

# Study on the Application of Sex Pheromone in the Control of Asian Corn Borer

Jin Long-fei, Li Meng-han, Liu Bin, Xu Wen-ping

School of Pharmacy, East China University of Science and Technology, Shanghai, China

## Email address:

xuwp@ecust.edu.cn (Xu Wen-ping)

## To cite this article:

Jin Long-fei, Li Meng-han, Liu Bin, Xu Wen-ping. Study on the Application of Sex Pheromone in the Control of Asian Corn Borer.

*International Journal of Applied Agricultural Sciences*. Vol. 9, No. 5, 2023, pp. 168-174. doi: 10.11648/j.ijaas.20230905.16

**Received:** September 20, 2023; **Accepted:** October 23, 2023; **Published:** October 28, 2023

---

**Abstract:** *Aim:* To verify the control effect of the 0.75% volatile core of the sex pheromone of the Asian corn borer, and provide a optimal dosage and method for the green control of the Asian corn borer. *Methods:* The experimental reagent treatment area adopts the method of trapping, with a trapping device installed every 666.67 m<sup>2</sup>, and 1, 2, and 3 volatile cores suspended in the device. The control agent and the blank control area were treated with spray, and the control agent was prepared by twice dilution method, and the blank control area was treated with the same amount of water. Investigate the number of the trapped moths, harm rates, and population decline rates at different times. *Results:* The cumulative amount of the trapped moths increased with the increase of the dosage. The control effect of pest and the damage caused by the pest increased with the time and the increase of dosage. After 56 days, the control effect of pest and the damage caused by the pest were 70.30%, 71.92%, 77.32%, and 71.36%, 73.40%, and 76.47%, respectively. The control agent showed a gradual decrease in its control effect over time, with only 13.20% and 11.26% of the pest and damage control effects observed 56 days after treatment. *Conclusions:* The 0.75% volatile pheromone core showing good damage control and pest control effects on the Asian corn borer, after 28 days of suspension, and is safe for other non-target organisms.

**Keywords:** Sexual Attractant, Asian Corn Borer, Microcapsule, Volatile Core

---

## 1. Introduction

The corn borer, also known as the diamondback moth, is Lepidoptera Borer family. The stalk field borer is an insect of the genus *Ostrinia*, which mainly affects grain crops such as corn, sorghum, grain, and rice. The corn borer can be classified as European corn borer (*Ostrinia nubilalis* (Hübner)) and Asian corn borer (*Ostrinia furnacalis* (Guenée)) [1]. The Asian corn borer is mainly distributed in areas such as eastern Asia and Australia, while the European corn borer is widely distributed in Central Asia, Europe, North Africa and North America [2]. It is found that the Asian corn borer is the main dominant species of corn borer in China, distributed in the three northeastern provinces, Beijing, Hebei Province, Henan Province, Sichuan Province, Guangxi Province, etc., and it occurs in various corn production areas along the route from Heilongjiang to Hainan [3]. The Asian corn borer mainly reproduces through proximity diffusion, endangering various parts of the corn plant, causing it to lose its growth function and lowering seed yield. In the corn heart leaf stage, most of

the low instar larvae crawl into the inner part of the heart leaf after hatching, feeding on the leaf flesh part of the heart leaf, with white film-like epidermal residue; most of the high instar larvae crawl into the heart leaf and lurk inside, and continue to moth into the stalks to infest the plant when it unfolds, resulting in a large amount of fecal matter accumulating at the mouth of the moth holes; when the stalks, stalks, and axes of the cob are all moth-eaten, this will cut off the plant's water transport and nutrient supply, and in the long run the crop stops growing, making the stalk collapse rate increase, and making the plant lose its growth function. Stalk folding rate increases, grain deflation, insufficient irrigation resulting in a significant decline in yield [4, 5]. Research has found that the Asian corn borer is a serious threat to China's major food crops, with the corn crop suffering the most severe yield loss of up to 30%-40% per year, resulting in serious economic losses; at the same time, hundreds of millions of dollars in human and material resources are spent annually on the prevention and control of Asian corn borer reproduction and infestation [6, 7]. For this reason, the development of novel mechanisms of

action is a natural trend.

Insect pheromones, also known as insect pheromones, are microchemicals released by insect individuals to regulate or induce the behavior and response of other individuals of the same species [8]. According to their different effects, they can be broadly categorized into insect sex pheromones, tracer pheromones, alarm pheromones and aggregation pheromones. Insect pheromones are mainly used for insect detection, trapping and disorientation [9]. Insect sex pheromones are secreted by the gonads of insects after sexual maturity, and are transmitted by air or other media to stimulate the chemical sensory organs in the antennae of the opposite sex, causing individual sexual impulses and inducing them to fly toward the release source, and to mate with adults of the opposite sex in order to reproduce their offspring [10]. Sex pheromones are usually released by female moths in Lepidoptera. The molecular composition of the Asian corn borer sex pheromone was first determined by Klun *et al.* in 1980 [11]. They found that the main active ingredient is a pair of cis-trans isomeric (Z,E)-12-tetradecen-1-ol acetate, in which the cis-trans ratio is approximately close to 1:1. Since then, many researchers at home and abroad have conducted a lot of research on this pheromone [12, 13], mainly focusing on the synthesis method of the active ingredient, the relationship between the ratio of the different components and the activity of the moths, the manufacturing process of the sex pheromone, the determination of the bioactivity of the field, the formulation of the core, the formulation of the core, and the determination of the activity of the moths in the field. The main focus is on the relationship between the synthesis method of its active ingredients and the activity of different components, the manufacturing process of sex lure products, the determination of biological activity in the field, the formulation of traps, the carrier of traps, the use of technology, and the selection of supporting traps [14, 15]. In this paper, the sex lure synthesized in the laboratory was formulated into a microcapsule slow-release dispersal core according to the proportion, placed in the traps arranged in the field, and released slowly and uniformly to attract male moths, thus causing the disproportion between males and females and reducing the mating behavior between males and females, so that the density of the pest's next-generation population was greatly reduced, and the purpose of protecting the maize from fewer or more infestations was achieved.

## 2. Materials and Methods

### 2.1. Test Agent

0.75% Asian corn borer sex lure pheromone volatile core

### 2.3. Experimental Design and Organization

#### 2.3.1. Pharmaceutical Dosage

(including cis-12-tetradecylenyl acetate 0.563%, trans-12-tetradecylenyl acetate 0.187%), 4 g/pc (Batch No.: 210318-Y01), produced by our laboratory.

Control agent: 32000 IU/mg *Bacillus thuringiensis* wettable powder, 50 g/bag (Batch No.: 20210122), Wuhan Kono Bio-technology Co.

### 2.2. Cultivation of Environments and Facilities

#### 2.2.1. Location of the Test Site

Shengli Village, Diantan Town, Tengchong City, Baoshan City, Yunnan Province, Longitude and Latitude: 98.478479, 25.406869.

#### 2.2.2. Test Target Situation

The Asian corn borer has occurred in this region in all the years, with serious overlapping of generations, 4~5 generations occurring annually. Adults and larvae of all ages of the Asian corn borer occurred at the time of application, and most of the larvae were in the 4th~5th instars, which meets the requirements for carrying out the test.

#### 2.2.3. Test Crops, Varieties, Growth and Neighboring Crops

Test crop: corn; crop variety: Gaokang 6;

GROWTH: Corn is in the trumpet stage and is growing well and uniformly;

Neighboring crops: corn, yam, konjac.

#### 2.2.4. Soil Type of the Test Site

The soil of the experimental field was red loam with pH 6.5, organic matter content of 5.08% and high soil fertility.

#### 2.2.5. Tillage Background of the Test Site

Crop condition: corn was sown on June 23, 2021, plant spacing: 50 x 35 cm.

Fertilizer management: 10 kg of urea per mu was applied on July 29, 2021 as a catalytic fertilizer.

#### 2.2.6. Meteorological Information

On the day of application (August 6, 2021), it was cloudy, with a westerly wind of 2.10 m/s, a temperature of 21.4°C, a relative humidity of 64.6% RH, and a soil temperature of 19°C. Meteorological information at the time of application and throughout the test period is shown in Exhibit 1 and Exhibit 2.

#### 2.2.7. History of Drug Use at the Test Site

On 07/14/2021 39% octane-smoke-atrazine dispersible oil suspension was applied to control annual weeds at a rate of 100 ml/acre. No other pesticides were used during the trial.

Table 1. Experimental dosage of pharmaceuticals.

Processing number	Name of the medicine	Formulation rate (/666.67 m <sup>2</sup> )	Test area
1	0.75% Asian Corn Borer Sex Lure Pheromone Dispersal Core	1 volatile core (100 mg)	3.33 hm <sup>2</sup>
2	0.75% Asian Corn Borer Sex Lure Pheromone Dispersal Core	2 volatile cores (200 mg)	3.33 hm <sup>2</sup>
3	0.75% Asian Corn Borer Sex Lure Pheromone Dispersal Core	3 volatile cores (300 mg)	3.33 hm <sup>2</sup>

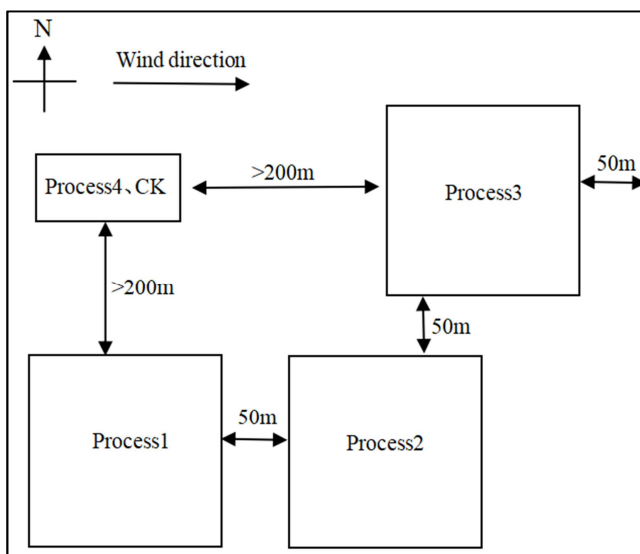
Processing number	Name of the medicine	Formulation rate (/666.67 m <sup>2</sup> )	Test area
4	32000 IU/mg <i>Bacillus thuringiensis</i> wettable powder	200 grams	333.33 m <sup>2</sup>
5	CK (water control)	/	66.67 m <sup>2</sup>

### 2.3.2. Sectoral Arrangements

No replications were set up for the test agent area and four replications were set up for the control agent and blank control areas.

Control agent, blank control area: randomized arrangement with 2 m protected rows between the plots.

Test agent area: choose to carry out in the maize field 200 m away from the control agent, blank control area downwind, between the different treatments and around the test site to set up isolation rows, isolation rows width of 50 m, test the arrangement of the treatments are shown in Figure 1.



**Figure 1.** Schematic diagram of the arrangement of the treatment areas of the experiment.

### 2.3.3. Methods of Application

Experimental pharmaceutical treatment area: 1 trapping device was set up every 666.67 m<sup>2</sup> and volatile cores were hung according to the design, and the height of the traps was about 150 cm.

Control agent, blank control area: accurately weigh a certain amount of control agent in a special bottle, well labeled to the test site, before the application of the second dilution method of preparation of the test agent, one by one on the treatment area of maize plants evenly sprayed, no re-spraying, no leakage of spraying. The blank control was applied with equal amount of water. Water consumption in

the control area and blank control area: 45 L/666.67 m<sup>2</sup>.

### 2.3.4. Timing, Frequency of Application and Crop Fertility Period

Application time: 06/08/2021 Setting traps and hanging sex attractant volatile cores, while applying in the control agent area and blank control area;

Number of applications: 1;

Crop Fertility: Trumpet stage.

### 2.4. Survey, Recording and Measurement Methods

#### 2.4.1. Number and Duration of Surveys

Moth attraction: A total of six surveys were conducted, and the amount of Asian corn borer moths attracted was recorded and removed 3d, 7d, 14d, 28d, 42d and 56d after each of the waved cores were hung.

Rate of population reduction: A total of seven surveys were conducted; the number of larvae in the blank control area was surveyed before the waved core and trap were hung (on the day of application), and the number of surviving larvae of the Asian corn borer was surveyed once in each of the 3d, 7d, 14d, 28d, 42d, and 56d after setup, and the number of surviving larvae of the Asian corn borer was recorded in each of the surveys.

Infestation rate: A total of six surveys were conducted. One survey was conducted 3d, 7d, 14d, 28d, 42d and 56d after hanging the dispersal core, and the number of maize plants infested was recorded.

#### 2.4.2. Survey Methodology

Moth trapping survey: In each treatment plot, after the waving core and traps were hung, the amount of Asian corn borer moths trapped in each of the five traps was surveyed and removed according to the 5-point sampling method in five directions: east, south, west, north, and center.

Infestation rate and population reduction rate survey: each treatment plot was sampled by diagonal 5-point sampling method, 50 plants were surveyed at each point, a total of 250 maize plants, and the number of infested maize plants and the number of surviving larvae were recorded.

#### 2.4.3. Calculation of Potency

The rate of insect mouth reduction was calculated according to equation (1):

$$\text{Dropping rate of insect}(\%) = \frac{\text{Number of live insects before application} - \text{Number of live insects after application}}{\text{Number of live insects before application}} \times 100 \quad (1)$$

The effectiveness of larval control was calculated according to equation (2):

$$\text{Effect of prevention}(\%) = \frac{\text{Reduction rate of insect population in the treatment area} - \text{Reduction rate of insect population in the control area}}{100 - \text{Reduction rate of insect population in the control area}} \times 100 \quad (2)$$

The rate of infestation was calculated according to equation (3) and the effect of pest control according to equation (4):

$$\text{Damage rate}(\%) = \frac{\text{Number of damaged plants}}{\text{Total number of plants}} \times 100 \quad (3)$$

$$\text{effect of prevention}(\%) = \frac{\text{Injury rate in the control area} - \text{Injury rate in the treatment area}}{\text{Injury rate in the control area}} \times 100 \quad (4)$$

## 2.5. Data Processing Methods

The experimental data were statistically analyzed by Duncan's method of new complex polarity (DMRT) to test the significance of differences between treatments at the 5% level.

## 2.6. Impact on Crops

Observe the test agent for damage to corn during the test and record the type and extent of damage. Other beneficial effects on the crop (e.g., maturation promotion, growth stimulation, etc.) are also recorded.

## 2.7. Effects on Other Organisms

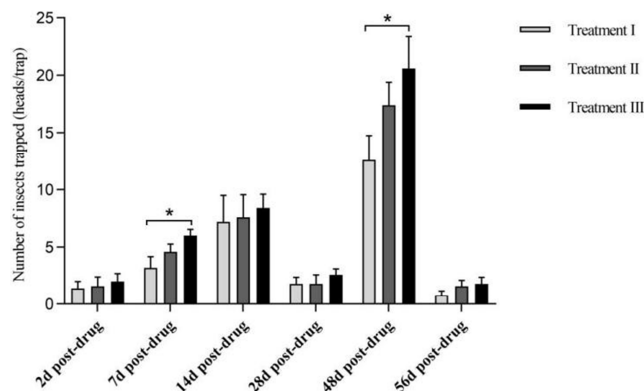
The effects of the test agent on non-target organisms were observed at all times during the test.

# 3. Results and Discussion

## 3.1. Moth Trapping Effect

The statistical results showed that the average cumulative moths trapped by the 0.75% Asian corn borer sex lure pheromone dispersal core treatment 3 was the highest, 41.40 moths/trap; treatment 2 was the second highest, 34.60 moths/trap; and treatment 1 was the lowest, 27.00 moths/trap. In terms of the amount of moths trapped in each treatment in a single survey, treatment 3 was the most and treatment 1 was the least in all cases. From the moths trapped in each survey within the treatments in Figure 2, there were two peaks of moth trapping after hanging the 0.75% Asian corn borer sexually induced pheromone dispersal cores, which were 14

and 42 days after the drug, respectively. At 14 days post-dose, the number of moths trapped with one volatile core, two volatile cores and three volatile cores was 7.2, 7.6 and 8.4, respectively, and there was no significant difference between the treatments at  $P=0.05$ . At 42 days post-dose, the number of moths trapped with one volatile core, two volatile cores and three volatile cores was 12.6, 17.4 and 20.6, respectively, and there was no significant difference between treatments one and three at  $P=0.05$ . Significant differences were found between treatments one and three at  $P=0.05$  level. It was statistically found (see Table 2) that as the dosage of volatile core was increased, the average cumulative number of moths trapped increased significantly with it.



Moth attraction of 0.75% Asian corn borer sex attractant pheromone

**Figure 2.** Moth attraction effect of 0.75% Asian corn borer sex attractant pheromone.

(Treatments I, II and III represent 1 volatile core dose, 2 volatile core doses and 3 volatile core doses, respectively)

\* indicates  $p < 0.05$

**Table 2.** Results of field efficacy test of 0.75% Asian corn borer sex lure pheromone volatile core for control of Asian corn borer in maize (amount of moths lured).

Name of agent (dosage/666.67m <sup>2</sup> )	Average number of moths trapped (heads/trap)						Average cumulative number of moths trapped (heads/trap)
	3d post-drug	7d post-drug	14d post-drug	28d post-drug	42d post-drug	56d post-drug	
0.75% Asian corn borer sex attractant pheromone (1 volatile core)	1.40a	3.20b	7.20a	1.80a	12.60b	0.80a	27.00
0.75% Asian corn borer sex attractant pheromone (2 volatile cores)	1.60a	4.60ab	7.60a	1.80a	17.40ab	1.60a	34.60
0.75% Asian corn borer sex attractant pheromone (3 volatile cores)	2.00a	6.00a	8.40a	2.60a	20.60a	1.80a	41.40

Note: The values in the table are the means of moths lured by five traps, and the differences between treatments labeled with different letters are significant, while those labeled with the same letter are not significant.

## 3.2. Effectiveness of Pest Control

Analysis of the data in Table 3 revealed that the insect mouth control efficacy increased with the time of hanging the volatile core of 0.75% Asian corn borer sex lure pheromone

and the increase of the dosage, and the test agents began to reflect better control effects after 14 days, and the insect mouth control efficacy of treatment 1, treatment 2, and treatment 3 were 43.66%, 45.36%, and 49.92% respectively, and the control efficacy after 28 days was 66.45%, 68.95%, 71.16%, 69.53%, 71.19%, 75.62% after 42 days, and 70.30%,

71.92%, 77.32% after 56 days, respectively; the control agent, 32,000 IU/mg of *Bacillus thuringiensis* wettable powder in the preparation of the dosage of 200 g/mu, the prevention of Asian corn borer in the 14th day after the drug was the highest, at 73.64%, and after the dosage of 200 g/mu, the prevention of Asian corn borer in the 14th day after the drug was the highest, at 73.64%. 73.64%, then with the passage of

time the preventive effect gradually decreased, 28 days after the drug for 57.33%, 42 days after the drug for 33.16%, 56 days after the drug for 13.20%. Starting from 28 days post-dose, the efficacy of control treatment 4 was lower than that of the three treatments of the test agent. (The three treatments of the test agent did not show better control effect at 3, 7 and 14 days post-dose, so they were not analyzed.)

**Table 3.** Results of field efficacy test of 0.75% Asian corn borer sex lure pheromone volatile core for control of Asian corn borer in maize (pest control efficacy).

Name of the medicine (dosage/666.67m <sup>2</sup> )	Pre-drug base	28d post-drug		42d post-drug		56d post-drug	
		Number of living insects	Efficacy/%	Number of living insects	Efficacy/%	Number of living insects	Efficacy/%
0.75% Asian corn borer sex attractant pheromone (1 volatile core)	16	22	66.45	10	69.53	20	70.30
0.75% Asian corn borer sex attractant pheromone (2 volatile cores)	22	28	68.95	13	71.19	26	71.92
0.75% Asian corn borer sex attractant pheromone (3 volatile cores)	22	26	71.16	11	75.62	21	77.32
32000IU/mg <i>Bacillus thuringiensis</i> wetable powder (200g/mu)	19.5	34	57.33	26.75	33.16	71.25	13.20
ck	18.75	76.50		38.25		78.50	

*Table 3. Continued.*

Name of the medicine (dosage/666.67m <sup>2</sup> )	Pre-drug base	3d post-drug		7d post-drug		14d post-drug	
		Number of living insects	Efficacy/%	Number of living insects	Efficacy/%	Number of living insects	Efficacy/%
0.75% Asian corn borer sex attractant pheromone (1 volatile core)	16	17	-2.15	18	12.60	18	43.66
0.75% Asian corn borer sex attractant pheromone (2 volatile cores)	22	23	-0.25	22	17.40	24	45.36
0.75% Asian corn borer sex attractant pheromone (3 volatile cores)	22	24	-4.88	20	20.60	22	49.92
32000IU/mg <i>Bacillus thuringiensis</i> wetable powder (200g/mu)	19.5	16.5	18.66	10	49.67	10.25	73.64
ck	18.75	19.50		19		37.5	

### 3.3. Efficacy of Pest Control

Table 4 data statistics can be seen, 0.75% Asian corn borer sex lure pheromone volatile core of the pest control efficiency with the passage of time and increase in the amount of hanging time and the dosage of the test agent after 28 days of treatment 1, treatment 2, treatment 3 of the pest control efficiency of 59.70%, 64.18%, 67.16%, respectively, after 42 days of the prevention efficiency of 65.96%, 67.17%, 70.82%, respectively, after 56 days of prevention efficiency

of 71.36%, 73.40%, 76.47%. 71.36%, 73.40% and 76.47% after 56 days, respectively. The control agent 32000 IU/mg *Bacillus thuringiensis* wettable powder in the preparation of 200 g/mu, 14, 28, 42, 56 days after the drug after the pest prevention efficiency were 69.28%, 45.90%, 25.53%, 11.26%, treatment 4 28, 42, 56 days after the drug after the pest prevention efficiency are lower than the three treatments of the test agent. (The three treatments of the test agent 3, 7 and 14 days after the drug did not show better control effect, so they were not analyzed).

**Table 4.** Results of field efficacy test of 0.75% Asian corn borer sexually induced pheromone volatile core for control of Asian corn borer in maize (damage and prevention efficacy).

Name of the medicine (dosage/666.67m <sup>2</sup> )	total number of plants	3d post-drug		7d post-drug		14d post-drug	
		Number of damaged plants	Efficacy/%	Number of damaged plants	Efficacy/%	Number of damaged plants	Efficacy/%
0.75% Asian corn borer sex attractant pheromone (1 volatile core)	250	20	-8.11	24	6.80	27	29.41
0.75% Asian corn borer sex attractant pheromone (2 volatile cores)	250	19	-2.70	25	2.91	25	34.64
0.75% Asian corn borer sex attractant pheromone (3 volatile cores)	250	19	-2.70	23	10.68	23	39.87
32000IU/mg <i>Bacillus thuringiensis</i> wetable powder (200g/mu)	250	18.25	1.35	18.25	29.13	11.75	69.28
ck	250	18.50		25.75		38.25	

Table 4. Continued.

Name of the medicine (dosage/666.67m <sup>2</sup> )	total number of plants	28d post-drug		42d post-drug		56d post-drug	
		Number of damaged plants	Efficacy/%	Number of damaged plants	Efficacy/%	Number of damaged plants	Efficacy/%
0.75% Asian corn borer sex attractant pheromone (1 volatile core)	250	27	59.70	28	69.53	28	71.36
0.75% Asian corn borer sex attractant pheromone (2 volatile cores)	250	24	64.18	27	71.19	26	73.40
0.75% Asian corn borer sex attractant pheromone (3 volatile cores)	250	22	67.16	24	75.62	23	76.47
32000IU/mg <i>Bacillus thuringiensis</i> wetable powder (200g/mu)	250	36.25	45.90	61.25	33.16	86.75	11.26
ck	250	67.00		82.25		97.75	

### 3.4. Discussion

In terms of the amount of moths trapped in each survey within the treatment, there were two peaks of moth trapping after hanging the 0.75% Asian corn borer pheromone dispersal core, which were 14 and 42 days after the application of the pheromone, respectively. At 14 days after application, the trapping amount of 0.75% Asian corn borer sex lure pheromone experimental group was less, and did not show good preventive effect, compared with the control agent, *Bacillus thuringiensis* powder control group in a short time to achieve the highest prevention and control effect, the number of insect mouths and the number of infested plants is less; at 42 days after application, it can be found that biopesticide *Bacillus thuringiensis* powder control group with the efficacy of time to time the effectiveness of the prevention and control effect is gradually decreased, and the effectiveness of the control group with the time to time. The 0.75% Asian corn borer sex lure pheromone showed excellent efficacy in preventing and controlling the Asian corn borer. Comprehensive analysis, 0.75% Asian corn borer sex lure pheromone in the control of Asian corn borer has a slow and uniform diffusion of the effect of good persistence; in the quick-acting, due to its special sex lure pheromone action mechanism, to attract the mating of distant male insects, so that the female mating rate in the field population decreased, the reproduction coefficient is reduced, so as to reduce the degree of corn borer infestation. However, it takes more than 2 months for the eggs to hatch into adults, and during this period, there are still larvae infesting the stems, so the sexually induced pheromone can not quickly prevent the Asian corn borer in a short period of time. Compared with chemical pesticides and biopesticides, 0.75% Asian corn borer sex lure pheromone has weaker fast-acting effect; in terms of dose, with the increase of the number of volatile core, the dose of pheromone increased, the effectiveness of Asian corn borer sex lure pheromone's pest control and damage prevention have been improved to a certain extent, showing the dose effect.

At present, there are dozens of sexually induced pheromone products developed and used in the market for vegetables, flowers, fruit trees and other crops, mainly for the control of oblique moths, cabbage moths, stem borers, tigresses, fruit flies and other pests, which are non-toxic,

harmless, safe and efficient. The Asian corn borer sex lure pheromone of this experimental research has good control effects, only for a single insect, on plants, people, the environment is completely non-toxic and harmless; easy to pass, suitable for large areas of farmland; long persistence period, can effectively reduce the amount of chemical pesticides, enhance the quality of crops; at the same time, the operation is relatively simple, time-saving, labor-saving, each acre of land placed in a trap with 1~3 dissipation of the core can be used for a month or two months, the cost is low, economic savings, and can be used. At the same time, the operation is relatively simple, labor-saving, placing 1 trap with 1~3 dispersal cores per mu can be used for one to two months, with low cost and economic savings. Therefore, it is very suitable for maize, sorghum, grain, rice and other grain crops to choose the application of the base, is a real "green" biological pest control technology.

In the control of the Asian corn borer, the sexually induced pheromone needs to be used at the early stage of the pest's occurrence, when the population density is low, i.e., at the beginning of the overwintering generation of adult corn borer pests. At the same time, according to the characteristics of its occurrence, to take physical, chemical, biological and other methods for integrated control. Physical control can make use of the phototropism of the adult corn borer, the field placed black light trapping method to control the corn borer; chemical control can be carried out at the end of the heart leaf and spike period, with the liquid irrigation of the male ears of the method of prevention and control, commonly used agents are insecticidal bisulfite, azinphos-methyl and so on; biological control is the use of the white fungus sealing technology, the release of the red-eyed wasp natural parasitism method in the field, bio-pesticide *Bacillus thuringiensis* insecticides, and so on. Through the combination of various control methods can effectively reduce the degree of Asian corn borer damage, thereby increasing corn yield. At the same time, the development and application of Asian corn borer sexually induced pheromone microcapsules volatile core will help to promote the sustainable development of agriculture and protect the safety of the ecological environment. More importantly, reducing the use of chemical pesticides will effectively enhance the international competitiveness of China's agricultural products and provide very favorable conditions for the export of corn products.

### 3.5. Security

No adverse effects of the test agent on wildlife and beneficial insects in and around the test area were observed during the test, and it is safe for other non-target organisms and can be registered for use as a control agent for the Asian corn borer in corn.

## 4. Conclusion

The 0.75% Asian corn borer sex lure pheromone microcapsule dispersal core was developed at a dosage of 1~3 dispersal cores/666.67m<sup>2</sup>, and the cumulative number of moths lured increased with the dosage of dispersal cores, and started after 28 days of hanging dispersal cores, which showed a good efficacy in infestation control and pest control against the Asian corn borer. By 56 days, the efficacy of moth control and infestation control were 70.30%, 71.92%, 77.32% and 71.36%, 73.40%, 76.47%, respectively. The control agent gradually decreased with time, and the efficacy of the insect mouth and pest control was only 13.20% and 11.26% respectively 56 days after the drug. It is recommended to place one trap per 666.67m<sup>2</sup>, each trap with 1~3 dispersal cores, and hang the dispersal cores and matching traps before the peak season of adult pests, and the height of the traps is about 150cm.

The sex-inducing pheromone can effectively reduce the degree of Asian corn borer infestation, has the advantages of targeting characteristics, high efficiency, persistence, non-toxicity, and most importantly, can reduce the use of chemical pesticides. Meanwhile, the sexually attractive pheromone synthesized in this laboratory has low synthesis cost, is formulated into microcapsules with slow-release volatile core in proportion, and has excellent effect in field experiments, and the technology is perfect. Therefore, it can be applied on a large scale in agricultural production in the future to provide a new method for biological control of corn borer.

## Funding

This study was funded by Shanghai "Science and Technology Innovation Action Plan" (21N41900400) and Shanghai Qingpu District Science and Technology Development Fund Project (Qingkefa 2022-03).

## References

- [1] Nafus D M, Schreiner L. Review of the Biology and Control of the Asian Corn Borer. *Ostrinia furnacalis* (Lep Pyralidae) [J]. Tropical Pest Management, 1991, 37 (1): 41-56.

- [2] Chong Weiye. Research on the occurrence pattern and control technology of Asian corn borer [D], Heilongjiang: Longjiang University, 2010.
- [3] Li Ping. Research on the application of integrated control measures for corn borer [D] Beijing: Research Institute of Chinese Academy of Agricultural Sciences, 2013.
- [4] WU F, CHI Chang, SHA Honglin et al. Research on the effect of corn borer sex pheromone lure core on field control of corn borer [J]. Jilin Agricultural Science, 2014, 39 (06): 31-33.
- [5] DI Dianping, YANG Fei, ZHANG Aihong et al. Effectiveness of combined application of sex attractant and seed coating agent on the control of corn borer [J]. Hebei Agricultural Science, 2022, 26 (01): 81-84.
- [6] HUANG Meiling, WANG Xiaojing, JIN Hualiang et al. Application of sex lure in monitoring of noctuid moth in grassland [J]. Anhui Agricultural Science, 2022, 50 (02): 151-153.
- [7] Editorial Committee of Chinese Crop Pests and Diseases. Crop Pests and Diseases of China [M]. The first volume. Beijing: Agricultural Press, 1979: 492-502.
- [8] HAN Hailiang, ZHANG Jinming, BAO Fei et al. Trapping efficiency of different sex attractants for Asian corn borer and their application in population monitoring [J]. Plant Protection, 2021, 47 (05): 310-313+319.
- [9] Wang L, Yang C, Mei X, et al. Identification of sex pheromone in *Macdunnoughia crassissima* Warren (Lepidoptera: Noctuidae) and field optimization of the sex attractant [published online ahead of print, 2023 Sep 21]. Pest Manag Sci, 2023.
- [10] YANG Zhixiang, ZHU Feng, WANG Jiansheng et al. Effect of food and sex attractants on the control of rice leaf borer [J]. China Plant Protection Guide, 2022, 42 (02): 38-40.
- [11] Klun J A, Leonhardt B A, Schwarz M. Sex Pheromone of the Asian Corn Borer [J]. Life Sciences, 1980, 27 (17): 1603-1606.
- [12] Kang S K, Park J M, Hwang K L, et al Synthesis and Biological Test of the Pheromone of the Asian Corn Borer Moth (*Ostrinia furnacalis*) [J]. Bulletin of Korean Chemical Society, 1985, 6 (1): 15-19.
- [13] Liu W. Research on the recognition mechanism of sex pheromone by cotton bollworm and Asian corn borer [D]. Chinese Academy of Agricultural Sciences, 2020.
- [14] LI Jintao, WANG Yingxiu, ZHANG Zuoshan et al. Advances in the synthesis method and application of Asian corn borer sex pheromone [J]. World Pesticides, 2019, 41 (01): 34-38.
- [15] WANG Youchu, LIU Fuchu. Improved synthesis of sex pheromone in Asian corn borer [J]. Journal of Kunming Teachers' College (Natural Science Edition), 1994, 9 (1): 90-94.