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Assessment of Insect Abundance and Diversity Associated with Sorghum Ecosystem

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ABSTRACT: An intensive survey was conducted during *Rabi* 2021 at Tamil Nadu Agricultural University, Coimbatore, to investigate the insect diversity in sorghum agroecosystem. Sampling was done from seedling to maturity stages at weekly intervals to assess the richness and diversity of insect pests and natural enemies using well-known diversity indices *viz*., Simpson's diversity index, Shannon-Wiener diversity index, Margalef richness index, and Pielou's evenness index. A total of 46 species of insect species have been recorded from different orders including Hemiptera (7), Diptera (6), Coleoptera (4), Hymenoptera (4), Orthoptera (3), Lepidoptera (3) and one species each under Mantodea, Dictyoptera, Neuroptera and Dermaptera. The highest percent relative abundance was found in Hemiptera (77.09%) followed by Coleoptera (9.10%), Hymenoptera (6.34%) and Diptera (5.21%) while the remaining orders contributing less than one percent of total population. The biodiversity analysis using Shannon-Wiener index and Margalef's richness index revealed that Coleoptera had more diversity (2.201 and 1.922, respectively); Simpson's index was highest for Hemiptera (0.7514), and the equitability index was highest for Lepidoptera (0.9012) indicating greater diversity of insects in sorghum ecosystem. Understanding the biodiversity interactions in sorghum ecosystems will have a wider utility in developing effective management measures against major insect pests.

Keywords: Sorghum, biodiversity, diversity indices, insects, pests, ecology, Coimbatore.

INTRODUCTION

Sorghum, a grain crop used for both human and animal consumption, is the sixth most dryland crop. Sorghum and other coarse grains have historically been the central part of the diet of rural and lower-income semi-urban households in India. India ranks sixth in total sorghum output with 4.8 million tonnes, with Tamil Nadu producing 4.27 lakh tonnes (INDIASTAT, 2021). Sorghum, popularly known as "cholam," is grown in Tamil Nadu for both grain and fodder purposes. From the time of emergence until the late stages of grain filling, more than 150 species of insects have been identified as sorghum pests (Harris, 1995).

Biodiversity is a function of the total number of taxa present, the evenness with which they are dispersed (either within species or within families), and the relationship between richness and evenness, or diversity (Ludwig and Reynolds, 1988). Insect diversity accounts for more than 80% of the diversity of species on the planet, making them a common choice for ecological indicators (Samways, 1993).

Studies on the status pertaining to insect diversity in sorghum ecosystems are considerably poor. Therefore, an attempt was made to assess the diversity and abundance of sorghum insect pests and natural enemies in sorghum ecosystem to have a better understanding of the selection pressure to which the crop is subjected to.

MATERIALS AND METHODS

Arthropod diversity in sorghum was studied at the Millet Breeding Station, Tamil Nadu Agricultural University (TNAU), Coimbatore during *Rabi* 2021 (11°01'01.8"N 76°55'50.5"E; 420 MSL). Sorghum variety Co 32 was cultivated in an area of around 1.4 acre with standard package of practices. Arthropod sampling was undertaken at weekly intervals from 7 days after germination to harvest spanning a total of 110 days. Different sampling methods were employed *viz* net sweeping, pitfall traps and light traps. Net sweeping was carried out by walking diagonally inside the field in the morning and evening hours. Five places were chosen randomly and 15-20 net sweeps were done at each place to collect insects. Pitfall traps were kept at 7 different sites randomly in the field and collections were made at weekly intervals. Light trap was set up twice per week between 7 pm and 11 pm and the samples were collected the following morning. The

insect samples collected were preserved using dry and wet preservation techniques (stored in 70 percent ethanol) for identification (Schauff, 1986).

Arthropod diversity was assessed using various diversity indices that included Shannon-Wiener index (Shannon & Weiner, 1949) for species diversity, Simpson's diversity index (Simpson, 1949) for species dominance, Margalef's index (Margalef, 1958) for species richness and Equitability J index (Magurran, 1987) for species evenness.

RESULTS AND DISCUSSION

A total of 3,361 individuals were collected which comprised of 46 species falling under of 30 families with the most dominant ones being the Hemiptera. The detailed list of the species is provided in Table 1.

Table 1: Arthropod diversity in sorghum ecosystem.

Order/Family/Scientific name	Functional relationship
Coleoptera	
Chrysomelidae	
Altica spp.	Herbivore
Aulocophora foveicollis (Lucas, 1849)	Herbivore
Chaetocnema spp.	Herbivore
Monolepta signata (Olivier, 1808)	Herbivore
Coccinellidae	
Cheilomenes sexmaculata (Fabricius, 1781)	Carnivore
Chilocorus melas Weise, 1898	Carnivore
Coccinella transversalis Fabricius, 1781	Carnivore
Micraspis spp.	Carnivore
Scymnus spp.	Carnivore
Curculionidae	
Apinocis deplanatus (Casey, 1892)	Herbivore
Myllocerus discolor Schoenherr, 1826	Herbivore
Staphylinidae	
Paederus fuscipes Curtis, 1775	Carnivore
Dermaptera	
Undetermined	Herbivore
Dictyoptera (Blattellidae)	
Balta scripta (Shelford, 1911)	Scavenger
Diptera	
Bibionidae	
Plecia spp.	Scavenger
Cecidomyiidae	
Contarinia sorghicola (Coquillet, 1899)	Herbivore
Dolichopodidae	
Undetermined	Carnivore
Musicidae	
Atherigona soccata Rondani, 1871	Herbivore
Undetermined	
Platystomatidae	
Undetermined	
Tachinidae	
Undetermined	Carnivore
Hemiptera	
Cicadellidae	
Nephotettix spp. (Uhler, 1896)	Herbivore
Cofana spp.	Herbivore
Delphacidae	
Peregrinus maidis (Ashmead, 1890)	Herbivore
Derbidae	
Proutista moesta (Westwood, 1896)	Herbivore
Lophophidae	
Pyrilla perpusilla (Walker, 1851)	Herbivore
Membracidae	
Oxyrachis tarandus (Fabricius)	Herbivore
Miridae	
Calocoris angustatus Lethierry, 1893	Herbivore
Cyrtorhinus lividipennis Reuter, 1884	Carnivore
Orthotylus spp.	Carnivore
Pentatomidae	
Dolycoris indicus Stal, 1876	Herbivore
Menida versicolor (Gmelin, 1790)	Herbivore
Nezara viridula (Linnaeus, 1758)	Herbivore
Hymenoptera	
Apidae	
Apis cerana indica (Fabricius, 1798)	Pollinator
Braconidae	
Stenobracon nicevillei (Bingham)	Carnivore
Formicidae	

Camponotus compressus (Fabricius, 1787)	Carnivore
Solenopsis spp.	Herbivore
Vespidae	
Ropalidia marginata Le peletier, 1836	Carnivore
Lepidoptera	
Pyralidae	
Chilo partellus (Swinhoe, 1885)	Herbivore
Noctuidae	
Spodoptera frugiperda (J.E. Smith, 1797)	Herbivore
Nymphalidae	
Ariadne merione (Cramer, 1777)	Herbivore
Mantodea (Hymenopodidae)	
Euantissa pulchella	Carnivore
Neuroptera (Chrysopidae)	
Chrysoperla spp.	Carnivore
Orthoptera	
Acrididae	
Cyrtacanthacris tatarica (Linnaeus, 1758)	Herbivore
Gryllidae	
Trigonidium humbertianum (Saussure, 1878)	Herbivore
Pyrgomorphidae	
Atractomorpha crenulata (Fabricius, 1793)	Herbivore

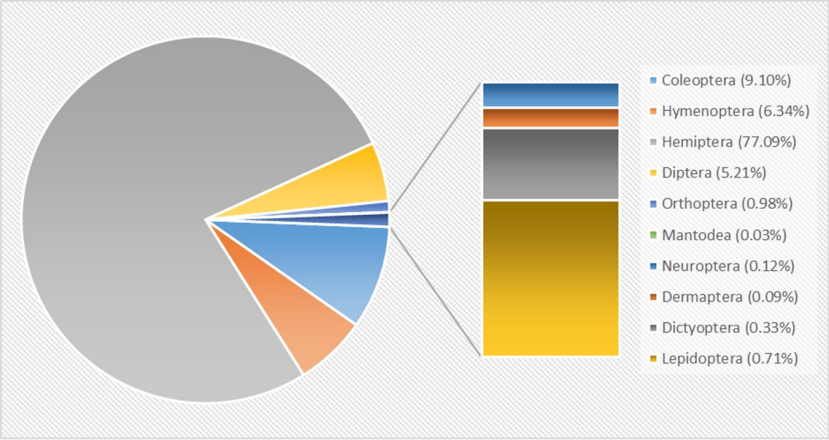

Fig. 1. Relative abundance of species in sorghum ecosystem.

The most abundant insect order was Hemiptera comprising 77.09% of the total population. Within the order, *Peregrinus maidis* was the most abundant species noticed in sorghum. Chelliah and Basheer (1965) reported that this pest may even cause death of the plant in severe cases. Pentatomid insects like *Nezara viridula*, *Dolycoris indicus* and *Menida versicolor* (Reddy and Davies 1979; Prabhakar *et al.,* 1981) have been reported damaging sorghum panicles. *Pyrilla* spp. also has been reported as a potential pest. So far, many mirid bugs have been reported attacking sorghum of which *Calocoris angustatus* was found to be a key pest in southern parts of India (Sharma and Lopez 1990). Hoppers like *Nephotettix* spp. (Kalaisekar *et al.*, 2017), *Cofana* spp. and *Proutista moesta* (Caasi-Lit 2018) were reported infesting sorghum and maize.

The second most abundant order, Coleoptera, made up 9.10% of all insect species. Many of coleopteran species were natural enemies of pests infesting sorghum. *Cheilomenes sexmaculata*, *Micraspis* spp. And *Chilocorus melas* were reported as natural enemies in sorghum ecosystem (Sherlin *et al.,* 2019). El-Gepaly (2019) also reported the following four species as predators of sorghum: *Coccinella transversalis, Scymnus* spp., *Chrysoperla* spp. And *Paederus fuscipes.* Kalaisekar *et al.* (2017) reported *Altica* spp. and *Myllocerus* spp. as pests infesting sorghum and millets in India. *Monolepta signata* and *Aulocophora foveicollis* were reported as defoliators of sorghum (Reddy and Davies 1979). The record of *Oxyrachis tarandus,* a pest of pigeon pea may be due to the presence of a pulse crop in the vicinity.

Hymenoptera was the next abundant order with 6.34% of total population. Tarihoran *et al.* (2020) reported hymenoptera as the most abundant order in sorghum ecosystem in Indonesia. He has reported that, the relative density value is high in the family Formicidae. Srivastava and Bryson (1956) reported *Solenopsis* spp. as the serious pest of planted sorghum seeds. *Apis cerana indica* and *Ropalidia marginata* were observed as pollinator and predator respectively. Diptera with 5.21% relative abundance has the most important pests such as *Contarinia sorghicola* and *Atherigona soccata* (Reddy and Davies 1979). Lepidopteran pests such as *Chilo partellus* (Young 1970) and *Spodoptera frugiperda* (Wilde 2006) were also recorded. Despite having a significant economic impact, these pests were not well represented in the collection. This may be caused by environmental factors like the weather, season, or type of light source, among others.

Mohyuddin (1970) reported a list of parasitoids attacking graminaceous stem borers which includes Braconidae and Tachinidae. *Camponotus compressus, Euantissa* spp*., Orthotylus* spp. and long legged bug were reported as predators by Sherlin *et al.* (2019). There are previous records of soil dwelling insects such as earwig by Hassan (1987) and sorghum root weevil, *Apinocis deplanatus* recorded by Bryson (1941) attacking sorghum and sugarcane. *Atractomorpha crenulata* was also found attacking millets. There are also reports of other acridids attacking sorghum (Reddy and Davies 1979). However, there are no reports of *Plecia* spp. and Dictyoptera in sorghum ecosystem. Other orders including Neuroptera, Mantodea, Dictyoptera and Dermaptera contributes less than one percent of total population.

Table 2: Biodiversity indices of various orders in sorghum ecosystem

Orders	Absolute Density	Shannon-Wiener index	Simpson index	Margalef richness index	Pielou's index
Coleoptera	306	2.2010	0.1271	1.922	0.8857
Hymenoptera	213	1.3050	0.3169	0.7461	0.8111
Hemiptera	2591	0.6532	0.7514	1.4000	0.2628
Diptera	175	1.3290	0.3488	0.9681	0.7418
Orthoptera	33	0.8174	0.5189	0.5720	0.7440
Lepidoptera	24	0.9901	0.3804	0.6293	0.9012
Others	19	1.0910	0.3743	1.0190	0.7869

The Shannon–Wiener diversity index, Simpson's diversity index, Margalef's richness index and Pielou's evenness were used as heterogeneity measures for computing diversity (Table 2). It could be observed that Shannon-Wiener index was the maximum for Coleoptera (2.201). Since each individual in this order belongs to a different species, their diversity index is the larger than others. The dominance as measured by Simpson's dominance index has values ranging from 0.12 to 0.75. Thus, the order Hemiptera (0.7514) had the maximum dominance index value and also it is the order with the most number of families. Hemiptera also has highest number of individual species count thus making it dominant over other orders. The value of Margalef index is different for all the Orders; maximum in Coleoptera (1.922) indicating high level of species richness, while least in Orthoptera (0.572) indicating low level of species richness. Pielou's evenness values range from 0 to 1.0, with 1.0 representing complete evenness (Magurran 2004). The order Lepidoptera (0.9012) with the Pielou's evenness value nearing 1 is considered to be having a more balanced distribution of species in the community.

These results are in agreement with those reported by Duffield (1995) who interpreted higher insect abundance to edaphic and locally prevailing ecological factors. Wang *et al.* (2000) stated that the reduction in species richness was mainly caused by biotic and abiotic factors; therefore, distribution of insect pests and predatory species in the selected study area seemed to be dependent on climatic factors such as temperature, relative humidity, rainfall and wind.

CONCLUSION

Intensive survey in sorghum agroecosystem in TNAU premises at weekly intervals revealed the presence of 46 insect species from a collection of 3,361 individuals representing an array of functions *viz.,* pests, natural enemies, scavengers, pollinators etc., The current work will be useful in the future for the use of specific management practices in sorghum fields, which will contribute to the sustainability of the agro-ecosystem. The agroecosystem, though man-made, display a diversified and widely distributed entomofauna.

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Conflict of Interest. None.

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