Int. J. Indust. Entomol. Vol. 18, No. 2, 2009, pp. 105~112

International Journal of
Industrial Entomology

Test of Insecticidal Efficacy of Some Commercial Natural Products against *Trialeurodes vaporariorum* (Homoptera : Aleyrodidae), *Bemisia tabaci* (Homoptera : Aleyrodidae), and *Spodoptera litura* (Lepidoptera : Noctuidae)

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(Received 06 April 2009; Accepted 27 May 2009)

The greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) and the sweet potato whitefly, *Bemisia tabaci* (Gennadius) are serious insect pests that have a wide host range including cucumber, tomato, and pepper. In this study, we tested larvicidal efficacy of several on-the-market environment–friendly agricultural materials (EFAM) to select the effective products after the target pests were stabilized in indoor rearing condition. The developmental periods of two whiteflies are as follows: in the case of *T. vaporariorum*, egg duration is 9.6 days and nymph is 18.9 days, and in the case of *B. tabaci*, egg duration is 7.4 days and nymph is 15.2 days under 25°C with relative humidity (RH) of 60±5% and a photoperiod of 16 L : 8D. The total period of *T. vaporariorum* was 5 days longer than *B. tabaci*. Among 22 EFAMs six products showed more than 60% of insecticide efficacy against *T. vaporariorum* BTV B, BTV D, BTV G, BTV L, BTV M, and BTV S. On the other hand, seven EFAM products showed over 60% of insecticide efficacy against *B. tabaci* BTV D, BTV G, BTV K, BTV L, BTV M, BTV N, and BTV U. In the case of *Spodptera litura* previously, 16 EFAMs were tested against 2nd instar *S. litura*, and six EFAMs were found to have more than 90% efficacy. Test of these six EFAMs against entire larval stages were performed in this study. Although some of these products showed still more than 90% of insecticidal efficacy against up to 3rd instar larvae, the efficacy of these EFAMs sharply decreased as ages increase, resulting in less than 60% of efficacy of the products at most. This result indicates the difficulty to control *S. litura* with the on-the-market EFAMs alone under economic injury level. Collectively, it is required to find more EFAMs, and find alternative method, and combined way of controlling to control those insect pests tested in this study.

Key words: *Bemisia tabaci,* Greenhouse whitefly, Insecticidal efficacy, Life cycle, Plant extracts, *Spodoptera litura,* Sweet potato whitefly, Tobacco cutworm, *Trialeurodes vaporariorum*

Introduction

The greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood) belonging to an insect family Aleyrodidae in an insect order Homoptera, attacks about 249 species of host plants belonging to 84 families and favors cucumber, tomato, pepper, sesame, and green perilla (Oh, 1998). The species was first found in a facilitated *Stevia rebaudiana*, *Ooptis japonica*, and *Valeriana fauriei* plantation in Suwon, Gyunggi province, Korea in 1977 (Choi and Park, 1983). It causes a direct damage by feeding on leaves, an indirect damage by encouraging the growth of black sooty mold on their honeydew secretions, and by transmitting plant pathogenic plant viruses (Gill, 1992; Zalom *et al*., 1995).

The sweet potato whitefly, *Bemisia tabaci* (Gennadius), is a major pest of indoor and outdoor crops in warm climates worldwide. It feeds on over 600 host plants (Mound and Halsey, 1978; Secker *et al*., 1998). The species is very similar to greenhouse whitefly morphologically, but has some morphological features that can be well distinguished. The species was first found in Jincheon, Chungbuk province, Korea (Lee *et al*., 2005). The damage caused by the

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sweet potato whitefly also is similar to that of the greenhouse whitefly (Duffus, 1987; Rapisarda and Garzia, 2002).

The tobacco cutworm, *Spodoptera litura* (Fabricius) is a polyphagous pest belonging to an insect family Noctuidae in an insect order Lepidoptera (Holloway, 1989). The species attacks about 120 plants including beans, redish, cabbage, kale, pepper, and rose (Moussa *et al*., 1960; Ramana *et al*., 1988; Subramanian *et al*., 2005). The larvae consume their host plants very rapidly as they grow (Kim *et al*., 1998). Once the species is infesting on crops, the damage by the species is severe because adults lay eggs hundreds to thousands at one time in an irregular furry mass (Bae and Park, 1999). Although over-wintering is not clearly confirmed, there is such possibility in the facilitated greenhouse in Korea (Bae and Park, 1999).

With the increasing concern on the environment and health the practice of environment-friendly agriculture and its products are one of the major concerns for farmers and consumers. With such trend, a number of environment-friendly agricultural materials (EFAM) are manufactured and sold on the market. They are mainly plant extracts, microbial organisms, and natural enemy. Nevertheless, the whiteflies and tobacco cutworm are ones that are difficult to control, and actually no EFAMs have been collectively tested in their efficacy. Furthermore, the problem of EFAMs is lack of precise applicable range. Thus, it is difficult for farmers to select proper products that are specific to target insect pests. In fact, in the local markets, many EFAMs are sold without accurate information on the target insect pests. Absence of proper information of EFAM products on the efficacy and target pests will bolster negative mind in success of environment-friendly agriculture. Therefore, in the study, we tested several on-the-market EFAMs that state efficacy on the tested pests in order to obtain better information.

Materials and Methods

Host plant and test insects

Experiments were conducted on tobacco and cabbage plants. In the case of whiteflies, tobacco seeds were sowed in a plastic cage (6×6×10 cm) and provided to adult whiteflies 50 days after growing in a growth cage (165 cm×83 cm×124 cm) with a photoperiod 16L:8D. In the case of the tobacco cutworm, the purchased seeds of kidney bean were germinated at 28°C for two days with wet towel covered and provided 20 days after growing in a growth cage (165 cm×83 cm×124 cm) with a photoperiod of 16:8 hrs (L:D).

The adults of *T. vaporariorum* and *B. tabaci* were collected in a greenhouse of Chonnam National University, Korea. The two whiteflies were reared in a acrylic insect breeding cage (35×35×40 cm) containing tobacco plants. *S. litura* were collected in bean farm at Naju, Chonnam province, Korea and provided with leaf of bean. These insects were maintained in the laboratory at 25~27°C, 50~60% RH and a photoperiod of 16:8 hrs (L : D). In the case of *T. vaporariorum* and *B. tabaci*, 3rd instar nymph were used. In the case of *S. litura*, whole instar larvae were tested.

The developmental period of *T. vaporariorum* and *B. tabaci*

To evaluate the developmental period of two whiteflies, tobacco leaf were used for their host plant. The petiole of tobacco leaf were wrapped up with the tissues saturated with water to prevent drying and put it into 1.5 ml conical tube, and then placed in an acrylic rectangular pot (6×6×10 cm). The adults were introduced into the pot to lay eggs for 1 day. After examination the presence eggs under the stereoscopic microscope, the adults were removed, leaving one egg/leaf. The developmental period was recorded every 12 hrs. This experiment was carried out in the incubator at 25°C, 50~60% RH, and a photoperiod of 16:8 hrs (L:D) and 30 replicates.

Screening bioassay

A total of 28 environment-friendly agricultural materials (EFAM) were used: 22 products are plant extracts, three with plant extract and microorganism, one microorganism, one natural mineral, and one plant oil for *T. vaporariorum* and *B. tabaci*, and 6 plant extracts materials for *S. litura*. The details of the products were represented in Table 1.

50-day-old leaf of tobacco was used to evaluate the insecticidal efficacy of EFAM against *T. vaporariorum* and *B. tabaci*. Cotton (or tissue) soaked in water was wrapped around the petiole to keep it from withering. After then, the adults of whiteflies were allowed to lay eggs for 1 day. After 14 days they were reached 3rd instar nymph. A leaf-dipping method was applied to evaluate the mortality efficacy of the test samples. The 3rd instar nymph was dipped in a diluted solution of EFAM as recommended by the company in 20 seconds. The mortality of whiteflies was checked every day over a period of five days. Untreated and H_2O were used as control and the experiment was carried out in triplicate. If the body color was changed (e.g., black color) or the larvae were not developed into next nymphal stage they were considered as dead.

A pesticide-free cabbage was used as a host for *S. litura*. The cabbage leaf was cut off Ø10 cm in size, and then put it into a petri dish (Ø10×6 cm). After that, *S. litura* larvae at each stage 1st to 6th instar was inoculated and sprayed with EFAMs as recommended concentration. Every 12 hrs, *S. litura* was checked, dead *S. litura* larvae were removed,

Table 1. List of environment-friendly agricultural materials tested in this study

List	Insecticidal range (pests or crops)	Major component	Recommended dilution*
BTV A	Trialeurodes vaporariorum	Plant extracts	1000
BTV B	Trialeurodes vaporariorum	Plant extracts	500
BTV C	All crops	Plant extracts	1000
BTV D	Fruit and vegetable plant	Plant extracts + *Bacillus subtilis*	1000
BTV E	Unknown	Plant extracts	800 ~ 1000
BTV F	Unknown	Plant extracts	600 ~ 800
BTV G	Most pests	Plant extracts	1000
BTV H	Most pests	Plant extracts	1000
BTV I	Unknown	Unknown	800 ~ 1000
BTV J	Trialeurodes vaporariorum	Plant extracts	1000
BTV K	Mite, *Trialeurodes vaporariorum*	*Beauveria bassiana* TBI-1	500
BTV L	Aphid, mite	Plant extracts + *Bacillus cereus*	1000
BTV M	Trialeurodes vaporariorum	Bacillus subtilis	1000
BTV N	Most pests	Plant extracts	1000
BTV O	Aphid, flies etc.	Plant extracts	1000
BTV P	*Bemisia tabaci*, thrip	Plant extracts	500
BTV Q	Unknown	Natural mineral	500 ~ 1000
BTV R	Helicoverpa assulta	Plant extracts	500
BTV S	Bemisia tabaci	Plant extracts	1000
BTV T	Aphid, *Bemisia tabaci*	Natural material	800 ~ 1000
BTV U	Scal insect, *Trialeurodes vaporariorum*	Plant extracts + *Bacillus subtilis*	1000
BTV V	Unknown	Plant oil	2000
SPL A	Moth	Plant extracts	1000
SPL B	Most pests	Plant extracts	1000
SPL C	Moth	Plant extracts	1000
SPL D	Most pests	Plant extracts	1000
SPL E	Most pests	Plant extracts	1000
SPL F	Mite, *Spodoptera exigua* etc.	Plant extracts	1000 ~ 1500

*per 20 liter of water.

and eventually mortality was determined 48 hrs after EFAMs were treated. All the experiments were carried out in triplicate. All moribund larvae were considered as dead.

Data analysis

Using SAS programs, Duncan's multiple range test ($p < 0.05$) was performed to test if any significant difference in the insecticidal effect exists among EFAMs (Duncan, 1955).

Results and Discussion

Development of *T. vaporariorum* and *B. tabaci*

In order to verify that the *T. vaporariorum* and *B. tabaci* are properly stabilized, their life cycles were checked under laboratory condition at 25°C on tobacco plant. The developmental duration of each stage of *B. tabaci* is presented in Table 2. Egg period was taken 7.4 days and the nymphal developmental period from 1st to 4th was 3.1, 2.9, 2.8, and 6.4 days (a total of 15.2 days), respectively. Thus, 2nd and 3rd nymphal periods were shorter than 1st and 4th mymphal periods, and 4th was longest. Ahn *et al*. (2001) reported that the developmental period of *B. tabaci* on tomato plants was 7.3 days for egg and 13.9 days for nymphal period. Compared with the study, the nymphal period of Ahn *et al*. (2001) was somewhat prolonged. The difference may have been derived from difference in host plants between the two studies. The developmental period from egg to 4th nymph of *T. vaporariorum* was about 9.6, 4.3, 3.0, 3.7, and 7.9 days, respectively (Table 3). The developmental period of *T. vaporariorum* on cucumber plants by Kim *et al*. (1986) was 8.2 days for egg and 16.7 days for nymphs on cucumber plant at 25°C. Compared

Table 2. The development of *Bemisia tabaci* on tobacco at 25°C

Temperature (°C)	Egg	Duration of nymph (mean ± SD)				Total nymph	Accumulated duration
		1st	2nd	3rd	4th		
25	7.4 ± 0.50	3.1 ± 1.14	2.9 ± 0.47	2.8 ± 0.58	6.4 ± 1.02	15.2 ± 1.48	22.6 ± 1.65

Table 3. The development of *Trialeurodes vaporariorum* on tobacco at 25

Temperature (°C)	Egg	Duration of nymph (mean ± SD)				Total nymph	Accumulated duration
		1st	2nd	3rd	4th		
25	9.6 ± 0.63	4.3 ± 1.39	3.0 ± 1.21	3.7 ± 1.01	7.9 ± 1.63	18.8 ± 0.26	28.4 ± 0.72

Table 4. Insecticidal activity of twenty two environment-friendly agricultural materials against *Bemisia tabaci*

Products	% mortality (± SD) after
	5 DAT*
BTV A	42.0 ± 3.5fg
BTV B	38.7 ± 12.8g
BTV C	47.1 ± 11.0cdefg
BTV D	62.6 ± 3.7abcd
BTV E	22.0 ± 11.6h
BTV F	51.1 ± 4.7bcdefg
BTV G	66.3 ± 9.2ab
BTV H	29.7 ± 19.6efg
BTV I	48.9 ± 10.2cdefg
BTV J	44.4 ± 10.2efg
BTV K	53.2 ± 0.2bcdefg
BTV L	71.5 ± 10.7a
BTV M	60.3 ± 2.9abcdef
BTV N	63.6 ± 7.4abc
BTV O	58.3 ± 1.9abcdef
BTV P	40.4 ± 3.1g
BTV Q	43.4 ± 8.7efg
BTV R	46.5 ± 12.6defg
BTV S	53.5 ± 13.3bcdefg
BTV T	51.0 ± 1.7bcdefg
BTV U	62.1 ± 18.2abcd
BTV V	47.1 ± 6.8cdefg
H2O	4.1 ± 3.6i
Nothing	1.2 ± 2.2i

Mean values with the same alphabet are not significantly different ($p > 0.05$).
*Day(s) after treatment.

Table 5. Insecticidal activity of twenty two environment-friendly agricultural materials against *Trialeurodes vaporariorum*

Products	% mortality (± SD) after
	5 DAT
BTV A	55.6 ± 15.1a
BTV B	64.1 ± 19.5a
BTV C	44.0 ± 11.3a
BTV D	63.9 ± 15.4a
BTV E	50.5 ± 5.9a
BTV F	52.3 ± 24.5a
BTV G	65.7 ± 18.5a
BTV H	45.3 ± 0.9a
BTV I	45.3 ± 4.2a
BTV J	46.3 ± 6.1a
BTV K	51.8 ± 14.1a
BTV L	63.0 ± 14.0a
BTV M	61.6 ± 14.4a
BTV N	55.6 ± 3.9a
BTV O	59.3 ± 17.8a
BTV P	44.4 ± 10.0a
BTV Q	46.5 ± 8.9a
BTV R	44.7 ± 5.6a
BTV S	63.7 ± 21.1a
BTV T	55.0 ± 19.7a
BTV U	50.0 ± 5.6a
BTV V	47.6 ± 8.2a
H2O	2.7 ± 3.5b
Nothing	7.4 ± 8.5b

Mean values with the same alphabet are not significantly different ($p > 0.05$).

with the study, the nymphal period of Kim *et al.* (1986) decreased 3 days. This may be come from different host plants. The total developmental period of *T. vaporariorum* was 5 days longer than *B. tabaci* in this study on tobacco plants at 25°C.

Screening bioassay

T. vaporariorum and *B. tabaci*

Among 22 EFAMs, 14 showed more than 50% of insecticidal activity against *T. vaporariorum* (Table 4). These include BTV A, BTV B, BTV D, BTV E, BTV F, BTV G,

Table 6. The mortality of 1st instar *Spodoptera litura* larvae, in response to six environment-friendly agricultural materials

Products	% mortality (±SD) after			
	12 hrs	24 hrs	36 hrs	48 hrs
SPL A	86.7±5.8ab	100.0±0.0a	100±0.0a	100±0.0a
SPL B	76.7±5.8b	86.7±5.8a	90±0.0b	90.0±0.0b
SPL C	86.7±11.5ab	100.0±0.0a	100.0±0.0a	100.0±0.0a
SPL D	100.0±0.0a	100.0±0.0a	100.0±0.0a	100.0±0.0a
SPL E	20.0±17.3c	53.3±20.b	73.3±11.5c	93.3±11.5ab
SPL F	26.7±15.3c	43.3±5.8b	66.7±5.8c	76.6±5.8c
H2O	0.0±0.0d	0.0±0.0c	0.0±0.0d	0.0±0.0d
Nothing	0.0±0.0d	0.0±0.0c	0.0±0.0d	0.0±0.0d

Mean values with the same alphabet are not significantly different ($p>0.05$).

Table 7. The mortality of 2nd instar *Spodoptera litura* larvae, in response to six environment-friendly agricultural materials

Products	% mortality (±SD) after			
	12 hrs	24 hrs	36 hrs	48 hrs
SPL A	26.7±5.8c	96.7±5.8a	100.0±0.0a	100.0±0.0a
SPL B	43.3±5.8b	66.7±5.8b	76.7±15.3b	76.7±15.3b
SPL C	63.3±5.8a	100.0±0.0a	100.0±0.0a	100.0±0.0a
SPL D	63.3±11.5a	76.7±11.5b	90.0±10.0b	90.0±10.0b
SPL E	20.0±10.0c	66.7±5.8b	86.7±5.8ab	90.0±10.0ab
SPL F	26.7±5.8c	46.7±5.8c	60.0±10.0c	63.3±5.8c
H2O	0.0±0.0d	0.0±0.0d	0.0±0.0d	0.0±0.0d
Nothing	0.0±0.0d	0.0±0.0d	0.0±0.0d	0.0±0.0d

Mean values with the same alphabet are not significantly different ($p>0.05$).

BTV K, BTV L, BTV M, BTV N, BTV O, BTV S, BTV T, and BTV U. Among these BTV B, BTV D, BTV G, BTV L, BTV M, and BTV S showed more than 60% of insecticidal efficacy (Table 4). On the other hand, in the case of *B. tabaci*, 11 EFAMs showed more than 50% of insecticidal efficacy. There include BTV D, BTV F, BTV G, BTV K, BTV L, BTV M, BTV N, BTV O, BTV S, BTV T, and BTV U (Table 5). Among them BTV D, BTV G, BTV K, BTV L, BTV M, BTV N, and BTV U were recorded to have more than over 60% of insecticidal efficacy (Table 5). In particular, BTV L showed the highest insecticidal efficacy at 71% against *B. tabaci* (Table 5). This EFAM contains two major materials, plant extract and bacterial strain (*Bacillus cereus*), although other major component is not known. Among the EFAMs, four showed more than 60% of insecticidal efficacy to both species: BTV D, BTV G, BTV L, and BTV M. Thus, these four EFAMs are recommendable for the field test. However, it should be noted that *T. vaporariorum* and *B. tabaci* control should be accompanied with other biological agent (i.e., natural enemy) considering the best EFAMs on the markets are still too low to use as a sole control agent for the species. Thus, more selection of EFAMs for the control of *T. vaporariorum* and *B. tabaci* is regarded, and effort to find alternative control agent should be studied.

S. litura

All products tested in this study were originated from plant extracts (Table 1). Before testing insecticidal efficacy of EFAMs against all stages of *S. litura* we first conducted insecticidal efficacy of 16 EFAM products against 2nd instar larvae of *S. litura* and selected six EFAM products which showed relatively high mortality (data not shown). In 1st and 2nd larval stages, all EFAM products showed 90% of insecticidal efficacy, except for SPL B (76.7%) and SPL F (63.3%) in the 2nd instar larvae (Table 6, 7). From 3rd instar larvae the insecticidal efficacy was rapidly decreased in several EFAMs. SPL B showed the lowest insecticidal efficacy as 3.3%. Only two products, SPL A (93.3%) and SPL C (93.3%), were recorded to have more than 90% of insecticidal efficacy in the 3rd instar larvae (Table 8). In the 4th instar larvae, the insecticidal efficacy of all EFAMs showed less than 60% (Table 9). This indicates that currently available EFAMs may have limited efficacy, and this stage of *S. litura* larvae

Table 8. The mortality of 3rd instar *Spodoptera litura* larvae, in response to six environment-friendly agricultural materials

Products	% mortality (±SD) after			
	12 hrs	24 hrs	36 hrs	48 hrs
SPL A	80.0±17.3a	86.7±15.3a	93.3±32.1a	93.3±11.5a
SPL B	0.0±0.0d	3.3±5.8c	3.3±5.8c	3.3±5.8c
SPL C	70.0±10ab	86.7±23.1a	86.7±23.1a	93.3±11.5a
SPL D	23.3±11.5cd	36.7±5.8b	70.0±26.5ab	80.0±20.0a
SPL E	46.7±15.3bc	63.3±5.8ab	73.3±5.8ab	76.7±5.8ab
SPL F	30.0±30.0c	43.3±32.1b	43.3±32.1b	43.3±32.1b
H2O	0.0±0.0d	0.0±0.0c	0.0±0.0c	0.0±0.0c
Nothing	0.0±0.0d	0.0±0.0c	0.0±0.0c	0.0±0.0c

Mean values with the same alphabet are not significantly different ($p > 0.05$).

Table 9. The mortality of 4th instar *Spodoptera litura* larvae, in response to six environment-friendly agricultural materials

Products	% mortality (±SD) after			
	12 hrs	24 hrs	36 hrs	48 hrs
SPL A	13.3	36.7±5.8bc	43.3±5.8b	43.3±5.8bc
SPL B	0.0±0.0c	0.0±0.0d	0.0±0.0d	3.3±5.8d
SPL C	30.0±10.0a	53.3±5.8a	30.0±10.0a	36.7±5.8a
SPL D	16.7±11.5b	43.3±5.8b	50.0±10.0ab	50.0±10.0ab
SPL E	13.3±11.5bc	36.7±5.8bc	40.0±0,0b	43.3±5.8bc
SPL F	3.3±5.8bc	26.7±11.5c	26.7±11.5c	33.3±5.8c
H2O	0.0±0.0c	0.0±0.0d	0.0±0.0d	0.0±0.0d
Nothing	0.0±0.0c	0.0±0.0d	0.0±0.0d	0.0±0.0d

Mean values with the same alphabet are not significantly different ($p > 0.05$).

Table 10. The mortality of 5th instar *Spodoptera litura* larvae, in response to six environment-friendly agricultural materials

Products	% mortality (±SD) after			
	12 hrs	24 hrs	36 hrs	48 hrs
SPL A	0.0±0.0b	20.0±10.0a	30.0±10a	36.7±5.8a
SPL B	0.0±0.0b	0.0±0.0b	0.0±0.0b	0.0±0.0b
SPL C	6.7±5.8ab	26.7±5.8a	43.3±5.8a	46.7±5.8a
SPL D	13.3±11.5a	20.0±17.3a	26.7±28.9a	30.0±26.5a
SPL E	0.0±0.0b	13.3±5.8ab	23.3±11.5ab	26.7±15.3a
SPL F	0.0±0.0b	23.3±5.8a	33.3±15.3a	33.3±15.3a
H2O	0.0±0.0b	0.0±0.0b	0.0±0.0b	0.0±0.0b
Nothing	0.0±0.0b	0.0±0.0b	0.0±0.0b	0.0±0.0b

Mean values with the same alphabet are not significantly different ($p > 0.05$).

is difficult to control. Furthermore, the insecticidal efficacy against both 5th and 6th instar larvae were very low than other larval stages, particularly showing that SPL B and SPL E are the lowest two EFAMs against 5th instar larvae (Table 10). SPL F is the lowest insecticidal EFAM efficacy against the 6th instar larvae (Table 11). Considering that the efficacy of EFAM against old instars is rapidly decreasing, it is required to find more EFAMs and find alternative methods to control *S. litura* larvae.

In this study, we tested insecticidal efficacy of on-the-market EFAMs against three major agricultural pests. For *T. vaporariorum* and *B. tabaci* all EFAMs showed ≤70% insecticidal efficacy. This result indicates the difficulties to control the whiteflies with the on-the-market EFAMs under economic injury level. Thus, more effort to find and develop EFAMs is required. Further, considering that this study was conducted only for 3rd nymph, more extensive effort to find better product is required. One alternative

Table 11. The mortality of 6th instar *Spodoptera litura* larvae, in response to six environment-friendly agricultural materials

Products	% mortality (±SD) after			
	12 hrs	24 hrs	36 hrs	48 hrs
SPL A	13.3±5.8ab	40.0±17.3a	53.3±20.8ab	53.3±20.8a
SPL B	0.0±0.0c	3.3±5.8c	3.3±5.8c	3.3±5.8c
SPL C	16.7±5.8a	36.7±15.a	56.7±23.1a	60.0±17.3a
SPL D	13.3±11.5ab	26.7±5.8ab	46.7±5.8ab	46.7±5.8ab
SPL E	10.0±10.0abc	43.3±5.8a	63.3±5.8a	63.3±5.8a
SPL F	3.3±5.8bc	16.7±11.5bc	30.0±20.0b	30.0±20.0b
H2O	0.0±0.0c	0.0±0.0c	0.0±0.0c	0.0±0.0c
Nothing	0.0±0.0c	0.0±0.0c	0.0±0.0c	0.0±0.0c

Mean values with the same alphabet are not significantly different ($p>0.05$).

way of biological control could be to use natural enemy. For example, the ladybird beetle, *Serangium japonicum* (Coleoptera: Coccinellidae) might be one possible natural enemy against whitefly and this is very much favored in China (Yao *et al*., 2005). Also various microbial control agents can be considered. For example, *Paecilomyces fumosoroseus* (Wize) and *Lecanicillium* sp. have been registered as micirobial control agents for whitefly management (Bolckmans *et al*., 1995; Wright, 1992; Ravensberg *et al*., 1990; Faria and Wraight, 2001).

In the case of *S. litura*, as they grow, their feeding quantity increases rapidly, and quickly destroy crops, especially during 5th and 6th instars (Lee *et al*., 2006). Thus, the currently available EFAMs do not provide complete control efficiency alone. Thus, more alternative and/or additional control method should be accompanied. One such solution could be combined use of light trap together with the on-the-market EFAMs.

Acknowledgement

This study was supported by Ministry for Food, Agriculture, Forestry and Fisheries, Republic of Korea.

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