Diversity Indices of Arthropods in Selected Vegetable Crops

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Abstract

Two vegetable crops (okra and brinjal) were selected for the study and they were grown in Ganabathipuram and Pannaivillai of Kanyakumari district, Tamilnadu respectively. The plants were grown in 3 slots with 20 plants each. The biodiversity of arthropods in both the gardens were noted for three months from August to October 2020. The total population of arthropods in both the crops were recorded and they were used for calculating the biodiversity indices. In okra plants, mealy bug (Hemiptera) was found be more and Hymenoptera was found to be less. In brinjal also the Hemiptera was high in number and Lepidoptera and odonata were found in lesser number. The biodiversity indices Shannon – Weinner index, Species evenness and Species richness were calculated for the total population of arthropods in both brinjal and okra garden. The values of Shannon – Weinner diversity index, Species evenness and Species richness revealed that the arthropodan diversity was medium in okra garden and less in brinjal garden. From the current investigation it was clear that Hemipterans were found to be the major pests in okra and brinjal garden. This project helped in identifying the various arthropods attacking both okra and brinjal garden and this will help to formulate different pest management strategies in the long run.

Keywords

Okra, Brinjal, Arthropods, Diversity indices, Hemipterans, Hymenopterans.

I. INTRODUCTION

Growing vegetable crops at home provide economic, social and nutritional benefits. Vegetables supply the minerals, vitamins and fibre. These elements are not present in other staple foods[1]. Almost every meal of human beings contains vegetables. The quantity of carbohydrates, protein and fats present in vegetables is very less. High amount of starch is present in some tubers. Vegetables also contains nitrogen compounds and enzymes like oxidoreductases, hydrolases, transferases, lyases and ligases[2]. India is the second largest producer of fruits and vegetables in the world next only to China. Small scale production of vegetables is carried out nowadays in India. Most people meet their daily vegetable requirement through their small vegetable garden. The expenditure for the vegetable garden and the labour needed are less.

According to the temperature, soil condition and availability of water, the type of vegetables are chosen. The choice of which vegetable to be grown depends on the environmental conditions like temperature, climate, water, humidity, day length and soil type. All these factors should be considered while growing vegetables. Providing optimal growing condition, avoiding more irrigation, rotation of crops, controlling weeds, using pest resistant varieties will improve the growth of vegetables in the garden. Vegetable garden at home are easily susceptible to pest attack. A large number of Arthropods are seen in the garden as pesticides are avoided. The range of pests and diseases that can damage vegetables vary from plant to plant and species to species.

Pests and diseases may be soil borne or air borne and can be crop specific or generic, so the range of potential control measures is huge. The worst common twelve arthropodan pests which attack all the vegetable garden are Colorado potato beetle, Cabbage looper, cut worms, bean leaf beetle, aphids, cucumber beetles, squash vine borer, squash bug, Flea beetles, European corn borers, Asparagus beetles, tomato and tobacco hornworms[3]. Arthropods because of their small size, diversity and sensitivity to environmental variability, can be good indicators of habitat heterogeneity, ecosystem biodiversity, and environmental stress[4].

The common vegetables grown in Kanyakumari district are brinjal (*Solanum melongena*) and Okra (*Abelmoschus esculentus*). Hence in this project, we selected two vegetable crops brinjal and okra and they were grown in Ganabathipuram and Panaivillai of Kanyakumari district, Tamilnadu respectively without using pesticides. Only organic manure in the form of cowdung is administered to the plants. The abundance and biodiversity indices of Arthropods were recorded in both the garden from the month of August. The data was collected for the three months August, September and October 2020.

II. MATERIALS AND METHODS

A. Study location and duration

The study was conducted in Ganabathipuram village (8.1366° N, 77.3497° E) and Panaivillai village (8.6501° N, 77.9981° E) of Kanyakumari district of Tamilnadu from July 2020 to September 2020. Two types of vegetable crops, okra and brinjal are grown in Ganabathipuram and Panaivillai respectively.

B. *Cultivation of okra and brinjal plants*

Seeds of country okra and brinjal are purchased from Raj Agro Service, Nagercoil, Kanyakumari district, Tamilnadu. The seeds were sown in mud pots. When the plants were two leaf stage, they were planted in the beds. The study was arranged in Randomized Complete Block Design (RCBD) with three replications, each replicate containing 20 plants each[5]. Only cowdung is used as organic manure and no pesticides were used. The seeds were sown on 17.06.2020

C. *Insect collection and identification*

Arthropods data were collected by visual searching method. All the 20 plants of each plot were carefully observed for the identification of attacking arthropods. In every stage (vegetative, flowering and reproductive) every part of each plant viz. lower, middle and higher part leaves were selected. The lower surface of the leaf was thoroughly examined for the presence of any arthropods. Counting was done before 08:30 hr to avoid the excessive mobility of the adult insects[6].

For identification, the insects were compared with the specimen photos and compared with pictures or descriptions from the book named "Indian insects and Arachnids" [7]. The identified insects were categorized to genus level and their relative abundance were calculated[8].

D. *Relative abundance*

Relative abundance is the percent composition of an organism of a particular kind relative to the total number of organisms in the area[9]. Relative abundance was calculated:

$$\text{Relative abundance} = \frac{\text{Total no. of each species}}{\text{Total no. of all species}} \times 100$$

E. *Measurement of Biodiversity indices*

Biological diversity studies use diversity indices as indicators. Following formulae were used to calculate the diversity indices.

Shannon - Wiener index

$$H = -\sum PiLNPi$$

Where,
H' = Shannon - Wiener index
Pi = the relative proportion (n/N) of the individual of one particular species found.
(LNPi) = The natural logarithm (LN) of the value Pi.
(Σ) = summation of the outputs with the final value multiplied by negative one (– 1) [10].

Species evenness

$$J = \frac{H'}{\log S}$$

Where,
J = species evenness
H' = Shannon - Wiener index
S = Number of species in the community

Species richness

$$\text{Species richness } R = \frac{S - 1}{\log N}$$

Where,
R = Species richness
S = Number of species in the community
N = Total population of all the species[11].

The data obtained for the three months August, September and October was used for calculating the biodiversity indices of arthropods and the results were recorded.

III. RESULT

A. *Setting of vegetable garden*

Two types of vegetable plants were selected for this study. Okra plants were grown in Ganabathipuram and brinjal plants were grown in Pannaivillai of Kanyakumari district of Tamilnadu. Seeds were sown on 17.07.2020. When the plants were two leafed stage they were planted 20 each in three plots. They were planted in different locations of same area in both gardens. Only cow dung was used as manure. Proper irrigation was given in both the gardens each day. The data for this study was collected from 01.08.2020.

B. *Biodiversity studies*

The leaves and stem of each plants in a plot were analysed visually for any arthropods at 8.30 am everyday. The first plot was analysed the first day and the second and third plots on second and third days respectively. This process was repeated again in such a way that each plot was tested once in three days. The number of each species present in a plot was noted and the total number of each species per month was calculated for three months from August till October 2020. Around fifteen and ten species of arthropods were recorded in okra fields and brinjal fields respectively.

The arthropods identified in okra fields belong to the orders Lepidoptera, Orthroptera, Diptera, Hemiptera, Hymenoptera, Coleoptera and Araneae which includes *Spodoptera*, *Pseudocoladenia*, Gymnoscirtetes, *Myrmeleotettix*, *Pterophylla*, *Condylostylus*, *Musca*, *Pseudococcus*, *Coccinella, Oxyopes*, *Thomisus*, *Solenopsis* and *Xylocopa*. Around 15 different species of arthropods were recorded in okra garden within the three months (Table 1).

The arthropods identified in brinjal garden belong to the orders Lepidoptera, Odonata, Diptera, Hemiptera, Hymenoptera, Coleoptera and Araneae which includes *Aphis, Leptoglossus, Alydus, Condylostylus, Solenopsis, Agriocnemis, Henosepilachna, Xysticus and Pachliopta*. Around 10 different species of arthropods were recorded in brinjal garden within the three months (Table 2).

Table:1 Arthropods in okra garden during the month of August, September and October

Common name	**Generic name**	**Family**	**order**	**Total number in 3 months**	**Abundance (%)**
Beet army worm	*Spodoptera*	Noctuideae	Lepidoptera	7	1.23
Fall army worm	*Spodoptera*	Noctuideae	Lepidoptera	27	4.73

Fulvous Pied Flat	*Pseudocoladenia*	Hesperiidae	Lepidoptera	1	0.17
Wingless grasshopper	*Gymnoscirtetes*	Acrididae	Orthoptera	2	0.35
Grasshopper	*Myrmeleotettix*	Acrididae	Orthoptera	6	1.05
Katydid	*Pterophylla*	Tettigoniidae	Orthoptera	3	0.52
Long legged fly	*Condylostylus*	Dolichopodidae	Diptera	20	3.50
House fly	*Musca*	Muscidae	Diptera	9	1.58
Mealy bug	*Pseudococcus*	Pseudococcidae	Hemiptera	241	42.20
Lady bird beetle	*Cocinella*	Cocinellidae	Coleoptera	9	1.58
Lynx spider	*Oxyopes*	Oxiopidae	Araneae	7	1.23
Flower crab spider	*Thomisus*	Thomidae	Araneae	6	1.05
Carpenter bee	*Xylocopa*	Apidae	Hymenoptera	2	0.35
Red fire ants	*Solenopsis*	Formicidae	Hymenoptera	48	0.084
Garden ants	*Solenopsis*	Formicidae	Hymenoptera	39	0.068

Table 2: Arthropods in brinjal garden during the month of August, September and October

Common name	**Generic name**	**Family**	**Order**	**Total number in 3 months**	**Abundance (%)**
Aphids	*Aphis*	Aphididae	Hemiptera	479	76.03
Leaf footed bug (nymph)	*Leptoglossus*	Coreidae	Hemiptera	1	0.16
Tree bugs	*Alydus*	Alydidae	Hemiptera	6	0.95
Long legged fly	*Condylostylus*	Dolichopodidae	Diptera	24	3.80
Red fire ant	*Solenopsis*	Formicidae	Hymenoptera	93	14.76
Red flying ant	*Solenopsis*	Formicidae	Hymenoptera	3	0.48
Variable wisp	*Agriocnemis*	Coenagrionidae	Odonata	1	0.16
Lady bird beetle (larvae)	*Henosepilachna*	Coccinellidae	Coleoptera	16	2.54
Red crab spider	*Xysticus*	Thomisidae	Araneae	6	0.95
Common rose	*Pachliopta*	Papillonidae	Lepidoptera	1	0.16

Fig. 1: Abundance percentage of arthropods in okra garden during the month of August, September and October

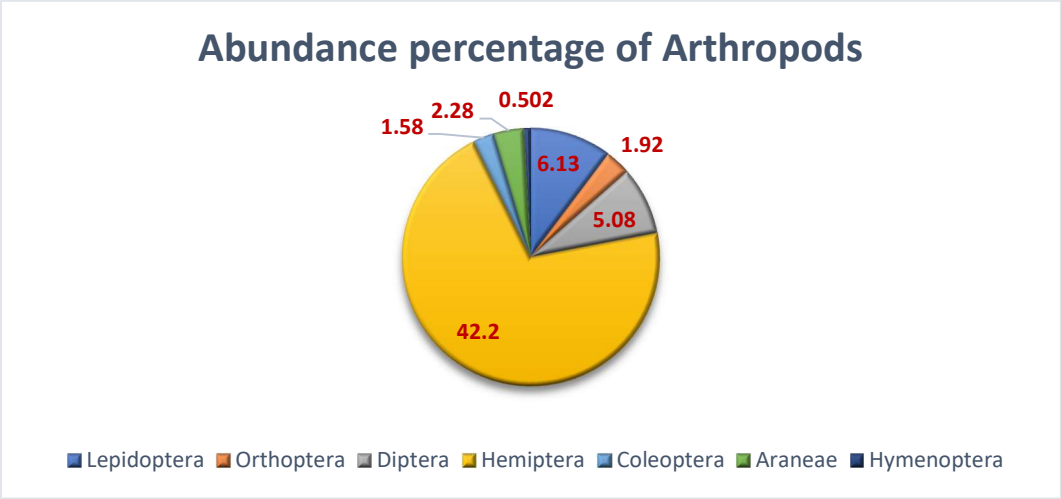
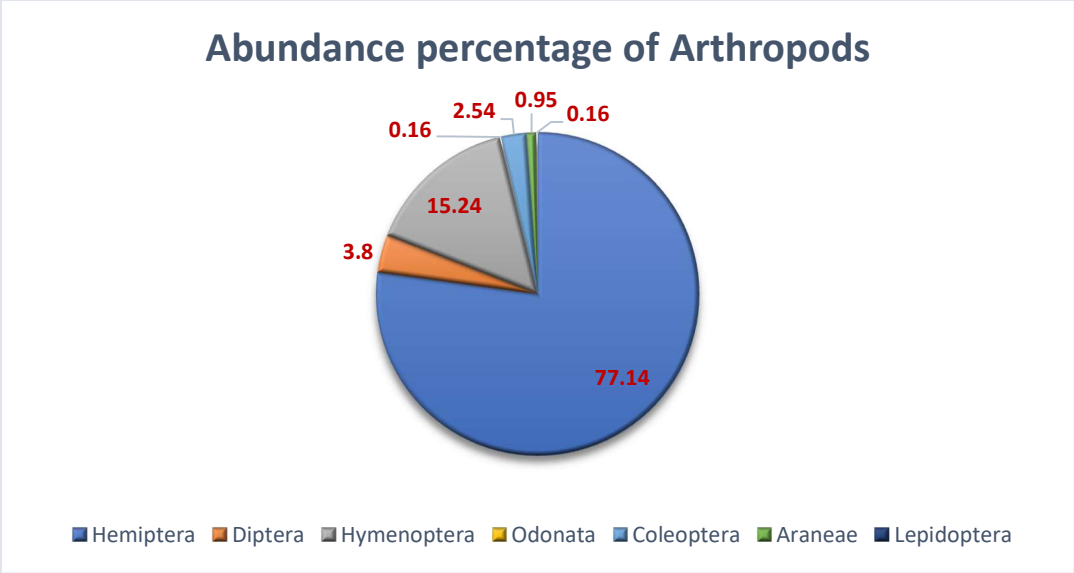


Fig .2: Abundance percentage of arthropods in brinjal garden during the month of August, September and October



C. Abundance percentage of arthropods in okra and brinjal garden

The total number of individuals in each order were counted daily and the data was recorded for 3 months. The total number of individuals were noted. The total number of species recorded was also noted. The percentage was calculated using these two parameters.

In okra garden, the percentage of Hemiptera was high with 42.20, followed by Lepidoptera with 6.13, Diptera with 5.08, Araneae with 2.28, Orthoptera with 1.92, Coleoptera with 1.58 and the percentage of Hymenoptera was less with only 0.502 (Fig. 1).

In brinjal garden, the percentage of Hemiptera was high with 77.14, followed by Hymenoptera with 15.24, Diptera with 3.80, with 0.16, Coleoptera with 2.54, Araneae with 0.95, and the percentage of Lepidoptera and Odonata was less with only 0.16 each (Fig. 2).

Table 3: Biodiversity indices of arthropods in okra garden

Common name	P	Pi	Ln(Pi)	PiLn(Pi)	- PiLn(Pi)	Shannon – Weinner index	Species evenness	Species richness
Beet army worm	7	0.012	-4.423	-0.053	0.053	1.66	1.407	5.078
Fall army worm	27	0.047	-3.057	-0.144	0.144			
Fulvous Pied Flat	1	0.001	-6.907	-0.007	0.007			
Wingless grasshopper	2	0.003	-5.809	-0.017	0.017			
Grasshopper	6	0.010	-4.605	-0.046	0.046			
Katydid	3	0.005	-5.298	-0.026	0.026			
Long legged fly	20	0.035	-3.352	-0.117	0.117			
House fly	9	0.015	-4.199	-0.063	0.063			
Mealy bug	241	0.422	-0.862	-0.364	0.364			
Lady bird beetle	9	0.015	-4.199	-0.063	0.063			
Lynx spider	7	0.012	-4.423	-0.053	0.053			

Flower crab spider	6	0.010	-4.605	-0.046	0.046			
Carpenter bee	2	0.003	-5.809	-0.017	0.017			

Table 4: Biodiversity indices of arthropods in brinjal garden

Common name	**P**	**Pi**	**Ln(Pi)**	**PiLn(Pi)**	**- PiLn(Pi)**	**Shannon – Weinner index**	**Species evenness**	**Species richness**
Aphids	479	0.760	-0.274	-0.274	0.274	0.861	0.861	3.214
Leaf footed bug (nymph)	1	0.002	-6.215	-0.012	0.012			
Tree bugs	6	0.010	-4.605	-0.046	0.046			
Long legged fly	24	0.038	-3.270	-0.124	0.124			
Red fire ant	93	0.148	-1.911	-0.283	0.283			
Red flying ant	3	0.005	-5.298	-0.026	0.026			
Variable wisp	1	0.002	-6.215	-0.012	0.012			
Lady bird beetle (larvae)	16	0.025	-3.689	-0.092	0.092			
Red crab spider	6	0.010	-4.605	-0.046	0.046			
Common rose	1	0.002	-6.215	-0.012	0.012			

D. Biodiversity indices

The biodiversity indices Shannon – Weinner index, Species evenness and Species richness were calculated for the total population of arthropods in both brinjal and okra garden.

The Shannon – Weinner diversity index was found to be 1.66 and 0.861 in okra and brinjal garden respectively. The value 1.66 is considered to be the medium level of diversity and 0.861 is considered to be low level of diversity. The Species evenness was found to be 1.407 and 0.861 in okra and brinjal garden respectively. The Species richness was found to be 5.078 and 3.214 in okra and brinjal garden respectively (Table 3, Table 4).

IV. DISCUSSSION AND CONCLUSION

In this project, the arthropods identified in okra fields belong to the orders Lepidoptera, Orthroptera, Diptera, Hemiptera, Hymenoptera, Coleoptera and Araneae which includes *Spodoptera*, *Pseudocoladenia*, Gymnoscirtetes, *Myrmeleotettix*, *Pterophylla*, *Condylostylus*, *Musca*, *Pseudococcus*, *Coccinella, Oxyopes*, *Thomisus*, *Solenopsis* and X*ylocopa*. Around 15 different species of arthropods were recorded in okra garden within the three months. The same orders of arthropods were recorded in previous studies also. A total of 28 insect pests belonging to 6 orders and 20 families were recorded by[12] Nair *et al*., 2017. Among these, the maximum number of species were belonging to Order Hemiptera (12 species under 10 families) followed by Lepidoptera (9 species under 4 families) and Coleoptera (4 species under 3 families). Remaining three orders namely, Diptera, Orthoptera and Thysanoptera were represented by one species each. The results from the study of[13] Bhatt *et al*., 2017 revealed the occurrence of several insect pests and predators. 17 species of the insect pests belonging to four orders namely Hemiptera, Lepidoptera, Coleoptera, Orthoptera and thirteen families were recorded. Among the various insect pests of okra recorded in the experimental field in the present study the order Hemiptera represented the highest number of seven species.

The arthropods identified in brinjal garden belong to the orders Lepidoptera, Odonata, Diptera, Hemiptera, Hymenoptera, Coleoptera and Araneae which includes *Aphis, Leptoglossus,*

Alydus, Condylostylus, Solenopsis, Agriocnemis, Henosepilachna, Xysticus and Pachliopta. Around 10 different species of arthropods were recorded in brinjal garden within the three months. These orders of arthropods present in brinjal garden were similar with certain previous works. [14]Kumar *et al*., 2019 reported that 10 insect species which belong to 4 orders (Hemiptera, Lepidoptera, Coleoptera and Orthoptera) and 9 families were found associated with brinjal in Meerut region. These were jassid, *Amrasca biguttula biguttula* Ishida; white fly, *Bemisia tabaci* Gennadius; Aphid, *Aphis gossypii* Glover; Leaf roller, *Eublemma olivacea* Walker; Shoot and fruit borer, *Leucinodes orbonalis* Guenee; Leaf miner, *Trachys herilla* Obenberger; Hadda beetle, *Henosepilachna vigintioctopunctata* Fabricius; Lace wing bug, *Urentius hystericellus* Richter; Stem borer, *Euzophera perticella* Ragonot and Grass hopper, *Melanoplus differentialis* Thomas. [15]Kadam *et al*., 2006; [16]Elanchezhyan *et al*., 2008 also reported the occurrence of *Aphis gossypii* on brinjal crop. These reports coincides with the reports produced from the current research work.

The ant population is also found to be increasing in brinjal garden from August to October in our project. This may be because there were more mealy bug population. This report coincides with the reports of the following. [17]Mahal *et al*., 1994 reported that spiders, ants and beetles played significant role in balancing the population of harmful insects in bhendi. [18]Rajpal and Joshi, 2003 reported that, the ants, spiders and beetles were the main defenders in bhendi ecosystem.

In okra garden, the percentage of Hemiptera was high with 42.20, followed by Lepidoptera with 6.13, Diptera with 5.08, Araneae with 2.28, Orthoptera with 1.92, Coleoptera with 1.58 and the percentage of Hymenoptera was less with only 0.502. In brinjal garden, the percentage of Hemiptera was high with 77.14, followed by Hymenoptera with 15.24, Diptera with 3.80, with 0.16, Coleoptera with 2.54, Araneae with 0.95, and the percentage of Lepidoptera and Odonata was less with only 0.16 each. According to[19] Amin *et al*., 2018, the percent of insects in different taxonomic orders varied from 0.4 to 33.6. Among the taxonomic orders, Hemiptera (33.6) was the most dominant followed by Coleoptera (28.3%), Hymenoptera (12.7%), Diptera (8.8%), Lepidoptera (7.6%), Odonata (2.6%) and Dermaptera (2.5%). Other orders namely Orthoptera (2%), Dictyoptera (1.2%) and Thysanoptera (0.4%) showed very lower percentages of abundance. These results were similar to our reports.

The biodiversity indices Shannon – Weinner index, Species evenness and Species richness were calculated for the total population of arthropods in both brinjal and okra garden. The Shannon – Weinner diversity index was found to be 1.66 and 0.861 in okra and brinjal garden respectively. The value 1.66 is considered to be the medium level of diversity and 0.861 is considered to be low level of diversity. The Species evenness was found to be 1.407 and 0.861 in okra and brinjal garden respectively. The Species richness was found to be 5.078 and 3.214 in okra and brinjal garden respectively. The species richness and evenness in both the fields were less. But the Species richness and evenness in okra garden was higher than the brinjal garden. The diversity indices by using Shannon diversity index in present study shows that the diversity of arthropods was stable in brinjal agro-ecosystem. An increase in the value of index indicates an increase in diversity. The biodiversity among crops and insects can be categorized in two types that are species richness and evenness[20] (Chang *et al*., 2019). [21]Vanclay (1992) told that species richness shows that the numbers of species present in study area and species evenness shows the abundance of each species. [22]Magurran (1988) suggested that species richness provides an extremely useful measure of diversity when a complete catalogue of species in the community is obtained.

[23]Rehman *et al*., 2019 reported in general, among vegetable crops the species diversity index for surveyed locations was highest on brinjal (1.309) followed by potato (1.233), chilli (0.881), cucumber (0.766), mint (0.677), pumpkin (0.677), knolkhol (0.634), chinese spinach (0.435) and turnip (0.410). The reports on brinjal crops were close to our research. Home garden often contain a large number of individuals for certain species that are commonly utilized by the households[24] (Neelamegam *et al*., 2015).

[25]Nair *et al*., 2017 calculated the Shannon and Wiener diversity index (H') during summer and winter season for the insect pest complex of okra and he calculated as 1.01 and 0.91, respectively indicating almost similar diversification during the two seasons. Similarly, Species Richness (7.31 and 7.49) and Species Evenness (0.71 and 0.64) during summer and winter season were more or less equal which coincides with the present study results.

This project brought the biodiversity of arthropods affecting the Okra and brinjal garden to lime light and this data will help the local farmers to identify the arthropod pests of both okra and brinjal. Also with the help of this data various pest management strategies can be adopted for the arthropod pests in the long run.

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