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Diversity and abundance of predatory arthropods in sunflower and sunnhemp patches

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Abstract : Predatory arthropods function as natural enemies to control insect pests. Nevertheless, predatory arthropods are commonly affected by natural disturbances and human management. Therefore, conservation of predatory arthropods through enrichment of habitat could assist the control of insect pests. This study aims to assess the abundance and diversity of predatory arthropods and their preys in sunflower plots, sunnhemp plots, mixed plots of sunflower and sunnhemp, and fallowed plots. Predatory arthropods were sampled using hand collecting with constant time, sweep net and pitfall trap. Field works were conducted for one cropping season during May–August 2015. A total of 234 predatory arthropods were collected from 1,314 arthropod specimens. Predatory arthropods were from 6 orders of Araneae, Coleoptera, Hemiptera, Diptera, Mantodea and Dermaptera. The highest abundance was found in sunnhemp plots (23.2 individuals/m^2), followed by fallowed plot (19.6 individuals/m^2), sunflower plot (18.8 individuals/m^2) and mixed plot (16.4 individuals/m^2) respectively. Spiders frequently found common predatory arthropods, particularly in families Clubionidae (16.5 individuals/m^2) and Lycosidae (16.1 individuals/m^2), while cicadellids were the most of common pests (78.2 individuals/m^2). Predatory arthropods were mostly found during leaf stage followed by flower stage and seed stage. Sunnhemp had the highest diversity of predatory arthropods, followed by fallowed plot, mixed plot, and sunflower plot, respectively.
Keywords : predatory arthropods, refuge, sunflower, sunnhemp, fallowed plot

Introduction

Predatory arthropods, such as beetles, spiders and bugs, can quickly control pests at high density. *Philodromus* spiders have reported to successfully control pests in fruit gardens (Michalko and Pekár, 2015), and which beetles can control aphids on greenhouse roses (Snyder *et al.*, 2004). However, predatory arthropods are negatively affected by natural disturbance and human management. Pesticide treatments, harvesting, plowing or burning can destroy food and habitat of arthropods (Cloyd and Dickinson, 2006). Moreover, predatory arthropods are affected by intraguild predation, especially with inadequate food (Takizawa and Snyder, 2011).

Habitat enrichment may be implemented by providing refuge of food and microhabitats to predatory arthropods. Several plants have been used as refuge for predatory arthropods, such as alfalfa (Fahrig and Jonsen, 1986; Arbab and McNeill, 2014; Ximenez-Embun *et al*., 2014), marigold, sunflower (Hilgendorf and Goeden, 1981; de la Fuentea *et al.*, 2014), and sunnhemp (Tavares *et al.*, 2011). There plants would help maintain populations of predatory arthropods. Sunflower and sunnhemp have been used as rotation al crops Saraburi and other provinces in Thailand to improve the quality of soil as green manure (Ministry of Agriculture and Cooperatives, 2015). However, there is limited information on predatory arthropod community in sunnhemp. Therefore, this study aims to compare abundance and diversity of predatory arthropods in sunflower, sunnhemp, mixed plot of sunflower and sunnhemp, and fallowed plot in order to improve the conservation of predatory arthropods.

Methodology

1. Study area

The 300 - ha study site was about located at the Chulalongkorn University Center of Learning Network for the Region (CU-CLNR), Kangkhoi District, Saraburi Province. The study site contained organic field about 1.5 ha surrounded by 200 – ha reforested plots and 35 – ha secondary forest. The area had about 0.5 ha with sunflower and sunnhemp patches all year long. The experiment plots located was about 500 m^2 in the center of the organic field. There were 12 of 3×3 m^2 plots with 4 treatments and using randomized completely block design as following: 3 replications for each treatment

1. Sunflower plot (*Helianthus annuus* cv.) (at 9 plants/m^2, Ministry of Agriculture and Cooperatives, 2015).
2. Sunnhemp plot (*Crotalaria juncea* cv.) (at 150 plants/m^2, Ministry of Agriculture and Cooperatives, 2015).
3. Mixed plot (at 4 sunflower/m^2 and 75 sunnhemp/m^2). 4. Fallowed plot with natural succession of vegetation.

2. Arthropod collecting methods

Predatory arthropods and pests were sampled with 3 methods every week from May – August 2015. Growth stages of plants, such as leaf stage, flower stage and seed stage, were also recorded on the sampling day. Samples were collected with the following sampling methods,

a. Hand collecting with constant time

Predatory arthropods and pests on the ground, in blade of grass and on sunflower and sunnhemp were collected with forceps in three subplots of each 3×3 m^2 plot. The three 1×1 m^2 subplots were the middle subplot and two randomly selected bordered subplots. The sampling time was 5 minutes at each subplot.

b. Sweep net

Arthropods were collected with a 30 cm diameter sweep net in each the three subplots described in the method a. The net was swept four times back and forth at 1 m at each subplot.

c. Pitfall trap

Plastic cup (diameter 9 cm and height 5 cm) with 70 ml of detergent solution (1%) was placed in each of the three subplots next to sticky traps. Each trap was collected after 24 hours.

3. Preservation and identification

Arthropod specimens were preserved in tubes containing 70% ethanol. Arthropods were identified to the family level (Triplehorn and Johnson, 2005) or the possible smallest classification. Ecological roles, such as predator, herbivore or detritivore, were assigned to each taxon based on the taxonomic affiliation.

4. Data analyses

Shannon-Wiener's diversity index and Simpson diversity index were calculated and compared between plots and growth stage of plant. (Brower *et al.*, 1997) The Sorensen similarity index (Brower *et al.*, 1997) was calculated to determine similarity of predatory arthropods and pests between treatments.

Results and Discussion

1. Diversity of predatory arthropods and pests

From the total 1,314 arthropod individuals collected, there were 234 individuals of collected predatory arthropods from all methods, and they were from 6 orders and 29 families, including 18 families of order Araneae, 4 families of order Hemiptera, 3 families of order Coleoptera, 2 families of order Diptera, 1 families of order Mantodea and 1 families of order Dermaptera. Most predatory arthropods were from family Clubionidae (21.20%), Lycosidae (20.55%) and Gnaphosidae (10.13%). Other group of predatory arthropods were Coleoptera (11.22%), Hemiptera (6.23%), Diptera (5.28%), Mantodea (0.10%) and Dermaptera (0.05%). The composition of predatory arthropods by order and family were similar among all 4 treatments (Table 1).

Spiders were the most common predatory arthropods, particularly in families Clubionidae (16. 5 individuals/ m^2 or 21. 20%) and Lycosidae (16. 1 individuals/ m^2 or 20. 55%), while cicadellids were the most of common pests (78. 2 individuals/ m^2 or 18. 34%) followed by phytophagous insect pests from families Thripidae, Elateridae, Miridae, and Drosophilidae. Other predatory arthropods were lady beetle, ground beetles, ants, big-eyed bugs and assassin bug.

The most abundant predatory arthropods were found in sunnhemp plots (23. 2 individuals/ m^2) followed by fallowed plot (19. 6 individuals/ m^2), sunflower plot (18. 8 individuals/ m^2) and mixed plot (16. 4 individuals/ m^2) respectively (Figure 1). However, the abundance predatory arthropods in all plots were not significantly different (Kruskal-Wallis, P> 0. 05). In addition, the diversity of predatory arthropods based on Shannon-Wiener's index (H') and abundance of predatory arthropods with Simpson index (D) among treatment have comparatively similar values (Table 2.) because the experiment plots in the area together.

A total of pest arthropod 1,080 individuals from 8 order and 84 families were found from all experiment plots. Diptera 20 families, Hemiptera 26 families, Lepidoptera 6 families, Orthoptera 3 families, Psocoptera 2 families, Thysanoptera 1 families and Isoptera 1 families. The most abundant pests were from Cicadellidae (78. 3 individuals/ m^2) of order Hemiptera followed by Thripidae (74. 9 individuals/ m^2) of order Thysanoptera, Elateridae (59.8 individuals/ m^2) of order Coleoptera, Miridae (40.9 individuals/ m^2) of order Hemiptera, and other families (105.99 individusls/ m^2) respectively.

In addition, the most abundance pests were found in the sunnhemp plot (116.1 individuals/ m^2) followed by fallowed plot (92. 9 individuals/ m^2), mixed plot (82. 4 individuals/ m^2) and sunflower plot (70. 3 individuals/ m^2) respectively. Moreover, abundance pests in all plots were not significantly different (Figure 2.) (Kruskal-Wallis, P> 0.05)

In sunnhemp plots, most predatory arthropods were found in leaf stage (2. 1 individuals/ m^2) followed by seed stage (1.6 individuals/ m^2) and flower stage (1.1 individuals/ m^2). In sunflower plots, predatory arthropods were found in leaf stage (1. 8 individuals/ m^2) followed by seed stage (1. 7 individuals/ m^2) and flower stage (0. 9 individuals/ m^2). And mixed plots, predatory arthropods were found in leaf stage (1. 6 individuals/ m^2) followed by flower stage (1.2 individuals/ m^2) and seed stage (1.0 individuals/ m^2). Moreover, abundance predatory arthropods in all plots were not significantly difference (Kruskal-Wallis, P> 0. 05) (Figure 3). In addition, the diversity of predatory arthropods based on Shannon-Wiener's index (H') and abundance of predatory arthropods with Simpson index (D) among treatment have comparatively similar values (Table 3). Information from growth stage were found in leaf stage have the mostly diversity of predatory arthropods due to the leaf stage have pest very infestation.

2. Similarity index

All four treatments had highly similar composition of predatory arthropods at the family level with Sorensen similarity indies ranges from 0.829-0.976 due to similar pests (Table 4).

Conclusion

Diversity among of predatory arthropods had been found to be similar among the four treatments and the abundance at predatory arthropods were also not different among the 4 treatments possibly due to close proximity of the plots and ability of predatory arthropods to disperse over the plots. Data from three more crops will be combined and calculated the pattern of predatory arthropods and abundance between sunnhemp plots, sunflower plots, mixed plot and fallowed control plots.

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Table 1. Number and presence percent of predatory arthropod families in the experiment plots with collected all sampling methods.

Order	Family	indiv/m^2	Presence
Araneae		**60.09**	**77.13 %**
Araneae	Clubionidae	16.52	21.20
Araneae	Lycosidae	16.01	20.55
Araneae	Gnaphosidae	7.89	10.13
Araneae	Corinnidae	6.45	8.28
Araneae	Oxyopidae	4.37	5.61
Araneae	Unknown 1	2.13	2.73
Araneae	Ctenidae	2.11	2.71
Araneae	Anapidae	0.96	1.24
Araneae	Saltieidae	0.85	1.09
Araneae	Opiliones	0.30	0.38
Araneae	Unknown 3	0.26	0.33
Araneae	Unknown 4	0.11	0.14
Araneae	Pholcidae	0.07	0.10
Araneae	Unknown 6	0.24	0.31
Araneae	Uloboridae	0.04	0.05
Araneae	Unknown 2	0.04	0.05
Araneae	Unknown 5	0.04	0.05
Coleoptera		**8.74**	**11.22 %**
Coleoptera	Carabidae	5.70	7.32
Coleoptera	Cleridae	1.59	2.04
Coleoptera	Coccinellidae	1.44	1.85
Hemiptera		**4.85**	**6.23 %**
Hemiptera	Gecoridae	3.70	4.76
Hemiptera	Reduviidae	0.56	0.71
Hemiptera	Psylloidea	0.48	0.62
Hemiptera	Nabidae	0.11	0.14
Diptera		**4.11**	**5.28 %**
Diptera	Cecidomyiidae	3.96	5.09
Diptera	Dolichopdidae	0.15	0.19
Mantodea		**0.07**	**0.10 %**
Mantodea	Mantidae	0.07	0.10
Dermaptera		**0.04**	**0.05 %**
Dermaptera	Carcinophoridae	0.04	0.05

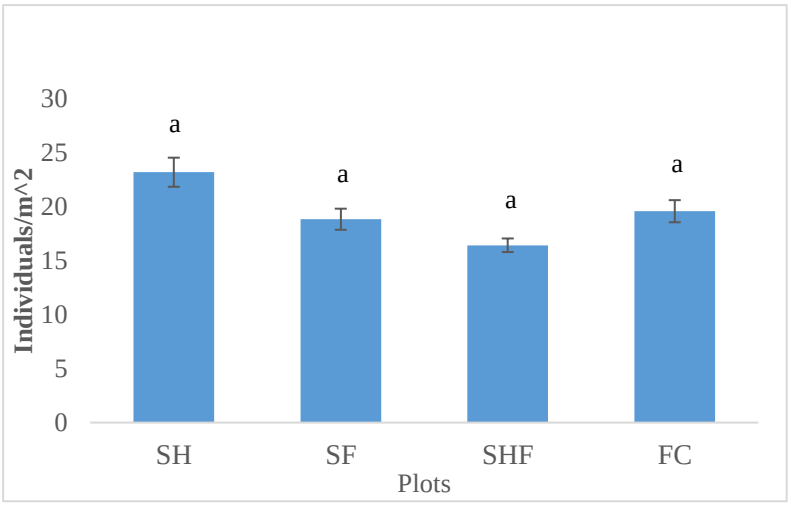

Figure 1. Abundance of predatory arthropods in sunnhemp plots (SH), sunflower plots (SF), mixed plots (sunnhemp and sunflower) (SHF) and fallowed plot (FC) Remke: abundance of predatory arthropods in each column not significantly difference in all plots by Kruskal-Wallis, P> 0.05

Table 2. Diversity of predatory arthropods based on Shannon-Wiener's index (H') and Simpson index (D) in sunnhemp plots (SH), sunflower plots (SF), mixed plots (sunnhemp and sunflower) (SHF) and fallowed plot (FC).

Plots	H'	D
SH	2.292	0.926
SF	2.332	0.950
SHF	2.400	0.940
FC	2.313	0.933

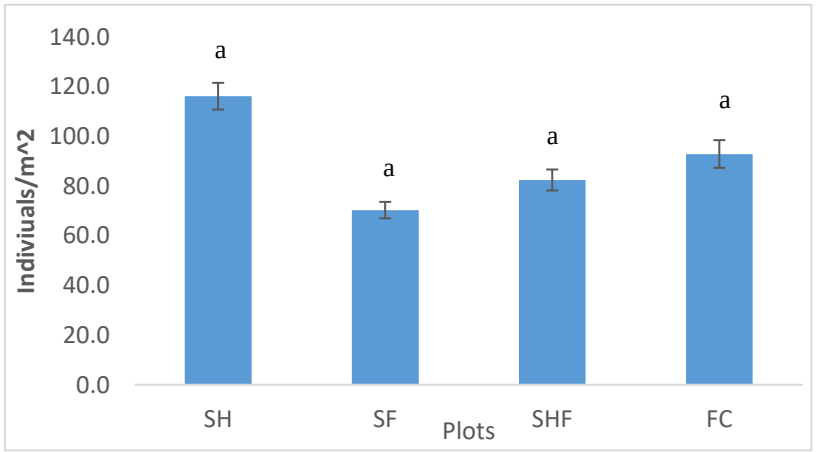

Figure 2. Abundance of pests in sunnhemp plots (SH), sunflower plots (SF), mixed plots (sunnhemp and sunflower) (SHF) and fallowed plot (FC) Remke: abundance of predatory arthropods in each column not significantly difference in all plots by Kruskal-Wallis, P> 0.05

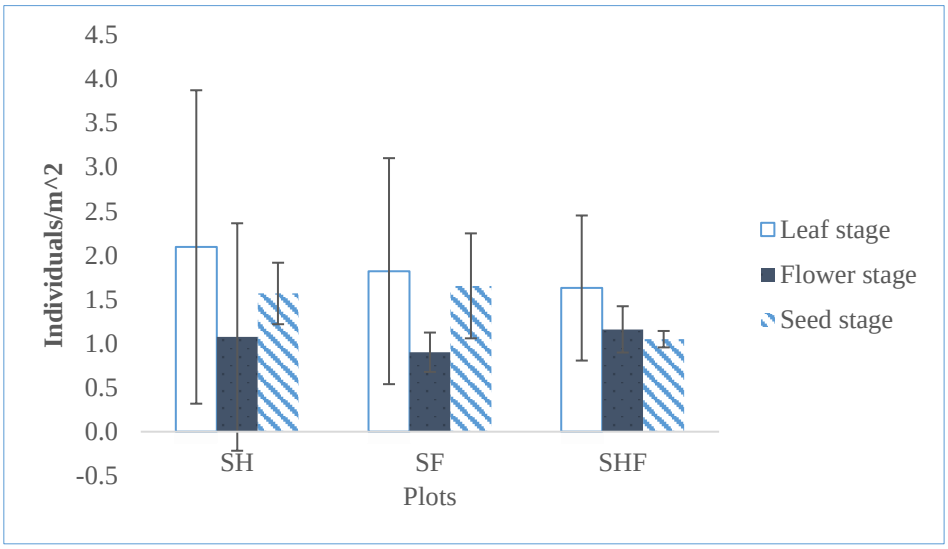

Figure 3. Abundance of predatory arthropods in growth stage of plant. Remke: abundance of predatory arthropods in each column not significantly difference in all plots by Kruskal-Wallis, P> 0.05.

Table 3. Diversity of predatory arthropods based on Shannon-Wiener's index (H') and Simpson index (D) in growth stage of plant.

Growth stage		H'	D
Leaf stage	(SH)	0.3608	0.9338
	(SF)	0.3648	0.9360
	(SHF)	0.3637	0.9256
Flower stage	(SH)	0.3364	0.8548
	(SF)	0.3254	0.8810
	(SHF)	0.3616	0.8517
Seed stage	(SH)	0.3659	0.8690
	(SF)	0.3677	0.8381
	(SHF)	0.3545	0.8828

Table 4. The Sorensen's similarity index of family predatory arthropods in study plots of sunnhemp plots (SH), sunflower plots (SH), mix plots (sunnhemp and sunflower) (SHF) and fallowed plot (FC).

Plots	SH	SF	SHF	SC
SH	1			
SF	0.829	1		
SHF	0.933	0.894	1	
SC	0.956	0.871	0.976	1