The effect of the modified pheromone traps for capturing Indian meal moth, *Plodia interpunctella* (Hüb), (Lepidoptera: Phycitidae)

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Abstract

The two modified traps, K-1, K-2 and the four imitated from traditional models with synthetic sex pheromone were applied in this test The result of 8-day comparative test showed that K-1 (no any viscose in); K-2 similar in structure demonstrated excellent effect in capturing Indian meal moth (male). Duncan's SSR indicates that the male moths trapped by each of the two modified traps, accumulated within 8 days, were significantly or very significantly more than those by any other type of traps for the test. In sustained testing, each of the two modified traps captured male moths accumulated within various days to a significant or very significant degree at least three times more than those within previous days, while each of the four traditional pheromone traps achieved twice at most. There was no significant difference between quantities of moths captured by the two new traps It proved that the openings of the two traps were escape proof.

Introduction

The Indian meal moth, *Plodia interpunctella* (Hubner) is an important initial stored product insect. Larvae of this species attack various dry and fresh fruits, dry vegetables, spice, candy, unprocessed medicinal herbs, tobacco as well as many grains and their products (Chen, 1984) Vick et al. (1979) found from a comparative test that wing traps were effective in capturing Indian meal moth and Angoumois grain moth when compared with eight types of traps In Britain, viscose traps and funneled traps were used to capture phycitid moths in mills, storehouses and food factories (Pinniger and Chambers, 1986) Wing traps and funneled traps were used to capture three species of phycitid moths in storehouses and food factories in Italy (Suss and Trematerra, 1986) In China, several types of traps have been recommended and used to monitoring stored-product moths They are basin, wing trap, pot trap, cylinder trap, triangle trap, Pherocon IC Pherocon II (Zhou, 1978; Zhao and Yang, 1989; Jiang, 1992; Shen et al., 1994) Most of them were introduced from abroad or modeled domestically. These have played an active role in detecting and monitoring stored product insects We tried to improve some traditional traps to increase moth capture efficiency.

Materials and Method

Insects

Species of insect used for this test is *P. interpunctella* Individuals (adults) were captured from grain distribution store and households near the institute. The insects were bred in insect culture room at 27 ± 1℃, 70 ± 10% rh and a photoperiod of 12 12(L D). Adults and larvae were raised in glass jar. Peanut served as food for the larvae. Every 4th or 5th male instars were selected from the jars and e put into a glass tube with a diameter of 13 mm and height of 60 mm. One peanut was laid in the tube to feed the larva. The mouth was covered with nylon net In 5 days or so after larva had pupated, adults would begin to emerge. The male moths were collected for the test Additional male moths were captured from grain distribution store and households to add to the number of moths from the insect culture room.

Attractant

Synthetic sex pheromone used for this test was provided by the Institute of Entomology, Milan University, Italy. Its chemical composition is (Z. E) - 9, 12 - tetradecadienyl acetate (TDA). Each piece containing TDA at o.25mg, with release rate at 1.63μg per day, was set in every trap for tests

Preparation of traps

Six kinds of traps were used in the test, of which four

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were traditional ones, i e, Pherocon IC, Triangle trap, Delta trap and Cylinder trap The other two were modified traps designed and made by ourselves. They were respectively named K-1, K-2 Structures and specifications of the six kinds of trap are described below:

Pherocon IC: Also named boat and wing trap. It was shaped like two layers of a boat. The dimension of the trap was 28 cm (L) × 22.8cm (W) × 12cm (H). The two layers of the trap were linked with polyester film strips and 3 cm apart from each other. A sheet of viscose polyester film measuring 12.5 × 9.5cm was laid in the bottom of trap. A piece of TDA was hung in the middle of trap by a plastic strip

Triangle trap: The dimension of the trap was 12.5cm (L) × 9.5cm (W) × 9.5cm (H). Viscose polyester film and TDA piece were all the same as the former trap in dimension and installation

Delta: The structure of this trap was similar to Triangle trap. Its dimension was 18.4 cm (L) × 10.2cm (W) × 11.2m (H) There were folded edges on the two sides. There was a bent edge in the upper corner. Viscose polyester film and TDA piece were used as above

Cylinder trap: Length was 27cm, diameter 9 cm. A cone shaped mouth was set in each end Both TDA piece and its installation were same as the former. Viscose polyester film inside measured 25.1cm × 9.5cm

K-1 trap: Its structure could be divided into two parts: cylinder that is 32cm in length, 8cm in diameter and top hat that is 12.5 cm in length, 3.9cm in diameter. TDA piece was laid in the bottom of the trap. There was no viscose material in it.

K-2 trap: It was the same as K-1 trap in structure and specification, but a viscose polyester film was used in it.

Among the traps described above, the former four traps were all modeled on existing designs (Du Jawei, 1998; Miao Jiancai, 1990). Material of which the traps were made was polyester film that was 10 μm thick.

Experimental Design

Three traps of each type were manufactured for the tests. Eighteen traps were hung on two parallel ropes that were 200 cm high and 84 cm apart from each other. The four-modeled traps had a distance of 170 cm between the bottom and floor. The two modified traps had that a distance of 164 cm Any two adjacent were 35 cm apart Positions of the six traps were changed each day. Male moths taken from insect-culture box or from traps were released at 8 00 – 9 00 p. m Number of released moths ranged from 20 to 113 Next morning at 7 00 a m. captured male moths in every trap were counted and the traps were removed from the test room to avoid accumulation of released TDA The eight-day tests were conducted in an insect laboratory that had dimension of 350 × 276 × 365cm. Temperature and rh were 30 – 32℃ and 50 – 70% respectively.

Statistical Analysis

The data were analyzed using analysis of variance and Duncan's multiple range tests

Results

Accumulated male moths captured by the traps during 8 days

The statistical results showed that there are differences between accumulated male moths in different traps during 8-day test period ($F = 19.19 > F_{0.01} = 5.64$ DF = 10). Male moth catch in each of the two modified traps was significantly higher (0.01 significance level) than the other 4 traps, which were not statistically different from one another (Table 1).

Table 1. Cumulative captives of male Indian meal Moth over an 8-day period in 6 trap types.

Trap	Replicate			Sum	Average	Significance of difference	
	I	II	III			$P \leqslant 0.05$	$P \leqslant 0.01$
K-1	50	33	53	136	45.33	A	A
K-2	41	43	49	133	44.33	A	A
Delta	19	22	9	50	16.67	B	B
Triangle	14	14		42	14.0	B	B
Cylinder	6	7	22	35	11.67	B	B
Phercon IC	10	2	9	21	7.0	B	B

Means followed by the same letter in small are not significantly different ($P \leqslant 0.05$)
Means followed by the same letter in capitals are not significantly different ($P \leqslant 0.01$)

The increased effectiveness of the two modified traps seems to be attributable to their upper and lower cone-shaped mouths and top hats, which made male moths, enter the trap easily. Observing at the male moth catch in K-2

trap, which was higher than in K-1 trap, had proved such escape proof feature. Sustained effectiveness of capture in the traps.

Indian meal moth catch on different days of the test showed that the two modified trap, K-1, K-2, gave the best effectiveness of catch (Table 2). Number of male moth captured in K-1 was almost statistically significant or significantly higher, especially on days 1 & 2 relative to other traps. The K-2 trap also was effective in capturing insects

The four traditional traps did not capture a lot of moths. Among them, Pherocon IC and Delta trap seemed to be unable to catch male moth from the 4th day onwards. Obvious differences between the modified traps and the traditional ones were due to two factors, the structure of the mouth mentioned above and the other was the material in the trap viscose. We would here make a discussion on the latter. In the beginning days of the test, the viscose film in the four traditional traps could normally stick male moth that stayed on it though the moth managed to escape. But later on, the surface of viscose was covered with scales from flying moths or escaping one

Table 2. Daily captures of male Indian meal moths in 6 trap types.

Day of test	K-1	K-2	Pherocon IC	Cylinder	Delta	Triangle
8	45.33	44.33	7.0	11.67	16.67	14.0
7	37.33	38.67	7.0	11.0	15.67	14.0
6	30.33	32.33	7.0	9.0	15.0	14.33
5	24.0	29.0	7.0	6.33	14.33	14.0
4	19.0	13.67	7.0	3.67	12.0	14.0
3	15.67	8.67	6.67	3.0	6.0	13.33
2	6.33	3.67	4.33	1.33	3.0	7.0
1	2.33	0.33	1.67	0.33	1.33	1.0

Conclusion

The K-1 trap can be used in grain storehouse, grain distribution stations and household to catch Indian meal moth The K-1 trap features make it easy for the moth to enter and difficult for it to escape. Therefore there is no need to set viscose in the trap.

Polyester film used as materials for traps has not been reported previously This material is light in weight, pliable, inexpensive in cost and resistant to heat, dampness In addition it is transparent and smooth, so it looks both robust and artistic.

K-1 trap is a high effective sex pheromone trap suitable both for monitoring and mass trapping for India meal moth. Additionally, this trap can also be applied to other species of stored product moths.

Acknowledgmen

We appreciate the assistance of L. Suss, Milan University, Milan, Italy in providing Synthetic sex pheromone TDA.

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