Trapping stored-product insects using an unbaited multifunnel trap

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Abstract

Unbaited multifunnel traps have been used in a warehouse where different cereals were stored and two rooms of a flour mill where bran and cracked kernel waste were present.

In the cereal warehouse only Coleoptera were trapped, whereas in the flour mill Coleoptera, Diptera and Lepidoptera were trapped.

During a six-week trial in the cereal warehouse, the multifunnel traps caught adults of *Cryptolestes ferrugineus* (Stephens), *Rhyzopertha dominica* (F.), *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst).

The species found in the flour mill were different, more numerous and dependent upon location. In the room storing bran, the most frequent species were the moths *Ephestia kuehniella* Zell., *Pyralis farinalis* (L.) and *Nemapogon granellus* (L.), and the beetles *R. dominica* and *T. castaneum*. In the room storing the cracked kernel waste Lepidoptera were predominant with *E. kuehniella, N. granellus, Hofmannophila pseudospretella* (Staint.) and *P. farinalis* present.

The silhouette of the multifunnel trap (shaped like a tree trunk) may attract these species because the shape resembles their original food source.

A comparison made with other commercial pheromone traps showed the versatility of the multifunnel trap in complex infestations where various species of flying beetles and moths are present. The multifunnel trap in such situations may provide a better means of the detection of pests, especially when used as part of a control program.

Introduction

Trematerra and Girgenti (1988) noted in studies on the behaviour of the Lesser grain borer *Rhyzopertha dominica* (F.) in a grain store that the multifunnel traps they used also captured *Cryptolestes ferrugineus* (Stephens), *Sitophilus oryzae* (L.) and *Tribolium castaneum* (Herbst).

This led to the investigation undertaken in a cereal warehouse (Trematerra and Daolio 1990) of the role of synthetic dominicalure on nontarget species, the effects of silhouette on trapping efficiency and the influence of trap position in different lit areas of the store. It was found that for *R. dominica* the orientation to the traps could be mediated by chemical and visual cues. Also *C. ferrugineus, S. oryzae* and *T. castaneum* did not respond to dominicalure but visual cues may have played a major role in the orientation of the beetles to the multifunnel traps.

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The effectiveness of the multifunnel trap in a warehouse and flour mill was used to test the supposition that this response is a relict of an ancient behaviour pattern from times in which the *C. ferrugineus, R. dominica, S. oryzae* and *T. castaneum* had not adapted to storage conditions.

Materials and Methods

The exercise was undertaken in a cereal warehouse and in two rooms of a flour mill where bran and cracked kernel wastes were present. Both places were unheated.

Using three multifunnel traps, preliminary trials were carried-out for six weeks during June–August, in the cereal warehouse. Subsequently two traps were used to observe the effectiveness of the traps for nine months in two locations of a flour mill.

The multifunnel trap was 80 cm high, with a 30 cm diameter and consisted of 9 vertically aligned white funnels. The traps were placed in the middle of each location and positioned 30–60 cm from the floor (Fig. 1).

The multifunnel traps were compared with the effectiveness of other commercial traps baited with pheromones of some moths and beetles infesting stored products and with the same traps without baits. The following substances have been used (Z,E)-9,12-tetradecadien-1-yl acetate (or TDA) for phycitid moths and (Z, E)-7,11-hexadecadien-1-yl acetate (or HDA) for *S. cerealella,* and pheromones of *R. dominica* (Dominicalure 1+2), *Sitophilus* spp. (sitophinone) and *Tribolium* spp. (dimetyldecanal). The traps were inspected weekly.

Results and Discussion

Numerous male and female insects were found in the unbaited multifunnel traps. Many flying Lepidoptera and Coleoptera were trapped both in the warehouse and in the flour mill.

Only the Coleoptera *C. ferrugineus, R. dominica, S. oryzae* and *T. castaneum* were trapped in the cereal warehouse. This contrasts with the flour mill where different orders: Coleoptera, Diptera and Lepidoptera were trapped.

In the cereal warehouse during the six-week trial the multifunnel trap caught 11 250 adults of *C. ferrugineus*, 3183 of *R. dominica*, 423 of *S. oryzae* and 2157 of *T. castaneum* (Table 1). In the flour mill the species found were more numerous and differentiated according to the location. In the bran room, the most frequent species among the moths were *E. kuehniella* , *P. farinalis* and *N. granellus* , and among the beetles *R. dominica* and *T. castaneum* (Table 2). In the room where cracked kernel waste was present the Lepidoptera were predominant with *E. kuehniella, N. granellus, H. pseudospretella* and *P. farinalis* (Table 3).

Data for the comparison with the commercial pheromone traps used at the same time and in the same locations are reported in Table 2 for Lepidoptera and Table 3 for Coleoptera.

The pheromone traps of Lepidoptera were more effective compared to the multifunnel traps, but they may be used only

Table 1. Insects trapped by multifunnel traps in the cereal warehouse

	Species				
Weeks	*C. ferrugineus*	*R. dominica*	*S. oryzae*	*T. castaneum*	Total
I	6400	553	151	728	7832
II	1200	664	36	139	2039
III	300	509	20	122	951
IV	1050	714	61	403	2228
V	1500	519	98	467	2584
VI	800	224	57	298	1379
Total	11250	3183	423	2157	17013

Table 2. Insects trapped in the room of flour mill with bran

	Traps				
Species	Multi funnel	TDA[a]	HDA[a]	Control[a]	Total
Lepidoptera					
E. elutella	-	4	-	-	4
E. kuehniella	56	197	3	2	258
H. pseudospretella	26	1	-	-	27
N. granellus	55	9	8	1	73
P. farinalis	15	1	-	-	16
P. interpunctella	2	18	-	-	20
S. cerealella	3	1	14	-	18
Coleoptera					
T. castaneum	-	-	1	-	1

[a]Wing trap produced by G. Donegani Institute, Novara, Italy.

Table 3. Insects trapped in the room of flour mill with cracked kernel waste

	Traps					
Species	Multifunnel	*Rhyzopertha* pheromone[a]	*Sitophilus* pheromone[b]	*Tribolium* pheromone[c]	Control[d]	Total
Lepidoptera						
E. kuehniella	75	-	-	-	8	83
H. pseudospretella	4	1	1	1	1	8
N. granellus	26	-	-	-	-	26
P. farinalis	41	3	3	3	1	51
P. interpunctella	1	1	-	1	-	3
S. cerealella	-	-	1	-	1	2
Coleoptera						
A. unicolor	4	3	6	4	6	23
C. ferrugineus	12	85	114	68	71	350
R. dominica	686	917	144	43	76	1886
S. oryzae	9	33	51	29	43	165
T. castaneum	56	103	126	132	127	544
T. mauritanicus	1	21	23	24	25	104
T. molitor	-	2	-	1	1	4
Diptera						
C. pipiens	1	-	-	-	-	1
M. domestica	1	-	-	-	-	1

[a]Cardboard trap baited with 2.5 mg + 2.5 mg of dominicalure 1+2.
[b]Cardboard trap baited with 1 mg of sitophinone.
[c]Wyatt-Wynn trap baited with 2 mg of dimethyldecanal.
[d]Cardboard trap unbaited.

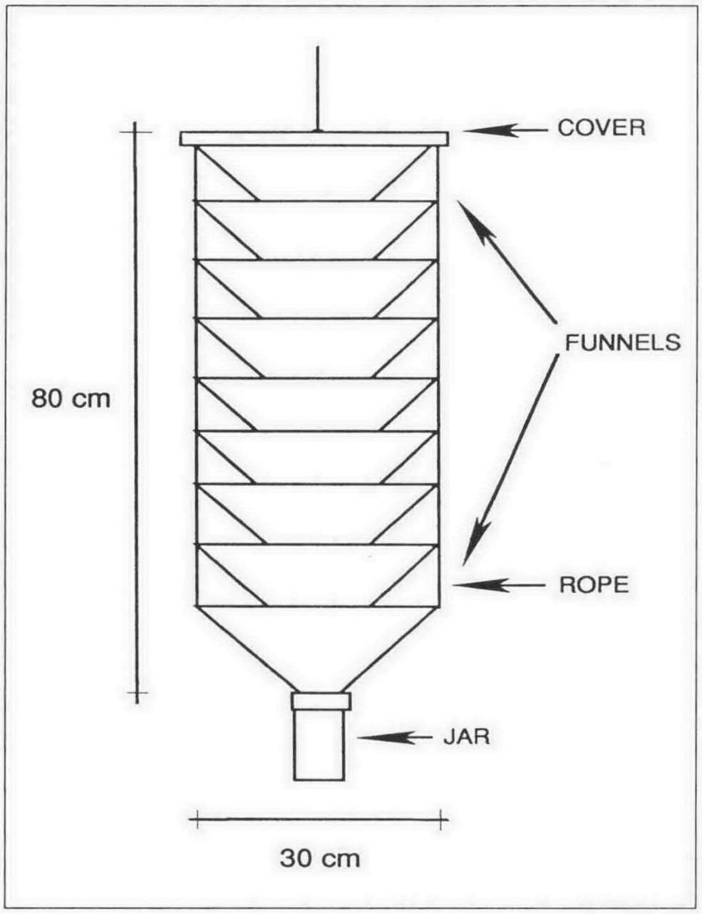

Fig. 1 Multifunnel trap used in the experiments.

for the control of phycitid moths. Similarly the traps baited with HDA captured mainly *S. cerealella*. By comparison, the unbaited multifunnel traps collected a large numbers of *H. pseudospretella*, *N. granellus* and *P. farinalis*.

The multifunnel traps located in the cracked kernel waste room collected many species of Lepidoptera and Coleoptera. In the commercial beetle traps, nontarget species were also trapped, probably attracted by refuges. This was also observed in the unbaited cardboard traps used as control. The multifunnel trap caught more species of Coleoptera and with its high capacity there was no need to change any part of the trap during the trapping period. In the complex infestations with more than one species of moths and flying beetles involved, the multifunnel trap should provide better monitoring of all species and thus enable better pest management.

The success of the multifunnel trap directly relates to the flying insect, which depends upon factors influencing the initiation of flight such as population density, starvation, age and time of day on initiation of flight of adult insects, and by the capacity of the insects to fly towards the silhouette of the trap (McNeil 1991; Barrer et al. 1993).

It is possible that the species captured in a large number showed an attraction towards the silhouette of the multifunnel traps. This trap does resemble a tree trunk which may have been their original food source. Trunks of various trees may have provided the 'sign stimulus' for settling, calling and mating.

Similar behaviour was observed for some Coleoptera:Scolitydae by Vité and Bakke (1979), Borden et al. (1982), Lindgren et al. (1983), Birch (1984), Niemeyer (1985), McLean et al. (1987), Chénier and Philogène (1989) and for the Lepidoptera:Phycitidae by Lorenz (1937) and Levinson and Hoppe (1983), in *Pectinophora gossypiella* Saunders by Farkas et al. (1974), in *Lymantria monacha* (L.) by Schneider (1981), in *Coleophora laricella* (Hübner) by Witzgall and Preisner (1984).

A review on factors affecting the design of traps for stored-product insects was reported by Barak et al. (1990).

Kennedy and Marsh (1974) described optomotor reactions in *E. cautella*, *E. kuehniella* and *P. interpunctella* males to a stripe pattern on the ground as an anemotactic guide to the appropriate pheromone stimulus. Levinson and Buchelos (1981) found that *Ephestia* males did not fly to a source of TDA in complete darkness, while they readily flew toward the pheromone at dim light, suggesting that optical stimulation of the retina is important for taking off.

Levinson and Hoppe (1983) showed that male *E. cautella* and *P. interpunctella* are visually attracted to certain shapes, preferably towards vertical rectangles. Leos-Martinez (1989) used Lindgren funnel traps without any attractant to determine the daily flight periodicity of *Ahasverus advena* (Waltl), *C. ferrugineus*, *O. surinamensis*, *R. dominica*, *T. castaneum*, *E. cautella*, *P. interpunctella* and *S. cerealella*. Trematerra and Capizzi (1991) reported that in the presence of sex pheromone, males of the Mediterranean flour moth attempt to mate with objects resembling females. Quartey and Coaker (1992) improved trap design by studying visual responses of *E. cautella* to rectangles of different colour and size and to brown and white stripes. They showed that moths were attracted to darker coloured vertical rectangles on a white background and to brown and white stripes. Buchelos and Levinson (1993) reported the efficacy of multisurface traps with and without pheromone addition, for monitoring and mass trapping of *Lasioderma serricorne* F.

Conclusions

Before mating, most male or female storage insects respond to their pheromone in combination with supplementary key stimuli. The sequence of sensory stimuli can be used in the design of attractant traps to be employed in the manipulation of storage pests. Trap design should be based on a thorough knowledge of the insect's behaviour and ecology. In this respect the preferential flight of many insects toward unbaited multifunnel traps is vital for developing trapping strategies. Accurate studies for estimating pest population levels are a necessity in order to maximise the efficiency of control procedures.

Trap design for monitoring storage moths has generally been empirical although consideration has been given to flight behaviour and to the form of the pheromone plume. Other factors may also affect trap efficiency such as its shape and colour, location of entry ports and ability to retain the insect after it enters the trap. The type of lure, release rate and plume dimension influence the active space of the plume and the insect's response to the lure. Trap positioning, environmental factors and trap type can also affect insect behaviour.

Ideally, traps should detect low levels of infestations which would otherwise go unnoticed and operate across a range of conditions to reflect accurately population changes in the target species.

In the case of complex infestations, where more than one species of flying insect is involved, the use of the multifunnel trap may be effective and may also reduce the costs of sampling and monitoring.

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