Formosan Entomologist
Journal Homepage: entsocjournal.yabee.com.tw

【Research report】

利用性費洛蒙與殺蟲劑綜合防治甘藷蟻象效益評估【研究報告】

黃振聲、洪巧珍

*通訊作者E-mail :

Received: Accepted: 1991/03/31 Available online: 1991/06/01

Abstract

摘要

本研究於台中地區四塊各約1公頃甘藷田，利用性費洛蒙配合殺蟲劑對甘藷蟻象進行綜合防治效益評估。結果顯示每分地設置四個性費洛蒙誘蟲器，可減少甘藷被害率達65%；永誘蟲器並於作畦時施用陶斯松粒劑2.25kg a.i. /ha一次，可減少甘藷被害率75%；前述處理效果與於作畦及中耕培土時共施藥二次的防治效果（84.5%），並無顯著差異。依相關性分析顯示，調查蟻象為害程度時，可僅以藷塊被害率做為評估標準；蟻象性費洛蒙誘蟲器亦可用來偵測蟻象於甘藷田的為害狀況。

Key words:

關鍵詞: 甘藷蟻象、性費洛蒙誘殺、綜合防治、效益評估。

Full Text: PDF(0.31 MB)

中華昆蟲 11：140－146 (1991)
Chinese J. Entomol. 11：140－146 (1991)

Evaluation of the Effect of Integrated Control of Sweetpotato Weevil, *Cylas formicarius* Fabricius, with Sex Pheromone and Insecticide*

Jenn-Sheng Hwang Taiwan Agricultural Chemicals and Toxic Substances Research Institute, 189 Chungcheng Road, Wufeng, Taichung, Taiwan, R.O.C.
Chau-Chin Hung Taiwan Agricultural Chemicals and Toxic Substances Research Institute, 189 Chungcheng Road, Wufeng, Taichung, Taiwan, R.O.C.

ABSTRACT

Experiments were conducted in 4 fields in Taichung Prefecture of Taiwan to evaluate the integrated effect of sex pheromone and insecticide in the control of sweetpotato weevil (SPW), *Cylas formicarius* Fabricius. The results show that the use of pheromone-baited traps placed at a density of 4 traps/0.1 ha reduced 65% of storage root damage caused by SPW compared with that of the untreated control. Use of pheromone-baited traps in combination with preplant application of Dursban at 2.25 kg a.i./ha reduced storage root damage by 75%. These effects are comparable to that from 2 applications of Dursban, one before planting and another at the time of earthing-up. Correlation analysis revealed that the best criterion for evaluating the loss of sweetpotatoes caused by SPW was the number of damaged storage roots.

Key words: sweetpotato, sweetpotato weevil, *Cylas formicarius*, sex pheromone, mass trapping, integrated pest management.

* Contribution No. Jih 67 from Taiwan Agricultural Chemicals and Toxic Substances Research Institute.

利用性費洛蒙與殺蟲劑綜合防治甘藷蟻象效益評估*

黃振聲 臺灣省農業藥物毒物試驗所 台中縣霧峯鄉中正路 189 號
洪巧珍 臺灣省農業藥物毒物試驗所 台中縣霧峯鄉中正路 189 號

摘 要

本研究於台中地區四塊各約 1 公頃甘藷田，利用性費洛蒙配合殺蟲劑對甘藷蟻象進行綜合防治效益評估。結果顯示每分地設置四個性費洛蒙誘蟲器，可減少甘藷被害率達 65 %；放誘蟲器並於作畦時施用陶斯松粒劑 2.25kg a.i./ha 一次，可減少甘藷被害率 75 %；前述處理效果與於作畦及中耕培土時共施藥二次的防治效果（84.5%），並無顯著差異。依相關性分析顯示，調查蟻象爲害程度時，可僅以藷塊被害率做爲評估標準；蟻象性費洛蒙誘蟲器亦可用來偵測蟻象於甘藷田的爲害狀況。

關鍵詞：甘藷蟻象，性費洛蒙誘殺，綜合防治，效益評估。

Introduction

Sweetpotato (*Ipomoea batatas* (L.)) is the seventh most important crop in the world (Chalfant, 1990). In Taiwan, the area cultivated to sweetpotato and its production were once ranked second to paddy rice. Sweetpotato is used as a food, feed, and industrial crop, and more recently has become appreciated as a fibrillous food or green vegetable because of its good keeping quality and the people's demand for natural health foods. The total area of sweetpotato cultivation in Taiwan has remained steady at about 15,000 ha in recent years (Anonymous, 1989).

The sweetpotato weevil (SPW), *Cylas formicarius* Fabricius, is the most destructive pest of sweetpotato in the field and in storage. SPW completes 7 to 8 generations annually in Taiwan (Yen *et al*., 1982). The adults prefer to live in the canopy of vines with leaves and feed on all parts of sweetpotato. Females oviposit within cavities excavated in vines or storage roots, where the larvae also develop. Damage results from adult feeding and oviposition and larval tunneling through the storage roots. The tunnels are filled with saw-dust like excrements, and give the characteristic terpene odor and a bitter flavor that render sweetpotatoes unsuitable for human and livestock comsumption.

* 臺灣省農業藥物毒物試驗所研究報告第 67 號

Although various control measures have been practised to reduce the damage caused by SPW, application of insecticides remain the main control method. Since the banning of chlorinated-hydrocarbon insecticides, it has been difficult to find alternative insecticides which are both environmentally safe and reliably effective. The underground feeding habits of the larvae and nocturnal activity of the adults make it necessary for farmers to apply insecticides 3 to 5 times during the 5 to 6 months of the growing season in order to obtain effective control of SPW. The rate of storage root damage caused by SPW is typically at least 18% and sometimes reaches 88% in severely infested fields (Yen *et al.*, 1982).

Recently, a sex pheromone, (Z)-3-dodecen-1-01(E)-2-butenoate, has been identified as highly attractive to the male weevils (Heath *et al.*, 1986; Proshold *et al.*, 1986). We have also prepared a formulation of synthetic sex pheromone and developed a device for mass trapping of male weevils which is effective, inexpensive, and easy to handle (Hwang, 1988; Hwang *et al.*, 1989). Use of pheromone-baited traps in the integrated control of SPW on Penghu island and other prefectures of Taiwan gave promising results (Hwang and Hung, 1990; Hwang *et al.*, 1991; Talekar *et al.*, 1989). A further study was undertaken to evaluate the effect of using sex pheromone together with soil insecticides in integrated control of SPW in Taiwan.

Materials and Methods

Source of Sex Pheromone: Synthetic SPW sex pheromone was provided by the Institute of Applied Chemistry, Providence University, Taichung, Taiwan (Yen and Hwang, 1990). According to our previous study (Hwang *et al.*, 1989), the attractiveness of the trap baited with 1 mg of synthetic sex pheromone was about 8 to 11 times higher than the equivalent of 20 virgin females, and it remained effective for more than 2 months.

Release of Sex Pheromone: A double-funnel trap described by Hwang *et al.* (1989) was used for the release of synthetic sex pheromone.

For trapping of male weevils throughout the period of planting to harvest, 4 pheromone-baited traps were set in each 0.1 ha field (Figure 1). Traps were fixed with their tops about 10 cm above sweetpotato canopy. Trapped male weevils were counted, pheromone was renewed, and each trap was moved every month.

A field experiment was conducted at Sha-

100 meters

Treatment (A) Four pheromone-baited traps evenly placed in the field.	Treatment (E)	Treatment (C) Dursban 5% granules applied twice, before planting and at the time of earthing-up.
Treatment (E)	Treatment (E) Conventional insecticide, as applied by farmers.	Treatment (E)
Treatment (B) Pheromone-baited traps, and Dursban applied once before planting.	Treatment (E)	Treatment (D) Untreated control

Fig. 1. Layout of different treatments in the sweetpotato field for evaluating the efficacies of sex pheromone, using insecticide or both to control SPW.

lu, Taichung Prefecture, from April to October 1989. We selected 4 sweetpotato fields of ca. 1 ha each, with a distance of 300 m between each field. Four corner plots of 0.1 ha in each field respectively received one of four treatments: (A) only use of pheromone-baited traps; (B) pheromone-baited traps and preplanting application of Dursban granules in the furrows; (C) application of Dursban before planting and at the time of earthing-up; and (D) untreated control. The middle section of each field received three treatments of Terbufos, an insecticide commonly used by the farmers (as E treatment) (Figure 1). Where soil insecticide was used, Dursban 5% granules were applied at the rate of 2.25 kg a.i/ha.

In order to detect the relative densities of SPW in plots with different treatments, pheromone-baited traps were placed in the plots at the rate of 4 traps/plot 2 weeks before harvest. The trapped male weevils were counted 4 to 7 days later. At the time of harvest, 6 sampling sites were randomly selected in each plot, and 10 consecutive plants in each sampling site were examined for SPW injury to vines and storage roots. The main vines 10 cm above the ground were inspected and the percentage of plants damaged was recorded. The roots were then dug out, and numbers and weights of damaged and undamaged roots were recorded. Storage roots weighing less than 30g were considered unmarketable and discarded. Percentages were subjected to arcsine $\sqrt{x}$ transformation prior to an analysis of variance.

Results and Discussion

Table 1 summarizes the results of integrated application of synthetic sex pheromone and insecticide for the control of SPW. Percentages of plants with vine damage ranged from 19.6% for the treatment of 2 applications of Dursban (treatment C) to 32.1% for untreated plots (treatment D). However, the differences in the levels of SPW infestation did not vary significantly among the different treatments. On the other hand, percentages of storage roots damaged, whether based on number or weight, showed a significant difference between the pheromone and/or insecticide treatments and the untreated control. The latter showed the highest root damage, 14.2% by number and 20.0% by weight.

The number of storage roots per 10 plants in different treatments ranged from 28.6 to 40.8, and root weight per 10 plants ranged from 7.1 to 9.5 kg (Table 1). There was no significant difference in the number or weight of storage roots between treatments which included pheromone traps and the untreated control. Under the conditions of this study, SPW infestation did not appear to greatly reduce the potential yield of sweetpotatoes. However, the weight of roots was reduced significantly (27%) in the untreated plots when compared with the plots that received the conventional, relatively intensive application of Terbufos. It was likely that SPW infestation did not reduce the yield (number and weight) of storage roots but reduced their quality for human and livestock consumption.

During the entire season, we collected 1,547 to 21,722 male weevils from plots with pheromone-baited traps. We also collected 1,877 to 18,290 male weevils from the plots treated with pheromone-baited traps and preplant application of Dursban. As shown in Table 1, the number of male weevils trapped from the untreated plot 2 weeks before harvest of sweetpotato reached 59.5 per trap, which was significantly higher than that of the other treatments.

In order to compare the efficacy of different treatments for the control of SPW, the percentage of damaged storage roots measured by number and weight was converted to control rate and shown in Table 2. Control rates with pheromone-baited traps for the number and weight of roots were 62.6% and 67.4% respectively, with a mean of 65.0%. Control rates for B and E treatments averaged 75.4 and 71.0%, respectively. The control rate of SPW with 2 applications of Dursban averaged 84.5%, the highest among the treatments but not significantly greater than the others.

The correlation between the parameters used to evaluate the efficacy of integrated control of SPW was also examined. Correlation coeffi-

Table 1. The effect of integrated application of sex pheromone and insecticide on the control of *C. formicarius*

Treatments 1)	% plants damaged	% roots damaged		No. of roots per 10 plants	Root weight per 10 plants	No. of weevils per trap
		Measured by number	Measured by weight			
A	25.4a	5.4a	5.7a	28.6a	7.1a	22.5a
B	25.0a	4.8a	4.6a	37.2a	9.0ab	13.8a
C	19.6a	2.5a	3.0a	38.9a	8.3ab	26.8a
D	32.1a	14.2b	20.0b	29.4a	6.9a	59.5b
E	25.0a	4.4a	5.3a	40.8a	9.5b	17.2a

1) A:use of pheromone-baited traps; B: use of pheromone-baited traps and Dursban before planting; C:application of Dursban before planting and at the time of earthing-up; D: untreated control; and E: conventional insecticide as applied by farmers. Data were transformed to arc sine $\sqrt{x}$ prior to analysis, and means within each column followed by the same letter are not significantly different at 5% level by DMRT.

Table 2. Percent control of *C. formicarius* obtained with different treatments

Treatments 1)	Percent control (%) 2)		
	% root damage by number	% root damage by weight	mean
A	62.6a	67.4a	65.0
B	70.5a	80.3a	75.4
C	83.3a	85.7a	84.5
D	0	0	0
E	69.7a	72.3a	71.0

1) See footnote of Tabel 1.
2) Percent control =

$$\frac{\text{\% damage in check} - \text{\% damage in treatment}}{\text{\% damage in check}} \times 100\%$$

Table 3. Correlation coefficients for parameters used in evaluation of the control of *C. formicarius*

Evaluated measure (X)	Evaluated measure (Y) 1)				
	% plant damage	% root damage by number	% root damage by weight	No. of roots per 10 platns	Root weight per 10 plants
No. of weevils trapped	-0.03	0.17	0.28	-0.18	-0.28
% plant damage		0.72**	0.62**	-0.64**	-0.32
% root damage by no.			0.96**	-0.56*	-0.31
% root damage by wt.				-0.48*	-0.27
No. of roots per 10 plants					0.69**

1) The marks "*" and "**" indicate significant correlations at the 5 and 1 % levels respectively.

cients between the parameters shown in Table 3 indicated a low positive correlations between the number of weevils trapped in pheromone trap and SPW damages to various parts of plants. Therefore, the pheromone trap may be used as a tool for locating, surveying, and monitoring the occurrence of SPW, but the trap catches alone are not a good predictor of SPW infestation.

Based on analysis of correlation coefficients, the number of weevils trapped together with the rates of SPW damage to main vines and storage roots could be used as an index of SPW infestation. However, considering the ease and accuracy of sampling, we recommend the rate of root damage by number as the preferred index of SPW infestation level on sweetpotatoes.

The efficacy of using sex pheromone for mass-trapping male adults to suppress insect pests of crop has been a controversial question. The results presented here indicate that the use of pheromone-baited traps in the field not only mass-trapped male weevils, but also reduced storage root damage by 65% relative to untreated plots, where root damage averaged 20%. Similar trials in another prefectures of Taiwan confirm the efficacy of pheromone-baited traps to suppress SPW infestation (Hwang *et al.*, 1991).

Some SPW males will escape from pheromone-baited traps, and other insect pests will also infest sweetpotatoes after planting. In this study, the integrated application of pheromone-baited traps and Dursban granules before planting resulted in 75.4% control of SPW. This method in combination with other cultural practices, such as crop rotation, planting of SPW-free cuttings, flooding of fields before planting, control of alternate hosts and earthing-up of vines, are also suggested as further measures to obtain effective and safe control of SPW.

The cost of one pheromone lure is about 5 NT$ and the cost of a double-funnel type PET bottle trap is about 20 NT$, or less than 5 NT$ when made from discarded soft drink bottles. When pheromone-baited traps are used in integrated pest management of SPW, it will save 1 to 3 applications of insecticide as compared with the conventional control measure used by farmers. This will save several thousand NT$ of insecticidal expenditure per ha. Therefore, the sex pheromone of SPW appear to be a valuable component in integrated management of SPW and should be studied further.

Acknowledgements

This study was supported by a research grant from the Council of Agriculture, Executive Yuan, Taiwan, R.O.C. The authors wish to express appreciation to Dr. Y. S. Pan, the Director of Taiwan Sugar Research Institute, Dr. M. R. Barrett of US-EPA and Dr. C. K. Starr of National Museum of Natural Science for suggestions in improving the manuscript.

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Received for publication March 6, 1991; revised manuscript accepted March 31, 1991.