

Natural enemies of important insect pests of field crops and utilization as biological control agents in Thailand

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ABSTRACT

Survey and evaluation of natural enemies of insect pests were investigated by researchers at National Biological Control Research Center (NBCRC); and more than 110 species of natural enemies associated with important insect pests of sugarcane, cassava, soybean and cotton were recorded including parasitic and predatory insects, predatory mites and insect pathogens. Among these natural enemies, *Eocanthecona furcellata* was utilized as biological control agent for control of several lepidopterous caterpillar pests; *Trichogramma chilotreae*, *Cotesia flavipes* and green muscadine *Metarhizium anisopliae* were utilized for control sugarcane moth borer and sugarcane longhorn borer and the green lacewings, *Plesiochrysa ramburi* and *Mallada basalis* were employed for control cassava mealybugs complex. The mass production of these natural enemies have been done at National Biological Control Research Center, Central Regional Center, Kamphaeng Saen for inoculative field release and evaluation. Further investigations proved that these promising natural enemies are useful for utilization biological control of the insect pests of field crops in Thailand.

Keywords: natural enemies, insect pests of field crops, utilization, sugarcane, cassava

INTRODUCTION

The strategy for utilization of natural enemies for biological control of many species of economic insect pests in Thailand has been intensively investigated by the researchers of the National Biological Control Research Center (NBCRC), Kasetsart University /National Research Council of Thailand and their cooperative networks since 1978. The basic ground works including the explorations of natural enemies which associated with insect pests and the evaluation of their control potential and effectiveness as biological control agents.were widely assessed. Through these extensive examinations, those inherent natural enemies were then identified and summarized by Charearnsom and Suasaard (1994) to be important natural enemies of insect pests of Thailand and subjected to further study of

possible exploitation in term of augmentation and promotional campaigns for their utilization and conservation.

The utilization of natural enemies for augmentative biological control of insect pests in Thailand was initially summarized by Napompeth (1989, 1990a, 1990b, 1992) and subsequently updated by Suasa-ard (2000).

Two main purposes of this paper are: to present and highlight current activities of the insect pests of some economic field crops and their natural enemies; and to manifest the impact of the successful implementation of effective natural enemies for biological control of insect pests in field crops in Thailand.

INSECT PESTS OF FIELD CROPS AND THEIRS NATURAL ENEMIES

In Thailand field crops have been played an important role in domestic and export commercial industry. The significant field crops have been cultivated such as sugarcane, *Saccharum officinarum* L.; cassava, *Manihot esculenta* (L.) Crantz; corn, *Zea mays* L.; soy bean, *Glycine max* L. and cotton, *Gossypium* spp. Among these, sugarcane and cassava are considered the most important crops in term of production.

In sugarcane, cassava, corn, soy bean and cotton, there are more than 196, 42, 69, 16 and 39 species of recorded insect pests, respectively (Charemsom and Suasa-ard, 2010).- However, the number of economic important species are much fewer than those reported.

In sugarcane, only nine species of the insect pests are important ones, including five species in the sugarcane shoot and stem borers complex: *Chilo infuscatellus*, *Chilo sacchariphagus*, *Chilo tumidicostalis*, *Sesamia inferens* and *Scirpophaga excerptalis*. The others are the sugarcane white fly; *Aleurolobus barodensis*; the sugarcane longhorn stem borer, *Dorysthenes buqueti*; the sugarcane scale, *Aulacaspis sacchari* and the sugarcane pink mealybug, *Saccharicoccus sacchari*. Among these, the sugarcane moth borers complex and the longhorn stem borer are the most serious ones.

The insect pest attacking cassava, mainly, are the cassava mealybugs complex: *Phaenacoccus manihoti*, *Ferrista virgata*, *Phaenacoccus madeirensis*, *Pseudococcus jackbiersleyi* and *Phenacoccus solenopsis* comprising of endemic and exotic species. They have been conjointly causing enormous economic damages since 2008, in some planting areas with 100% yield loss.

In corn plantation, there are six species of insect pests, the prominent ones are *Ostrinia furnacalis* and *Helicoverpa armigera* which also pests of soybean and cotton.

In other crops, soybean and cotton, *Ophiomyia phaseoli* and *Bemisia tabaci* are found attacking soybean; and *Amrasca biguttula*, *Aphis gossypii*, *Thrips tabaci* and *B. tabaci* cause noteworthy damages to cotton.

The natural enemies of these important insect pests were investigated and summarized by Charemsom and Suasa-ard (1994) and updated in 2010 including new records are shown in Table 1.

UTILIZATION OF EFFECTIVELY NATIVE NATURAL ENEMIES AS BIOLOGICAL CONTROL AGENTS IN THE FIELDS

As possible targets for biological control, including both natural enemies ranged from insects with both parasites and predators, predatory mites and entomopathogenic fungus, the effective native natural enemies promoted by NBCRC are *Eocanthecona furcellata*, *Cotesia flavipes*, *Plesiochrysa ramburi*, *Mallada basalis* and *Metarhizium anisopliae*. Mass rearing of these natural enemies are being carried out at NBCRC laboratories for widely used in large scale damaged sugarcane and cassava plantations in Thailand.

The principal step of utilization of the pentatomid predator, *E. furcellata* for augmentative biological control of insect pests was the field released in castor plantation in the North of Thailand and success achieved in controlling of castor semi-looper, *Achea jarata* (Suasa-ard, 1988). The on going mass rearing program of this predator at NBCRC-Central Regional Center, Kamphaeng Saen, has made and inoculative field releases for augmentative biological control of cutworm and several species of other lepidopterous pests in the field crops were done and successful programs were achieved (Suasa-ard, 1999; Kernasa *et.al.*, 2004).

Sugarcane

One of the most outstanding successful programs in augmentative biological control was the use of the egg parasite, *Trichogramma cilograeae* and the larval parasites, *Cotesia flavipes* for biological control of the sugarcane moth borer complex, *Chilo tumidicostalis*, *C. infuscatellus*, *C. sacchariphagus*, and *S. inferens*. The larval parasite, *C. flavipes*, was the most effective parasite which could be mass reared in large numbers and used as a biological control agent in augmentative biological control of sugarcane moth borers (Suasa-ard and Permmiyomkit, 2000). It was evident that field releases of *C. flavipes* for augmentative biological control of the sugarcane moth borers (Suasa-ard and Charernsom, 1996) and the sugarcane stem borer *C. tumidicostalis* (Suasa-ard *et.al.*, (2001) were successfully achieved in many locations. Afterwards the success of *C. flavipes* for control sugarcane moth borers was confirmed in 1995-1997 (Suasa-ard and Charernsom, 1999). Utilization of *C. flavipes* for augmentative control of sugarcane moth borers have been being further investigated (Suasa-ard *et.al.*, 2005, Suasa-ard *et.al.*, 2006, and Suasa-ard *et.al.*, 2007).

Besides the parasites, the green muscadine fungus, *M. anisopliae* is a promising natural enemies of sugarcane longhorn stem borer, *Dorystenes buqueti*. This stem borer is considered the most important destructive insect pest of sugarcane. Its outbreaks have caused devastating damages in some areas in the Central and Northern parts of Thailand since 1990. Accomplished mass production of green muscadine fungus, *M. anisopliae*, was done at NBCRC-Central Regional Center and fields released were done in several sugarcane planting areas with infestation of the insect pest. Successful control was achieved in all areas of the release of the natural enemy. (Pimpun *et.al.*, 2006 and Suasa-ard *et.al.*, 2010).

Cassava

Cassava is the staple food for about 600 million people across the world. The estimated growing areas in Thailand in 2007 was about 1.2 million ha (7.5 million rai), with the average yields of 18.75 mt/ha (3 mt/rai). The notable insect pests mainly are those cassava mealybugs, including stripe mealybug, *Ferrisia virgata*; Solenopsis mealybug, *Phenacoccus solenopsis*; Jack Beardsley mealybug, *Pseudococcus jackbeardsleyi*; Green's mealybug, *Phenacoccus madeirensis* and pinkish cassava mealybug, *Phenacoccus manihoti*. These mealybugs have their outbreaks in cassava fields in more than 25 provinces in Thailand, especially in principal planting areas in Kanchanaburi, Nakhon Ratchasim, Lopburi and Saraburi provinces. The severe damages caused by the insects to the shoots can be easily observed in the fields. Generally the control measures are chemical applications. Though sometimes it is slightly too late to control these pests when they occur in the dry season, but when approaching the rainy season these mealybugs are washed out naturally by rain. The use of biological control is another remarkable alternative control measure and evidently it has been being successfully applied in other countries.

Utilization of native natural enemies both predators and parasites such as the predatory green lacewings, *Plesiochrysa ramburi* and *Mallada basalis*; coccinellid predators *Nephus* sp., *Brumoides* sp., *Cheilomenes sexmaculatus* and *Micraspis discolor* and parasitic hymenoptera, *Anagyrus* sp., *Allotropia* sp. and *Acerophagus* sp. as biological control agents for biological control of cassava mealybugs complex have been researched. The production of *P. ramburi* and *M. basalis* have been mass reared at NBCRC-Central Regional Center; and about 10,000,000 eggs of these green lacewings and 10,000,000 parasites are being produced monthly. These native natural enemies have been released in the mealybug infestation areas of Kanchanaburi and Suphanburi provinces since January 2010.

Utilization of these natural enemies is being evaluated after releasing and the results obtained of the utilizing of the natural enemies shows that the population of cassava mealybug in released plots is remarkably lower than those non-released plots. The assessments will be completed in March 2011.

CONCLUSIONS

More than 110 species of natural enemies including insects predators, parasitic insects and pathogens associated with economic insect pests of sugarcane, cassava, corn, soybean and cotton were recorded. These natural enemies are considerable regulation factors for the control the population of these insect pests in term of natural biological control agents. Among these natural enemies, the pentatomid predator, *E. furcellata*; the hymenopterous parasites, *T. chirotreae* and *C. flavipes*; the green muscadine fungus, *M. anisopliae* and the green lacewings: *P. ramburi* and *M. basalis* have been utilized for augmentative biological control of many species of lepidopterous pest, sugarcane moth borers complex, sugarcane longhorn stem borer and the cassava mealybugs complex. The results from the utilization of these natural enemies gave most satisfaction control every area applied. They are

appreciated and it is very challenging for future research to control important insect pest of field crops and conserving agricultural and natural resources in Thailand.

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Table 1. Economic insect pests of some field crops and their natural enemies in Thailand

Plants:	Parasitic Insect/Predatory Insect/Spider and Entomopathogenic Fungus	
Pests		
Sugarcane (<i>Saccharum officinarum</i> L.)	<u>Parasitic Insect:</u>	
<i>Chilo infuscatellus</i>	<i>Bracon chinensis</i>	(Hymenoptera: Braconidae)
<i>Chilo sacchariphagus</i>	<i>Cotesia flavipes</i>	(Hymenoptera: Braconidae)
<i>Chilo tumidicostalis</i>	<i>Telenomus beneficiens</i>	(Hymenoptera: Scelionidae)
<i>Scirpophaga excerptalis</i>	<i>Telenomus rowani</i>	(Hymenoptera: Scelionidae)
(Lepidoptera: Pyralidae)	<i>Elasmus zehneri</i>	(Hymenoptera: Encyrtidae)
<i>Sesamia inferens</i>	<i>Tetrastichus schoenobii</i>	(Hymenoptera: Eulophidae)
(Lepidoptera: Noctuidae)	<i>Tetrastichus ayyari</i>	(Hymenoptera: Eulophidae)
	<i>Trichogramma chilotreae</i>	(Hymenoptera: Trichogrammatidae)
	<i>Trichogramma confusum</i>	(Hymenoptera: Trichogrammatidae)
	<i>Trichogramma australicum</i>	(Hymenoptera: Trichogrammatidae)
	<i>Temelucha philippinensis</i>	(Hymenoptera: Ichneumonidae)
	<i>Xanthopimpla stemmator</i>	(Hymenoptera: Ichneumonidae)
	<u>Predatory Insect:</u>	
	<i>Anthicus ruficallis</i>	(Coleopter: Anthicidae)
	<i>Formicinus braminus</i>	(Coleopter: Anthicidae)
	<i>Proreus similans</i>	(Dermaptera: Chelisochidae)
<i>Dorysthenes buqueti</i>	<u>Entomopathogenic Fungus:</u>	
(Coleoptera: Scarabaeidae)	<i>Metarhizium anisopliae</i>	(Hypocreales: Clavicipitaceae)
<i>Lepidiota stigma</i>	<u>Parasitic Insect:</u>	
(Coleoptera: Cerambycidae)	<i>Camsomeris</i> sp.	(Hymenoptera: Scoliidae)
	<u>Entomopathogenic Fungus:</u>	
	<i>Metarhizium anisopliae</i>	(Hypocreales: Clavicipitaceae)

Table 1. Continued

Plants:	Parasitic Insects/Predatory Insect/Spider and Entomopathogenic Fungus	
Pests		
<i>Aleurolobus barodensis</i> (Homoptera: Aleyrodidae)	<u>Parasitic Insect:</u>	
	<i>Amitus</i> sp.	(Hymenoptera: Platygasteridae)
	<i>Azotus bimaculatus</i>	(Hymenoptera: Aphelinidae)
	<i>Encarsia muliyali</i>	(Hymenoptera: Aphelinidae)
	<i>Encarsia ochai</i>	(Hymenoptera: Aphelinidae)
	<u>Predatory Insect:</u>	
	<i>Catana parcesetosa</i>	(Coleopter: Coccinellidae)
	<i>Cheilomenes sexmaculatus</i>	(Coleopter: Coccinellidae)
	<i>Coccinella transversalis</i>	(Coleopter: Coccinellidae)
	<i>Aulacaspis tegalensis</i> (Homoptera: Diaspididae)	<u>Parasitic Insect:</u>
<i>Adelencyrtus mayurai</i>		(Hymenoptera: Encyrtidae)
<i>Physcus subflavus</i>		(Hymenoptera: Encyrtidae)
<u>Predatory Insect:</u>		
<i>Cheilomenes sexmaculatus</i>		(Coleopter: Coccinellidae)
<i>Chilocorus nigritus</i>		(Coleopter: Coccinellidae)
<i>Chilocorus circumdatus</i>		(Coleopter: Coccinellidae)
<i>Coccinella transversalis</i>		(Coleopter: Coccinellidae)
<u>Entomopathogenic Fungus:</u>		
<i>Aschersonia</i> sp.		(Hypocreales: Clavicipitaceae)
<i>Ceratovacuna lanigera</i> (Homoptera: Aphididae)	<u>Parasitic Insect:</u>	
	<i>Diaeretus</i> sp.	(Hymenoptera: Aphelinidae)
	<i>Encarsia flavoscutellum</i>	(Hymenoptera: Aphelinidae)
	<u>Predatory Insect:</u>	
	<i>Ankylopteryx octopunctata</i>	(Neuroptera: Chrysopidae)
	<i>Hemerobius</i> sp.	(Neuroptera: Hemerobiidae)
	<i>Mallada basalis</i>	(Neuroptera: Chrysopidae)
	<i>Cheilomenes sexmaculatus</i>	(Coleoptera: Coccinellidae)
	<i>Coccinella transversalis</i>	(Coleoptera: Coccinellidae)
	<i>Scymnus apiciflavus</i>	(Coleopter: Coccinellidae)
<i>Synonycha grandis</i>	(Coleoptera: Coccinellidae)	
<i>Thiallela</i> sp.	(Lepidoptera: Pyralidae)	

Table 1. Continued

Plants:	Parasitic Insect/Predatory Insect/Spider and Entomopathogenic Fungus		
Pests			
<i>Saccharicoccus sacchari</i> (Homoptera: Pseudococcidae)	<u>Parasitic Insect:</u>		
	<i>Anagyrus saccharicola</i>	(Hymenoptera: Encyrtidae)	
	<i>Cladiscodea sacchari</i>	(Hymenoptera: Encyrtidae)	
	<i>Rhopus fullawayi</i>	(Hymenoptera: Encyrtidae)	
	<i>Tetrastichus pyrillae</i>	(Hymenoptera: Eulophidae)	
	<u>Predatory Insect:</u>		
	<i>Chelisochea</i> sp.	(Dermaptera: Chelisocheidae)	
	<i>Proreus simulans</i>	(Dermaptera: Chelisocheidae)	
	<i>Chrysopa</i> sp.	(Neuroptera: Chrysopidae)	
	<i>Hyperaspis trilaneata</i>	(Coleoptera: Coccinellidae)	
<i>Gitona perspicax</i>	(Diptera: Drosophilidae)		
<i>Phaenacantha saccharicida</i> (Hemiptera: Calobathristidae)	<u>Predatory Insect:</u>		
	<i>Ankylopteryx</i> spp.	(Neuroptera: Chrysopidae)	
	<i>Chrysopa</i> spp.	(Neuroptera: Chrysopidae)	
Cassava (<i>Manihot esculenta</i> (L.) Crantz)	<u>Parasitic Insect:</u>		
	<i>Ferrisia virgata</i>	(Hymenoptera: Platygasteridae)	
	<i>Phenacoccus madeirensis</i>	(Hymenoptera: Encyrtidae)	
	<i>Phenacoccus manihoti</i>	(Hymenoptera: Encyrtidae)	
	<i>Phenacoccus solenopsis</i>		
	<i>Pseudococcus jackbeardsleyi</i> (Homoptera: Pseudococcidae)	<u>Predatory Insect:</u>	
		<i>Plesiochysa ramburi</i>	(Neuroptera: Chrysopidae)
		<i>Mallada basalis</i>	(Neuroptera: Chrysopidae)
		<i>Spalgis epius</i>	(Lepidoptera: Lycaenidae)
		<i>Brumoides</i> sp.	(Coleoptera: Coccinellidae)
<i>Chilomenes sexmaculatus</i>		(Coleoptera: Coccinellidae)	
<i>Micraspis discolor</i>	(Coleoptera: Coccinellidae)		
<i>Nephus</i> sp.	(Coleoptera: Coccinellidae)		

Table 1. Continued

Plants:	Parasitic Insects/Predatory Insect/Spider and Entomopathogenic Fungus	
Pests		
Corn (<i>Zea mays</i> L.)	<u>Parasitic Insect:</u>	
<i>Ostrinia furnacalis</i>	<i>Bachymeria albotibialis</i>	(Hymenoptera: Chalcidae)
(Lepidoptera: Pyralidae)	<i>Telenomus rowani</i>	(Hymenoptera: Scelionidae)
	<i>Trichogramma australicum</i>	(Hymenoptera: Trichogrammatidae)
	<i>Trichogramma chilonis</i>	(Hymenoptera: Trichogrammatidae)
	<u>Predatory Insect:</u>	
	<i>Proraeus simulans</i>	(Dermaptera: Chelisochidae)
	<i>Mallada basalis</i>	(Neuroptera: Chrysopidae)
	<i>Anthicus ruficollis</i>	(Coleoptera: Anthicidae)
	<i>Ophionia indica</i>	(Coleoptera: Carabidae)
	<i>Paederus fuscipes</i>	(Coleoptera: Staphylinidae)
	Spider	
<i>Frankliniella williamsi</i>	<u>Parasitic Insect:</u>	
(Thysanoptera: Thripidae)	<i>Megaphragma</i> sp.	(Hymenoptera: Trichogrammatidae)
	<u>Predatory Insect:</u>	
	<i>Orius persequens</i>	(Hemiptera: Anthocoridae)
	<i>Wollastoniella rotunda</i>	(Hemiptera: Anthocoridae)
	<i>Aeolothrips</i> sp.	(Thysanoptera: Aeolothripidae)
	<i>Amblyseius okinawanus</i>	(Acarina: Phytoseiidae)
	<i>Amblyseius</i> sp.	(Acarina: Phytoseiidae)
<i>Adoretus compressus</i>	<u>Parasitic Insect:</u>	
(Coleoptera: Scarabaeidae)	<i>Camsomeris marginella billitonensis</i>	(Hymenoptera: Trichogrammatidae)
	<i>Typhia</i> sp.	(Hymenoptera: Trichogrammatidae)
<i>Helicoverpa armigera</i>	<u>Parasitic Insect:</u>	
(Lepidoptera: Noctuidae)	<i>Chalonus</i> sp.	(Hymenoptera: Braconidae)
	<i>Eriborus argenteopilosus</i>	(Hymenoptera: Ichneumonidae)
	<i>Exorista sorbilans</i>	(Diptera: Tachinidae)
	<i>Exorista xanthaspis</i>	(Diptera: Tachinidae)
	<i>Goniophthalmus halli</i>	(Diptera: Tachinidae)
	<i>Trichogramma chilonis</i>	(Hymenoptera: Trichogrammatidae)

Table 1 Continued

Plants:	Parasitic Insect/Predatory Insect/Spider and Entomopathogenic Fungus	
Pests		
<i>H. armigera</i>	<u>Predatory Insect:</u>	
	<i>Eocanthecona furcellata</i>	(Hemiptera: Pentatomidae)
	<i>Eocanthecona robusta</i>	(Hemiptera: Pentatomidae)
	<i>Sycanus collaris</i>	(Hemiptera: Reduviidae)
	<i>Nabis</i> sp.	(Hemiptera: Nabidae)
	<i>Geocoris</i> sp.	(Hemiptera: Geocoridae)
	<i>Mallada basalis</i>	(Neuroptera: Chrysopidae)
	<u>Entomopathogenic Fungus:</u>	
	<i>Nomuraea rileyi</i>	(Moniliales: Moniliaceae)
	<i>Mythimna separata</i> (Lepidoptera: Noctuidae)	<u>Parasitic Insect:</u>
<i>Apanteles</i> sp.		(Hymenoptera: Braconidae)
<i>Microbracon</i> sp.		(Hymenoptera: Braconidae)
<i>Telenomua</i> sp.		(Hymenoptera: Scelionidae)
<i>Tetrastichus</i> sp.		(Hymenoptera: Eulophidae)
<i>Trichogramma</i> sp.		(Hymenoptera: Trichogrammatidae)
<u>Predatory Insect:</u>		
<i>Eocanthecona robusta</i>		(Hemiptera: Pentatomidae)
<i>Sycanus collaris</i>		(Hemiptera: Reduviidae)
<i>Patanga succincta</i> (Orthoptera: Acrididae)		<u>Parasitic Insect:</u>
	<i>Scelio hieroglyphi</i>	(Hymenoptera: Scelionidae)
	<i>Scelio facialis</i>	(Hymenoptera: Scelionidae)
	<u>Predatory Insect:</u>	
	<i>Epicauta maclini</i>	(Coleoptera: Meloidae)
	<i>Epicauta waterhousei</i>	(Coleoptera: Meloidae)
	<i>Mylabris phalerata</i>	(Coleoptera: Meloidae)
	<i>Sphex viduatus</i>	(Hymenoptera: Sphecidae)
	<u>Entomopathogenic Fungus:</u>	
	<i>Entomophaga grylli</i>	(Entomophthorales: Entomophthoraceae)

Table 1. Continued

Plants:	Parasitic Insects/Predatory Insect/Spider and Entomopathogenic Fungus	
Pests		
Soybean (<i>Glycine max</i> L.)	<u>Parasitic Insect:</u>	
<i>Myzus persicae</i>	<i>Aphelinus asychis</i>	(Hymenoptera: Aphelinidae)
(Homoptera: Aphidae)	<i>Aphelinus mali</i>	(Hymenoptera: Aphelinidae)
	<i>Aphidius</i> sp.	(Hymenoptera: Aphelinidae)
	<i>Tassonia magniclava</i>	(Hymenoptera: Encyrtidae)
	<u>Predatory Insect:</u>	
	<i>Mallada basalis</i>	(Neuroptera: Chrysopidae)
	<i>Cheilomenes sexmaculatus</i>	(Coleoptera: Coccinellidae)
	<i>Coccinella transversalis</i>	(Coleoptera: Coccinellidae)
	<i>Scymnus apiciflavus</i>	(Coleoptera: Coccinellidae)
<i>Nezara viridula</i>	<u>Parasitic Insect:</u>	
(Hemiptera: Pentatomidae)	<i>Gryon antestiae</i>	(Hymenoptera: Encyrtidae)
	<i>Ooencyrtus</i> sp.	(Hymenoptera: Encyrtidae)
	<i>Telenomus</i> sp.	(Hymenoptera: Encyrtidae)
	<i>Trissolcus basalis</i>	(Hymenoptera: Scelionidae)
	<i>Trichopoda pennipes</i>	(Diptera: Tachinidae)
	<u>Predatory Insect:</u>	
	<i>Geocoris punctipes</i>	(Hemiptera: Geocoridae)
	<i>Sycanus collaris</i> F.	(Hemiptera: Reduviidae)

Table 1. Continued

Plants:	Parasitic Insects/Predatory Insect/Spider and Entomopathogenic Fungus	
Pests		
<i>Helicoverpa armigera</i> (Lepidoptera: Noctuidae)	Natural enemies same as upper page	
<i>Heliothis assulta</i> (Lepidoptera: Noctuidae)	<u>Predatory Insect:</u>	
	<i>Eocanthecona furcellata</i> (Wolff)	(Hemiptera: Pentatomidae)
	<i>Eocanthecona robusta</i> Distant	(Hemiptera: Pentatomidae)
Cotton (<i>Gossypium</i> spp)	<u>Parasitic Insect:</u>	
<i>Amrasca biguttula</i> (Homoptera: Cicadellidae)	<i>Anagrus empoascae</i>	(Hymenoptera: Encyrtidae)
	<i>Conatocerus empoascae</i>	(Hymenoptera: Mymaridae)
	<u>Predatory Insect:</u>	
	<i>Mallada basalis</i>	(Neuroptera: Chrysopidae)
	<i>Geocoris</i> sp.	(Hemiptera: Geocoridae)
	<i>Nabis</i> sp.	(Hemiptera: Nabidae)
<i>Aphis gossypii</i> (Homoptera: Aphidae)	<u>Parasitic Insect:</u>	
	<i>Aphelinus gossypii</i>	(Hymenoptera: Aphelinidae)
	<i>Aphidius</i> sp.	(Hymenoptera: Braconidae)
	<i>Lysiphlebus</i> sp.	(Hymenoptera: Aphidii)
	<i>Trioxus communis</i>	(Hymenoptera: Aphidii)
	<i>Trioxys</i> sp.	(Hymenoptera: Aphidii)
	<i>Syrphophagus sphidivorus</i>	(Hymenoptera: Encyrtidae)
	<u>Predatory Insect:</u>	
	<i>Geocoris</i> sp.	(Hemiptera: Geocoridae)
	<i>Nabis</i> spp.	(Hemiptera: Nabidae)
	<i>Hemerobius</i> sp.	(Neuroptera: Hemerobiidae)
	<i>Mallada basalis</i>	(Neuroptera: Chrysopidae)
	<i>Cheilomenes sexmaculatus</i>	(Coleoptera: Coccinellidae)
	<i>Harmonia octomaculatus</i>	(Coleoptera: Coccinellidae)
	<i>Coccinella transversalis</i>	(Coleoptera: Coccinellidae)
	<i>Micraspis discolor</i>	(Coleoptera: Coccinellidae)
	<i>Syrphus balteatus</i>	(Diptera: Syrphidae)

Table 1. Continued

Plants:	Parasitic Insects/Predatory Insect/Spider and Entomopathogenic Fungus	
Pests		
<i>Thrips tabaci</i> (Thysanoptera: Thripidae)	<u>Parasitic Insect:</u>	
	<i>Ceranisus brui</i>	(Hymenoptera: Eulophidae)
	<i>Megaphragma</i> sp.	(Hymenoptera: Trichogrammatidae)
	<u>Predatory Insect:</u>	
	<i>Campylomma</i> sp.	(Hemiptera: Miridae)
	<i>Orius</i> sp.	(Hemiptera: Anthocoridae)
	<i>Wollastoniella rotunda</i>	(Hemiptera: Anthocoridae)
	<i>Wollastoniella parvicuneis</i>	(Hemiptera: Anthocoridae)
	<i>Franklinothrips vespiformis</i>	(Thysanoptera: Aeolothripidae)
	<i>Mallada basalis</i>	(Neuroptera: Chrysopidae)
	<i>Amblyseius</i> sp.	(Acarica: Phytoseiidae)