Monitoring of Insect Pests, Natural Enemies of Sweet Corn and Study on Control Methods in Khon Kaen University

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Abstracts

Current situation of insect pests in sweet corn, their natural enemies and control practices were investigated in the field condition during May-July 2004 in vegetable research farm within Khon Kaen University. Total 7 methods are comprising of carbofuran 3%G, one and two releases of brown earwig *(Proreus simulans*), one release of black earwig (*Euborellia annulipes*), two releases of brown earwig with *Trochogramma* sp. and two releases of common brown earwig (*Labidura riparia*). Total 22 insect pest species and 14 species of natural enemies have been recorded. Insect pests were noted as causing severe or moderate injury were corn borer (*Ostrinia furnacalis*), corn earworm (*Helicoverpa armigera*), and aphid (*Rhopalosiphum maidis*); causing light injuries were corn looper (*Phytometra chalcytes*), corn thrip (*Frankliniella williamsi*), derbid planthopper (*Phenice moesta*), rose beetle (*Adoretus compressus*), and leaf eating beetle (*Monolepta signata*). Natural enemies were spiders, earwig (*P. simulans*), coccinellid (*Menochilus sexmaculatus, Micraspis discolor*), black ant (*Componotus* sp.) found commonly while big eyed bug (*Geocoris* sp.), mantid, green lacewing (*Chrysopa* sp.), predatory bug (*Eocanthecona furcellata*) were less prevalent. Crop damage assessment indicated that it was no plant damage from *O. furnacalis* during early three surveys at day 14, 21 and 28 after planting. Plant damage at day 49 was not statistically significant difference. However, it was highest damage in T1 at day 56 (27.5%) and statistically significant difference at $P \leq 0.05$ with T2, T5, T6, T3, T4 and T7 respectively. Ear damage was found highest (12.3%) at control (T1) and was statistically significant difference at $P \leq 0.05$ with T5, T6 and T7 but it was not statistical significant difference with T2, T3 and T4 respectively. However yield, marketable, unmarketable ears and return cost were not statistically significant differences.

Key words : Damage, earwig, insect pest, IPM, natural enemy, sweet corn

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Introduction

Sweet corn production is rapidly increasing in Asian region, especially in Eastern and Southeast Asia. Recently, area and production for processing have increased also. It has increased from 87 million tons in 1980 to 167 million tons in 1999. In Thailand, it is continuously being economic important crop and will be increased in the future (Kongkanjana and Choonhawong, 1997). Approximately 350.000 rai with 437. 000 tons were produced in 2001.

Insects generally are more damaging in farmers'fields in the tropics and sub tropics than diseases and over half of the area under maize is seriously affected by insect problems (Granados et. al., 2000). He also reported that from the large number of insect species that can be found feeding on the corn plant, only a few cause damage of economic importance. Kongkanjana and Choonhawong (1997) reported that 76 insect pest species of corn have been reported in Thailand, but only 8-9 species are common. These insects can damage the different parts of the plant and interfere with normal plant development, thus becoming an important factor in the reduction of yield and of grain quality. Jamjanya et al. (2000) reported that the major pests of sweet corn in Khon Kaen University are corn stem borer (*O. furnacalis*) and corn earworm (*H. armigera*) with damaging 10-65%. To understand the situation of existed natural enemies, survey, collection and evaluation natural enemies of insect pests need to be regularly undertaken which objects to conservation, augmentation and utilization them carefully and appropriately (Napompeth, 2001). Furthermore from this output, we can understand their diversity that helped making decision in biological control and integrated pest management. In the past three decades, entomologists have developed several new controls to become part of the integrated pest management concept since they are effective and have a very minimal disruptive effect in ecosystem. Biological control of *O. furnacalis* is an attractive alternative to insecticidal control because of environmental and health issues associated with insecticides. A number of egg parasitoids (largely Trichogrammatidae, Hymenoptera) have been considered for biological control of Ostrinia nubilalis (Smith, 1996). *T. ostriniae* was initially identified as a potential biological control agent of *O. nubilalis* because of its effectiveness against *O. furnacalis* Guenee in Asia. Siri et al. (2003) reported that *P. simulans* is a predator which can control population of many insect pest species such as corn armyworm, corn earworm and corn aphid. They are mostly found and effective predator in sweet corn field. The optimum rate is 100 insects/rai. Thus, this potential and effort need to be strengthened. Toward on environment friendly and sustainable agriculture in sweet corn production, Integrated Pest Management technology is the most suitable package to be understood.

Therefore this study comprises the following objectives:

1. To identify the abundance of insect pest species and their natural enemies in sweet corn production from each growth stage and assess the economic importance of major pest species and crop damaged at the same time to find out potential natural enemy.

2. To determine an effective method to control insect pests of sweet corn.

Materials and methods

The experiment was conducted in vegetable research farm of Khon Kaen University during May to July 2004. The experimental materials were comprised from sweet corn variety super sweet Khon Kaen Bi-color, carbofuran 3%G, Trichogramma sp., brown earwig (*Proreus simulans*), black earwig (*Euborellia annulipes*) and common brown earwig *(Labidura riparia*). The experiment designed as a Randomized Completed Block Design (RCBD) with 7 treatments and 4 replications. Plot size is 4 m x 6.5 m. A non released control plot (T1) was compared with 6 other plots which treated with carbofuran 3%G at 37.5kg/ha (T2), one and two releases of brown earwigs (*P. simulans*) (T3, T4), two releases of black earwigs (*E. annulipes*) (T5), two releases of brown earwigs (*P. simulans*) in combination with two releases of egg parasite (*Trichogramma* sp.) 30.000 wasps/rai (T6) and two releases of common brown earwigs *L. riparia* (T7). One individual per tiller or equation to 4 earwigs per square meter, third instar and adult of earwigs were released at day 30 and day 40 after planting. However carbofuran was single application per crop season at only day 30 after planting (DAP) and *T. ostriniae* was released also at day 30 and day 40 after planting as pupae inside the host egg as rice moth egg (*Corcyra cephalonica*). The parasitized pupae was distributed in the field just prior to emergence of the adult wasps. The parasitoid host egg was glued to paper card (1x1cm) and the card attached to the corn leaf. Totally 20.000-30.000 wasps per rai were released (Siri et al., 2003). This was done when corn borer's mass eggs had been observed. Corn was planted in 11 May 2004 with total 5 rows and 20 plants per row by spacing 30x80 cm. Fertilizer 15-15-15 was applied as basal with a rate of 30 kg/rai while land was last harrowing at one day before planting. An exceed plants were thinned at eight days after planting and remaining only one or two plants per hill. Weeding was practiced prior to second fertilizer (18 days after planting). Urea 46-0-0 was applied 30 kg/rai at day 21 and day 57. Insects were surveyed at day 14, 21, 28, 35, 42, 49 and 56. The frequency of monitoring was once a week throughout harvest. Total 20 plants in between population from 3 rows inside each plot were

randomly checked insect pest infestation. Pests and natural enemies were observed in each leaf, stem, tassel and ear. The number of each pest species and natural enemies were recorded. Corn borer damage stalk was particularly focused by checking plant tunnel and ear damage. Sucking species particularly corn aphids were recorded by score in 4 levels: 0 no aphids, 1 = 1-50 individuals, 2 = 51-100 and 3 = >100 and others were counted (Jamjanya et al., 2000). The situation of *P. simulans* and *Trichogramma* sp. after realeases was also recorded.

Fresh ears from each plot were harvested when corn reaches 65 days within 3 rows in the middle. All ears were weighed and converted into ton per hectare. The ears were grading in 3 categories A>4x17 cm, B>3x15 cm, C≤3x15cm (Jamjanya et al., 2003). The cost was A = 1.50 baht, B = 1.00 baht C = 0.50 baht. The damaged ears from *O. furnacalis* and *H. armigera* were separated and measured width and length. Total plants, ears damaged, marketable and unmaketable ears were percentaged. Means of plant damage in each crop stage, yield, damaged, marketable, unmarketable ears and return cost from each treatment were analyzed of variance (ANOVA) and compared with control by DMRT. The population density of *P. simulans* was recorded from cutting 20 tillers from each plot to check its change and movement in one week after harvest.

Results

Survey of insect pests, natural enemies of sweet corn and damage assessment

The result of insect pests and natural enemies surveys from sweet corn experimental field of Khon Kean University in wet season 2004, total 22 insect pest species and 14 of natural enemies have been recorded from 8 field surveys (Table 1 and 2). Only some from which are noted as causing severe or moderate injury. There are corn borer (*O. furnacalis*), corn earworm (*H. armigera*), corn armyworm (*Mythimna separata*), corn looper (*Phytometra chalcytes*), and aphids (*Rhopalosiphum maidis*); causing light injuries are corn thrip (*Frankliniella williamsi*), derbid planthopper (*Phenice moesta*), and rose beetle (*Adoretus compressus*), cletus bug (*Cletus trigonus*), mirid bug, leaf eating beetle (*Monolepta signata*), leafhopper (*Bothrogonia* sp.), rice green bug (*Nizara viridula*) and hairy caterpillar (*Orgyia turbata*). Mole crickets (*Gryllotalpa africana*) are only presented in the first and second weeks after germination, but damage was severely in the first week only. Corn thrips were also presented high density from second and third weeks after planting but their infested level was lower in fourth and fifth weeks after planting respectively. It was appeared in the second week after planting and it concerned very much with weather condition. Aphid infestation was 0.64, 0.13, 0.06,

Table 1 Insect pests of sweet corn in Khon Kaen University during wet season 2004

No.	Common name	Scientific name	Week after planting							Insect stage	Crop damage
			1 & 2	3	4	5	6	7	8		
1	Corn thrip	*Frankliniella williamsi*	✔✔✔	✔						Nymph, adult	Leaf
2	Corn aphid	*Rhopalosiphum maidis*				✔	✔	✔		Nymph, adult	Leaf, tassel
3	Corm earworm	*Helicoverpa armigera*				✔	✔	✔	✔✔✔	Larvae	Leaf, ear
4	Corn borer	*Ostrinia furnacalis*			✔✔	✔✔	✔✔	✔✔✔	✔✔✔	Larvae	Tip, ear, stem
5	Corn looper	*Phytometra chalcytes* sp.	✔✔✔	✔✔	✔					Larvae	Leaf
6	Corn armyworm	*Mythimna separata*	✔✔✔	✔✔✔	✔✔	✔	✔	✔	✔	Larvae	Leaf
7	Cletus bug	*Cletus trigonus*	✔✔✔	✔✔✔	✔✔	✔✔	✔✔✔	✔	✔	Adult	Leaf
8	Mirid bug	unidentified	✔✔	✔✔✔	✔✔✔	✔✔✔	✔✔	✔✔	✔✔	Adult	Leaf
9	Leaf eating beetle	*Monolepta signata*	✔	✔	✔✔✔	✔✔✔	✔✔✔	✔✔	✔✔	Adult	Leaf
10	Rice grasshopper	*Hieroglyphus banian*				✔	✔	✔	✔	Adult	Leaf
11	Common black cricket	*Gryllus bimaculatus*	✔✔✔	✔✔						Adult	Leaf
12	Black cricket	*Modicogryllus confirmata*	✔✔✔	✔✔						Adult	Leaf
13	Mole cricket	*Gryllotalpa africana*	✔✔✔							Adult	Root
14	Bombay locust	*Patanga succincta*				✔	✔	✔	✔	Adult	Leaf
15	Leaf eating weevil	unidentified				✔	✔	✔		Adult	Leaf
16	Derbid planthopper	*Phenice moesta*				✔✔✔	✔✔✔	✔✔✔	✔✔✔	Adult	Leaf
17	Leafhopper	*Bothrogonia* sp.	✔✔✔	✔✔✔	✔✔	✔✔	✔✔✔	✔	✔	Adult	Leaf
18	Rose beetle	*Adoretus compressus*				✔	✔	✔	✔	Adult	Leaf
19	Sap beelte	*Carpophilus dimidiatus*		✔	✔	✔	✔	✔	✔	Adult	Grain
20	Pink stem borer	*Sesamia inferencs*				✔	✔✔	✔	✔	Larvae	Stem
21	Rice green bug	*Nazara viridula*			✔	✔	✔	✔✔	✔	Adult	Tassel, leaf, ear
22	Leaf eating caterpilliar	*Orgyia turbata*					✔	✔		Larvae	Leaf

Table 2 Natural enemies in sweet corn in Khon Kaen University during wet season 2004

No.	Common name	Scientific name	Week after planting							Insect stage
			1 & 2	3	4	5	6	7	8	
1	Ladybird beetle	*Micraspis discolor*	✔✔✔	✔✔✔	✔✔✔	✔✔✔	✔✔✔	✔✔✔	✔✔✔	Larvae, adult
2	Ldaybird beetle	*Menochilus sexmaculatus*	✔	✔	✔✔✔	✔✔✔	✔✔✔	✔✔✔	✔✔✔	Larvae, adult
3	Green lacewing	*Chrysopa* sp.					✔	✔	✔	Egg, larvae, adult
4	Ladybird beetle	*Coccinnella transversalis*	✔	✔	✔✔	✔✔✔	✔✔✔	✔✔✔	✔✔✔	Larvae, adult
5	Predatory bug	*Eocanthecona furcellata*					✔	✔	✔	Nymph, adult
6	Black ant	*Componotus* sp.	✔✔✔	✔✔	✔✔	✔✔	✔✔	✔✔	✔✔✔	Adult
7	Egg parasitoid	*Trichogramma* sp.			✔	✔	✔✔	✔	✔	Adult
8	Black earwig	*Euborellia annulipes*	✔	✔	✔	✔	✔	✔	✔	Nymph, adult
9	Brown earwig	*Proreus simulans*	✔		✔	✔✔	✔✔✔	✔✔	✔✔	Egg, nymph, adult
10	Common brown earwig	*Labidura riparia*	✔	✔	✔	✔				Nymph, adult
11	Big-eyed bug	*Geocoris* sp.					✔	✔✔	✔✔	Adult
12	Spider	*Lycosa* sp., *Tetragnatha* sp.	✔✔✔	✔✔✔	✔✔✔	✔✔	✔✔✔	✔	✔✔	Nymph, adult
13	Mantid	unidentified			✔	✔	✔	✔	✔	Adult
14	Long-horned grasshopper	*Conocephalus maculatus*	✔	✔✔✔	✔✔✔	✔✔✔	✔✔✔	✔✔	✔✔	Nymph, adult

0.05 and 0.1 in T1, T2, T5, T6, T7 respectively (Fig. 1). Corn borer (*O. furnacalis*) damage was first appeared in third week after planting with leaf blade feeding. However, stem tunnel was considerable increased in the incidence level from the fifth week after planting up to harvest during this field experiment. In the group of natural enemies, predators are the most number than parasitoids. Among them are spiders *(Lycosa, Tetragnatha* spp.), brown earwig (*P. simulans*), coccinellids (*M. sexmaculatus, M. discolor*). However, black ants (*Componotus* sp.) found commonly while big eyed bug (*Geocoris* sp.), assassin bug (*Syncanus* sp.), green lacewing (*Chrysopa* sp.) were less prevalent.

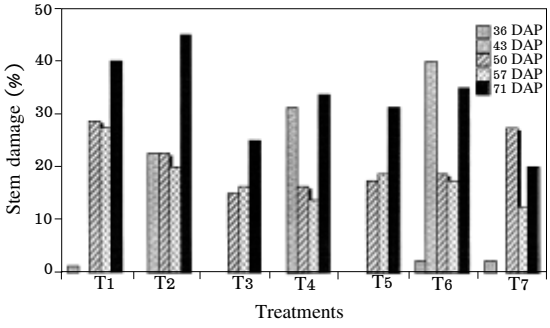

Fig. 1 Stem damage of each treatment from corn borer (*Ostrinia furnacalis*) during June-July 2004

Crop damages were assessed from plant tunnel mainly from corn borer, ear damage from both corn borer and corn earworm (Table 3). The figure of plant tunnels was considerable variability in each treatment from each field survey. There was no plant damage from *O. furnacalis* during early three surveys at day 14, 21 and 28. Percent stalk damage was found low number at day 35 and 42 and existed in only some treatments. It was more consistent at day 49 with 28.7, 22.5, 15.0, 16.2, 17.5, 18.7, 27.5; at day 56 with 27.5, 20.0, 16.2, 13.7, 18.7, 17.5 in T1, T2, T3, T4, T5, T6 and T7 respectively. They were often high in control (T1) and carbofuran (T2) plots. Relatively clear picks in percentage of ear damage from all seven treatments, particularly at havest (Fig. 2). Percent ear damage was respectively lower with 12.2%, 14.2%, 11.2%, 10.0%, 9.6%, 6.9% and 6.8% in T1,T2,T3,T4,T5,T6 and T7 respectively.

Feature of control methods

As indicated above that the insect pest infestation at day 14 up to day 42 was low, therefore comparison was not means. Thus, mean number of percent plant tunnels recorded from day 49, 56, percent ear damage from corn borer, corn earworm, marketable, unmarketable ears, yield and return cost in baht for all seven treatments were shown in Table 3. The plant damage at day 49 was not statistically significant differences at $P \leq 0.05$ and it was generally higher than day 56. Percent plant damage at day 56 was highest in control treatment (T1) (27.5%) than T2, T5, T6, T3, T4 and T7 with 20.0%, 18.7%, 17.5%, 16.2%, 13.7% and 12.5% respectively and was statistically significant difference at $P \leq 0.05$. Ear damage

Table 3 Stalk, ear damaged by corn borer, yield, marketable, unmarketable ears and return cost of sweet corn in Khon Kaen Universiry during wet season 2004

	Treatments	Stalk damage at (%)		yield	Damage ear	Marketable	Unmarketable	Return cost
		49DAP	56DAP	(t/ha)	(%)	ear(%)	ear(%)	(Baht/rai)
T1	Control	28.7a[1/]	27.5a	8.9a	12.34a	73.49a	12.46a	6.440a
T2	Carbofuran 3% G	22.5a	20b	8.97a	11.48a	78.84a	9.89a	5.960a
T3	Brown earwig (lrelease)	15.0a	16.2b	8.81a	11.21a	77.42a	9.45a	6.030a
T4	Brown earwig (2 releases)	16.25a	13.7b	9.49a	10.04a	79.26a	11.87a	6.242a
T5	Black earwig	17.5a	18.7b	9.17a	9.64b	77.43a	8.80a	6.680a
T6	Brown earwig+*Trichogramma* sp.	18.75a	17.5b	9.86a	6.93b	77.77a	6.44a	6.934a
T7	Common brown earwig	27.5a	12.5b	9.05a	6.85b	74.18a	7.45a	6.538a
	F-test	ns	*	ns	*	ns	ns	ns
	CV(%)	17.79	15.38	12.5	10.03	11.53	28.53	11.1

[1/] Means followed by the same letter in the same colum are not significantly different at P≤0.05 by DMRT.

DAP=Day after planting.

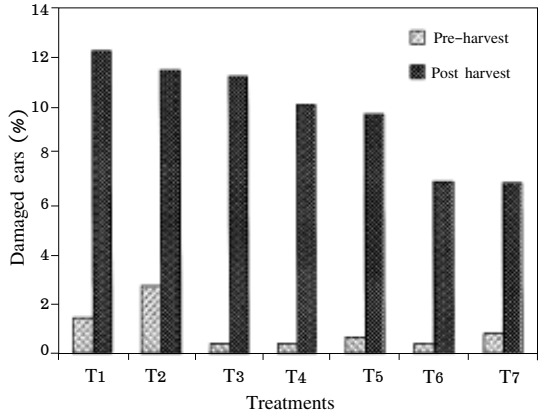

Fig. 2 Ear damaged percentage of each treatment from pre and post harvests

was found highest (12.3%) at control (T1) and was statistically significant difference at P≤0.05 with T5, T6 and T7 but it was not statistical significant difference with T2, T3 and T4 respectively. However yield, marketable, unmarketable ears and return cost were not statistically significant differences. Brown earwig number have been found in all released treatments (T3,T4,T6) with 1.85, 1.36, 0.46 and non released treatments(T1,T2,T5,T7) with 0.38, 0.54, 0.46, 0.15 individuals per tiller respectively (Fig. 3)

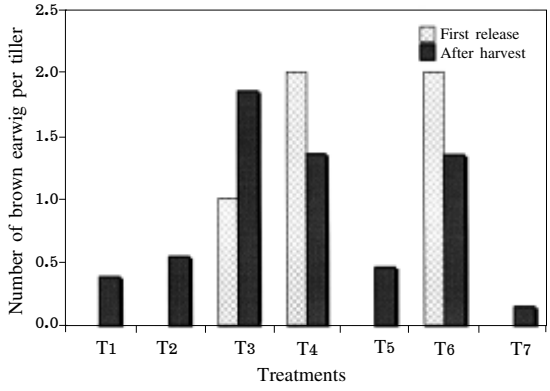

Fig. 3 Average of brown earwigs per sweet corn plant in each treatment at before and after harvest in wet season 2004

Discussions

There was high mortality of insect pests and predators in treatment of carbofuran 3% G from day two after application. Low percent plant damage was observed during one week from there. However, at the third week later, plant damage was appeared again. Low percent stalk damage for all treatments was observed if compared with December 2003, the damage was greatest in reproductive stage at 75.56 %. Some fields had incidences as high as 100 % (Douang Boupha et al., 2004). It may be distribution of brown earwigs in all treatments was found. Corn armyworm, corn looper damages were incresead in the early to mid-whorl stages. However, damage from corn borer was first appeared from the fourth survey with very low percentage than is constantly increased with crop ages. The results obtained in this study have been shown positive effect that releases *P. simulans* 2 individuals per tiller, combination between *P. simulans* with *Trichogramma* sp. and *L. riparia* can suppress *O. furnacalis* damage decreasing during 20 and 30 days after release. They can also adequately to increase the proportion of marketable ears and to reduce the proportion of unmarketable ears as well. Releasing three species of earwigs were able to reduce *O. furnacalis* damage lower than control and conventional as chemical application plots though damage levels were variable among them. IPM in sweet corn by release *P. simulans* 4.37 individuals per tiller could be controlled

many pests under economic threshold, given resulting as well as 2 chemical applications (Choonhawong et al., 1999). The percentage of unmarketable ears in treatment of combination between *P. simulans* with *Trichogramma* sp. reached to 6.4- 7.4% that a little higher than threshold level (5%) that accepted by growers (Riggs et al., 1998). We observed that there was high mortality of adult of *P. simulans* in two-three weeks after releases from fungus. Despite yields in all treatments were not statistically significant difference but we have seen higher yields in treatment plots that we released three species of earwigs than control and carbofuran treatments. In fact, we get more benefit already from safety food and friendly environment.

Conclusions

Sweet corn sucking insect pests are more abundance than chewing insects but they are opposite in aspect of crop damage. Total 22 insect pest species were recorded in vegetable farm of Khon Kaen University. Insect pests were causing severe or moderate damage to sweet corn are corn borer (*O. furnacalis*), corn earworm (*H. armigera*), corn armyworm (*M. separata*), corn looper (*P. chalcytes*), and aphids (*R. maidis*); causing light injury were corn thrip (*F. williamsi*) derbid planthopper (*P. moesta*), rose beetle (*A. compressus*) and mole crickets (*G. africana)*. Total 14 species of natural enemies were recorded among them, predators are the most number than parasitoids. Lady bird beetle (*M. sexmaculatus, M. discolor*), common natural enemies such as spiders were found in most field surveys. This study was demonstrated positive results of combination releases of *P. simulans* with *Trichogramma* sp. and R. riparia, but further work is required in appropriated handle technique while insect released to be avoided painful insects particularly *P. simulans* and increased rate when damage situation is higher level. Third instars is better to be released, if adult should be pair of male and female together in the same tiller.

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