

Timed Mating Disruption: a new pheromone-dispensing device for the protection of orchards from *Cydia pomonella*, *C. molesta* and Leafrollers

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Abstract

A computerized system for dispensing insect sex pheromones at various release rates is presented. The installation consists of an electronic device which, through a suitable timed dripping system, distributes the pheromone formulate on a plaited filament that moves within the orchard. The pheromone-impregnated thin rope runs over a system of pole-mounted pulleys above the tree canopy, releasing the semiochemical into the orchard. The versatility of such a mating-disruption system makes it possible: i) to distribute different pheromones at the same time and on the same support as required; ii) to avoid possible chemical treatments due to dispenser depletion in the last part of the season; iii) to change the operational parameters, in particular the timing and the dosage of pheromone dispensing, according to: a) time of the day during which adults are active for mating; b) trap catches in the reference field; c) possible trap catches within the disrupted orchard. Field tests were carried out in the period 2000-2001 on apple and pear orchards to control Codling moth (*Cydia pomonella*), Oriental fruit moth (*C. molesta*) and the Leafrollers complex. The amount of pheromone released during the season varied from 160 to 220 g, according to the species to be controlled and their respective populations. Good results have been achieved in most tests, showing an efficacy comparable with the standard IPM practise.

Introduction

The orchard protection from *Cydia pomonella* (L.) and *Cydia molesta* (Busck) has been going through a significant technical evolution in the last few years. The remarkable population density and aggressiveness of these two pests, the ever-increasing difficulty in controlling them by traditional insecticides, and especially the need for integrated defence techniques (EC Regulation 2078 and others) fostered the development of new defence strategies which do not rely on chemicals only.

Currently, a suitable alternative to chemical treatments is the mating-disruption method, which is carried out by shielding the natural female call through the saturation of the environment with a high dose of synthetic pheromone formulated into various matrices. The efficacy of this method has been tested for years in many countries (Becid, 1997; Neumann, 1997; Rama, 1997; Waldner, 1997; Brunner, 2000). Major drawbacks of the use of “discrete” pheromone dispensers lay on the lack of control of their release rates and the need to distribute them by hand, which involves heavy manpower requirements. To avoid such disadvantages, metered semiochemical timed release system (MSTRS) have been introduced by Shorey (1996) and further developed by Mafra-Neto (1996) and Baker (1997).

The device we describe here is a further improvement on such a delivery system, introducing the concept of a “mobile dispenser” carrying the pheromone through the orchard and a computerized mechanism that permits to:

- i. distribute different pheromones at the same time and on the same support as required;
- ii. avoid possible chemical treatments due to dispenser depletion in the last part of the season;
- iii. change the operational parameters, in particular the timing and the dosage of pheromone dispensing, according to:
 - a) time of the day during which adults are active for mating;
 - b) trap catches in the reference field;
 - c) possible trap catches within the disrupted orchard.

Methods and materials

Pheromone release device

The installation consists of an electronic-, microprocessor-controlled device which, through a suitable timed dripping system (Fig. 1), distributes the pheromone formulate(s) on a filament moving along a predetermined path within the orchard. The pheromone-impregnated thin rope runs over a system of pole-mounted pulleys above the tree canopy (Fig. 2), releasing the semiochemical into the orchard. (Pratizzoli, 1998).

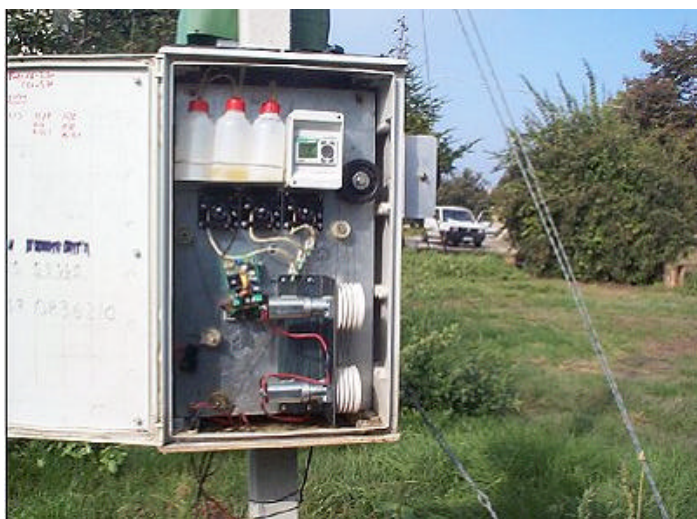


Figure 1. Pheromone dispensing device



Figure 2. Pole-mounted pulley and rope

The dispenser is thus made up of a polyamide plaited filament of considerable length, joined at the two ends to create an endless, closed-circuit line, which is moved along the orchard at 400 – 600 m/hour by a traction mechanism. The dripping system permits to deliver up to four different pheromones simultaneously, while all the operational parameters (speed and timing of rope movement, timing of individual semiochemical distributors...) are controlled by the microprocessor and can be modified at any time even in remote-mode by a GSM unit, which also promptly warns the farmer of occasional failures (blocked rope, empty pheromone container, low battery...). Power is supplied by a buffer battery, charged by either a solar panel or a conventional power source.

Pheromone formulations

Pheromone formulations involved were prepared into separate containers, dissolving the required pheromone (E8,E10-12:OH for *C. pomonella*; a 93:6:1 blend of Z8-12:Ac:E8-12:Ac:Z8-12:OH for *C. molesta* and Z11-14:Ac for leafrollers, 25% w/w) in a suitable solvent (tetrahydrofurfurylic alcohol (THFA), or paraffin oil), adding 10% each (w/w with respect to pheromone) of antioxidants and UV screeners (Rama et al., 1990).

Orchards and installation planning

Apple and pear orchards of suitable shape and with surfaces comprised between 1.5 and 4 ha were selected taking into account the pest population density in the previous year and the presence of particular points of local infestation, such as fruit warehouses, light sources, buildings and so on. The pheromone distributing device was installed downwind with respect to the prevailing winds, while the filament was installed along the rows, about one meter above the tree canopy, using pole-mounted pulleys. For regularly-shaped, medium-height trees, the distance between two rope paths were 12.5 m for border rows and 25 m for central rows, using about 600 meters of filament per hectare, while in

case of higher and more vigorous trees smaller distances of 8 m for border rows and 16 m for central rows were required, using about 1000 meters of filament per hectare (Fig. 3).

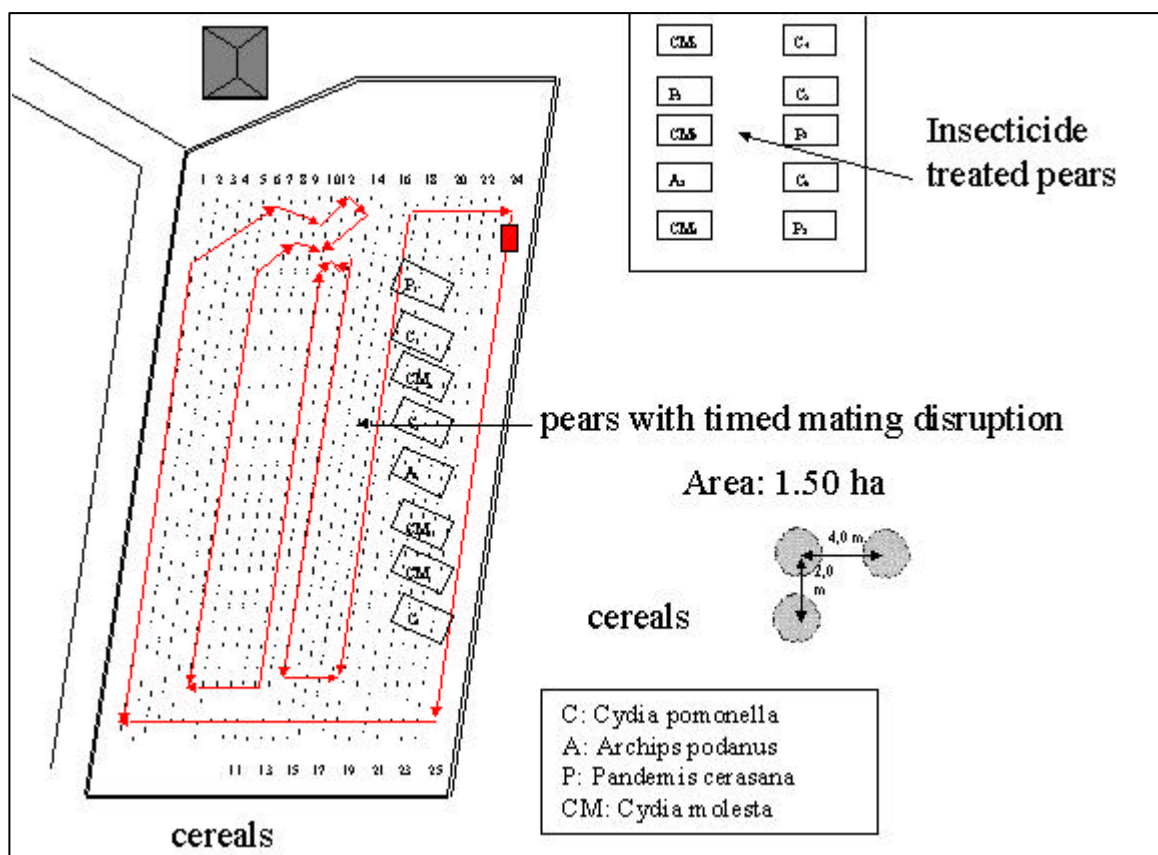


Figure 3. Example of device installation

Start of daily pheromone distribution was set up according to the period of flight of individual species to be controlled (Table 1) and the speed of rope motion was set to 0.4 – 0.6 km/h.

The daily amount of pheromone to be distributed was set up according to the orchard characteristics, climatic conditions and pest population and was varied according to pest fluctuations registered by pheromone traps catches and forecasting models.

Table 1. Daily timetable of pheromone distribution	
Pest	Timing
<i>Cydia pomonella</i>	from 5.30 pm to 8.00 pm
<i>Cydia molesta</i>	from 5.30 pm to 8.00 pm
Leafrollers	from 5.30 pm to 8.00 pm

Controls and damage assessment

The main three-pronged control of method efficiency consisted of:

- Weekly check of pheromone traps for captures
- Visual checks on 500 fruits in 5 positions, representative of the plot, at the end of every pest generation;
- Evaluation of the damage caused at harvest.

Results and discussion

In the year 2000 field tests were carried out in orchards showing a medium pressure of pests. Pest control was in every case satisfactory (Table 2), but the device used, being a prototype, was subject to frequent mechanical failures and did not allowed us to standardize the daily amount of pheromone distributed.

Site	Area	Crop	Damage (%)	Total trap catches	
				Test	Control
Castello d'Argile (BO)	2.2	Pear	0.8 overall	0 CP 0 CM	24 CP 50 CM
Corpo Reno (FE)	1.0	Apple Pear	3.0 overall	12 CP 4 CM	59 CP 26 CM
Dodici Morelli (FE)	1.8	Pear	0.5 overall	1 CP 2 CM	18 CP 22 CM

CP = *Cydia pomonella*; CM = *Cydia molesta*

In 2001, on the basis of previous good results, orchards with higher pressure of pests have been chosen, in order to evaluate the real possibilities of the method in problematic situations (Table 3). The improvements made on the dispensing device made it possible to solve the mechanical troubles and also to monitor the daily pheromone consumption.

Site	Area	Crop	a. i. Consumption/Ha	Damage (%)	Total trap catches	
					Test	Control
S. Caterina (VR)	2.0	Apple	190 g CP 220 g CM 211 g AP	0.41 CP 5.22 CM 3.66 AP	2 CP 73 CM 5 AP	175 CP 2432 CM 1616 AP
Corpo Reno (FE)	1.0	Apple Pear	118 g CP 58 g CM 44 g AP	27.4 overall	5 CP 33 CM 1 AP	169 CP 81 CM 152 AP
S. Cesario (MO)	3.5	Pear	174 g CP 88 g CM 112 g AP	1.0 overall	2 CP 2 CM 15 AP	59 CP 54 CM 326 AP

CP = *Cydia pomonella*; CM = *Cydia molesta*; AP = *Argyrotaenia pulchellana*

The control of various pests was highly satisfactory when using a dosage of 170-200 g of pheromone per hectare, even in the presence of very large populations as shown by the trial in S. Caterina, where a total of 175 *C. pomonella* individuals was caught in pheromone traps placed in a nearby control plot. More troublesome was the control of an impressive population of *C. molesta* and *A. pulchellana*, represented by more than 2400 and 1600 adults respectively, trapped in the control plot.

Figure 4 shows the good correspondence between codling moth flights and pheromone distribution. A lighter pest population in the trial at S. Cesario allowed us to reduce the amount of pheromone used, in particular for Oriental fruit moth and leafrollers, while maintaining the total damage within acceptable limits.

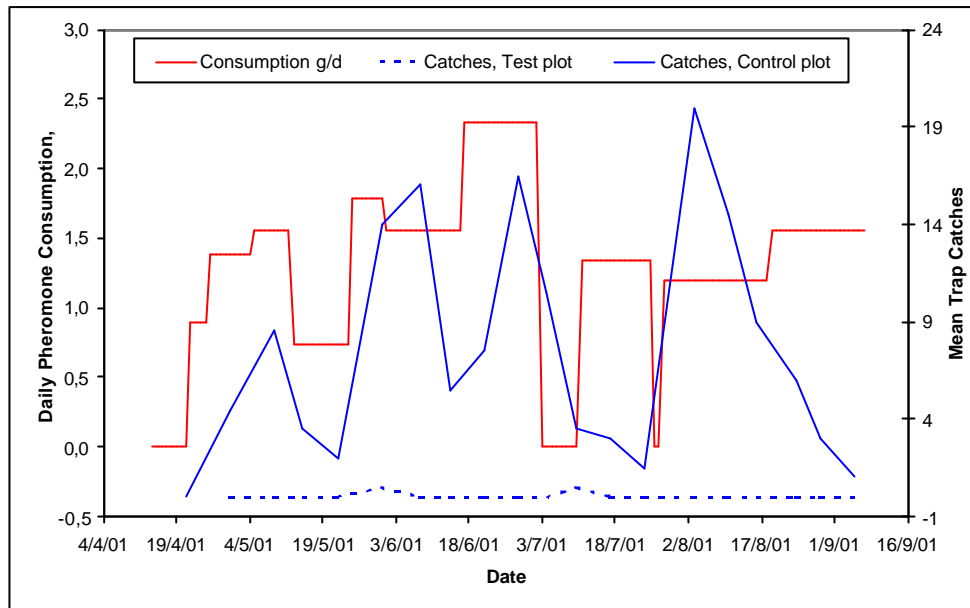


Figure 4. Pheromone consumption and codling moth flight – S. Caterina 2001

On the other hand, if the pheromone dispensed during the highest pest activity is lower than 1 g/Ha/day, the orchard protection is only partial, with the occurrence of significant damage as demonstrated at Corpo Reno, where an inopportune decrease of pheromone dosage coincided with the outbreak of codling moth second generation (Fig. 5).

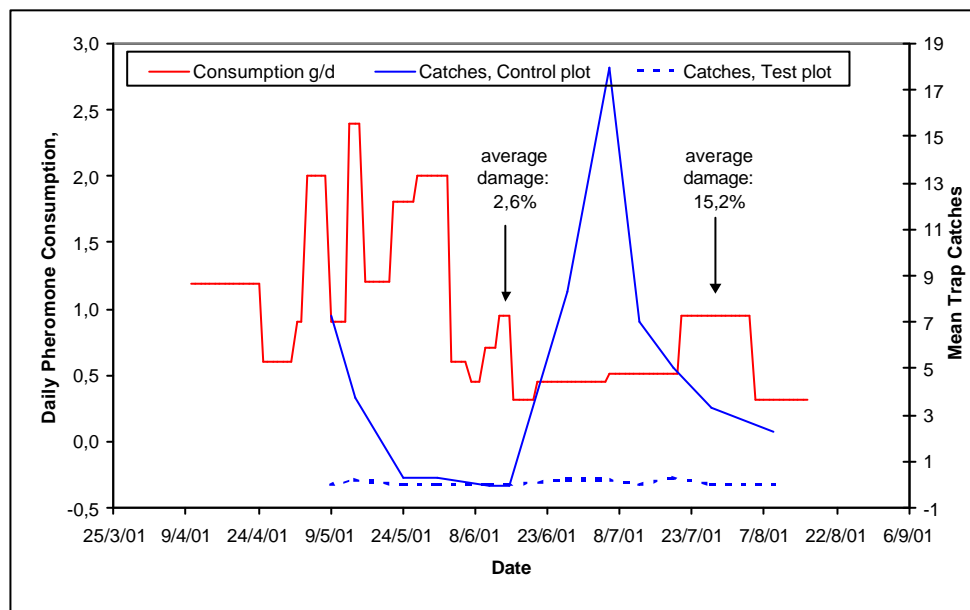


Figure 5. Pheromone consumption and codling moth flight – Corpo Reno 2001

Conclusions

The tests carried out in the last two years have made it possible to set up a reliable dispensing device and to establish the amount of pheromone required to achieve a good orchard protection. The average quantity of pheromone needed per season is thus 170-200 g per hectare; its distribution can be modulated from 2 g/Ha/day during pest peak of flight to less than 1 g/Ha/day when the pest pressure is lower.

The Timed Mating Disruption can hence be easily implemented into the integrated pest management or organic farming protocols. Such a methodology represents an evolution with respect to standard mating disruption since its versatility makes it possible to control several pest species at the same time, to avoid possible chemical treatments due to dispensers depletion in the last part of the season, together with significant savings in terms of manpower.

References

- Baker T. C., Dittl T., Mafra-Neto A. (1997). Disruption of sex pheromone communication in the black-headed fireworm in Wisconsin cranberry marshes by using MSTRS devices. *J. Agric. Entomol.*, 14(4), 449-457.
- Barnes B. N., Blomefield T. L. (1997). Goading growers towards mating disruption: the South African experience with *Grapholitha molesta* and *Cydia pomonella* (Lepidoptera, Tortricidae). *Bull. IOBC/WPRS*, 20(1), 45-56.
- Becid P. (1997). Mating disruption of codling moth, *Cydia pomonella*: experiences from the U.N.C.A.A. Arbotech Pool. *Bull. IOBC/WPRS*, 20(1), 79-82.
- Brunner J. F. (2000). Codling moth mating disruption in the Western United States. Abstracts of IOBC/WPRS Working Group Pheromones and Other Semiochemicals in Integrated Control, 25th Anniversary Jubilee Meeting, Samos (Greece), Sept. 25-29, 2000.
- Mafra-Neto A., Baker T.C. (1996). Timed, metered sprays of pheromone disrupt mating of *Cadra cautella* (Lepidoptera: Pyralidae). *J. Agric. Entomol.* 13(2): 149-168.
- Neumann U. (1997). Successful employment of pheromones in apple: exemplary results from Europe. *Bull. IOBC/WPRS*, 20(1), 73-78.
- Pratizzoli W. (1998). World Patent WO 98/20730; US Patent 6,298,596 B1.
- Rama F. (1997). Ecopom dispensers for mating disruption in apple orchards. *Bull. IOBC/WPRS*, 20(1), 65-72.
- Rama F., Capizzi A., Arsura E. (1990). Mating disruption in the control of codling moth and apple leafrollers in orchards. Abstracts of IOBC/WPRS Working Group Pheromones and Other Semiochemicals in Integrated Control, "Pheromones in Mediterranean pest management", Granada (Spain), Sept. 10-15, 1990, p. 23.
- Shorey H. H., Gerber R. G. (1996). Use of puffers for disruption of sex pheromone communication among navel orange worm moths (Lepidoptera: Pyralidae) in almonds, pistachios, and walnuts. *Environ. Entomol.*, 25(5), 1154-1157.
- Waldner W. (1997). Three years of large scale control of codling moth by mating disruption in the South Tyrol, Italy. *Bull. IOBC/WPRS*, 20(1), 35-44.