



ABUNDANCE AND DIVERSITY OF SPIDERS IN AGROECOSYSTEMS OF JABALPUR

JAGRATI UPADHYAY^{1*} AND S B DAS²

¹Faculty of Agriculture, Mangalayatan University Jabalpur 483002, Madhya Pradesh, India

²Department of Entomology, College of Agriculture, JNKVV, Jabalpur 482004, Madhya Pradesh, India

*Email: jagratu.09@gmail.com (corresponding author); ORCID ID 0000-0001-5978-4741

ABSTRACT

The fauna of spiders which is a significant part of agriculture ecosystem was observed in 8 crop fields during the kharif. The spiders were caught from June-October, using sweep nets. The total numbers of spider species were 37 representing 12 families. Araneidae was the most abundant family, followed by Thomisidae, Salticidae, Oxyopidae, Tetragnathidae, Clubionidae, Dictynidae, Gnaphosidae, Lycosidae, Sparassidae, Theridiidae and Ulboridae. The species diversity index (H') was 4.98 and the Equitability index (E_H) was 0.95. An ordination of correspondence analysis demonstrated a bunching of the spiders commencing to paddy fields was more as compared to other crops. Thus, paddy seemed to give better natural niche for the spiders than other field crops. Increasing use of pesticides is the main menace to the several species and their survival in agroecosystem.

Key words: Spider, fauna, abundance, field, kharif season, paddy, diversity index, soybean, equitability index, maize, cowpea, correspondence analysis, sorghum, pigeonpea, agroecosystem, crop, green gram.

The survey was conducted on farms of the Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), located about 7 km of Jabalpur district of Madhya Pradesh. The survey represented an area of 1544 ha of land of the University. This area astonishingly exalted species diversity of spider, harboured in the fields. Spiders are spectacular primitive arthropods belonging to the class Arachnida and order Araneae that occupy all habitats on the earth, from Arctic Islands to desert region, except marine (Chakrabarti, 2013). The word spider comes from the Latin word "Spinnen" meaning to spin (Foelix, 2011). As per the World Spider Catalogue (2023) described approximately 51478 spider species associated with 135 families and 4339 genera were recorded. The most comprehensive work on Indian spiders was carried out by Tikader (1987), who listed 1066 species belonging to 43 families followed by 1686 spider species (Keswani, 2015). Presently from India, about 1960 spider species belonging to 496 genera under 61 families have been reported (Caleb and Sankaran, 2023), whereas from Jabalpur 88 species under 54 genera representing 18 families have been reported by Gajbe (2004). Despite the diversity of spider fauna, spider taxonomy is still understudied (Zehbi and Yousuf, 2023). The main focus of spider research in India is to give the taxonomic identification while the assessment of their ecological importance in agroecosystems in India has been neglected (Sudhikumar et al., 2006).

Spiders are an essential set of predators with regards

to species diversity and ranking seventh in the global diversity after insect orders. Biodiversity of spider species in natural ecosystems, including agriculture is high and this predator community is closely related to the characteristics of the plant community where it lives (Symondson et al., 2002; Platnick, 2009). Spiders prey upon the majority of phytophagous insects and remain in the ecosystem for a long time even after the harvest of the crops (Chakrabarti, 2013). The predatory capacity of spider makes them effective biocontrol agents (Upadhyay et al., 2018b). High abundance and diversity of spiders coupled with its predatory nature are viewed as significant in both the chemical-based and natural cropping systems (Kuusk et al., 2008). The most commonly seen spiders in agroecosystems belong to the families namely Salticidae, Oxyopidae, Lycosidae, Thomisidae, Theridiidae, Linyphidae, Tetragnathidae, Gnaphosidae and Araneidae (Kumar and Shivakumar, 2004). Research is required to explore the fauna of the spiders in agroecosystem as the variety of spider families in agroecosystem reveal that spiders can be significant supporters of organic IPM.

MATERIALS AND METHODS

The field experiments were conducted in the farms of JNKVV (22°49' and 20°89' N, 78°21' and 80°58' E). The average yearly rainfall is nearly 1423 mm, which is received mostly between mid-June to mid-September. The maximum and minimum temperature ranges

between 24° C to 45° C and 2° C to 32° C, respectively. (www.mp.gov.in/agro-climatic-zones). The survey on the diversity of spider fauna was conducted during kharif. For the systematic recording of the data, eight fields of about one acre were randomly selected from each farm and thus a total of 32 fields were observed in four farms. Each field was divided into four equal blocks and the spider population was recorded randomly at five sites per block. The observational unit in each site was comprised of a quadrat of 1x1 m² (Khan and Rather, 2012). Thus a total of 20 observations were recorded every time from each field. Three different techniques were adopted to collect and count the spider population as proposed by Khan (2009) i.e. insect sweeping-net (30 cm dia and 60 cm deep), locate-and-find-hand-collection visually and beating the crop, respectively. The observation was initiated immediately after the germination of the crops and was continued up to its maturity. The spiders collected, were kept in collection bottles containing 70% alcohol, labeled crop-wise and were brought in the laboratory for identification by an expert Dr. S. Chakrabarti. Observations were recorded once in a standard week (Kacar, 2015).

Spider species recorded on kharif crops viz., maize *Zea mays* L. (Poaceae), paddy- *Oryza sativa* L. (Poaceae), sorghum- *Sorghum bicolor* L. (Poaceae), soybean- *Glycine max* (L.) Merr. (Fabaceae), green gram- *Vigna radiate* L. (Fabaceae), Pigeonpea- *Cajanus cajan* L. (Fabaceae), cowpea- *Vigna unguiculata* (L.) Walp. (Fabaceae), garlic- *Allium sativum* (L.) (Amaryllidaceae). Quantitative estimation of individual spider species in agroecosystem of JNKVV farms was made using the data derived from field surveys. Collected data were analyzed to calculate species diversity based on Shannon-Wiener function (Henderson and Southwood, 2016). The data was assessed using correspondence analysis (CA) on the relative abundances of species (Benzécri, 1992; Beh and Lombardo, 2015).

RESULTS AND DISCUSSION

The kharif crops harboured 37 species of spiders which represented 12 families. Based on behaviour and prey, they may be either weaver or non-weaver. The non-weaver spiders were hunting and ambushing types. The web-building spiders are again categorized into four groups i.e. Orb spiders (Araneidae), mesh web weaver (Dictynidae), long-jawed spiders (Tetragnathidae), comb foot spiders (Theridiidae) and Cribellate orb weaver (Ulboridae). The hunting spiders are divided

into six groups i.e. Huntsman spiders (Sparassidae), wolf spiders (Lycosidae), sac spiders (Clubionidae), jumping spider (Salticidae), lynx spiders (Oxyopidae) and ground spiders (Gnaphosidae). Ambushing spider as crab spider (Thomisidae). The collected spider specimens were grouped as family-wise and also proposed by Khan (2009). Family Araneidae, Thomisidae and Salticidae dominated (5 species each), followed by Oxyopidae and Tetragnathidae (4 species each). Presence of only one species in families Clubionidae, Dictynidae, Gnaphosidae, Lycosidae, Sparassidae, Theridiidae and Ulboridae were the least abundant families (Upadhyay et al., 2018a). Among the aforementioned only orb weaver (Ulboridae) lack venomous glands, ensnare prey in fine cribellate fibers (Babu et al., 2022). Spider species belonging to the Salticidae (largest family of spiders) possess type II functional response which makes it effective Biocontrol agent of various cropping systems (Upadhyay and Das 2020; Caleb, 2023). The abundance of families might be pest density dependent and spiders exhibit a wide scope of predating strategies and as such lessen herbivore pest population (Marc et al., 1999).

The species diversity index (H') based Shannon-Wiener function was 4.98. In the previous studies on post rainy season crops, the diversity index was 1.31 (Upadhyay et al., 2018a). In the majority of cases of predators, the value above 2.5 indicates that the habitat is stable and has high diversity (Elekcioglu, 2020). The diversity index was 1.29 in the fruit ecosystem of Kashmir valley which is low (Khan, 2009) and the variation might be due to low temperature which leads to dormancy in spiders. Simpson Yule Index (D) was 0.03 this shows a higher diversity as the calculated value is near to zero (Elekcioglu, 2020). The Equitability index (E_{H'}) was 0.95 when the diversity is at a greatest then all the species inside a population are similarly abundant (Henderson and Southwood, 2016).

Correspondence analysis (CA) is a technique for studying the association amid the two qualitative factors and graphically showing a two-path table by computing coordinates representing its lines and segments. In the present study, four major crops (in terms of abundant spider population) were taken from the kharif season viz., paddy, pigeonpea, soybean and cowpea. The ordination (CA) displayed an incline of a spider along the first two CA axes (Fig. 1). A clear clustering appeared relating to crops i.e. more families of spider harboured in paddy followed by pigeonpea, cowpea and soybean crop. The inclination with CA

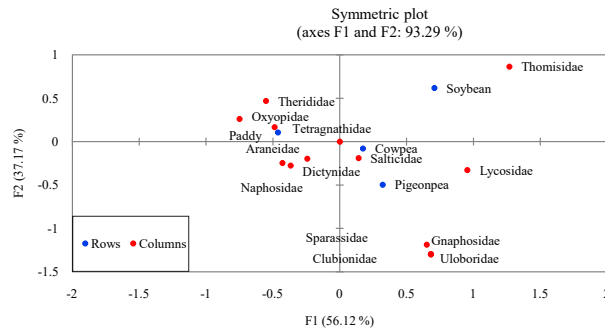


Fig. 1. Correspondence analysis of spider families identified as indicators in major crops

(The first axis is horizontal and the second axis is vertical; 2-D ordination diagram CA accounts for 93.29% of information together; Samples indicated by red dots for spider families and blue dots for major crops)

axis 1 explained 56.12%, and the inclination all along CA axis 2 an extra 37.17% of the disparity in the species information, giving a sum of 93.29% clarified variability. The variation in the spider abundance and diversity may be accredited to the locale complexity, sensitiveness to small changes in the habitat structure, microclimate characteristics and seasonal variation (Topping and Sunderland, 1994; Brown et al., 2003; Pluess et al., 2010; Takada et al., 2014, Kumari et al., 2017 and Upadhyay et al., 2018a). During the cropping season, spider family Araneidae was dominant followed by Salticidae, Thomisidae, Tetragnathidae, Oxyopidae, Clubionidae, Lycosidae, Dictynidae, Sparassidae, Theridiidae and Uloboridae. The species diversity index (H') was 4.98 and equal abundance is observed within the fields. The correspondence analysis showed that various crops attract a particular type of spider families. The abundance and diversity of the spider families in agroecosystems advocates that spiders might be a chief patron to the biological management system of insect pests.

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AUTHOR CONTRIBUTION STATEMENT

JU have conducted experiments, prepared the manuscript and SD edited it. Both the authors read and approved the final manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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