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Efficacy of Pheromone on Capturing Angoumois Grain Moth (*Sitotroga Cerealella*) in Stored Rice (*Oryza Sativa* L.) Grain

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Abstract

An experiment on the efficacy of pheromone on capturing angoumois grain moth, *Sitotroga cerealella* (Olivier) was conducted in the laboratory of the Department of Entomology, Sher-e-Bangla Agricultural University, Bangladesh, using rice variety BR11. Pheromone (X-lure) trap was used as a treatment and data were recorded at different days and distances. The experiment was laid out in a Completely Randomized Design (CRD) with four replications. In case of total captured moth, the highest percentage (%) was recorded at 1st day (28.60%), whereas the lowest percentage (%) was recorded at 15th day (7.60%). It was also observed that with the increase of distance of pheromone trap, the % of captured moth was decreased. The pheromone X-lure was found useful only for monitoring *S. cerealella* (Olivier).

Keywords: Efficacy, Pheromone, Angoumois Grain Moth (*S. cerealella*), Population, Monitoring

1. Introduction

Angoumois grain moths are serious destructive stored insect pest and frequently found flying haplessly in stored house. The adult moths do not feed but the larvae, which can penetrate seed coat and enter the grain. They also feed in the grain and stay there before emergence. After emergence the moth start the process again. It can be identify these pests and can prescribe a treatment, sometimes using pheromone traps, or attractants to male adult moths. Pheromones are chemical signals used between members of the same species (Karlson and Lüscher, 1959; Nordlund, 1981). Thus pheromones operate in special biological contexts and they are very species-specific. Attractant pheromones have been identified and synthesized for most major stored-product pests. Although synthetic pheromones can be used to lure large numbers of certain pest species into traps where they die, and methods have been researched for manipulating and suppressing populations with pheromones, pheromones are not typically used for controlling pest populations directly at the present time. Aggregation pheromone systems are highly tied to food resources, as many studies indicate that optimum response by females and males is achieved when the aggregation pheromone is released together with food odors (Phillips, 1997). Such sticky traps usually require the insect to orient to a lure placed on or near the sticky trapping surface within a part of the trap protected from dust and debris. An interesting and apparently effective application of pheromone traps for storage moths is in computer-assisted spatial analysis to locate and precisely target local infestations in a building (Brenner *et al.*, 1998).

Several studies reported successful population suppression of storage moths following deployment of a high density of traps (Levinson and Levinson, 1979; Suss and Trematerra, 1986; Trematerra and Batiani, 1987; Trematerra, 1988, 1990). The moth suppression trap is the first system to use both egg-laying attractants to capture female moths as well as sex pheromones to attract male moths. The result is a pest management tool that has direct effect on suppressing the population of stored grain moths by capturing the egg-laying females. Female Angoumois grain moths are able to lay 40 – 150 eggs during her lifetime. Capturing female moths prevents them from laying eggs on storage grains.

The current use of stored-product insect pheromones as monitoring tools does not represent a direct alternative to chemical control, but clearly is an important component in decision-making and threshold-based IPM that strives for reduced pesticide use. The predominant use of stored-product insect pheromones remains as tools for monitoring and detection, although research continues on methods to apply pheromones for control purposes. The benefit of these pheromone traps is that they do not use chemicals that are not harmful to human or animal. The study was undertaken to know the efficacy of pheromone trap on capturing angoumois grain moth from different distances at various intervals.

2. Materials and Methods

The present experiment was conducted in the laboratory of the Department of Entomology, Sher-e-Bangladesh Agricultural University, Dhaka, Bangladesh, during period during December 2013 to March, 2014.

2.1. Collection of experimental materials

For the experiments, de-infested rice variety BR-11 was collected from farm store house of Sher-e-Bangla Agricultural University. The pheromone traps used as a treatment for the experiments were collected from Safe Agro bio-tech Ltd. Mirpur, Dhaka.

The insect *S. cerealella* (Olivier) was reared from pure culture on rice of BR-11 to ensure the continuous supply of adults.

2.2. Rearing of S. cerealella

Eggs of *S. cerealella* (Olivier) were collected from special mass rearing chamber. One thousand eggs of *S. cerealella* (Olivier) were introduced into each plastic containers (26cm ht x 110 cm dia) containing 1 kg of de-infested rice grains. The mouth of the containers were covered by fine mesh nylon nets and kept in the laboratory at the prevailing temperature and relative humidity. The rice grains with eggs were kept for 25 days to develop into adults and then the adult emergence was observed. One- day old adults sorted from rice grains were used for the study.

2.3. Composition of pheromone trap

Used pheromone trap is Pheromone X-lure RTU which is the ready to use monitoring trap for stored products flying insects where a multiple of pheromones and attractants are incorporated with trap adhesive. This trap contains pherogel TM technology which gives a controlled release of pheromone. Craft board constructed in the form of a trap coated with chemically inert non-dying adhesive based on polyolefin and containing the insect pheromones as well as food grade vegetable extract as an attractant.

2.4. Experimental setup and data collection

Pheromone X-lure used as a treatment. Pheromone trap (X-lure) replaced up 1 meter distance from upper layer of the floor. Plastic containers with one day old adults were kept at 1 meter distance away the pheromone trap. Then fine mesh nylon net cover was removed from the mouth of the container for coming out of adult insects from the container. Adult insects attracted to pheromone and captured in the trap. Number of capturing moths in the trap was recorded on every alternate day upto 15 days. Secondly, plastic containers with one day old adults were kept away at seven distances (1, 2, 3, 4, 5, 6 and 7 meters) from the pheromone trap and fine mesh nylon net cover removed from the containers for coming out of adults from the container. Then data were recorded. The experiment was laid out in a Completely Randomized Design (CRD) with four replications.

In case of old ages adult insect, pheromone trap was replaced on the same way with four replications. Then adult insects of different age were released from the container at different times of a day. Secondly, plastic containers with adult moth were kept away in the different distances (1, 2, 3, 4, 5, 6 and 7 meters) from the pheromone trap and fine mesh nylon net cover was removed from the container and data were recorded. The different parameters were used estimated as:

$$\text{\% of captured moth} = \frac{\text{Number of captured moths from the trap}}{\text{Total number of released moths from the container}} \times 100$$

$$\text{\% of captured female moth} = \frac{\text{Number of captured female moths from the trap}}{\text{Total number of captured moths from the trap}} \times 100$$

$$\text{\% of captured male moth} = \frac{\text{Number of captured male moths from the trap}}{\text{Total number of captured moths from the trap}} \times 100$$

2.5. Statistically analysis

The data were analyzed using computer based programme MSTAT-C software. The mean values were judged by Duncan Multiple Range Test at 5% level of probability (Gomez and Gomez, 1984).

3. Results and Discussion

3.1. Capture of angoumois grain moth for different days

Capture of angoumois grain moth at different days due to pheromones showed statistically significant differences. The highest percentage of total captured moth was recorded at 1st day (28.60%) followed by 3rd day (24.40%) and subsequently for 5th day (21.80%), 7th day (20.20%), 9th day (18.40%), 11th day (16.20%), whereas the lowest percentage (%) was recorded for 15th day (7.60%) followed by 13th day (13.80%) (Table 1).

In case of captured female moth, the highest percentage was recorded for 13th day (86.96%) which was almost identical with 9th day (86.74%) and followed by 3rd (84.43%), 15th (84.21%), 11th (83.95%) and 5th day (83.49%). The lowest was recorded for 1st day (81.82%) which was statistically similar to that of 7th day (82.18%). In case of male captured moth, the highest percentage male moth was recorded for 1st day (18.18%) which was statistically identical to 7th days (17.82%). Again, the lowest percentage of male moth was captured for 13th day (13.04%) which was statistically identical to 9th day (13.26%) and were followed by 3rd (15.57%), 15th (15.79%), 11th (16.05%) and 5th day (16.51%), respectively.

3.2. Capture of angoumois grain moth at different distance

Effect of pheromone in the capture of angoumois grain moth showed statistically significant differences for different distance. It was revealed that with the increases of distance percent of captured moth decreased. The highest captured moth population was recorded at 01 meter distance (29.40%) which was followed by 2 meter distance (23.80%) and the lowest captured moth was recorded from 7 meter distance (3.20%) (Table 2).

The highest % of captured female moth was recorded at 01 meter distance (85.54%) which was followed by 02 (82.35%), 03 (81.63%) and 4 meter distances (81.16%). The lowest % captured female moth was recorded at 5 meter distance (72.22%), which was statistically similar to 6 meter distance (72.73%). The lowest % of captured male moth was recorded at 3 meter distance (14.46%) which was followed by 2 (17.65%), 1 (18.37%) and 4 meter distances (18.84%), whereas the highest % captured male moth was recorded at 5 meter distance (27.78%).

Table 1. Effect of pheromone X-lure on capturing newly emerged adults of *S. cerealella* at different days after emergence

Days	Total no. of capture moth	% of capture moth	
		Male	Female
1st	28.60 a	18.18 a	81.82 c
3rd	24.40 b	15.57 b	84.43 b
5th	21.80 c	16.51 b	83.49 b
7th	20.20 c	17.82 a	82.18 c
9th	18.40 d	13.26 c	86.74 a
11th	16.20 e	16.05 b	83.95 b
13th	13.80 f	13.04 c	86.96 a
15th	7.60 g	15.79 b	84.21 b
$LSD_{(0.05)}$	1.651	1.458	0.782
Level of significance	0.01	0.01	0.05
CV(%)	6.12	5.89	4.41

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Table 2. Effect of pheromone X-lure on capturing newly emerged adult of *S. cerealella* at different distances

Distance (meter)	Total no. of capture moth	% of capture moth	
		Male	Female
1	29.40 a	18.37 c	85.54 a
2	23.80 b	17.65 c	82.35 b
3	16.60 c	14.46 d	81.63 b
4	13.80 d	18.84 c	81.16 b
5	10.80 e	27.78 a	72.22 d
6	6.60 f	27.27 a	72.73 d
7	3.20 g	25.00 b	75.00 c
$LSD_{(0.05)}$	2.134	2.143	2.091
Level of Significance	0.01	0.01	0.01
CV(%)	8.34	7.33	5.33

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

3.3. Capture of 3 days old adult moth at different days

Significant variations were recorded in terms of capture of 3 days old adult angoumois grain moth at different days due to the utilization of pheromones (Table 3). In case of total % of old adult moth capture, the highest % was recorded for 3rd day (30.20%) followed by 1st day (27.20%) and no captured old adult moths were recorded for 10th day (Table 3). In case of captured female old adult moth, the highest % was recorded for 8th day (100.00%) which was followed by 3rd (94.70%), 5th (90.70%) and 1st day (83.82%). No captured old adult female was recorded for 10 day. In case of captured male old adult moth, the highest % of male moth was recorded at 1st day (16.18%) which was followed by 5th (9.30%) and by 3rd day (5.30%), and no captured old adult male was found at 8th and 10th day.

Table 3. Effect of pheromone X-lure on capturing 3 days old adult angoumois grain moth, *S. cerealella* at different days

Days	Total no. of capture moth	% of capture moth	
		Male	Female
1st	27.20 b	16.18 a	83.82 d
3rd	30.20 a	5.30 c	94.70 b
5th	8.60 c	9.30 b	90.70 c
8th	0.60 d	0.00 d	100.00 a
10th	0.00 e	0.00 d	0.00 e
$LSD_{(0.05)}$	0.498	2.671	3.871
Level of Significance	0.01	0.01	0.01
CV(%)	11.23	5.66	6.78

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Table 4. Effect of pheromone X-lure on capturing of 3 days old adult angoumois grain moth, *S. cerealella* at different distances

Distance (meter)	% of capture moth		
	Total	Male	Female
1	27.00 a	8.89 c	91.11 a
2	26.20 a	6.87 c	93.13 a
3	15.60 b	8.97 c	91.03 a
4	11.40 c	19.30 b	80.70 b
5	5.20 d	19.23 b	80.77 b
6	3.00 e	33.33 a	66.67 c
7	0.00 f	0.00 d	0.00 d
$LSD_{(0.05)}$	1.913	3.281	8.901
Level of Significance	0.01	0.01	0.01
CV(%)	7.81	9.22	10.01

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

3.4. *Capture of 3 days old adult angoumois grain moth at different distances*

Capture of 3 days old adult angoumois grain moth at different distance due to pheromones showed significant differences. The highest % of 3 days old adult moth capture was recorded for 1 meter distance (27.00%) which was statistically similar to 2 meter distance (26.20%) and was followed by 3 meter distance (15.60%). The lowest % of capture moth was recorded at 6 meter distance (3.00%), followed by 5 meter distance (5.20%). In case of female moth, the highest % of captured 3 days old adult female moth was recorded at 2 meter distance (93.13%) which was statistically similar to 1 meter (91.11%) and 3 meter distance (91.03%) and was followed by 5 (80.77%) and 4 meter distance (80.70%). In case of male 3 days old adult moth, the highest % was recorded at 6 meter distance (33.33%) followed by 4 (19.30%) and 5 meter distance (19.23%) (Table 4).

Efficacy of pheromones on capturing angoumois grain moth, *Sitotroga cerealella* in stored rice grain as found in the present investigation is in agreement with theme of David *et al*. (1998);

Phillips (1997); Vick *et al.* (1981); Levinson *et al.* (1999); Suss *et al.* (1986); Trematerra *et al.* (1987); and Trematerra (1988, 1990).

David *et al*. (1998) showed that pheromones X-lure had attractant, repellent, insecticidal and juvenile hormone activity against several species of insect pests including stored product pest larvae of Lepidoptera and *Culex quinquefasciatus*. Phillips (1997) reported that aggregation pheromone systems are highly tied to food resources, as feeding is required by males to produce pheromone and optimum response by females and males is achieved when the aggregation pheromone is released together with food odors. According to Vick *et al.* (1981), release rate should be optimized for best performance of a lure. If pheromone release is too low then a lure may be ineffective simply because a threshold for insect response is not met.

Some insects display increased response to increasing pheromone release levels, such as with pyralid moths that increase response up to a given level with no indication of repellency. Several studies report successful population suppression of storage moths following deployment of a high density of traps (Levinson and Levinson, 1999; Suss and Trematerra, 1986; Trematerra and Batiani, 1987; Trematerra, 1988, 1990), but typically no evaluation of the success of the treatment is conducted except for continued monitoring with pheromone traps.

These results were different from the findings of others researchers (Brower, 1975; Burkholder, 1990; Wileyto *et al*., 1994; and Pierce, 1994). Brower (1975) reported that for aggregation pheromones that attract females, mass-trapping may have significant impact on a population if substantial females are removed. Burkholder (1990) reported that moth and beetle traps are used to detect the presence of pests by season and location within a capability, to monitor apparent changes in the size of pest populations over time, and to target focal points of infestations or entry.

Some trapping research has pursued the use of trap data to estimate pest population size (Wileyto *et al*., 1994), but pheromone traps are not yet used routinely to estimate moth population size or to indicate specific action thresholds for pest management. Pierce (1994) employed several combinations of pheromone-based trapping techniques with pyrethrin fogging to suppress the incidence of storage moths. However, since these studies were so successful in removing large numbers of target pests from an area in a short time, they revealed the true potential for pheromone-based suppression of these insects.

Pheromone traps for moth suppression are slightly more expensive, but may be cost effective. Although, the results obtained in this study differed from those of the other workers to some extent, It was logical because they used stored-product insect pheromones as monitoring tools which does not represent a direct alternative to chemical control. However, clearly it is an important component in decision-making and threshold-based IPM that strives for reduced pesticide use.

4. Conclusions

Capturing female moths prevents them from laying eggs on storage grains. The moth suppression trap is the first system to use both such as egg-laying attractants to capture female moths as well as sex pheromones to attract male moths. The pheromone trap is a pest management tool that has direct effect on suppressing the population of stored grain moths by capturing the egg-laying females. Rather, synthetic pheromones are used routinely in traps as detection and monitoring tools in pest management programs. The use of pheromones and related trapping and luring technologies as IPM tools will also explore the potential for developing pheromone-based methods of pest suppression.

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