Journal of Entomology

ISSN 1812-5670

Academic Journals Inc.

www.academicjournals.com

Journal of Entomology 6 (1): 28-34, 2009
ISSN 1812-5670

Survey of Arthropod Biodiversity in the Brinjal Field

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Abstract: Field experiment was conducted to study the arthropod biodiversity in the brinjal field during February to August. Twenty species of harmful arthropods under 17 families were observed belonging to 6 different orders. The brinjal shoot and fruit borer (*Leucinodes orbonalis*), jassid (*Amrasca biguttula biguttula*), epilachna beetle (*Epilachna* sp.) white fly (*Bemisia tabaci*) and aphid (*Aphis gossypii*) were found as the most common and major insect pests of brinjal. Ten plant dwelling predaceous arthropod families were found in the field among them 42.44% were occupied by three families under Coleopteran insect. Spider under lycosidae family possessed 30.23%, which was ranked as the second most important arthropods. Surface dwelling arthropods caught in pitfall traps were grouped into 17 families among them 7 families were identified as predators. Formicidae was occupied 67% of the total surface dwelling predaceous arthropod.

Key words: Arthropod biodiversity, brinjal shoot and fruit borer, jassid, plant dwelling, surface dwelling

INTRODUCTION

Arthropods are important components of ecosystems occupying vital positions in food webs, dynamics of populations and communities. They play various roles in ecosystems acting as herbivores, predators, decomposers, parasitoids and pollinators. Arthropods possess several characteristics that make them suitable for environmental monitoring; high diversity, small body size, high reproductive capacity, acute sensitivity to environmental changes and ease of sampling (Weaver, 1995). Moreover, arthropods can be sampled quickly and reliably using various survey methods (New, 1998). Thus, arthropods are often used as biological indicators of ecosystem integrity (Tscharntke *et al*., 1998) and could be used reliably to infer ecosystem function and habitat condition (McGeoch, 1998; Weisser and Siemann, 2004). Population ecologists discussed diversity of arthropods in two aspects, species richness (i.e. the number of species in a set of samples) and equitability e.g., the number of individuals of each species in a sample (Disney, 1999).

Brinjal, *Solanum melongena* L., is one of the three most important vegetables in South Asia (India, Bangladesh, Nepal and Srilanka), which accounts for almost 50% of the world's area under cultivation (Alam *et al*., 2003). In the brinjal field, various arthropod species both pests and natural enemies prevail during seedling to harvesting stage. El-Shafie (2001) observed 28 species of insect pests under seven different insect orders from the brinjal ecosystem while Nayar *et al*. (1995) reported 53 species of insect pests of brinjal. Although, several researchers published reports on pest of brinjal elsewhere however, information about total arthropods community in the brinjal agroecosystem is limited. So, our objective was to observe the arthropod biodiversity in the brinjal agroecosystem.

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MATERIALS AND METHODS

The experiment was laid out in the experimental farm of Bangabandhu Sheikh Mujibur Raman Agricultural University (BSMRAU), Gazipur in summer season during the period from February to August 2006. The region lies between 24.09° N latitude and 90.26° E longitudes with an elevation of 8.50 m from the sea level. The site was situated in the subtropical climatic zone, characterized by heavy rainfall during the month of May to September and scanty rainfall during the rest of the year. The soil of the experimental field was clay loam in texture and acidic in pH of around 5.8 and poor fertility status. The whole field was divided into three plots of equal size having 3 m space between the plots and the unit plot size was 5×5 m. The distance between row to row and plant to plant was 1 m. Brinjal variety, Uttara was grown following the recommended practices as described by Rashid (1993).

Data Collection

The number of species was the simplest measure of species diversity. However, for limitation in species identification, concept was restricted to order and family level in most of the cases. The counting of individuals was performed by using one absolute method viz., visual searching and two relative methods viz., pitfall trap and sweeping net.

Visual Searching Method

Adult whiteflies, jassid nymphs and aphids were counted from a random sample of 10 plants taken from each plot. Five leaves were chosen randomly on each plant, two from the bottom (older leaves), one from the middle and two from the top (younger leaves). The lower surface of the leaf was thoroughly examined for the presence of insects. Counts were made before 08:30 h (Bangladesh local time) to avoid the excessive mobility of the adult insects after this time, but nevertheless, the migration of the fast moving and mobile adults from one plot to the other could not be totally avoided. The data were pooled over the season and season's average was combined to provide an overall average density per plot. The population of spiders, lady bird beetles, ants, sessile insects, nymphs and larvae of flying insects on brinjal plants were counted from 5 branches selected randomly from 10 plants of each plot at weekly interval. The population density of each insect is expressed as number of individuals per 10 leaves of the plant.

Sweeping Method

This method was used for counting flying and sessile insects on brinjal plants to know the abundance pattern of insects in the present study. Five times return sweeping was done in each plot to make a composite sample by a sweeping net at 15 days intervals. Each sample was examined separately without killing the insects and released them in the same plot immediately after counting. The individuals of each sample were counted by family.

Pitfall Method

This method was used for the species that roam in the soil surface such as ground beetles, spiders, ants, beetles, earwig, crickets, collembola etc. Small plastic pots having 10 cm diameter and 8 cm deep were used as pitfall traps. Three traps were placed in soil in each of the plots and the mouth of the pot was kept at ground level so as not to obstruct insect movement. Each pot was then half filled with water and detergent as trapping fluid. After 48 h of setting traps, the trapped arthropods were emptied with a sieve and funnel into small plastic bottles filled to the half with 70% alcohol. The samples were

labeled and stored until sorting, counting and finally were identified. Traps were set at 15 days intervals throughout the cropping season and insects were collected and counted separately from each plot.

Measurement of Diversity Index

To assess the abundance pattern and the species richness in different insecticides treated plots, Simpson's diversity index was used.

$$\text{Simpson's index (D)} = \frac{1}{\sum_{i=1}^{S} P_i^2}$$

where, P_i is the proportion of individual for the ith insect family and S is the total numbers of insect family in the community (i.e., the richness).

The value of index depends on both the richness and the evenness (equitability) with which individuals were distributed among the families. Equitability was quantified by expressing Simpson's index, D as a proportion of the maximum possible value of D.

$$\text{Equitability (E)} = \frac{D}{D_{max}} = \frac{1}{\sum_{i=1}^{S} P_i^2} \times \frac{1}{S} \quad [D_{max} = S]$$

RESULTS

Plant Dwelling Harmful Arthropods

Twenty species of insect pests were recorded from the brinjal agroecosystem throughout the cropping season from February to August, which belonged to 17 different insect families under 6 orders (Table 1). Three species of insect pests were found to damage on the reproductive parts (flower buds and fruits), two species caused damage to the stem and roots and 15 species caused injury to the foliage. Most of the insect pests were belonged to four orders such as Homoptera, Coleoptera, Lepidoptera and Orthoptera. In terms of species composition, Homoptera and Coleoptera occupied top position (5 species) while Lepidoptera and Orthoptera ranked second position (4 species).

The data (Table 1) also revealed the relative abundance of different insect pests in brinjal agroecosystem. Jassid (*Amrasca biguttula biguttula* Ishida) was ranked first in respect to the frequency followed by white fly (*Bemisia tabaci* Genn.), aphid (*Aphis gossypii* Glover) and epilachna beetle (*Epilachna 28-punctata* Fab. and *Epilachna 12-punctata* Mots.). Therefore, by number, the sucking insects such as jassid, whitefly and aphid occupied the top position in the brinjal agroecosystem. Although the frequency of adult brinjal shoot and fruit borer (*Leucinodes orbonalis* Guenee) was very low in the field, it was the major pest of brinjal in respect of shoot and fruit damage. The number of adult brinjal shoot and fruit borer was very due to nocturnal in habit and no trap was used to collect the adult at night. Next to the brinjal shoot and fruit borer and jassid, white fly, epilachna beetle and aphid were the important pests of brinjal. Two important sucking insects, the jassid and the white fly inflicted serious damage in brinjal during the current study. Other insect pests like leaf roller, leaf beetle, red pumpkin beetle, flea beetle, semilooper (unidentified), hairy caterpillar (*Antoba olevacea*) green vegetable bug (*Nezara viridula* L.), hooded hopper (*Oxyrachis terandus* Fab.), elaterid beetle

Table 1: List of plant dwelling insect pests observed in the brinjal field and their relative abundance

Order	Family	Common name	Scientific name	Site of damage	Population frequency (%)
Homoptera	Cicadellidae	Cotton jassid	*Amrasca biguttula biguttula*	Leaf	58.37
	Cicadellidae	Rice green leaf hopper	*Nephotettix bipunctatus* Fab.	Leaf	2.94
	Aleyrodidae	Cotton white fly	*Bemisia tabaci* (Genn.)	Leaf	9.95
	Aphididae	Cotton aphid	*Aphis gossypii* Glover	Leaf, shoot, flower bud and fruit	6.33
Hemiptera	Membracidae	Hodded hopper	*Oxyrachis terandus* Fab.	Leaf/stem	0.68
Coleoptera	Pentatomidae	Green vegetable bug	*Nezara viridula* (L.)	Leaf	4.98
	Coccinellidae	Epilachna beetle	*Epilachna 28-punctata* Fab. *Epilachna 12-puntata* Mots.	Leaf	4.30
Lepidoptera	Chrysomelidae	Red pumpkin beetle	*Aulacophora foveicollis*	Leaf	0.45
	Chrysomelidae	Leaf beetle	*Monolepta signata* Ol.	Leaf	1.13
	Halticidae	Flea beetle	*Phyllotreta* sp.	Leaf	0.90
	Elateridae	Elaterid beetle	Uidentified	Leaf	0.68
	Pyralidae	Brinjal shoot and fruit borer	*Leucinodes orbonalis* Guen.	Stem and fruit	0.90
Orthoptera	Noctuidae	Leaf roller	*Antoba olevacea*	Leaf	1.13
	Noctuidae	Semilooper	Unidentified	Leaf	0.68
	Arctiidae	Hairy caterpillar	*Selepa celtis* M.	Leaf	0.90
	Acridiade	Short horned grasshopper	*Hieroglyphus banian* Fab.	Leaf	0.45
	Tettigoniidae	Long horned grasshopper	Unidentified	Leaf	0.68
Diptera	Gryllidae	Field cricket	*Brachytrypes protentosus* Licht.	Stem/root	2.26
	Gryllotalpidae	Mole cricket	*Gryllotalpa africana*	Stem/root	1.36
	Muscidae	Fruit fly	*Atherigona orientalis* Schiner	Fruit	0.90

Table 2: Relative abundance of plant-dwelling predaceous arthropod families and their stage(s) observed in the brinjal field

Order	Family	Common name	Stage observed	Frequency (%)	Diversity index (D)	Equitability (E)
Coleoptera	Coccinellidae	Lady bird beetle	Egg, larva, pupa and adult	25.58	5.14	0.51
Coleoptera	Carabidae	Carabid beetle	Adult	12.79		
Coleoptera	Staphylinidae	Staphylinid beetle	Adult	4.07		
Diptera	Syrphidae	Syrphid/hover fly	Larva and adult	2.91		
Hemiptera	Miridae	Mirid bug	Nymph and adult	5.23		
	Pentatomidae	Pentomid bug	Adult	4.65		
Dictyoptera	Mantidae	Praying mantid	Nymph and adult	1.16		
Neuroptera	Chrysopidae	Green lace wing	Nymph and adult	1.74		
Hymenotpera	Formicidae	Ant	Adult	11.63		
Aranae	Lycosidae	Lynx spider	Adult	30.23		

(uidentified) etc. were observed as phytophagous but they caused very little damage to brinjal. Although the number of harmful species seems to be high, the significant crop damage was caused by only 3-5 key pests (Brinjal shoot and fruit borer, jassid, white fly, aphid and epilachna beetle).

Plant Dwelling Predaceous Arthropods

The plant dwelling predaceous arthropods were grouped in 10 families under 7 taxonomical orders (Table 2). Coleoptera was the most important order of plant dwelling predatory insects, which occupied 42.44% of the total predators under 3 different families such as Coccinellidae, Carabidae and Staphylinidae. The rest of the plant dwelling predaceous insect orders were Hymenoptera, Hemiptera, Neuroptera, Diptera and Dictyoptera, which included 27.33% of the total arthropods. Next to the Coleoptera, spider was the single major plant dwelling predaceous arthropods under the family Lycosidae sharing 30.23% of the recorded total predatory arthropods found. The predators which were not caught but found hovering over the flowering brinjal in the field included common wasps and dragonflies of different sizes.

Table 3: Relative abundance of surface dwelling arthropods recovered from pitfall traps in the brinjal field

Order	Family	Total abundance	Frequency (%)	Diversity index (D)	Equitability (E)
Aranae	Lycosidae	166	13.91	2.56	0.16
Coleoptera	Carabidae	76	6.37		
	Cicindilidae	7	0.59		
	Staphylinidae	9	0.75		
	Elateridae	24	2.01		
Hymenoptera	Formicidae	703	58.93		
Dermaptera	Forficulidae	24	2.01		
Orthoptera	Gryllidae	29	2.43		
	Acrididae	6	0.50		
	Tettigoniidae	2	0.17		
	Gryllotalpidae	2	0.17		
Homoptera	Cicadellidae	26	2.18		
Diptera	Muscidae	30	2.51		
	Asilidae	5	0.42		
Acarina	Tetranychinichidae	12	1.01		
Collembola	Unknown	72	6.04		

Table 4: Relative abundance of surface dwelling predaceous arthropods recovered from pitfall traps in the brinjal field

Order	Family	Total abundance	Frequency(%)	Diversity index (D)	Equitability(E)
Hymenoptera	Formicidae	703	69.33	1.94	0.28
Aranae	Lycosidae	166	16.37		
Coleoptera	Carabidae	76	7.50		
	Staphylinidae	9	0.89		
	Cicindilidae	7	0.69		
Orthoptera	Gryllidae	29	2.86		
Dermaptera	Forficulidae	24	2.37		

Surface Dwelling Arthropods

The arthropods captured by pitfall traps from the brinjal agroecosystem during the study period were considered as surface dwelling. They were grouped into 16 families as shown in Table 3 under different orders. The Formicidae was the most abundant family and ranked as first in respect of frequency followed by Lycosidae and Carabidae, which occupied the 2nd and 3rd position, respectively. The other frequently occurring arthropod families were Collembola, Muscidae, Gryllidae Cicadellidae and Forficulidae. Although insects of some families such as Asilidae, Tetranychidae, Cicadellidae etc., were plant dwelling or flying however, they fell into the pitfall trap during their movement and were thus included in the surface dwelling arthropods.

The faunistic analysis of pitfall catches further revealed that the number of surface dwelling predaceous arthropods families were 7 such as Formicidae, Lycosidae, Carabidae, Gryllidae, Forficulidae, Staphylinidae and Cicindellidae under 5 orders (Table 4). Among the surface dwelling predaceous arthropods, Formicidae ranked top (69.33%) followed by Lycosidae, which occupied the second position (16.37%). Considering frequency, Carabidae was 3rd major family of predaceous arthropods (7.50%) and Gryllidae occupied the 4th position (2.86%). The individuals under the Staphylinidae and Cicindellidae families were 0.89% and 0.69%, respectively.

DISCUSSION

The findings in the present study regarding the insect pests have thus added some new species and variations in pest status of the recorded insect pests, although there is cognizance in many cases as reported by other researchers. Alam *et al.* (2003) reported that three insects was becoming alarming pests of brinjal in different region of Bangladesh, which had insignificant incidence in the recent past, among them white fly (*Bemisia tabaci*) and red mite (*Tetranychus biculatus*) in Jessore, Narsingdi and Comilla regions and jassids (*Amrasca biguttula biguttula*) in Gazipur region. The jassid was highly

prevalent during the dry periods, particularly from February to April. Although the number of insect pest species of brinjal found in the present study in Bangladesh differs from other brinjal growing countries, there is similarity in composition and the variations might be due to differences in prevailing conditions. These results also partially agree with the findings of the other researchers. El-Shafie (2001) recorded 28 species of insect pests under 7 different insect orders from the eggplant ecosystem in Sudan. Seven species of insect pests were associated with damage on the reproductive parts (flower buds and fruits), 3 species were responsible for the damage of stem and roots, while 18 species were notorious for their occurrence as foliage pests. However, Nayar *et al*. (1995) reported 53 species of insect pests of brinjal in the field of which shoot and fruit borer was the most destructive in India. Bhadauria *et al*. (1999) recorded 13 species of insect pests on brinjal during the summer and kharif season of 1995-96 in Madhay Pradesh, India. Shoot and fruit borer, jassid, aphids, leaf roller and stem borer (*Euzophera perticella*) were the most common pest. Aganon *et al*. (1997) reported that shoot and fruit borer, jassid (leaf hopper) and thrips (*Thrips tabaci*) were the most common pest of brinjal in the field. The major insect pest of brinjal in Asia was the brinjal shoot and fruit borer, which caused serious damage especially during the fruiting stage. Several researchers reported the severity of attack of jassid and white fly in brinjal (Aganon *et al*., 1997; Bhadauria *et al*., 1999; Alam *et al*., 2004). Anonnymous (2003) observed the similar level of infestation of both the species. Although some researchers reported thrips and red mites as important sucking pest in some location (Aganon *et al*., 1997) but they were not found in the present study. However, the variation of the results is logical because arthropod complex may vary in different geographic locations and season of the year.

The results regarding the plant dwelling predaceous and surface dwelling arthropods of the present study suggest that Coleoptera and spider are the most important plant dwelling predaceous arthropods in the brinjal ecosystem. Moreover, most of the surface dwelling arthropods are predators. Formicidae, Lycosidae, Carabidae and Forficulidae are the most frequently occurring surface dwelling predator families in the brinjal agroecosystem. Among them spiders, lady bird beetles and carabid beetles were the most frequent. The present findings partially agree with the findings of El-Shafie (2001), who reported that Coleoptera had occupied 60% of the total plant dwelling predators and Formicidae as the most frequently appearing surface dwelling predators in brinjal agroecosystem in Sudan.

Both pest and natural enemy population of arthropods were observed in the brinjal agroecosystem. Among the pest species, five species were found as major pest and sucking pests were becoming alarming for the crop. Ants, beetles and spiders were the most common predatory arthropods in the brinjal field.

ACKNOWLEDGMENT

This research was funded in part by Honorable Prime Minister, Peoples Republic of Bangladesh under the Prime Minister's Scholarship Programme for Higher Studies and Research Fund.

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