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Species Diversity of Cotton Insect Pests

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ABSTRACT

Field experiments were conducted at Suwan Farm, Northeastern Thailand during two growing periods of 2000 and 2001 to determine the species diversity and abundance of insect pests of cotton. Randomized Complete Block Design (RCB) was arranged with four replications of sixteen plots of four cotton varieties/lines. Weekly sampling was performed by visual count and pan trap methods. Species diversity of insect pests was analyzed by Shannon-Weaver diversity index. Species abundance of insect pests was computed for each crop together with eight sampling dates. Species ranking was also developed from species abundance. The results showed that insect pests were greatly abundant during the first crop while low diversity indices were observed. During the second crop there was less appearance of insect pest. The total species abundance of all varieties/lines ranged from 10 (cotton spiny bollworm, *Earias* sp.), to 11,431 (cotton leafhopper, *Amrasca biguttula* Ishida), in the first crop and from 11 (*Earias* sp.), to 1,955 (*A. biguttula*), in the second crop. The ranges of species diversity indices were from 0.27 [Sri Samrong 60 (SR 60)] to 0.62 [Sarid 1 (SD1)], in the first crop and from 0.61 (SR 60) to 0.83 (SD1), in the second crop. *A. biguttula* was observed to be the dominant species in both crops. Other insect pests with less obvious importance were *Thrips palmi*, *Bemisia tabaci*, *Aphis gossypi*, *Megacoelum biseratense* and *Carpophilus* sp. Although total of 28 species found on cotton, only 13-14 insect pests appeared in the cotton field regularly. Two rare species did not occur on some cotton varieties/lines during the second crop.

Key words: cotton, insect pests, species abundance, diversity index

INTRODUCTION

Cotton, *Gossypium hirsutum* L., is subject to attack by wide variety of insect pests. The number of insect pests in cotton recorded were 1326 species (Hargreaves, 1948), 46 groups (Aston and Winfield, 1972) and 20 to 60 species (Luttrell *et al.*, 1994). Luttrell (1994) emphasized that although the number of species recorded in the crop varied from region to region, 5-10 key pests caused significant crop damage. In Thailand, about 33 different species were recorded in cotton and only 13 species are known to damage cotton each year (Cantelo and Pholboon, 1965; Nachapong *et al.*, 1989). The abundance of insect pests depends on season length, rainfall, temperature, surrounding vegetation, and agronomic practices (e.g., pest management) (Pimentel and Wheeler, 1973; Wilson, 1994).

Species diversity is a parameter of community structure involving species richness and their abundance for the given taxa (Wang *et al.*, 2000). He also stated that the reduction in species

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richness was mainly caused by the loss of the rarely encountered species. The reason of the decline in species diversity is the increased dominance of one species (Price, 1984). As a result, species diversity and complexity of association among species are essential to the stability of the community. In addition, knowledge of species diversity and insect pests abundance at various times are fundamental of pest control (van Emden and Williams, 1974). This information is still lacking in Thailand. The objective of the study was then to determine the species diversity and seasonal abundance of insect pests on four cotton varieties/lines during the two growing periods.

MATERIALS AND METHODS

The experimental area was located at Suwan Farm (356 m above sea level and 101.25°N, 14.42 °E), Pak Chong, Nakon Ratchasima, Northeastern Thailand. The study was carried out for two consecutive growing periods during 2000 and 2001. The area of the experimental field was 0.30 ha. The soil texture was clay with pH 7-7.5. Sixteen plots were arranged in a Randomized Complete Block Design (RCB) with four replicates of four cotton varieties/lines. There were seven rows, each of which was 20 m long and spaced 1 m apart. A 2 m wide alley was separating each block and plot. The cotton varieties/lines included the two recommended varieties, Sri Samrong 60 (SR 60) and Sarid 1 (SD1), and the two mutant lines AP1 and AP2 of moderate resistance to cotton bollworm and cotton leafhopper. Plots were seeded with a spacing of 1 m on 1 October 2000 for the first crop and on 21 July 2001 for the second. Agronomic practices which were common use in the area for cotton production was applied in this experiment. Sprinkler and furrow irrigation systems were applied as required. During the experimental period, 50 ml per 20 litres of water Carbosulfan 20% EC and 40 ml/20 litres of water Omethoate 50% SL were applied 5, 6, 7, 8 weeks after sowing (WAS), alternately for first crop and 40 ml per 20 litres of water Azodrin 60% WSC applied only once 4 WAS for the second, to control severe attack of leafhopper. The control was administered before the samples were taken.

Sampling was conducted by visual count and pan trap methods. For visual count, a total of 160 sample plants were observed by stratified random sampling technique. Direct count of leaf sucking pests was only emphasized on 5 leaves/plant (one from the top, two each from the middle and bottom of the canopy) as described by Mabbett (1980). For the pan trap method, 16 yellow plastic trays were filled with water and placed in each plot 2-3 days before monitoring. The number and type of insect pests were checked, counted and recorded weekly, from 8 December 2000 (8 WAS) to 31 January 2001 (15 WAS) for the first crop and from 30 August 2001 (5 WAS) to 18 October 2001 (12 WAS) for the second crop. Different types of insect pests were recorded from each sampling method. However, they were combined for further calculations. Sampling in the second crop was completed 3 weeks earlier than in the first one because of early incidence of insect pests in this crop. The collected specimens were preserved in 70% alcohol and taken to the laboratory. The specimens were examined subsequently by specialized taxonomists and sorted to families and species.

Species diversity of insect pests was analyzed by using Shannon-Weaver diversity index, $H' = -\Sigma^{s}_{i=1} p_i \log p_I{}'$ method (Shannon and Weaver, 1949; Pielou, 1975), where, s = the number of species, p_i = the proportion of the total number of individuals consisting of the ith species and H' = an estimate of the diversity of the total population of individuals. The calculation of diversity index based on the number of insect pests found in each variety/line of eight sampling dates. Seasonal abundance of insect pests of each crop was also computed. During the sampling periods, the range of mean temperature of the first crop was from 24.3°C in December 2000 to 25.4°C in January 2001. For the second crop, the range was from 26.8°C in August 2001 to 26.3°C in October 2001. The total rainfall was recorded as 397.3 mm and 489.7 mm for the first and the second crops, respectively. The maximum number of rainny days (20) was recorded in September 2000 and October 2001. There was no rain in December 2000.

RESULTS AND DISCUSSIONS

A total of 28 insect pests species were found from both sampling methods (Table 1). There were 17 insect pests species recorded from visual count sampling method and 11 species from pan trap. However, only 14 species were mentioned for species abundance and species diversity index (Table 2 & 3). The rests did not occur in numbers large enough to be included.

Table 2 presents 14 species of insect pests collected from both sampling methods of four cotton varieties/lines during the first crop. The species were ranked according to their abundance. The most abundant species was *Amrasca biguttula* Ishida (11,431=rank no.1) followed by *Thrips palmi* Karny (2,385=rank no. 2) and the least abundant species, *Earias* sp, (10=rank no.14). The result indicated cotton leafhopper to be considered as the most serious key pest of cotton in Thailand.

All species found in the first crop were also observed in the second crop (Table 3). The total species abundance ranged from 11 (*Earias* sp.), to 1,955 (*A.biguttula*). The similar trend was observed

Table 1 Total insect pests species collected by visual count and pan trap sampling methods from four cotton varieties/lines at Suwan Farm, Northeastern Thailand in 2000 and 2001.

Insect pest species	
Sampling method	
Visual count	Pan trap
Adoretus sp.	*Aulacophora frontalis* Baly
Amorphoidea sp.	*Aulacophora indica* Gmelih
Amrasca biguttula Ishida	*Bothrogonia* sp.
Aphis gossypi Glover	*Earias* sp.
Bemisia tabici Gennadius	*Graptostethus servus* Fabr.
Carpophilus sp.	*Lactica perraudreri* Allard,
Cosmophila sp.	*Monolepta mignata* Oliver
Cyrtacanthacris tatarica L.	*Notogonia sp*
Dysdercus cingulatus (Fabricius)	*Onthophagus sp.*
Helicoverpa armigera Hubner	*Spodoptera litura* (F.)
Hypomoces squamosus Fabr.	*Trypoxylon sp.*
Megacoelum biseratense (Distant)	
Nezara viridula (L.)	
Pectinophora gossypiella Saunders	
Pseudatomoscelis sp.	
Sylepta derogata Fab.	
Thrips palmi Karny.	

in the second crop. The most abundant species was *A. biguttula* (rank=1) followed by the 2nd most abundant species, *T. palmi* whose population was 1.6 fold less than that of *A. biguttula* while the least abundant species was *Earias* sp. (rank=14) (Table 3). Comparing the two crops, the total number of insect pests during the second crop was substantially lower than during the first crop (Table 2 & 3). It was possible to assume that population levels of insect pest in the second crop were affected by climatic changes (e.g. rainfall and temperature). Frisbie (1983) reported that dry season was associated with lower infestation of bollworms and leafhoppers, while wet season was associated with higher infestation. Another possible reason was that the existing of surrounding crops such as other cotton fields and preferred host plants (e.g.maize), might influence the low species abundance in the second crop.

Concerning *Helicoverpa armigera* Hubner, although it had been considered as a primary key pest of cotton in Thailand for most of the years, the abundance was apparently low in this study (Table 2 & 3). The insect was more abundant in the second crop ca. 2 times than in the first one. During the first crop, the weather conditions seemed to be not favorable for the development and survival of *H. armigera* with not enough rain at flowering stage and therefore increased square shedding. As a result, the adult could go for alternate host plants during this season. All these might be the considered causes of low abundance of this pest in the study.

Table 2 Types of insect pest and their abundances collected by visual count and pan trap methods from 8 sampling dates of four cotton varieties/lines at Suwan Farm, Northeastern Thailand during the first crop.

Rank [1/]	Insect pests species	Species abundance [2/]				
		Varieties/lines				
		AP1	AP2	SD1	SR60	Total
1	*Amrasca biguttula* Ishida	2,988	2,837	2,898	2,708	11,431
2	*Thrips palmi* Karny.	663	839	859	24	2,385
3	*Bemisia tabici* Gennadius	646	482	774	105	2,007
4	*Megacoelum biseratense* (Distant)	411	468	549	112	1,540
5	*Aphis gossypi* Glover	158	58	82	75	373
6	*Pectinophora gossypiella* Saunders	91	94	127	9	321
7	*Carpophilus* sp.	57	76	96	16	245
8	*Cosmophila* sp.	35	49	25	19	128
9	*Pseudatomoscelis sp.*	20	18	16	4	58
10	*Spodoptera litura* (F.)	13	16	5	7	41
11	*Helicoverpa armigera* Hubner	10	11	9	8	38
12	*Sylepta derogata* Fab.	13	10	6	5	34
13	*Dysdercus cingulatus* (Fabricius)	3	6	5	9	23
14	*Earias* sp.	2	3	3	2	10

[1/] Cumulative importance of species collected.
[2/] Number of insect pests per 40 plants collected from 4 replicates and 8 sampling dates.

Table 3 Types of insect pest and their abundances collected by visual count and pan trap methods from 8 sampling dates of four cotton varieties/lines at Suwan Farm, Northeastern Thailand during the second crop.

Rank [1/]	Insect pests species	Species abundance [2/] Varieties/lines				
		AP1	AP2	SD1	SR60	Total
1	*Amrasca biguttula* Ishida	208	484	383	880	1,955
2	*Thrips palmi* Karny.	260	472	376	72	1,180
3	*Carpophilus* sp.	226	315	7	197	745
4	*Aphis gossypi* Glover	89	40	211	225	565
5	*Megacoelum biseratense* (Distant)	78	94	111	48	331
6	*Bemisia tabici* Gennadius	53	80	83	56	272
7	*Helicoverpa armigera* Hubner	25	20	24	24	93
8	*Cosmophila* sp.	25	14	4	5	48
9	*Pseudatomoscelis sp.*	4	4	17	5	30
10	*Dysdercus cingulatus* (Fabricius)	5	7	9	3	24
11	*Spodoptera litura* (F.)	6	4	4	4	18
12	*Sylepta derogata* Fab.	2	1	11	1	15
13	*Pectinophora gossypiella* Saunders	5	0	0	9	14
14	*Earias* sp.	0	1	8	2	11

[1/] Cumulative importance of species collected.
[2/] Number of insect pests per 40 plants collected from 4 replicates and 8 sampling dates.

Table 4 presents the number of individuals, number of species and species diversity indices of insect pest collected from four cotton varieties/ lines during 2000 and 2001. Fourteen species were found from each cotton variety/line in the first crop. 13 species were recorded from 3 cotton varieties/ lines except SR60 in the second crop. The ranges of total species abundance on cotton varieties/lines were from 3,101 to 5,110 in the first crop and from 986 to 1,536 in the second. Generally, insect pest abundance of the first crop was ca. 3 times higher than in the second one. It was observed that the second crop was more diversed than the first one. It might be due to the interaction between food availability and abundance of natural enemies. The results did not indicate the effect of cotton varieties/ lines on species abundance but SR60 seemed to have the lowest species diversity in both crops. The result agreed with Wang *et al*. (2000) who reported that when the species richness was high, diversity index tended to have smaller values. Moreover, severely physical limiting factors could result in a low diversity index.

Figure 1 shows the most five abundant species collected during the first crop. The relative abundance of different species varied considerably during the sampling period. Although the most abundant species, *A. biguttula* occurred throughout the season, there was a definite seasonal trend in population numbers. It reached peak numbers 10 WAS and then gradually declined till 15 WAS. The result indicated that *A. biguttula* was dominant species in this crop. The 2nd species, *T. palmi* occurred only 8, 9 and 10 WAS (Fig 1). The 3rd

Table 4 Species richness, abundance and diversity indices of insect pests on four cotton varieties/lines at Suwan Farm, Northeastern Thailand during two growing periods of 2000 and 2001.

Cotton variety/line	Species richness [1/]		Species abundance [2/]		Diversity indices [3/]	
	First crop	Second crop	First crop	Second crop	First crop	Second crop
AP1	14	13	5110	986	0.59	0.82
AP2	14	13	4967	1536	0.60	0.71
SD1	14	13	5454	1478	0.62	0.83
SR60	14	14	3103	1531	0.27	0.61

[1/] Number of species present
[2/] Number of individuals
[3/] Shannon- Weaver diversity index (H') values

species, *Bemisia tabaci* Gennadius, reached peak 8 WAS and gradually declined till 15 WAS (Fig 1). No *B. tabaci* was found 12 WAS. *B. tabaci*, the primarily late season pest was greatly abundant in early growing stages showing that the trend of pest could be changed at times. It was recorded as the fourth important pest of cotton in the early 1970's (Mabbett, 1980). The 4th, *Megacoelum biseratense* (Distant) occurred in all sampling dates and peak reached 11 WAS. In recent years, *M. biseratense* is potentially becoming one of the key pests of cotton

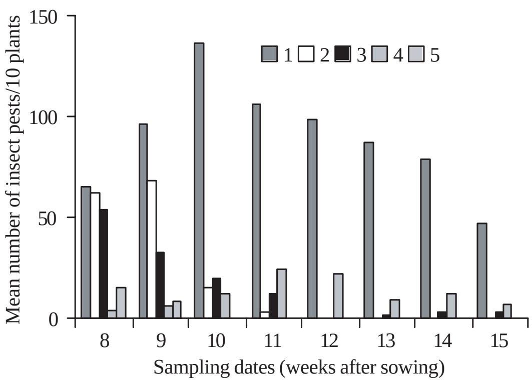

Figure 1 Seasonal trend of the most abundant insect pests found on four cotton varieties/lines during the first crop. (1) *Amarasca biguttula* (2) *Thrips palmi* (3) *Bemisia tabaci* (4) *Megacoelum biseratense* (5) *Aphis gossypi*

in Thailand (Hormchan and Wongpiyasatid, 1999). The 5th species, also the early season pest, *Aphis gossypii* Glover, was only abundant 8 and 9 WAS. The effects of parasites, predators and diseases might cause fluctuations in abundance of *A. gossypii*, since some of its predators as the *Menochilus sexmaculatus* (F.), *Micraspis discolor* (F.), *Chrysopa* sp. and *Geocoris* sp. were noticed.

The most abundant species, *A. biguttula* occurred during the entire sampling period except 9 WAS and the main peak appeared 11 WAS in the second crop (Fig 2). It might be due to the overlapping of generation at that time. Moreover, the peak might coincide with the lowest rainfall (6.5) mm 11 WAS. Mabbett, *et al*. (1984) found that reduction of nymph population could be affected by heavy rain. The 3 lesser peaks occurring 5, 7 and 9 WAS showed almost the same levels of abundance. The similar 2 peaks of the 2nd most abundant, *T. palmi* were observed 5, 7 and then declined 9 WAS (Fig 2). The 3rd species, *Carpophilus sp*. occurred during 9 to 12 WAS and the 3 peaks were found nearly the same abundance. The peak of 4th species, *A. gossypii* reached 6 WAS and sharply declined 7 WAS. *M. biseratense* also occurred throughout the sampling period and the small peak reached 7 WAS (Fig 2). It was found that *A. biguttula* was also dominant species in this crop. In general, rainfall possibly played an important role in suppressing any increase in the population of insect pests during 8 to 10 WAS (early–mid October).

The two dominant diversity curves of cotton insect pest for both crops were quite similar, but some differences were found in species ranking (Fig 3). It was assumed that differences between the two crops were distinct in terms of species abundance and the degree of dominance by the most to medium abundant species. The curves showed the decrease in species richness during the second crop. Field studies were conducted by Wang *et al*. (2000) and they observed that the reduction in species richness was mainly caused by the loss of the rarely encountered species. In this experiment, two occasional pest species, *P. gosssypiella* and *Earias* sp. that occurred in the first crop did not appear in some cotton varieties/lines of the second crop. Moreover, the decline in species diversity of the first crop might be due to the increased dominance of the most common species, *A. biguttula* throughout the season. Price (1984) revealed that the reason of the decline in diversity was due to the increased dominance of one species. However, Poole (1974) reported the diversity indices to be strongly affected by the abundances of the middle species of a community rather than by the common or rare species. It was reported that the increased diversity led to the increased stability (Poole, 1974; Risch *et.al*.,1983). However, this study did not provide any information of the role of diversity on the stability of insect pest populations, thus studies over some years should be furtherly conducted.

Risch *et.al* (1983) stated that monoculture had higher pest populations than polyculture. They also recorded fifty-three percentages of the herbivore species to decrease in the more diversified system. Therefore, it is possible that key pest populations could be maintained at relatively low abundance (below the economic threshold level) by diversifying agroecosystems. In addition, the diversity of crop habitats surrounding cotton may be advantageous over long-term period for pest management, such as the large number of predators, reduced weed problems or improved soil fertility. For the short-term benefit, increased cotton yields or reduced pest control costs may result.

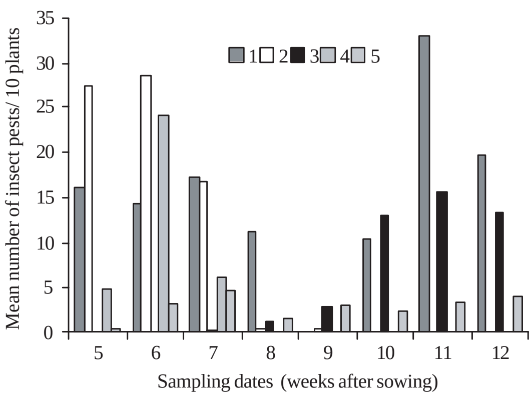

Figure 2 Seasonal trends of the most abundant insect pest on four cotton varieties/lines during the second crop. (1) *A. biguttula* (2) *T. palmi* (3) *Carpophilus* sp. (4) *A. gossypi* (5) *M. biseratense*

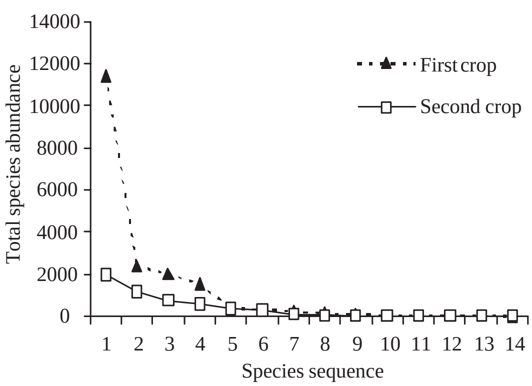

Figure 3 The dominant species diversity curves of cotton insect pests at Suwan Farm, Northeastern Thailand during 2000 and 2001 with species sequence arranged from the most to the least abundant species.

CONCLUSION

The dominant species of *Amrasca biguttula* Ishida exhibited the tendency to be the most alarming key pest of cotton in Thailand. It was possible to assume that the abundance and status of insect pests could be changed over the season and species diversity was directly affected by the fluctuation of individual species population. Comparing the diversity indices of both cropping periods, the second crop seemed to have diversed habitat. Even though diversification of crop habitats may provide the effective cotton pest control method, it tends to be restricted for less developed regions. Further studies in different communities will be beneficial to a better understanding of insect pests complex in cotton ecosystem and pest management.

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