RELATIVE ABUNDANCE AND DIVERSITY OF INSECTS IN SOME CUCURBIT PLANTS FROM HNAW-KONE VILLAGE, PAKOKKU TOWNSHIP

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Abstract

Relative abundance, species diversity, richness and evenness of insects from cucurbit plantations were investigated during May to August 2019. A total of 56 species belonging to 28 families in six orders were collected from studied plants (gourd, pumpkin, squash and watermelon). Insect population was more abundance in order Hemiptera followed by Coleoptera and Lepidoptera. The lowest population was found in order Odonata. Pumpkin plants have the highest diversity and gourd plants have lowest diversity of insects. The highest similarity value was found between pumpkin and squash plants.

Keywords: Insects, Relative abundance, Species diversity, Cucurbit plants

Introduction

Cucurbitaceae is a fairly large family containing about 100 genera and 800 species which are essentially distributed in tropical or subtropical regions and relatively few species extending into temperate climate. Cucurbitaceae are used as fruits and vegetables and most of them have economic value (Rahman, 2013). Agriculture is a major component of the Myanmar economy, contributing 42% to its GDP and involving 70% of the labour force (CIA 2006). Seventy-five percent of the population of Myanmar live in rural areas and depend on agriculture for their livelihood (Singleton 2003). Cucurbit vegetables are cultivated throughout in Myanmar.

Insect pests are major problem for productivity of cucurbit plants. Insects are important because of their diversity, ecological role, and influence on agriculture, human health, and natural resources (Berenhaum, 1995). They inhabit all habitat types and play major roles in the function and stability of terrestrial and aquatic ecosystems (Godfrays, 2002). Environmental variation contributes diversity of species in natural ecosystem and in agro ecosystems (Alencar *et al.*, 2013).

Species richness is currently the most widely used diversity measure. Relative species abundance in a community is another factor that affects diversity (Hurlbert, 1971). Species diversity is the most common representation of ecological diversity, uses mathematical indices broadly known as diversity indices, derived from combining information on richness and evenness (Hamilton, 2005).

The present study was aimed

- to study the relative abundance of insects in each order

- to investigate the diversity of insects in cucurbit plants from Hnaw-kone village.

Materials and Methods

Study Area

Hnaw-kone village is situated in Pakokku Township, Magway Region, located between North latitude 21° 22' 32.45" and East longitude 95° 09' 38.59" (Plate 1).

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Plate 1 Location map of the study area (**Source:** From Google Earth, 2019)

Site I. Gourd plants

Site II. Pumpkin plants

Site III. Squash plants

Site IV. Watermelon plants

Plate 2 Study Area

Study Period

The study period was lasted from May to August 2019.

Specimen Collection, Identification and preservation

Collection of insects was randomly carried out in the early hours of the day, chosen one day in a week. The host (cucurbit) plants were selected and insects were collected by hand pickling, with forceps and hand nets (sweep net) throughout the fields. The species identification was made by the following Hill (1983) and Nair (1995). The insects were killed with mild chloroform and then preserved in insects boxes for future study.

Data analysis

(a)Relative Abundance

$$\text{Relative Abundance} = \frac{\text{Total number of individuals of a species}}{\text{Total number of individuals of species in a order}} \times 100$$

(Bisht *et al*., 2004)

(b) Diversity of insect species

Species richness, diversity and evenness of collected species were analyzed by four methods; Margalef's Index (1958), Simpson's index diversity (1949), Shannon-Wiener's index (1948),and Hill's Evenness index (1973), cited by Ludwig and Reynolds, 1988.

For Margalef's species richness Index (1958)

$$d = \frac{S-1}{\text{Ln } (N)}$$

Where, d = Margalef's species richness index

S = Number of species

N = Total number of individuals

For Simpson's index diversity (1949),

$$D = \sum_{i=1}^{s} \frac{n_i\ (n_i - 1)}{n\ (n-1)}$$

D = Simpson's index of diversity

n_i = number of individuals in the i^{th} species

n = total number of individuals of all species

For Shannon-Wiener's index (1948),

$$H' = -\sum_{i=1}^{s} \left(\frac{n_i}{n}\right) \text{Ln } \left(\frac{n_i}{n}\right)$$

Where, H' = Shannon index of species diversity

S = number of species

n_i = number of individuals in the i^{th} species in the sample

n = total number of individuals of all species in the sample

Hill's Evenness index (1973)

$$E = \frac{(1/D)-1}{e^{H'}-1} = \frac{N2-1}{N1-1}$$

Where, E = Hill's evenness index (which approaches zero)

D = Simpson's index of diversity

H' = Shannon's index of species diversity

N_1 = number of abundant species in the sample

N_2 = number of very abundant species in the sample

(c) Sorensen's similarity index (1948)

$$S = \frac{2C}{A + B}$$

C=the number of species similar to both sites

A= the number of species in the site A

B= the number of species in the site B

Meteorological data

Meteorological data such as temperature, rainfall and relative humidity were obtained from the Meteorological and Hydrological Department, Pakokku Township.

Results

A total of 5271 individuals and 56 species belonging to 28 families and six orders were identified and recorded from four areas of cucurbit plantations (Table 1). During the study period, gourd, pumpkin, squash and watermelon plants were observed for collection of insects. Highest number of species and individuals (48 and 1597) were collected from pumpkin plants. The lowest number of species (37) was recorded from gourd plants and the lowest individuals (1088) was recorded from squash plants. Large numbers of insects (>200) were found in five species, *Aphis gossypii(1009), Bactrocera cucurbitae* (253), *Engytatus varians* (255), *Aulacophora foveicollis* (253), *Sphenarches anisodactylus* (279). The least numbers (under 20) of insects were recorded in *Teleogryllus commodus* (16) *Crocothemis servilia* (16) *Chrysocoris stolli* (10) *Bradymerus acutangulus* (7) *Diaphania nitidalis* (9) *Promachus* sp. (14) *Syphus* sp.(12) (Table 1).

Relative abundance of insect species in orders

In the gourd plants (site I) order Hemiptera (62.45%) was the numerically predominant order and most species rich, followed by Coleoptera (19.73%), Lepidoptera (7.94%) and Diptera (4.49%). In the pumpkin plants (site II), the highest relative abundance (54.98%) was found in order Hemiptera followed by Coleoptera (19.47%), Lepidoptera (10.77%), Orthoptera (10.77%), and Diptera (8.45%) (Table 2).

In the squash plants (site III), the results showed the similar trend with site I and Il, the highest was also found in Hemiptera (43.36%) followed by Coleoptera (19.85%) and Lepidoptera (17.56%). In the watermelon plant, Hemiptera (35.53%) was the first, Orthoptera ranked the second dominant order with the value (18.91%) followed by Lepidoptera (16.01%)(Table 2).

In general, within all study sites, Hemiptera was dominant order, Coleoptera was second dominant order followed by Lepidoptera (Table 2).

The least relative abundance values (2.94%, 2.11%, 7.65%) were found in the order Odonata from site II, III and IV. In site I, the least value (1.59%) was found in order Orthoptera. Individually, among the collected insects, *Bradymerus acutangulus and Daphania nitidalis* were the lowest relative abundance value (1.13%in each). *Aphis gossypii* had the highest relative abundance value (19.14%)(Table 2).

Diversity of insect species

In site I, the diversity indices showed that Hemiptera insects have the highest diversity with Margalef"s species richness value (d=2.9377), Simpson diversity (D=0.1448) and Shannon - Wiener's diversity (H'=2.5419). Order Diptera have the highest evenness index value (E=1.1025) and Odonata have the lowest value of evenness index (E=0.4547) (Table 3).

In site II, based on the values calculated by (d= 3.0984, D=0.1324 and H'= 2.5635) showed that Hemiptera was the highest diversity, Odonata was the lowest diversity. The highest evenness value (E=0.9450) was found in order Orthoptera, the lowest evenness value (0.5467) was observed in order Hemiptera (Table 4).

In site III, (d=2.3862) and (H'=2.0971) point out the Hemiptera was the highest diversity, the highest value (D=0.1487) showed that Coleoptera was most diverse order. The highest evenness (E= 0.9780) was found in Odonata, the lowest (E= 0.5369) was found in Hemiptera (Table 5).

In site IV, the highest value (d =1.9995) showed the Hemiptera was dominant, but (D) = 0.1616 and H'=1.9908, showed that Orthoptera was most diverse, Coleoptera insects were most evenly distributed in the order with the highest value (E) = 0.9301, the lowest (E= 0.4603) was found in Hemiptera(Table 6).

Generally for all study sites, calculated diversity indices (d, D, and H') showed that the order Hemiptera was most diverse order, (E) value showed that Hemiptera was less evenly distributed order.

Within the study areas, according to Simpson diversity (D=0.055), Shannon diversity (H'=3.391) and species richness (d=6.3721) indices, diversity values showed that the site (II, pumpkin) plants have the highest diversity values. Site I, gourd plants have lowest diversity values of D=0.0694, H'=3.1893, and d=4.9459. Highest evenness value (E= 0.6279) was observed in watermelon plants (Site IV) but the evenness value was lowest in the squash plants (E = 0.5718) (Table 7).

Similarity

The highest similarity was found in squash and pumpkin plants (0.860), the lowest similarity was found in gourd and watermelon plants (0.623) (Table 8).

Weather parameter and cucurbit plants

In the present study, all cucurbit plants were sown at the onset of the rainy season. The similar weather condition was observed in the study area, there is no rainfall in June and maximum rainfall (038 mm) was found in August. The mean temperature was ranged from 26.9ºC to 32.0ºC. The highest humidity (81%) was found in August, and the lowest (53%) was found in May. Among the observed plants, pumpkin plants were more thrive than the other cucurbit plants.

Table1 The Relative abundance of insect orders in different Cucurbitaceous plants in Hnaw-kone Village

No.	Order	Name of Species	Gourd	Pumpkin	Squash	watermelon	Total	R.A(%)
1	Orthoptera	*Atractomorpha crenulata*	9	22	7	23	61	0.157
2		*Trilophidia japonica*	14	0	8	26	48	0.911
3		*Acrida acuminata*	0	7	16	39	62	1.176
4		*Acrida conica*	0	0	6	49	55	1.043
5		*Oxya japonica*	0	17	8	44	69	1.309
6		*Teleogryllus commodus*	0	0	1	15	16	0.304
7		*Gryllus* sp.	0	8	3	19	30	0.569
8	Odonata	*Orthetrum sabina*	53	25	8	53	139	2.637
9		*Orthetrum glaucum*	2	17	12	26	57	1.081
10		*Crocothemis servilia*	0	5	3	8	16	0.304

No.	Order	Name of Species	Gourd	Pumpkin	Squash	watermelon	Total	R.A(%)
11	Hemiptera	*Chrysocoris stolli*	10	0	0	0	10	0.190
12		*Eysarcoris guttiger*	26	40	12	0	78	1.479
13		*Bagrada hilaris*	22	60	13	0	95	1.801
14		*Agonoscelis nubila*	19	11	8	10	48	0.911
15		*Nezara viridula*	33	22	7	11	73	1.385
16		*Spilostethus pandurus*	38	25	25	0	88	1.670
17		*Graptostethus servus*	38	23	19	0	80	1.518
18		*Arocatus melanocephalus*	17	13	10	12	52	0. 987
19		*Creontiades pallidus*	21	17	18	0	56	0.062
20		*Engytatus varians*	44	119	92	0	255	4.838
21		*Dysdercus cingulatus*	58	26	29	0	113	2.144
22		*Cletus bipunctatus*	22	19	14	17	72	1.366
23	Hemiptera	*Coreus marginatus*	13	11	0	11	35	0.664
24		*Clavigralla gibbosa*	23	16	15	0	54	0.024
25		*Riptortus pedestris*	31	24	0	38	93	1.764
26		*Leptocorisa acuuta*	59	46	41	0	146	2.769
27		*Aphis gossypii*	314	272	216	207	1009	19.14
28		*Rhynocoris fuscipes*	36	31	7	18	92	1.745
29		*Leucinodes orbonalis*	0	23	0	16	39	0.740
30	Coleoptera	*Zelus longipes*	0	23	0	18	41	0.778
31		*Geocoris pallens*	24	14	0	14	52	0. 987
32		*Coptosoma japonicum*	34	27	11	18	90	0.707
33		*Coptosoma cribrarium*	23	16	0	14	53	0.006
34		*Phyllotreta cruciferae*	0	26	10	21	57	0.081
35		*Aulacophora foveicollis*	44	101	55	53	253	4.790
36		*Monolepta signata*	0	31	20	0	51	0.968
37		*Coccinella transversalis*	83	47	34	0	164	3.111
38		*Cheilomenes sexmaculata*	86	52	18	30	186	3.529
39		*Cycloneda polita*	36	23	35	0	94	1.784
40		*Harmonia axyridis*	37	26	23	0	86	1.632
41		*Bradymerus acutangulus*	0	5	2	0	7	1.133
42		*Gelerita janus*	0	0	19	15	34	0.645
43	Lepidoptera	*Diaphania indica*	11	8	25	5	49	0.929
44		*Diaphania nitidalis*	0	0	9	0	9	0.003
45		*Leucinodes orbonalis*	0	26	0	28	54	1.024
46		*Spoladea recurvalis*	0	9	8	8	25	0. 474
47		*Euchrysops cnejus*	34	27	16	19	96	1.821
48		*Sphenarches anisodactylus*	45	82	80	72	279	5.293
49		*Uthethesia pulchella*	14	7	6	8	35	0.664
50		*Euchromia orientalis*	11	13	47	42	113	2.143
51	Diptera	*Efferia apicalis*	0	10	10	11	31	0.588
52		*Promachus* sp.	0	6	4	4	14	0.266
53		*Syphus* sp.	0	0	0	12	12	0.227
54		*Bactocera cucurbitae*	30	102	58	63	253	4.838
55		*Liriomyza pusilla*	35	0	0	17	52	0.987
56		*Chrysosoma leucopogon*	0	17	0	23	40	0.759
			1449	1597	1088	1137	5271	
			37	48	45	40	56	

Table 2 Relative abundance of insect orders

Sr. No	order	Gourd (site I)		Pumpkin (site II)		Squash (site III)		Watermelon (site IV)	
		No. Total	RA (%)	No. Total	RA (%)	No. Total	RA (%)	No. Total	RA (%)
1	Orthroptera	23	1.59	54	3.38	49	4.50	215	18.91
2	Odonata	55	3.79	47	2.94	23	2.11	87	7.65
3	Hemiptera	905	62.45	878	54.98	537	49.36	404	35.53
4	Coleoptera	286	19.73	311	19.47	216	19.85	119	10.46
5	Lepidoptera	115	7.94	172	10.77	191	17.56	182	16.01
6	Diptera	65	4.49	135	8.45	72	6.61	130	11.43

Table 3 Diversity of insect orders in gourd plants (site I)

Diversity Indices		Orthoptera	Odonata	Hemiptera	Coleoptera	Lepidoptera	Diptera
1	d	1.0261	0.2495	2.9377	0.7072	0.8430	0.2396
2	D	0.5019	0.9286	0.1448	0.2282	0.2673	0.4952
3	H	0.6693	0.1562	2.5419	1.5337	1.4328	0.6902
4	N_1	1.952	1.1691	12.7038	4.6353	4.1904	1.9941
5	N_2	1.9921	1.0769	6.9039	4.3823	3.7414	2.0194
6	E	1.0412	0.4547	0.5045	0.9304	0.8592	1.1025

Table 4 Diversity of insect orders in pumpkin plants (site II)

Diversity Indices		Orthoptera	Odonata	Hemiptera	Coleoptera	Lepidoptera	Diptera
1	d	0.7521	0.5194	3.0984	1.2196	1.1656	0.6116
2	D	0.2907	0.4125	0.1324	0.1833	0.2828	0.5912
3	H	1.2774	0.9419	2.5635	1.8536	1.5519	0.8038
4	N_1	3.5873	2.5648	12.9811	6.3828	4.7204	2.2340
5	N_2	3.4399	2.4237	7.5498	5.4561	3.5350	1.6916
6	E	0.9430	0.9098	0.5467	0.8279	0.6814	0.5601

Table 5 Diversity of insect orders in squash plants (site III)

Diversity Indices		Orthoptera	Odonata	Hemiptera	Coleoptera	Lepidoptera	Diptera
1	d	1.5417	0.6378	2.3862	1.488	1.1423	0.4677
2	D	0.1828	0.3833	0.2068	0.1487	0.2612	0.6667
3	H	1.7428	0.9724	2.0971	1.9995	1.5689	1.6089
4	N_1	5.7133	2.6443	8.1425	7.3853	4.8014	1.8384
5	N_2	5.4696	2.6082	4.8349	6.7226	3.8281	1.500
6	E	0.9483	0.9780	0.5369	0.8962	0.7439	0.5964

Table 6 Diversity of insect orders in watermelon plants (site IV)

Diversity Indices		Orthoptera	Odonata	Hemiptera	Coleoptera	Lepidoptera	Diptera
1	d	1.1171	0.4478	1.9995	0.6277	1.1529	1.0272
2	D	0.1616	0.4627	0.2842	0.3031	0.2447	0.2944
3	H	11.9908	0.8823	1.8672	0.2447	1.6025	1.4595
4	N_1	7.3214	2.4165	6.4701	3.4718	4.9654	4.3038
5	N_2	6.1891	2.1612	3.5177	3.2993	4.0850	3.3961
6	E	0.8209	0.8198	0.4603	0.9302	0.7779	0.7253

Table 7 Species richness, diversity and evenness of insects at four study sites

No.	Name of Species	Gourd (Site I)	Pumpkin (Site II)	Squash (Site III)	Watermelon (Site IV)
1	Total number of individuals	1449	1597	1088	1137
2	Total number of species	37	48	45	40
3	d	4.9459	6.3721	6.2928	5.5428
4	D	0.0694	0.055	0.0676	0.0576
5	H'	3.1839	3.391	3.2226	3.2973
6	N_1	24.1407	29.6956	25.0930	27.0395
7	N_2	14.4032	18.1769	14.7521	17.3517
8	E	0.5792	o.5985	0.5718	0.6279

Table 8 The similarity (Sorensen) matrix of insects between four study sites

Study Sites	Gourd (Site I)	Pumpkin (Site II)	Squash (Site III)	Watermelon (Site IV)
Site II (Pumpkin)	0.776	-		
Site III(Squash)	0.729	0.860	-	
Site IV(Watermelon)	0.623	0.773	0.706	-

Discussion

The present work was conducted from May to August 2019. The total of 5271 individuals and 56 species belonging to six orders (Orthoptera, Odonata, Hemiptera, Coleoptera, Lepidoptera and Diptera) were recorded in the present study.

The highest relative abundance was found in order Hemiptera, followed by Coleoptera, Lepidoptera, Orthoptera, Diptera and Odonata. During the present study, collected 23 species were belonging to the order Hemiptera, nine species in the Coleoptera and eight species in the Lepidoptera.

On the whole, in all study sites of the present study, the relative abundance value of order Hemiptera was dominant than other insects. The calculated diversity indices revealed that the values of species richness (d), Shannon's index (H') Simpson's index (D) were also highest in the Hemiptera out of the six orders. This findings showed that the larger number of cucurbit pests (> 200) were found from *Engytatus varians*, *Aphis gossypii*, *Aulacophora fovicollis*, *Sphenarches anisodactylus* and *Bactocera cucurbitae* in the Hemiptera. This finding is agreed with the Borrer and Delong (1964), they reported that the Hemiptera was a large and widely distributed group of insects. Fayyaz, *et al*., (2016) conducted the survey to determine the diversity and relative abundance of insects in pumpkin plantation in Haripur District (Pakistan) and indicated the Coleoptera was the

most abundance insect order. The present finding differ from Fayyaz, *et al*., 2016, this may be due to different environmental condition.

In all host plants, pumpkin plants were notability the highest in terms of diversity (d, D, H'). The least was found in the gourd plants. This may be due to host preference of some insect species. Singh *et al.,* (2000) pointed out the host suitability of insects, watermelon was the favorites host and pumpkin was median preference for red pumpkin beetle, *Aulacophora fovicollis.* The variation of diversity values among the insects indicated that the different condition (flowering and fruiting stages) of the plants influenced the abundance of insect fauna. So, the results were agreed with the finding of Singh *et al,* (2000).

The highest similarity was observed between pumpkin and squash plants. The lowest similarity was observed between gourd and watermelon plants. David *et al.*, (1994) pointed out the plants in two communities have been believed to co-evolve with their insects herbivores. Fayyaz *et al.*, (2016) observed that the Cucurbitacae vegetables; watermelon, squash, pumpkin, and round gourd constitutes an important group of vegetables having same type of insect fauna. This is close conformity with the present finding.

Conclusion

From this study, many insects were observed from four cucurbit plants. Relative abundance and all diversity indices showed that order Hemiptera was most diverse order. Based on the evenness values, the lowest value in Hemiptera indicated that insects were poorly distributed in this order. The suppression of the most abundance insects, *Engytatus varians, Aphis gossypii*, *Aulacophora fovicollis*, *Sphenarches anisodactylus* and *Bactocera cucurbitae* were important to yield the better quality fruits. Cultivators are necessary to develope the knowledge for pest management in the fields, application of the excessive insecticides destroyed the pests with the beneficial insects. So biological control measures should be used for productivity of safety qualifies food.

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