referred to in this present report and some conclusions are drawn that will serve as a springboard for further research.

Materials and methods

Investigations were carried out on Ephestia cautella Walker, E.kuehniella and P. interpunctella. For each species, the research was subdivided into two phases: the first took place in an artificially conditioned environment in which it was possible to test individually the most effective dose of pheromone with regard to males; in the second, tests on infestation were carried out in a natural environment.

Investigation conducted in conditioned environment. A room of 131 m^3 was used to simulate a warehouse with a controlled temperature of 25 ± 1°C and relative humidity of 65-70%. A particularly appetizing food-bait for oviposition was placed from time to time 4 m away from the pheromone traps. Light and changes of air were such as to reproduce those commonly found in places where food is stored or produced without air-conditioning. In such situations, diffusion of the pheromone molecules was distributed uniformly around the dispenser, i.e. spherically (Mankin et al., 1980).

In the course of the tests 30 couples of virgin insects bred artificially were used 1-3 days after emergence, as suggested by Roelofs and Comeau (1971).

The pheromone dispensers were made of natural rubber (provided by the Istituto Guido Donegani of Novara, Italy); the quantity of substances that emanated daily followed an exponential law and decreased slowly with time. Baited wing-traps were placed in the room at heights ranging from 2.20 to 2.60 m from the floor (Fig. 1A).

Starting with the lowest doses, pheromone was released in the environment for a week before the insects were introduced. This, to verify the activity of synthetic substance in comparison with the natural one emanating from virgin females under the most disadvantageous conditions namely, with a male to female ratio of 1 to 1, as suggested by Nakamura and Oyama (1978).

Capture counts were carried out every day for the first 4 days, with a final count on the seventh day. To observe if the experimental dose of pheromone had an effect on 'disruption' of the males present in the room, at the end of each test the food-bait placed in the environment was replaced to evaluate the infestation.

Doses of the substances with pheromone activity were chosen ((Z,E)-9,12-tetradecadienyl acetate (TDA), and (Z)-9-tetradecenyl acetate (TA)) having considered the reports of Read and Haines (1976), Mankin et al., (1980), Levinson and Buchelos (1981), Süss and Trematerra (1982), Trematerra and Rossi Porzio (1982), Levinson and Hoppe (1983), Hodges et al., (1984), Burkholder and Ma (1985).

Investigations conducted in natural environments. The tests which were carried out in the conditioned room were used to evaluate the efficacy of abundantly infested natural environments using only the doses of synthetic pheromones which gave the best results. Investigations were carried out on E.cautella in the warehouse containing nuts of a confectionery industry, on E.kuehniella in a flour mill, and on P.interpunctella in a store-room for orchard and garden seeds.

Results and Discussion

The percentage of total captures observed in the conditioned room, according to the doses of pheromone used are reported in Table 1. The results obtained for the synthetic pheromone are different for the 3 species; in E.cautella the best results for males was obtained from the mixture TDA + TA with doses of 10 + 5 µg respectively (at a daily release of 100 ng); in E.kuehniella the highest attraction was observed with the use of TDA in doses of 2000 µg (daily release of 13000 ng); finally for P.interpunctella the best results were obtained using the mixture TDA + TA in doses of 1 + 0.5 µg respectively (daily release of 10 ng).

Table 1 - Percentage of captures observed in the conditioned room

Baited dose in µg	TDA										TDA + TA	
	0.1	1	10	60	100	250	400	500	1000	2000	1+0.5	10+5
Daily release in ng	0.65	6 5	65	390	650	1300	2600	3250	6500	13000	10	100
E. cautella	13.33	40.00	33.33	13.33	16 66	20.00	9 99	16.66	6.66	9.99	53.33	70.00
E. kuehniella	-	-	-	-	-	26.66	-	60.00	56.66	76 66	-	-
P. interpunctella	53 33	56.66	36.66	-	36 66	20.00	-	23.83	-	-	63.33	56.66

In general, the activity of these moths resulting from pheromone reached a maximum level after 3-7 days from the beginning of the tests.

From the examination of the food-bait placed near the dispensers, it was possible to observe that only in E. kuehniella did the artificial pheromone substance interfere with sexual communication of the species. In the tests with dispenser baited with 500, 1000 and 2000 µg of TDA, there was no evidence of infestation indicating an effect of mating disruption in the males.

Regarding E. cautella the effectiveness of TDA was evaluated using the technique of 'mating-disruption' in an environment of 3582 m^3 used for toasted nuts. Taking into consideration the results obtained earlier in the conditioned environment, 200 dispensers bilaminated with aluminium and paper were used (Capizzi et al., 1986), each capable of dispensing 7.2 ng of TDA a day. These dispensers were distributed over the walls and on the machinery. The molecules that diffused into the environment continued to cause communication disruption among males for about two months; following this, however, when the temperature was raised,

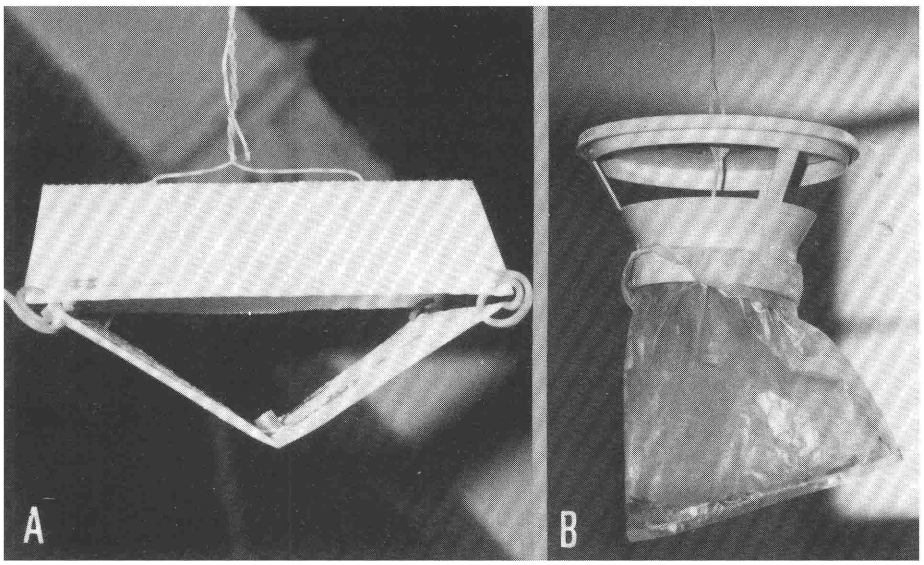

Fig. 1 - Wing trap (A); mass-trap (B).

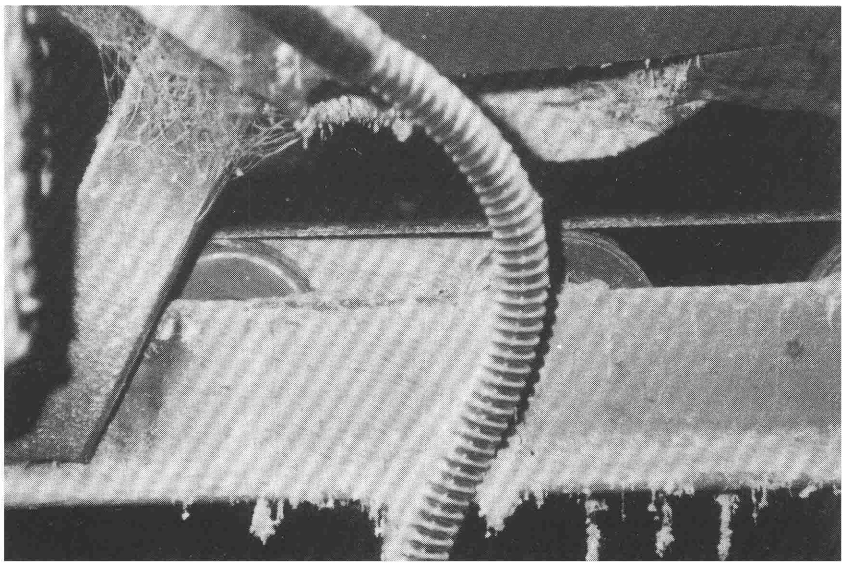

Fig. 2 - Detail of machinery in the absence of cleaning.

perhaps also because of the introduction of nuts which were already infested, the density of E. cautella increased and so the action of TDA became ineffective, and in proximity to points of major density of moths infestation in the nuts was observed. Such a situation was favoured in the absence of cleaning and debris removal by a continuous cycle of production and by an accumulation of numerous nut fragments near hopper conveyor belts and screws.

In processing and packaging departments in the same industry, using the usual technique of protection, the effective action of 22 dispensers of TDA lasted for about 4 months. It is important to note however, that in such a situation the density of insects did not increase during the experiment, because of the great care taken in cleaning the environment.

As for E. kuehniella, a mill was protected using 33 'mass-traps' baited with 2000 µg of TDA distributed in different departments. This operation, lasting over the period of a semester of experimentation, resulted in the capture of over 23448 males. Despite this, it was no possible eliminate infestation, or even reduce the level of 'insectistasis' (Levinson and Levinson, 1979), if trapping was not accompanied by careful cleaning of the rooms and particularly the machinery where the insects can hide and reproduce undisturbed. If such preventive measures are not observed, the pheromone will only reduce the number of insecticidal operations, which in such cases remain indispensable (Süss and Trematerra, 1985) (Fig. 1B).

Regarding P. interpunctella, TDA was tested in a store-room for seeds in doses of 0.1, 1 and 10 µg, and mixture of TDA + TA in doses of 1 + 0.5 µg and 10 + 5 µg which previously had brought about a strong attraction. From captures taken over the 6 months period, it was evident that the traps baited with the mixtures of TDA + TA in doses of 1 + 0.5 µg showed effect on males activity of this species which was greater than when TDA was used alone in doses of 1 µg. This confirms results observed in preliminary tests in a controlled environment. Even in this situation, as was already observed in E.cautella, TA demonstrated a synergyzing role on the activity of TDA. The traps placed in the store-room (wing traps which best conform to the particular flight of the insects) resulted in the captures of a high number of moths, consequently the residual infestation on the walls of the room was practically negligible. The prolonged presence (for about three years) of the traps in such environments, in particular during periods when the climatic situations favour development of the insect, controlled infestation and reduced damage (Trematerra, 1986).

Conclusions

Experiments carried out on E. cautella, E. kuehniella and P. interpunctella over the last few years pin-pointed the optimal doses for release of synthetic sexual pheromone, and revealed the existence of several problems when passing from laboratory tests to commercial conditions.

The control of infestation, although resulting in the capture of high numbers of insects, was not effective if not accompanied by thorough cleaning. This procedure eliminates the possibility of these insects reproducing in areas where food is present. Corners and the inside parts of equipment too should not be overlooked during cleaning; otherwise, they will remain focal points of infestation. The rational use of pheromone traps, reduces infestation and postpones the inevitable use insecticides (Fig. 2).

If infested products are brought into the warehouse or adjacent areas, the pheromone dispensers will be less effective, making both mass-trapping and mating-disruption difficult.

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