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Diversity of insect predators and spiders in the agroecosystems of maize (*Zea Mays* L.) in Telangana State, India

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Abstract
The study was conducted at maize/ corn crop fields in Nalgonda, Warangal, and Ranga Reddy, erstwhile districts of Telangana state, India during the 2021–22 Kharif and Rabi seasons**.** Main objective of the study is to investigate diversity of insect predators and spiders in the agroecosystems of maize (*Zea mays* L.) in Telangana state, India. We observed fifteen Insect predator's species, belonging to Coleoptera, Diptera, Hemiptera, Hymenoptera, Montodea, and Neuroptera orders in the class Insecta and two spider species, belonging to Araneae order in the class Arachnida of the Arthropoda phylum of the Kingdom Animalia**.** Among the orders, the order Coleoptera represented the highest number of five species followed by Hemiptera three species, Diptera, Hymenoptera, Neuroptera, and Araneae two species, and Montodea one species**.** Ecological indices of predatory arthropods i.e., Species richness (Margalefs Index), Species diversity (Shannon-Wiener Index), and Species evenness (Pielou Evenness Index) were calculated.

Keywords: Insect predators, spiders, agroecosystems, Maize (*Zea mays* L.), and Diversity

Introduction

Maize/ corn, *Zea mays* L., is commonly known as "Queen of Cereals" which belongs to Family Poaceae; Order Poales of kingdom Plantae. Maize/ corn is the world's third most widely cultivating crop after wheat and rice. India ranked third in terms of area and maize production. Around the world, corn crops constitute a major component of food supply for humans as well as animals (Erenstein *et al*., 2022). Maize is a source of various nutrients such as 71.5 percent starch, 1.9 percent protein, 4.8 percent fat and 1.4 percent ash (Rathore, 2001) [13]. The cultivation of maize in India covers an area of 9.63 million hectares, yielding an annual production of 25.90 million metric tons and an average productivity of 2.69 metric tons per hectare. The country is home to its cultivation.

Mathur, (1992) [12] reported 250 pests attacking maize, but only a dozen of them is serious and need to be controlled (Siddiqui and Marwaha, 1994) [19]. About 250 species of insect pests and mite pests have been observed harmful this crop out of which only half a dozen is of economic importance which threatens to limit the production of the maize (Mathur, 1991) [11]. The loss of almost 32.1 per cent of the actual produce in India is caused by insect pests (Borad and Mittal, 1983) [5]. The damage caused to maize crops by 141 insect pests varies from sowing to harvest (Reddy and Trivedi, 2008) [14]. Economic yield losses are caused by insect pests in different seasons throughout the country. During the cropping and storage phases, maize is attacked by insects, leading to losses of up to 10% to complete (Bergvinson *et al*., 2002).

It is important to focus on substitutes such biological solutions, which have been increasingly pushed in the last few years (Barratt *et al*., 2018 [3]; Armarego-Marriott, 2022 [2]; SP-IPM, 2006 [20]; Sharma *et al*., 2013) [18]. The most appropriate of these options is likely to be biological control using natural enemies/ insect predators and spiders that prey on pests and have a parasitic or predatory regime (Riddick, 2022) [15].

Main purpose of the study is to study diversity of insect predators and spiders in the agroecosystems of maize (*Zea mays* L.) in Telangana state, India.

Materials and methods

The study was conducted on maize/ corn crop fields in Nalgonda, Warangal, and Ranga Reddy, erstwhile districts of Telangana state, India. One crop field was selected from each district. The study was carried out during the 2021–22 Kharif and Rabi seasons. The maize variety '900M Gold' was cultivated in agroecosystems of maize.

The diversity of predatory arthropods was investigated on maize/corn from seedling emergence to the final harvest. Sample was collected every week from maize/ corn crop fields, in the morning hours because most of insects become active when temperature is about 25˚C to 30˚C (Garcia A. *et al*, 1982) [9]. Predatory arthropods were captured in maize/corn fields with the help of hand-picking methods and a sweep net (Hassan *et al*., 1995) [10]. For the predatory arthropod's population count, five plots each having an area of 5m x 5m were selected in the maize/corn fields. The predatory arthropods were observed visually on whole plants. The plant was observed from all angles, from bottom to top, and the leaves were examined on both sides (upper and lower). The predatory arthropods were carefully counted. predatory arthropods and spiders were well-preserved in 70% ethyl alcohol in glass vials of size 10 cm x

2.5 cm and labeled. predatory arthropods were identified with the help of keys by comparing the morphological and taxonomical features (Samiayyan, 2014) [16], and published literature.

Ecological indices of predatory arthropods i.e., Species richness (Margalefs Index), Species diversity (Shannon-Wiener Index), and Species evenness (Pielou Evenness Index) were calculated.

1. *Species diversity [Shannon-Wiener index (H)]*

$H = -\sum P_i \log P_i$

Where,

H = Shannon-Weiner index,

$\sum$ = Sum,

Pi = ni /N,

ni = Number of individuals of each species in the sample,

N = Total number of individuals of all species in the sample.

2. Species evenness [Pielou Evenness Index (J)]

$J = H/H_{max}$

Where,

J = Evenness index,

H= Shannon -Weiner index,

$H_{max} = \log S$,

S = number of species.

3. Species richness [Margalef's Index (D)]

$D = \frac{S-1}{\log N}$

Where,

D= Species richness,

S= total number of species,

N= total number of individuals.

Results

A total of 6025 Insect predators and 276 spiders were collected from maize/corn crop fields in Nalgonda, Ranga Reddy, and Warangal, erstwhile districts of Telangana state, India, using hand-picking methods and Sweep nets during the 2021–22 Kharif and Rabi seasons. Out of those, fifteen Insect predator's species, belonging to Coleoptera, Diptera, Hemiptera, Hymenoptera, Montodea, and Neuroptera orders in the class Insecta and two spider species, belonging to Araneae order in the class Arachnida of the Arthropoda phylum of the Kingdom Animalia (Table. 1). Among the orders Coleoptera, Diptera, Hemiptera, Hymenoptera, Montodea & Neuroptera and Araneae, the order Coleoptera represented the highest number of five species followed by Hemiptera three species, Diptera, Hymenoptera, Neuroptera, and Araneae two species, and Montodea one species (Fig. 1).

Table 1: Diversity of insect predators and spiders on maize/ corn agroecosystems.

S. No.	Order	Family	Species	Common name
1	Araneae	Araneidae	*Argiope aurantia* (Lucas, 1833)	Corn spider
2	Araneae	Araneidae	*Neoscona oaxacensis* (Keyserling, 1863)	Zig-zag spider
3	Coleoptera	Coccinellidae	*Cheilomenes sexmaculata* (Fabricius, 1781)	Six-spot zigzag ladybird beetle
4	Coleoptera	Coccinellidae	*Coccinella septempunctata* (Linnaeus, 1758)	Seven spot ladybird beetle
5	Coleoptera	Coccinellidae	*Coccinella transverslis* (Fabricius, 1781)	Transverse ladybird beetle
6	Coleoptera	Coccinellidae	Stethorus punctillum (Weise, 1891)	Lesser mite destroyer
7	Coleoptera	Staphylinidae	*Paederus baudii* (Fairmaire, 1859)	Rove beetle
8	Diptera	Cecidomyiidae	*Aphidoletes aphidmyza* (Rondani, 1847)	Aphid midge
9	Diptera	Cecidomyiidae	*Feltiella minuta* (Felt, 1907)	Gall midge
10	Hemiptera	Anthocoridae	*Anthocoris tomentosus* (Pericart, 1971)	Minute pirate bug
11	Hemiptera	Miridae	*Stenotus binotatus* (Fabricius, 1794)	Corn mirid bug
12	Hemiptera	Pentatomidae	*Eocanthecona furcellata* (Wolff, 1811)	Zoophytophagous predatory stink bug
13	Hymenoptera	Formicidae	*Lasius niger* (Linnaeus, 1758)	Common black ant
14	Hymenoptera	Vespidae	*Vespula vulgaris* (Linnaeus, 1758)	Common wasp
15	Montodea	Montidae	*Mantis religiosa* (Linnaeus, 1758)	Praying mantis
16	Neuroptera	Chrysopidae	*Chrysoperla carnea* ((Stephens, 1836))	Common green lacewing
17	Neuroptera	Chrysopidae	*Mallada basalis* (Walker, 1853)	Green lacewing

Fig 1: Number of insect predators and spider's species of different orders on maize/ corn agroecosystems.

The family Coccinellidae of Coleoptera was the richest with four species followed by Araneidae of Arachinada with two species, Cecidomyiidae of Diptera with two species, Chrysopidae of Neuroptera with two species, Staphylinidae of Coleoptera with one species, Anthocoridae, Miridae, and Pentatomidae of Hemiptera with one species, Formicidae, and Vespidae of Hymenoptera with one species, and Montidae of Montodea with one species on maize/ corn crop fields (Fig. 2).

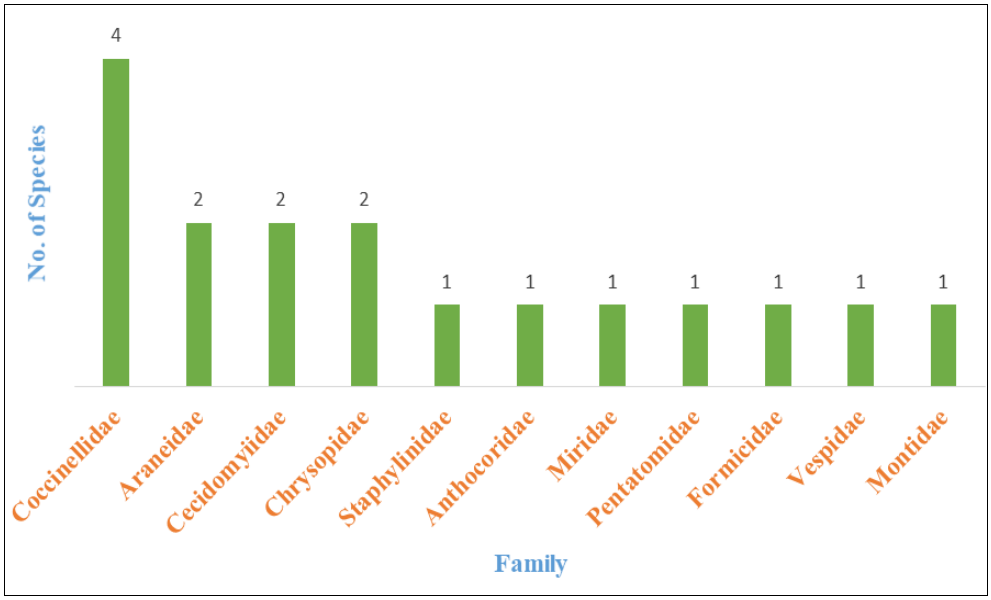

Fig 2: Number of insect predators and spider's species of different families on maize/ corn agroecosystems.

The spider species *Argiope aurantia* (Corn spider) and *Neoscona oaxacensis* (Zig-zag spider) of Araneidae family of Araneae order were observed. The species *Cheilomenes sexmaculata* (Six-spot zigzag ladybird beetle), *Coccinella septempunctata* (Seven spot ladybird beetle), *Coccinella transverslis* (Transverse ladybird beetle), and *Stethorus punctillum* (Lesser mite destroyer) of Coccinellidae family and *Paederus baudii* (Rove beetle) of Staphylinidae family of Coleoptera order were observed. The species *Aphidoletes aphidmyza* (Aphid midge) and *Feltiella minuta* (Gall midge) of Cecidomyiidae family of Diptera order were observed. The species *Anthocoris tomentosus* (Minute pirate bug) of Anthocoridae family, *Stenotus binotatus* (Corn mirid bug) of Miridae family, and *Eocanthecona furcellata* (Zoophytophagous predatory stink bug) of Pentatomidae family of Hemiptera order were observed. The species *Lasius niger* (Common black ant) of Formicidae family, and *Vespula vulgaris* (Common wasp) of Vespidae family of Hymenoptera order were observed. The species *Mantis religiosa* (Praying mantis) of Montidae family of Montodea order were observed. The species *Chrysoperla carnea* (Common green lacewing), and *Mallada basalis* (Green lacewing) of Chrysopidae family of Neuroptera order were observed (Table. 1).

The calculation included three characteristics, Species evenness (Pielou Evenness Index), namely species diversity (Shonnon-Wiener Index), and Species richness (Margalefs Index) for analysis of community structure of Insect predators and spiders on maize/ corn agroecosystems (Table. 2). According to ecological indexes, there is significant patronage shown in the species composition of Insect predators and spiders in the maize/corn agroecosystem.

The H-values of Hymenoptera, Montodea, & Neuroptera and Araneae are below 1.0, which indicates that the habitat structure is not suitable. Maize/ corn agroecosystems are stable for Coleoptera, Diptera, and Hemiptera if their H-values exceed 1.0. In the case of Coleoptera, Diptera, and Hemiptera, H-values are between 1.102 and 1.171, which indicates that the habitat structure is stable and suitable for these species. Maize/corn agroecosystems have evenness values closer to 1.0, which means that the individuals are equally distributed. Richness values in maize/corn agroecosystems are below 0.5. It indicates that the individuals are low, but closer to 1.0 indicates that they are more (Table. 2).

Discussion

Our results indicate that fifteen Insect predator's species, belonging to Coleoptera, Diptera, Hemiptera, Hymenoptera, Montodea, and Neuroptera orders in the class Insecta and two spider species, belonging to Araneae order in the class Arachnida of the Arthropoda phylum of the Kingdom Animalia. Among the orders Coleoptera, Diptera, Hemiptera, Hymenoptera, Montodea & Neuroptera and Araneae, the order Coleoptera represented the highest number of five species followed by Hemiptera three species, Diptera, Hymenoptera, Neuroptera, and Araneae two species, and Montodea one species. Many previous studies of insect predators' diversity on maize/ corn crop fields are similar or partially like our study. Edpuganti Sreelatha *et al*., (2022) [7] investigated the biodiversity of insect pests and their predators in the maize Agroecosystem. They found a total of five species of insect predators and one spider belonging to different orders and varied families were recorded. The present results are in partially accordance with the findings of Costea Maria, *et al*., (2023) [6] whose study revealed that ten insect predators and five spiders were observed at Corn crops in Romania at different growth stages of the crop. Saranya *et al*., (2018) [17] recorded 16 spider species in maize ecosystem throughout the crop growth, in Tamil Nadu Agricultural University, Coimbatore during 2013-2014.

Conclusion

As a result of this study, we observed fifteen Insect predator's species and two spiders were observed, during the 2021–22 Kharif and Rabi seasons. diversity of insect predators and spiders depends on many factors. It may be concluded that climatic factors determine diversity of insect predators and spiders of maize/ corn agroecosystems. An ecologically diversified agroecosystem can support different types of insect predators and spiders, which can naturally reduce pest populations, Altieri (1990) [1]. The results of present study would be helpful in developing efficient biocontrol management strategies against insect pests of maize/ corn agroecosystems for increased yields, profit, besides safely to the environment.

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