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Abundance and composition of arthropods in sugarcane (*Saccharum officinarum*) ecosystem

M RANJITH[1]*, D R BAJYA[2] and R S RAMYA[3]

Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu 641 003, India

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ABSTRACT

A short investigation was devised by Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore in 2022 to document the arthropod composition in sugarcane (*Saccharum officinarum* L.) ecosystem. Arthropod fauna was collected from sugarcane ecosystem in farmers' field at Puthur of Coimbatore district, Tamil Nadu at weekly intervals. Totally, 2,310 individuals of the subclass Pterygota were collected and among them most of specimens belonged to Exopterygota. The exopterygota (1,029) were represented by 5 orders, viz. Hemiptera, Odonata, Orthoptera, Isoptera and Dermaptera. Majority of the individuals belonged to the family Aphididae (330) under the order Hemiptera. Under order Orthoptera, Gryllidae (46) was the dominant family closely followed by Acrididae (45). Among these, the dominant species was *Gryllus* spp. The order Odonata was represented by a single family Libellulidae (38) and the species was identified as *Orthetrum sabina* Drury, 1773. Under Endopterygota, 4 orders were identified and among these, Hymenoptera was the most common order with 740 numbers, followed by Diptera (237), Coleoptera (215) and Lepidoptera (89). Under the order Coleoptera, 3 families were recorded, with most of them falling under the family Coccinellidae (172) followed by Cicindelidae. Hymenopteran order comprised majorly of ants, belonging to the family Formicidae, of which 3 species were identified. Lepidoptera consisted of single species *Ariadne merione* Cramer, 1779 belonging to family Nymphalidae. Majority of Arachinda was represented by order Araneae. Under the order Araneae most of them pertained to families Araneidae, Lycosidae and Thomisidae. *Neoscona* sp., *Hippasa* sp., *Pardosa* sp. and *Pardosa birmania* Simon were found to be common in sugarcane ecosystem.

Keywords: Arachnida , Arthropod, Biodiversity, Pterygota, Sugarcane

The animal kingdom which is comprised of more than 50% of the described insect species constitutes major portion of all biodiversity available on the planet (Tihelka *et al.* 2021). The sheer dominance of insects is the result of the development of different genetic, morphological and functional aspects which enables them to survive in the adverse and complicated habitats (Sollai and Solari 2022). Even though some of the insects are proven deleterious by causing harm to agriculture, natural resource and even human health by acting as pests or disease vectors, several insects are beneficial to human beings by producing useful substances (dyes, medicines). They also play a pivotal role as pollinators, biocontrol agents, scavengers and contributing as a food source for other animals and, in the near future, may serve as a protein source for humans too (Manno *et al.* 2018). Further, insects are also utilized as model organisms for conducting research on action of hormones, physiological processes and on the functions of nerve and sense organs. They are being used as bio-indicators. Merely, 7–10% of the total estimated insect species are taxonomically described (Samways 1993), while it is estimated that our planet inhabits around one million known insect species (Zhang 2011). Spiders with more than 40,000 species found all over the world, mainly prey on insects (Lee 2001). In India, Chakraborty *et al.* (2016), Rajeevan *et al.* (2019), and Sandeep *et al.* (2020) have studied different aspects of spiders like their role as a natural enemy in agriculture, taxonomic status, ecology and predator prey interactions.

At present, chemical control being highly criticized for its environmental deterioration, and management of pests by biological control agents is gaining importance as it is environmentally safe. In this regard the current study was carried out to explore the arthropod diversity and also to document the pest, natural enemies and spider fauna in sugarcane (*Saccharum officinarum* L.) ecosystem.

MATERIALS AND METHODS

Abundance of arthropod biodiversity in sugarcane ecosystem was studied during January-April, 2022 at farmers'

[1]Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu; [2]SKN Agricultural University, Jobner, Jaipur, Rajasthan; [3]ICAR-National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka. *Corresponding author email: entoranjith@gmail.com

field in Puthur of Coimbatore district, Tamil Nadu. Total area of 1 acre was selected and different techniques were followed for arthropod collection, their preservation and identification, which are described as follows.

Sampling methodology

Four different methods, viz. active searching, net sweeping, pitfall trap and rubbish trap were used for insect collection so as to assess the arthropod community in sugarcane ecosystem. For carrying out arthropod collection, the plot was divided into 100 quadrats (10 m × 10 m). Five quadrats were selected each at random and the observations were made in such a way that the whole plot was covered during the sampling period.

Active searching: The method of active searching for the collection of insects was employed during the early morning and evening hours. Random selection of quadrats was made and observations were recorded in these quadrats for a duration of 2 hours so as to record the presence of insects. Observations were made while walking diagonally in the field. Utmost care was taken while collecting spiders so as not to injure them and transferred them into polythene bags for further identification.

Net sweeping: One of the most effective methods to collect flying and saltatorial arthropods at the ground level or under storey vegetation is by the use of insect nets. The nets used for collecting insects were made of thick cotton cloth to avoid tearing. The dimensions of the net were 20 cm diameter (at the mouth) and 60 cm length (bag length). The entire plot was divided into hundred quadrats each measuring 10 m × 10 m each for the systematic collection of insects by net sweeping. Out of these, 5 quadrats were arbitrarily selected and sweeping was done in such a way that the entire ground level vegetation was covered. The net sweeping was routinely done during 10.00–12.00 hours in the ground vegetation and also at one foot height from the ground. The collected insects from each quadrat were transferred into a bucket containing minimal amount of ethyl acetate so as to kill them. The killed insects were sorted to different taxa and preserved by pinning or card mounting for further studies. Soft bodied insects like aphids, thrips. and spiders were sorted out and preserved in plastic vials containing 70% alcohol.

Pitfall traps: Pitfall taps were used to collect the ground dwelling and nocturnal arthropods. The traps were manifested using plastic containers with the dimensions of 15 cm height × 10 cm width. These containers were placed in small pits dug in the soil at a depth of 15 cm. Five 10 m × 10 m quadrats were randomly chosen and pitfall traps were placed in each of them. Hence, a total of 25 pitfall traps were placed in each plot. The containers were filled up to 3/4 of their capacity with water and 2–3 drops of Teepol was added into the water which acted as the trapping fluid. A flat stone supported on four smaller stones was used to cover the trap so that the traps wouldn't get filled with water or disturbed by mice or other animals. The trapping fluid was changed weekly and the trapped insects were sorted out and preserved for further studies.

Rubbish traps: Chicken wire mesh with dimensions of 45 cm length × 15 cm width were stuffed with leaf litter to make the rubbish trap. Five 10 m × 10 m quadrats were randomly chosen to set up the rubbish traps. These traps were kept in the field continuously for 7 days without any disturbance so as to allow arthropods to settle inside the trap. At the end of 1 week, the traps were removed and taken to the laboratory and the arthropod trapped inside the leaf litter were collected.

Collection and identification of arthropods: Sorting was done based on taxon for the collected arthropods. The soft bodied insects like aphids, thrips and spiders were preserved in 70% ethyl alcohol in plastic vials. Other insects are pinned or card mounted and stored in insect boxes with camphor balls for preservation. Image analyser was used to photograph the preserved specimens. The taxonomic characters of the preserved specimens were then examined to identify them. All arthropod species were identified till the lowest possible taxon. The insect clusters were identified following Lefroy (1984), Comstock (1984), Richards and Davis (1983), Ayyar (1984), Poorani (2002) and also by comparing them with the preserved specimens available in the Biosystematics Laboratory, Department of Agricultural Entomology, TNAU, Coimbatore.

RESULTS AND DISCUSSION

Biodiversity as a topic and an area of research has attained global importance recently. There has been increased focus on self-sustaining biological systems which involves multitude of organisms. Information on biodiversity is quintessential to comprehend the ecological changes happening in this planet and this knowledge facilitate the prudent use and management of several ecosystems through the use of various resources. Of all the known species in the world insects alone account for 66% (Zhang 2011), which includes more than three-fourth of the worldwide biodiversity (Kim 1993). The reasons behind vast insect diversity is still not clearly studied, however their phytophagous nature might have resulted in numerous insect clades (Sollai *et al.* 2014 and Wiens *et al.* 2015). The possible presence of around eight million species of insects on earth was estimated (Samways 2005). The vast biodiversity exhibited by insects have made them ideal objects of study in various field of biology, ecology and evolution. In fact, genetics research on fruit flies and population biology studies on flour beetle made scientists to garner vast scientific knowledge. Enormous and sincere efforts are required to identify all the insect specimens available.

The yield in sugarcane crop is influenced by several attributes like variety, strains, environmental factors (rainfall, temperature etc.) and also by the incidence of pests and diseases. Among all these factors, insect pests cause immense loss to the farmers by drastically reducing the yield of crops. The insect pests in addition to reducing the cane yield also affects the sugar output. Insect pests belonging to several orders like Coleoptera, Hemiptera, Isoptera and

Orthoptera have been proved to be damaging the sugarcane crop. Studies have also shown that sugarcane is majorly attacked by local insect pest species that have adapted to the crop as a result of its cultivation (Leslie 2004). It has also been noticed that the geographic distribution of these pests are not very wise except for a few pests which has a cosmopolitan distribution. The knowledge on the economic relevance of the various pests and their diversity is needed for formulating efficient insect pest management strategies and thus to prevent damage to the sugarcane crop. Further, proper determination of pest damage status and the pest population is quintessential in appropriate decision making for sustainable management of insect pests which can lead to increased crop production and productivity.

Since, insect diversity is often the base for formulating strategies that involve the appropriate application of pesticides by taking into account the ecosystem services provided by insects, we undertook this study with the aim of recording the arthropod diversity in sugarcane ecosystem. A total of 2,310 individuals of the subclass Pterygota were collected. Among the Pterygotes, the majority of the individuals belonged to the division of Exopterygota. The exopterygota (1029) were represented by 5 orders, viz. Hemiptera, Odonata, Orthoptera, Isoptera and Dermaptera. Of the three families of Hemiptera collected, the most of them belonged to the family Aphididae (330) followed by Derbidae (99) and Lophophidae (31). Under order Orthoptera, Gryllidae (46) was the dominant family closely followed by Acrididae (45) and Gryllotalpidae (40) (Table 1). Among these, the maximum collected were *Gryllus* spp. The order Odonata was represented by a single family Libellulidae (38) and the species was identified as *Orthetrum sabina* Drury (Table 1).

Under Insecta, endopterygotes were represented by 4 orders. Among these, Hymenoptera was the most common with 740 numbers followed by Diptera (237), Coleoptera (215) and Lepidoptera (89). Under the order Coleoptera, 3 families were recorded, prominent one belonging to Coccinellidae (172), followed by Cicindelidae and Cetoniidae. Hymenopteran order comprised mainly of ants (Family: Formicidae), of which 3 species were identified. Lepidoptera consisted of single species *Ariadne merione* Cramer, 1779 according to the family Nymphalidae (Table 1). In the present study, totally 3 families of coleopterans were collected and among them, maximum belonged to Coccinellidae. The documentation of various arthropods of sugarcane ecosystem is in concurrence with the findings of Selvi and Dayana (2015) and Kaur and Sangha (2020), who recorded insects belonging to Odonata, Orthoptera, Hemiptera, Homoptera, Coleopteran, Lepidoptera and Hymenoptera orders in sugarcane field.

The reason for the dominance of Hymenoptera was due to the preponderance of ants in the collection. Similarly, with reference to Hemiptera, maximum individuals belonged to Aphididae and Derbidae. The arthropods collected and identified in the present study coincides with the findings of Madhusoodhanan (2015) and Sajjad *et al.* (2012) who

Table 1 Diversity of arthropods in sugarcane ecosystem

Order	Family	Genus	Total
Araneae	Araneidae	*Neoscona* sp.	51
	Lycosidae	*Hippasa* sp.	59
	Thomisidae	*Pardosa* sp.	61
		Pardosa birmania Simon	43
	Salticidae	Unidentified sp.	21
Polydesmida	Polydesmidae	*Asiomorpha coarctata* (Saussure)	6
Total			241
Exopterygota			
Odonata	Libellulidae	*Orthetrum sabina* (Drury)	38
Orthoptera	Gryllotalpidae	*Gryllotalpa orientalis* (Burmeister)	40
	Acrididae	*Neorthacris simulans* (Bolivar)	45
	Gryllidae	*Gryllus* sp.	46
Total			169
Isoptera	Termitidae	*Odontotermes obesus* (Rambur)	383
Dermaptera	Forficulidae	*Forficula auricularia* (Linnaeus)	17
Hemiptera	Lophopidae	*Pyrilla perpusilla* (Walker)	31
	Derbidae	*Proutista moesta* (Westwood)	99
	Aphididae	*Melanaphis sacchari* (Zehnter)	330
Total			1,029
Endopterygota			
Lepidoptera	Nymphalidae	*Ariadne merione* (Cramer)	89
Diptera	Dolichopodidae	*Condylostylus* sp.	45
	Sarcophagidae	*Sarcophaga* sp.	45
	Calliphoridae	*Lucilia* sp.	147
Total			326
Hymenoptera	Formicidae	*Oecophylla smaragdina* Fab.	281
		Camponotus spp.	86
		Solenopsis sp.	373
Total			740
Coleoptera	Coccinellidae	*Coccinella septumpunctata* L.	104
		Cheilomenes sexmaculata Fab.	68
	Cetoniidae	*Oxycetonia versicolour* Fab.	21
	Cicindelidae	*Cicindela* sp.	22
	Total		215
	Grand Total		2,310

noted the presence of crickets, mole crickets, ants and grass-hoppers in sugarcane ecosystem.

Falling under the order order Araneae, the major families were found associated with Araneidae, Lycosidae, Thomisidae and Salticidae. *Neoscona* sp., *Hippasa* sp., *Pardosa* sp. and *Pardosa birmania* Simon were found to be common in sugarcane ecosystem (Table 1). Madhusoodhanan (2015) recorded ten families of Araneae from sugarcane ecosystem and among the Hemipteran families, Aphididae yielded the maximum number of individuals and abundance of *Proutista moesta* (Westwood), *Pyrilla perpusilla* Walker and *O. obesus* was higher in sugarcane field.

The detection of sugarcane insects and natural enemies in this study was related to the investigation of Kumarasinghe (2003) who identified insects associated with sugarcane in Sri Lanka. A survey was conducted by Kumarasinghe (2003) over 13 years (1986–1999) in sugarcane plantations in Sri Lanka to record insects associated with sugarcane. The survey yielded a total of 103 insect species comprising Coleoptera (31 spp.), Dictyoptera (2 spp.), Diptera (5 spp.), 12 Heteroptera (12 spp.), Homoptera (18 spp.), Hymenoptera (7 spp.), Isoptera (3 spp.), Lepidoptera (13 spp.), Orthoptera (9 spp.), and one species each of Thysanoptera, Neuroptera and Trichoptera. Among them 46 species were sugarcane pests. Further, 27 species of natural enemies of sugarcane pests belonging to the orders Coleoptera, Diptera and Hymenoptera were also recorded. Among the recorded insects was *Epiricania melanoleuca* which was introduced into Sri Lanka from Pakistan in 1991 for the control of the sugarcane planthopper. These kind of records underscores the importance of assessing the insect biodiversity of a particular crop ecosystem. Moreover, the diversity study of sugarcane insects in Pakistan recorded by Ahmed *et al.* (2004) showed the highest population of sugarcane plant hopper namely *Pyrilla perpusilla*, *Otinotus oneratus* and *Perkincsiella* sp, *Alerolobus barodenesis*). The varieties of sugarcane insect pests identified were Lepidoptera (*Scirpophaga nivella, Chilo infuscatellus, Emmalocera depressella, Acherontia atropos*), grasshoppers (*Atractomorpha acutipennis, Coenagrion puella, Gryllus bimaculatus, Trigonidium cicindeloides, Chrotogonus trachypterous, Oxya intricata, Euconocephalus incertus, Hedotettix gracilis, Chlaenius quadricolour, Orthrophagus atroplitus*), beetles (*Calosoma maderae, Craspendophorus elegans, Orthrophagus atroplitus, Scrabaeus brahminus, Heteroderes lenis, Aspidomorpha miliaris, Aulacophora foveicollis*) and Hymenoptera (*Vespa orientalus, Rhyssa persuasoria, Formica* spp., *Monomorium minimum*).

Mengistu and Selvaraj (2013) accomplished to assess the diversity of sugarcane borers in sugarcane plantations of Ethiopia and the extent of damage caused by them on the cane and sugar yield. Four lepidopteran borer species, viz. *Busseola fusca*, *Chilo partellus*, *Sesamia calamistis* and *Sesamia peophaga* were recorded to be damaging the sugarcane crop in 192 surveyed fields in Ethiopia. They could also observe that several attributes like crop type, season and variety had influenced the sugarcane borer diversity and the extent of damage caused by the species among the surveyed plantations.

Innocent and Merlindayana (2012) assessed the diversity of insects at Allinagaram village, Periyakulam in Theni District, Tamil Nadu. They have recorded a total of 2,660 insects which belonged to 44 species and 10 orders. The maximum population percentage (62%) was recorded to be in Diptera which recorded the maximum density of 1,650 insects. This was followed by Lepidoptera with a population percentage of 10.6% and records of 12 species. High numerical abundance of individuals was the reason behind the high diversity index in Diptera. Similarly, Banu *et al.* (2016) studied the diversity of insects in sugarcane field at Chinnamanur, Theni district, Tamilnadu by the collection of insects using light traps. The collection yielded a total number of 423 insects which belonged to 6 orders and 24 species. The data analysis on the order wise distribution and diversity of insects revealed the prevalence of Coleoptera order which was followed by Diptera, Hemiptera, Odonata, Orthoptera and Lepidoptera.

Voraphab *et al.* (2015) reported a total of 98,423 individuals including 143 species in sugarcane fields of Khon Kaen Province, Thailand. The identified insects were then classified into groups like herbivores, predators, decomposers, parasitoids, and pollinators. The diversity assessment of sugarcane insects and their natural enemies was also accomplished by Name (2021) in Sa Kaeo Province, Thailand. The sugarcane insect pests were collected by sweep netting and identified. About 31 species of insects belonging to 21 families and 7 orders, were associated with sugarcane crop and 11 species comprising 10 families and 5 orders were recovered as natural enemies. The species diversity was in the range of 1.63–2.49 and maximum was revealed in Nong Bon district.

This knowledge of insect pest biodiversity has enormous importance in the pest management strategies and adds information of predator behaviour with respect to the reproduction, population and incidence of the pest and the crops. The present study paved way to the documentation of various pests and natural enemies associated with sugarcane. Insect pests and natural enemies in sugarcane vary from place to place and there may be several other insects and arthropods associated with sugarcane ecosystem, which might have gone undocumented during this study. Therefore, further research with in-depth study is recommended so that the role of natural enemies in suppressing the pest population can be understood for integrated pest management in the sugarcane ecosystem.

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