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Biodiversity of Spiders from Banana Fields of District Matiari, Sindh, Pakistan

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Abstract
Biodiversity applied for diverse life forms existing in the globe. Here it means coexistence of spiders with banana plantations which was observed very affluent in the fields of banana located in the District Matiari. Total 992 specimens (including spiderlings) were assembled. The period of this research was from the month of January to October 2021 and January to May 2022. Spider biodiversity is was notice high because of the preferred environmental (Biotic: plantations; vegetation, prey etc and abiotic: temperature and humidity) circumstances. Present work is focused on the biodiversity of spiders from banana Agro-ecosystem of District Matiari. It is one of the most fertile agricultural districts of Sindh. Mostly the livelihood of the people of Matiari district depends upon the agriculture; hence many crops are being grown here. The banana (*Musa paradidica* L.) belongs to the family Musaceae is the major fruit crop of Sindh.. During field survey from frequently banana growing taluka's (Hala, New Saeedabad and Matiari). During this study six families are identified namely; Araneidae, Lycosidae, Oxyopidae, Tetragnathidae, Salticidae and Gnaphosidae. These families were classified on the basis of their web-building and predation methods.
Keywords: Biodiversity; Guild Structure; Spiders; Banana; Matriari; Hyderabad; Sindh

Introduction
Spider biodiversity is the study of the diversity of spiders, or arachnids, in the wild and in animal and plant communities (Schausberger, *et.al.*, 2021). It includes a wide variety of topics, from species identification to habitats and food webs. It also includes more specific studies of spider populations and their roles in the biotic and abiotic components of the environment (Hoove, K., 2019). Spider biodiversity is an important topic of study because it sheds light on the diversity and interactions among animal and plant communities (Jäger, *et al.*, 2021). By studying the various species of spiders, and

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how they interact, scientists can learn valuable information about the health of the environment and how it is affected by human activity (Alvarez, *et al.*, 2020). Spiders can serve as "indicators" of good environmental quality, meaning that when their numbers are healthy, the environment surrounding them is also likely to be healthy (Alvarez, *et al.*, 2020). For example, spider populations have been shown to change in response to air and water pollution, deforestation, and climate change. In addition, spiders are significant predators in many animal and plant communities. By studying their food webs and the conflicts between species, scientists can determine how the environment is being changed by human activities (Plath, *et al.*, 2021). In some cases, spiders can even help maintain diversity in the surrounding environment, by feeding on pests and competing with other predators who might otherwise be consuming beneficial organisms (Su, *et al.*, 2020). Spider biodiversity refers to the variability in spider species found in an ecosystem from region to region and over time (Gregorič, *et al.*, 2022). It is important to assess the various species of spiders in order to understand their roles in a given habitat (Vymazalová, *et al.*, 2021). The more diverse a spider community is, the more depth and stability is added to the local food web (Domènech, *et al.*, 2022). Different species of spiders can take advantage of different food sources, making them more resistant to disease and extreme weather conditions (Zhang, *et al.*, 2021). Due to range shifts caused by climate change, some spider species have become more broadly distributed, while others have become restricted to specific regions (Zarikian, *et al.*, 2023). This is why it is important to keep track of potential range shifts and monitor spider diversity. Spider biodiversity also sheds light on the conservation of species and ecosystems. By studying what they eat and understanding their relationship with other organisms, we can develop strategies to protect spider habitats, helping to maintain their diversity (Zarikian, *et al.*, 2023). This, in turn, will increase the overall health of an ecosystem, through maintaining healthy populations of other species (Zhang, *et al.*, 2021). Spider biodiversity consists of a complex network of species that are food for each other. As such, they contribute directly to each other's survival (Rischen, *et al.*, 2021). For example, spiders prey upon food sources for other organisms, as well as providing a supplemental food source themselves. In addition to providing sustenance to a variety of species, spiders are also important pollinators. Furthermore, spiders play a unique role in plant growth. Through their web building, which creates a waterproof canopy, they help to collect and redistribute water in their environment. They also assist in transporting pollen from one plant to another, aiding in the process of reproduction. Additionally, spiders can act as a means for controlling pest populations, thus helping to protect the overall balance of communities. Spiders are also ecologically important predators. They help to keep the balance of animal populations by controlling the populations of certain prey. This is beneficial to the overall health of an ecosystem as some species may otherwise exceed their population limits, depleting the number of resources available to others. Spider biodiversity is a vital and integral part of many ecosystems. By studying the life histories and relationships between species, we can better understand their oles in the life cycle of life as well as develop appropriate conservation plans. Doing this will help ensure that spider diversity is maintained,

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which will benefit the environment as a whole (Rajeevan, *et al*., 2019; Gogoi, *et al*., 2021). In banana plants of Sindh, Pakistan, Spider biodiversity is found to be quite exceptional, with as many as 85 different species of spiders already recorded.. This is a remarkable finding, considering that the majority of the world's spiders are found in tropical rainforests and in the temperate zone of the northern and southern hemispheres. Sindh province in Pakistan is a semi-arid region with varied climatic conditions. It is characterized by two distinct seasons – a hot summer (April to June) and a wet monsoon season (July to September). Spider diversity in the region's banana plantations has been divided into two broad categories - web-spinning spiders and active hunters. Among the web-spinning spiders, Araneids such as Argiope versicolor (zanzara) and Nephilakuhlii (yellow'web) are common. Additionally, there areMygalomorphae spiders that make purse shaped webs, including genus Acanthepeira, Hersiliola, Steatoda, and Tegenaria. The active hunters (Argyopidae) are also quite abundant in Sindh's banana plantations and include species such as Aelurillus v-insignitus, Euophrystestaceopilosa, Epocillasyarii, and Tapinocybamaculate. These predatory species are incredibly efficient in controlling the inordinate population of pest and other tiny arthropods, some of which are damaging to the banana plants. At the same time, other spider species are very beneficial for overall banana plantation maintenance in Sindh. Jumping spiders, such as Hasariusadansoni, Marpissamuscosa, and Plexippuspaykulli, are known to be exceptionally effective in controlling numerous arthropod pests in a single place (5). Moreover, these jumping spiders are also efficient in consuming obnoxious insects that can hurt crop production. Furthermore, long-jawed orb weavers, like Tetragnathastricta, help in pest management and maintaining the overall skin quality. These spider species reside in the web themselves within the banana plantation's canopy and consume numerous insects, including larvae, ants, and aphids (Rajeevan, *et al*., 2019; Gogoi, *et al*., 2021; Malik, *et al*., 2022; Devika, e*t al*., 2022; Simba, *et al*., 2023).

Material and Methods

For this study data was gathered from the banana fields of District Matiari located (026°28'13.3"N and 83°38'28.3"E) Fig.1. During field survey from frequently banana growing taulka's (Hala, New Saeedabad and Matiari), 992 specimen (including spiderlings) were gathered. The period of this research was from the month of January to October 2021 and January to May 2022. Keys followed; for the identifications of spiders were given by (Malik, *et al*., 2022; Devika, e*t al*., 2022; Simba, *et al*., 2023) for the study of diversity of spiders methods of was applied Fig.1-3, All specimens brought to laboratory (fig.4) and sorted out into six families (table 2-5).

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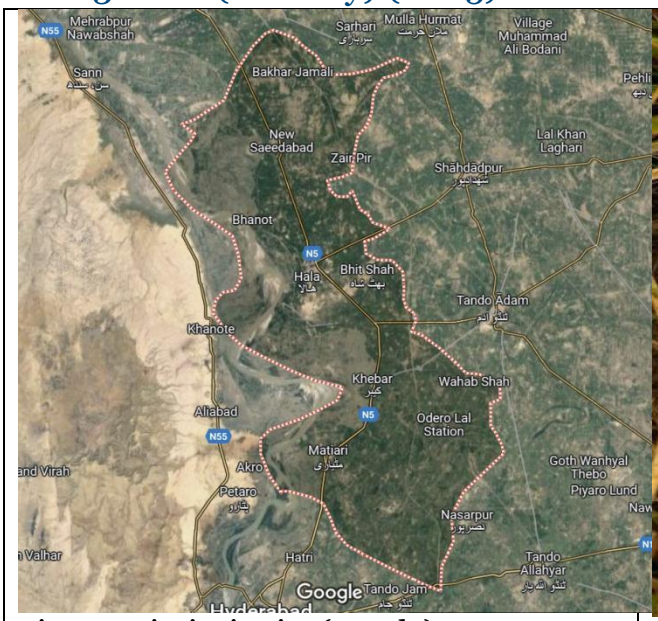

Fig.1 Matiari District (google)


Fig.2 Pitfall method for collection of spiders


Fig.3 Hand picking method for collection

Fig.4 Specimens persevered in different viols

Results and Discussion

Biodiversity applied for diverse life forms existing in the globe. Here it means coexistence of spiders with banana plantations which was observed very affluent in the fields of banana located in the District Matiari. Spider biodiversity is was notice high because of the preferred environmental (Biotic: plantations; vegetation, prey etc and abiotic: temperature and humidity) circumstances (Table 2-5). Present work is focused on the biodiversity of spiders from banana Agro-ecosystem of District Matiari (Fig 1). It is one of the most fertile agricultural districts of Sindh. Mostly the livelihood of the people of Matiari district depends upon the agriculture; hence many crops are being grown here. The banana (*Musa paradidica* L.) belongs to the family Musaceae is the

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major fruit crop of Sindh.. During field survey from frequently banana growing taluka's (Hala, New Saeedabad and Matiari). During this study six families are identified namely; Araneidae, Lycosidae, Oxyopidae, Tetragnathidae, Salticidae and Gnaphosidae. These families were classified on the basis of their web-building and predation methods. The existing spider families observed during study are dependant on insects and pest for food purpose. For example, Spiders are among the most varied and prevalent creatures in most ecological systems, and they play a major role as predators of other invertebrates, particularly insects and pests. The most serious insect pest in the world is the banana weevil. Various insects and pests were observed in banana crops, depending on the crop during observations in different months during banana cultivation till fruits. Many insects and pests were studied periodically and found to have significant effects on different parts of banana plants. Aphids and their nymphs, banana scab moths, banana skipper, banana thrips, banana aphids, and sugarcane weevil and pseudo stem weevil are among the other pests. The data surveyed total 992 specimens (including spiderlings) were assembled (tables 2-5). The period of this research was from the month of January to October 2021 and January to May 2022. All specimens brought to laboratory and sorted out into six families, nine Genera and thirteen Species were identified. During this study six families were identified namely; Araneidae, Lycosidae, Oxyopidae, Tetragnathidae, Salticidae and Gnaphosidae. These families were classified on the basis of their web-building and predation methods. During searching various web structures observed with web builder's spiders according its habitats and also non-web builders, on basis of habitats "ground spiders and arial spiders" families observed. In this survey three major spider guilds studied from banana crops, Orb-web weavers (Araneidae, Tetragnathidae), Foliage Runners (Gnaphosidae, Oxyopidae) and Ambushes and stalkers (Salticidae, and Lycosidae, Salticidae). In present study main Objectives were achieved such as **t**o determine the species diversity, abundance and composition of spiders in banana plantations in District Matiari Sindh, Pakistan, on the way to analyze the guild structure of the spiders in these banana plantations, to identify the environmental factors influencing the spider biodiversity and guild composition in these banana plantations, assessed the impact of these spiders on the banana production in the area. In year 2022 heavy rainfall caused severe damages to the agricultural land Banana plantation also destroyed one of the major reasons of less collection variety recommendations for the conservation and sustainable use of the spiders in this region. Spiders can act as effective biological control agents, controlling pest populations and reducing the need for harmful pesticides. On the other hand, some spider species may also feed on beneficial insects, which may have negative effects on crop production. Therefore, it is crucial to gain a better understanding of the specific roles played by different spider species in maintaining the ecological balance within the plantation. Overall, the study highlights the importance of promoting biodiversity in agricultural ecosystems and the need for sustainable farming practices that support the conservation of local spider species. Further research on the interactions between spiders and other organisms in the plantation, as well as their response to different agricultural practices, could provide valuable insights into the conservation and

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management of spider communities in banana plantations. Additionally, our findings call for the implementation of integrated pest management strategies that take into consideration the important role of spiders in maintaining a healthy and diverse Agro-ecosystem.

Table 1 Taluka wise data spider diversity

Sr. No.	Taluka (District Matiari)	Diversity / abundance	Percentage
1	Matiari	458	46.16
2	Hala	330	33.26
3	New Saeedabad	204	20.56
Total		992	100

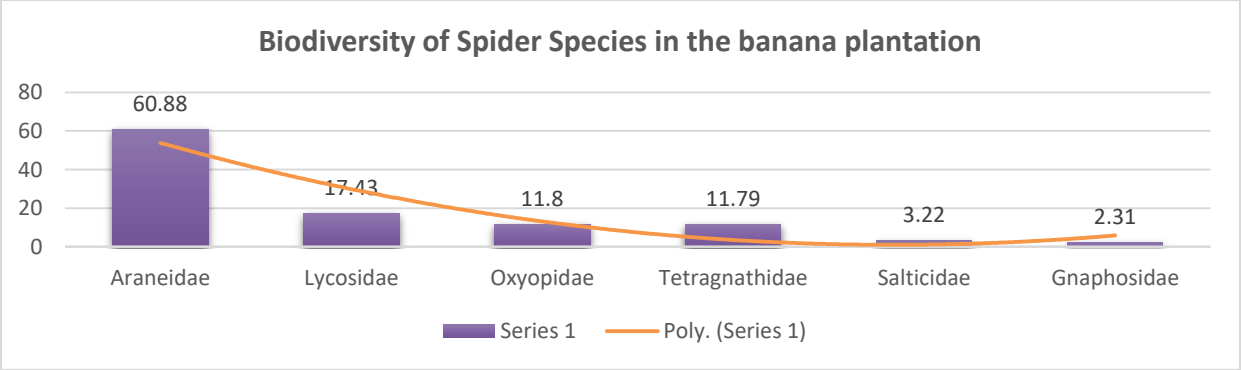

Figure 5 Spider Biodiversity Statistics in Banana Plants

The study conducted on the biodiversity and guild structure of spiders in the banana plantations of District Matiari, Sindh, Pakistan focused on analyzing the different species and families of spiders present in the area. The researchers collected and studied 992 spiders, comprising of 92 males and 900 females. The study aimed to provide a comprehensive understanding of the arachnid community in the specific agricultural region. The findings of the study were presented in the form of a table and a figure.

Table 2 Gender wise distribution of Spider Biodiversity

Family	Male	Female	Frequency	Percentage
Araneidae	54	550	604	60.88
Lycosidae	12	161	173	17.43
Oxyopidae	10	107	117	11.8
Tetragnathidae	8	35	43	11.79
Salticidae	3	29	32	3.22
Gnaphosidae	5	18	23	2.31

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Total	92	900	992	100%

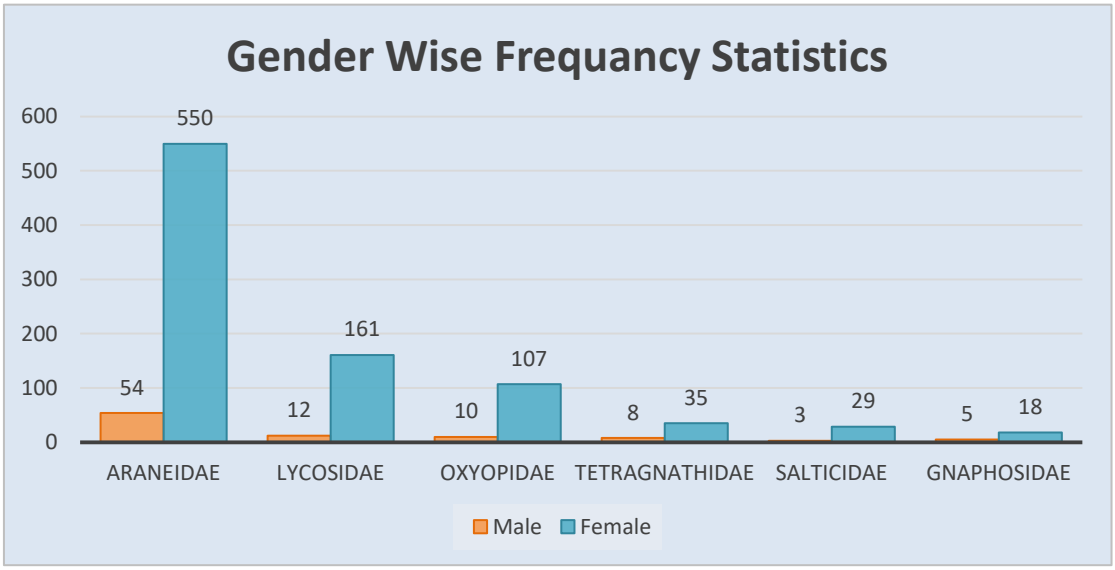

Figure 6 Gender wise distribution of Spider Biodiversity

Table. 3 Showing the list of spider families with genus and species

S.NO	FAMILY	GENUS	SPECIES
01	Araneidae	*Neoscona* *Argiope*	*Neoscona theisi* *N. rumfi* *N. javedensis** *Argiope anasuja* *A. trifasciata*
	Total	**02**	**05**
	Lycosidae	*Lycosa* *Pardosa*	*Lycosa maculate* *L. vulgaris* *Pardosa birmanica*
	Total	**02**	**03**
	Oxyopidae	*Oxyopes*	*Oxyopes marginalis*
	Total	**01**	**01**
	Tetragnathidae	*Tetragnatha*	*Tetragnatha javana*
	Total	**01**	**01**
	Salticidae	*Phidippus* *Plexipus*	*Phidippus sindhica* *P. bengalensis*
	Total	**02**	**02**
	Gnaphosidae	*Gnaphosa*	*Gnaphosa poonaensis*
	Total	**01**	**01**

* *Neoscona javedensis* first time reported*

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Table 4 Showing total no: of families, genera and species collected from Banana plantation, Matiari Year 2021 to 2022

FAMILIES	GENERA	SPECIES
06	09	13

Table 5 Analysis of Biodiversity of spiders in Banana plantation in Matiari.

S.NO	SPECIES NAME	TOTAL NUMBER COLLECTED	BIODIVERSITY INDEX $D=(n/N)^2$	SIMPSON INDEX OF DIVERSITY =1-D
1	*Neoscona theisi*	121	0.014	0.986
2	*N. rumfi*	142	0.020.	0.98
3	*N. javedensis**	105	0.011	0.989
4	*Argiope anasuja*	103	0.010	0.99
5	*A. trifasciata*	133	0.017	0.983
6	*Lycosa maculata*	72	0.005	0.995
7	*L. vulgaris*	48	0.002	0.998
8	*Pardosa birmanica*	53	0.002	0.998
9	*Oxyopes marginalis*	117	0.013	0.987
10	*Tetragnatha javana*	43	0.001	0.999
11	*Phidippus sindhica*	22	0.0001	1
12	*P. bengalensis*	10	0.0001	0.999
13	*Gnaphosa poonaensis*	23	0.0005	0.9995
		992		

Species richness
$R= s/\sqrt{N}$
$13/\sqrt{992} = 13/31.496 = 0.412$

Conclusion
In conclusion, the present study provides a comprehensive understanding of the biodiversity and guild structure of spiders in the banana plantation of District Matiyari, Sindh, Pakistan. It was found that the plantation area had a high diversity of spider

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species, with a total of 992 sample species belonging to 6 families. This high diversity could be attributed to the favorable habitat conditions provided by the banana plantation, which offered a variety of microhabitats for the spiders to thrive in. Moreover, the guild structure analysis revealed that the spider community in the plantation was dominated by Orb-web weavers (65%) , followed by Ambushes and stalkers (20%) and ground hunters (14%) . This distribution of guilds is consistent with other studies conducted in agricultural areas, indicating that spiders play an important role in maintaining a balanced ecosystem in agro-ecosystems. The high abundance and diversity of spiders found in the banana plantation can have both positive and negative impacts. On one hand, spiders can act as effective biological control agents, controlling pest populations and reducing the need for harmful pesticides. On the other hand, some spider species may also feed on beneficial insects, which may have negative effects on crop production. Therefore, it is crucial to gain a better understanding of the specific roles played by different spider species in maintaining the ecological balance within the plantation. Overall, the study highlights the importance of promoting biodiversity in agricultural ecosystems and the need for sustainable farming practices that support the conservation of local spider species. Further research on the interactions between spiders and other organisms in the plantation, as well as their response to different agricultural practices, could provide valuable insights into the conservation and management of spider communities in banana plantations. Additionally, our findings call for the implementation of integrated pest management strategies that take into consideration the important role of spiders in maintaining a healthy and diverse agro-ecosystem.

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