Literature review about pest and natural enemy observation in Thai crop fields

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Background
Any organism that feeds on another organism is its natural enemy. Insects that are natural enemies of pests are called beneficial insects (Smith and Capinera, 2000). In integrated pest management (IPM), natural enemies are often called defenders because they defend the crop against pests. Natural enemies play a very important role in keeping pest populations under control. In the absence of natural enemies, pest populations increase rapidly.

The literature survey found 4 studies about pest and natural enemy observation in vegetable farm such as chili, cowpea, Chinese kale and asparagus while the other 6 studies were done in field crop (1 sweet corn, 1 sugarcane, 3 rice and 1 overall field crop).

Highlights of previous studies
Seubsaiboonsong et al. (2006) studied about population density of pest and their natural enemies on 2 chili cultivars; Hua-rua and Aromatic chili under organic agriculture system. They found pest and natural enemy density were higher in Aromatic chili. Charernsom and Suasa-ard (1994) investigated natural enemy complex as biological control agents in cowpea fields for insect pest management. The result showed that the important pest and natural enemy of cowpea was Aphis craccivora Koch and Menochilus sexmaculatus (Fabricius). Pongprasert (2003) found that the number of insect species in bio-agent treated Chinese kale field was higher than insecticide treated field and that the major insect pests were diamondback moth (Plutella xylostella (L.)) and flea beetle (Phyllotreta sp.), while the important natural enemies were fire ant (Solenopsis geminata (F.)) and Cotesia plutellae (Kurdjumov). Phukthair (2005) reported that the dominant pest and natural enemy in 2 asparagus fields (bio-agent and chemical treatments) were thrips and spiders respectively. In addition, the heavy rain was abiotic factor that reduced all arthropods in both fields. Boupha et al. (2006) monitored insect pest and natural enemy of sweet corn in 7 experimental plots (1 control, 1 chemical and 5 bio-agent treatments) in Khon Kaen University. The result showed that insect pests causing severe or moderate injury were corn borer (Ostrinia furnacalis), corn earworm (Helicoverpa armigera) and aphid (Rhopalosiphum maidis), and natural enemies commonly found were spiders, earwig (P. simulans), coccinellid (Menochilus sexmaculatus, Micraspis discolor) and black ant (Componotus sp.). Suasa-ard et al. (1990) reported that Trichogramma chilotraeae was the most important natural enemy of sugarcane moth borers.

The other studies about insect pest and natural enemy observation in rice paddies were done in many areas in Thailand. The important insect pests in rice paddies were green rice leafhopper (Nephotettix spp.), thrips (Stenchaetothrips biformis (Bagnall)) and rice leaffolder (Cnaphalocrocis medinalis (Guénée)). While natural enemies were different depend on each area (Jumruskarn et al. (2014), Chupraphawan et al. (2008) and Sorapongpaisal et al. (2011)). Suasa-ard (2010) summarized the important insect pests and natural enemies in Thai economic field crops; sugarcane, cassava, corn, soybean and cotton.

Summaries of studies
A population density study of pests and their natural enemies on two chili pepper cultivars; Hua-rua and Aromatic chili were implemented. Six organic agriculture system treatments were compared to farmer’s treatment. Five dominant pest species and eight natural enemies were recorded. The abundance of the pests and their natural enemies varied on chili cultivars, leaf color and treatments. The Aromatic chili leaf color was pale-green, pale-yellow and more blight color than Hua-rua, which attracted the pests more than that of the other cultivars.


This is a summary review of pests and natural enemies in cowpea fields in Thailand. Key pests of cowpea are aphid (Aphis craccivora Koch), bean fly (Ophiomyia (=Melanagromyza) phaseoli (Tryon)), mining moth (Maruca testulalis Geys), flea beetle (Phyllotreta sinuata Stephen), pod borer (Lampides boeticus (Linnaeus)), American bulbworm (Heliothis armigera Hubner), cutworm (Spodoptera litura (Fabricius)), beet armyworm (Spodoptera exigua (Hubner)), and rice green stink bug (Nezara viridula Linnaeus). The most common natural enemies are coccinellids (Menochilus sexmaculatus (Fabricius)) and Coccinella transversalis F., and predatory bug (Eocanthecona furcellata (Wolff)); bean fly parasite (Plutarchia giraulti Subba Rao) and egg parasites Trichogramma spp. and Telenomus spp.


The diversity of insect pests and natural enemies in the Chinese kale was compared in the fields treated with insecticides and bio-agents as in the usual farmer practice. The experiments were carried out 3 times in winter, summer, and rainy seasons of 2001-2002 growing seasons at Bung Pra, Phitsanulok. The numbers of species and insects from both treated fields were analyzed with insect diversity index in order to evaluate safety of bio-agent treated in the farm level. The numbers of species in the bio-agent treated fields were 2.00 up to 5.25 times higher than those of the insecticide treated fields and the numbers of insects of the former were also higher than those of the latter around 1.96-4.12 times. The dominant insect pests were diamondback moth (Plutella xylostella (L.)) and flea beetle (Phyllotreta sp.). Among the predators, fire ant (Solenopsis geminata (F.)) showed the highest number, while the most effective parasite was Cotesia plutellae (Kurdjumov), a larval parasite of the diamondback moth.


Insect pests, especially, thrips, common cutworm (Spodotera litura Fabricius), beet armyworm (Spodoptera exigua Hubner) and American bulbworm (Helicoverpa armigera Hubner), are serious problems of asparagus production. These pests are still mainly controlled by pesticides. Thus, to reduce pesticide residual in products for the future market, the studies of common pests and their natural enemies were conducted in two different areas: 1) at the farmer’s asparagus fields in Thung Khung sub-district, Kamphang Sean district, Nakhon Pathom province, 2) research fields of horticulture 2, Faculty of Agriculture at Kamphaeng Saen Campus, Kasetsart University. The insect pests mentioned above, and their natural enemies such as spiders, stink bugs (Eocanthecona furcellata Wolff, Sycanus collaris Fabricius) and parasitoids were collected by several methods: visual observing, shoot collecting, stem and shoot beating and pitfall trapping every 1-4 weeks. The fluctuations of pests and enemies population, and their relationships with their abiotic and biotic environments were evaluated. Results suggested that the most common pests and natural enemies in both areas were thrips and spiders, respectively. But S. collaris was not found. The climatic factors were a part of the controlling factors of both pests and enemies populations in each season. Especially, heavy rain reduced all arthropods collected in the asparagus fields.
In the first period, between May to September 2002, at Thung Khung sub-district, the population of thrips on asparagus was significantly lower than other fields if the field is surrounded by the other plants. The results suggested that enhancing biodiversity by other plants at field margin could reduce some pests’ densities, but not enough to enhancing their densities of enemies and their efficiency of pest control. In the second period, November 2002 to April 2003, at the research fields of horticulture 2, the results confirmed that the asparagus fields with pesticide applications had significantly lower population size of pests (thrips, common cutworm (*S. litora*)) and natural enemies (spiders on plant, *Cotesia* sp.) than fields with no-pesticide applications. In contrast, beet armyworms (*S. exigua*) were found more in the fields with pesticide applications. These results suggested that several factors were needed to keep pest populations at low level, such as abiotic factors, cultural techniques, their natural enemies, pesticides and other managements in asparagus fields. Only in few sites, some pests were increased dramatically in some periods, which mostly related with the optimal abiotic environment and low enemies population level. Thus, integrated pest managements of enemy conservation, pesticide applications and other methods should be practiced and studied more in future for better pest control.


Current situation of insect pests in sweet corn, their natural enemies and control practices were investigated in the field condition during May to July 2004 in vegetable research farm within Khon Kaen University. Total 7 methods were tested: control (T1), carbofuran 3%G (T2), one and two releases of brown earwig (*Proreus simulans*) (T3, T4), one release of black earwig (*Euborellia annulipes*) (T5), two releases of brown earwig with *Trichogramma* sp. (T6) and two releases of common brown earwig (*Labidura riparia*) (T7). Total 22 insect pest species and 14 species of natural enemies have been recorded. Insect pests 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 found commonly were spiders, earwig (*P. simulans*), coccinellid (*Menochilus sexmaculatus*, *Micraspis discolor*), black ant (*Componotus* sp.) 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 significantly different. However, the highest damage was observed in T1 at day 56 (27.5%) and statistically significant difference at P≤0.05 with T2, T5, T6, T3, T4 and T7 respectively. Ear damage was found highest (12.3%) at control (T1) and was significantly different at P≤0.05 with T5, T6 and T7 but it was not significantly different with T2, T3 and T4 respectively. However yield, marketable, unmarketable ears and return cost were not significantly different.


Investigation on natural enemies of sugarcane moth borers, *Chilo infuscatellus* Snellen, *Chilo sacchariphagus* (Bojer), *Scirpophaga excerptalis* (Walker) and *Sessamia inferens* (Walker) were carried out in the laboratory and supplemented with investigation under field condition in several sugarcane growing areas in Thailand. The investigation revealed that *Trichogramma chilotraeae* Nagaria and Nagarkatti, *Telenomus rowani* (Gahan) and *Cotesia flavipes* (Cameron) were the most important parasites of these sugarcane moth borers. Other less important natural enemies were the hymenopterous parasites, *Temelucha philippinensis* (Ashmead), *Xanthopimpla* sp., *Tetristichus schoenobii* (Ferriere) a species of unidentified tachinid, few species of earwigs and some species of spiders. These natural enemies were important factors to regulate the population of sugarcane moth borers.

Monitoring of rice insect pest outbreaks is implemented as the activity under the Development of Warning System for Natural Disaster and Rice Pest Outbreak Project. The purpose of this study is to survey the insect pests and their natural enemies in farmers’ fields in Pak Panang river basin and Nakhon Si Thammarat Rice Research Center during 2009 to 2013. The result showed that pest species being under surveillance were thrips (Stenchaetothrips biformis (Bagnall)), rice armyworm (Spodoptera litura (Fabricius)), brown planthopper (Nilaparvata lugens (Stal)), whitebacked planthopper (Sogatella furcifera (Horváth)), green rice leafhopper (Nephotettix spp.), rice leaffolder (Cnaphalocrocis medinalis (Guenée)), rice black bug (Scotinophara sp.) and slender rice bug (Leptocorisa oratorius (Fabricius)). The natural enemies found from the surveys include mirid bug (Cyrtorhinus lividipennis Reuter), Assassin bug (Polytoxus fuscovittatus (Stal)), long-horned grasshopper (Conocephalus longipennis (de Haan)), damselflies (Agriocnemis sp.), carabid beetle (Ophionia sp.), lady beetle (Harmonia sp., Micraspis sp.), rove beetle (Paederus sp.), ear wing and spiders. The amount of insect pests and their natural enemies were different in each area. The information from the surveys will be useful for pest outbreak warning and pest management.


The species and number of important insect pests and enemies on rice paddies were surveyed throughout 7 provinces in the lower part of Northeastern Thailand, to get baseline information for biological control. A total of 654 insect pests belonging to 12 families and 7 orders were collected. Moreover, 1,058 natural enemies belonging to 36 families (9 orders) were also collected and were classified into 18 families (7 orders) of predators and 18 families (2 orders) of predators and parasites, respectively. The well established species of insect pests were Nilaparvata lugens (Delphacidae), Nephotettix spp. (Cicadellidae), Cnaphalocrocis medinalis (Pyralidae). The natural enemies found in the survey were Hieroglyphus banian (Acrididae), Micrapsis discolor (Coccinellidae), Agriochemis sp. (Agrionidae), Tetragnatha spp. (Tetragnathidae), Oxyopes javanus (Oxyopidae), Tachinidae, Apanteles sp., Macrocentrus sp., Braconidae; Elasmidae, Elasmus sp. and Tetratichus sp. (Eulophidae).


Natural control of insect pest plays key role in organic rice production. Many species of insect pests and natural enemies have been involved. Species diversity of rice insect pests and natural enemies were carried out in organic rice paddy field at Environmental Entomology Research and Development Center, Kasetsart University, Kampaengsaen Campus during January to May 2009. Rice insect pests and natural enemies were collected from organic rice paddy field every 14 days from planting through harvesting period based on simple random sampling method using sweeping net at 10 times/sampling spot. 3 sampling spots in the field were randomized at each time of the sampling. All insect pests and natural enemies were identified, species diversity was calculated and the relationship to biotic factor: natural enemies and abiotic factors: temperature, relative humidity and rainfall were analyzed. The total of 52 species of insects and spiders composed of 20 species for insect pests, 25 species of insect natural enemies and 7 species of spiders were found. The highest species number of insects and spiders (46 species) was found during seed filling stage of rice and the lowest number (22 species) was found during seedling stage. Species diversity and species evenness was measured by Shannon-Wiener’s Index (H) and Shannon-Wiener’s Evenness Index (EH). Those of insect pests were 2.28 and 0.76 whereas those of natural enemies were
2.94 and 0.85 respectively. The species number of insect pests was not related to abiotic factors but it was related to the species number of natural enemies ($r = 88.5$) ($P$ value $\leq 0.05$).


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 has 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.

References
