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Study of Insect Fauna and Spiders Prevailing in Lovely Professional University Research Farm, Punjab

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ABSTRACT

Background: The diverse insect fauna harboring in every corner of the agroecosystem plays a crucial role in ecological balance. The insect pest feeding on various crops which then it is preyed upon by diverse predators establishing an optimum food chain. With respect to the host plant interaction, it is of paramount importance to survey and identify the species prevailing the region and having the potential of causing a havoc to the host plant so as to initiate an effective pest management tactics. This research focuses on the species diversity of insect pest as well as biological control agents in the various crop ecosystem

Methods: Sampling of the insects and spider fauna were studied for two years, 2022 and 2023. Samplings were conducted in LPU research farm using three sampling techniques such as yellow sticky trap, sweeping net, pheromone lures. Following sampling of the insects and spiders species diversity was assessed using various indices such as shannon weiner indec, pielous index, simpsons index, margalefs index, Brillouins index and berger parker index

Result: 913 insects from 56 species and eight orders-Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Odonata, Orthopteraand Thysanoptera-as well as 9 species of spiders were recorded in the current study. Hemiptera, Lepidopteraand Coleoptera were the orders with the highest species abundance, while Hymenoptera was the least. Margalef's richness index ranged from 0.26-2.6 and 0.21-2.72 respectively, evenness ranged between 0.06-0.20 and 0.08-0.22 and the diversity index for the first and second year, as indicated by the Shannon-Weiner index, varied from 0.11-0.30 and 0.14-0.34, respectively. In order to develop a strategy framework for monitoring insect biodiversity, which depends on a number of factors, it is necessary to analyze and document insect diversity.

Key words: Biocontrol agents[1], Biodiversity, Diversity indices, Insects, Spiders.

INTRODUCTION

India is one of the most diverse countries in the world in terms of insect fauna and there is a wide range of different species of insects present all over the country with different ecosystems, climatic regions and altitudes. India occupies 7 percent of global faunal population and has 6.13 per cent of total species in the world (Ghosh, 1996). The highest biodiversity of insects in India is at the north-eastern states, western-ghats and Andaman and Nicobar Islands and these places are known to have high endemism (Sankarganesh, 2017). In India, Sikkim has the most diversity of insect fauna withholding 5941 species, followed by West Bengal (5818), Meghalaya (5118) and Uttarakhand (4160) (Chandra, 2011). Punjab have total of 1116 species of insect fauna but there are not many surveys done in this state to explore more diversity of species as about 6000 species are expected from here if adequate surveys are held. In comparison of insect fauna in Punjab region according to different insect orders, the most abundant order is Lepidoptera having total of 340 species, followed by Coleoptera having 296 species, Diptera having 109 species, Hymenoptera having 102 species, Orthoptera with 52 species, Thysanoptera with 45 species, Odonata having 36 species, Trichoptera having 24 species, Neuroptera having 12 species, Isoptera having 9 species, Dermaptera having 3 species, Siphonaptera having 2 species and Plecoptera only having one species (Chandra, 2011). Hymenopterans and dipterans are principal pollinators which are very necessary for pollinating the crops. About 73 per cent of world's cultivated crop is dependent on pollination out of which most of the pollinators are bees, flies and wasps. Bees pollinate 56.6 per cent of crops followed by flies (19 per cent), wasps (5 per cent), beetles (5 per cent) and butterflies and moths (4 per cent) (Shaheen *et al.,* 2017). Insects play a significant role in our lives and impact humanity's well-being in various ways. Additionally, ecosystems rely greatly on insect

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behavior. Insects have important functions in ecosystems, such as recycling nutrients, pollinating plants, dispersing seeds, preserving soil health, regulating other populationsand serving as a significant food source for other species. Some insects have the potential to harm human health, as well as domestic animals, agriculture and horticulture. Some insects like predatory beetles or parasitic wasps play a key role in agroecosystem by controlling pest populations, providing valuable benefits. Approximately 10% of insects are insect predators, while about 15 % are parasitic insects, both playing a crucial role in biological control (Sankarganesh, 2017). Along with insects, spiders are also important group of generalist predators of animal kingdom (Riechert and Lockley 1984) which are abundant in India. Some are polyphagous and carnivorous in nature and studies showed that spiders are good biological control agents demonstrating their potential to be used in IPM and it can reduce the indiscriminate use of pesticides (Benamu 2020; Pitilin *et al.,* 2019). Some of the most common families of spiders which can be found in Punjab are Lyssomanidae, Salticidae, Clubionidae, Thomisidae, Sparassidae, Oxyopidae and Argiopidae (Singh, 2017). Insect biodiversity is highly influenced by climate and environmental factors such as temperature, humidity, rainfall, light, wind, *etc*. Climate change heavily affects the insect fauna and it is highly responsible for physiological and behavioural changes in insect fauna (Samways, 2005; Parmesan and Yohe, 2003; Merrill *et al.,* 2008). The impact of climate change on insect population is complex and can vary depending on the species, region and type of ecosystem. Some insects may benefit from warmer temperatures or changes in precipitation, while others may struggle to adapt to these new conditions. Increase in temperature may increase the insect population which in terms may increase the insect-transmitted diseases also (Pareek *et al.,* 2017). Hot temperature like heat waves have negative impact on insect fauna and it is known that there is mass extinction of insect fauna with every 6°C increase in temperature (Karthik *et al.,* 2021). It is already found in studies that there shall be 40 percent extinction of insect fauna globally in near future (Iyer, 2019). Maintaining the biodiversity of insect fauna is paramount otherwise it will create an imbalance in the ecosystem in near future (Hallmann *et al.,* 2017; Gaston, 2018; Seibold *et al.,* 2019). The present study was formulated in order to discover the diversity, richness, evennessand dominance of the entomofauna and spiders in LPU, Punjab.

MATERIALS AND METHODS

Study area

The study was conducted at Lovely Professional University (LPU) research farm was used as the study site to document the diversity of insects based on the abundance of spiders and insects. The study was carried out from January to May, 2022 and 2023. Throughout the study period, weekly field trips were conducted to collect and survey insects. The specimens that were gathered were stored in 70% ethyl alcohol, labeled appropriately with the location and other relevant characteristics. The gathered samples were identified using taxonomic keys up to the species level and preserved in formalin-filled jars. Each daily collection's specimens were handled differently and placed in vials to be counted for biodiversity. The methods used for collecting insects and bio control agents such as spiders and dragonflies included Light traps, aerial net, sweeping net, Handpick method and pheromone traps. Care was taken to ensure that no harm was caused to the insects. Collected insects were transferred to glass vials (5.2cm x 2.0 cm). The indices for richness was represented by Margalef richness index (1958), for diversity by Brillouin, (Brillouin, 1956), Shannon-Weiner (Shannon, 1948), Simpson's index (Solow, 1993) and for evenness, Pielou's evenness index (Pielou, 1966) and other indices such as Berger-Parker dominance (Mateus, 2006).

Statistical analysis

All of the data obtained were analysed using Microsoft office Excel's statistical tools. Diversity-based indices were used to measure biodiversity.

RESULTS AND DISCUSSION

A total of 65 faunal species were found in Lovely Professional University research farm with 56 hexapod species and 9 arachnid species. The hexapod species comprised of the insects belonging to orders Coleoptera, Orthoptera, Diptera, Hymenoptera, Odonata, Lepidoptera, Hemiptera, whereas the arachnid species belonged to order Aranea. Of all the orders, maximum species belonged to order Odonata (14), followed by Coleoptera (13), Hemiptera (12), Aranea (9), Lepidoptera (7), Diptera (4), Hymenoptera (4), Orthoptera (2). The species observed are classified under 3 categories *viz*. Spiders (Table 1), bio-control agents (Table 2) and insect pests (Table 3). Most of the Bio-control agent species belonged to the order Odonata, followed by Coleoptera and Hymenoptera and least were found from the order Diptera. Hemiptera recorded the maximum pest species, followed by Lepidoptera and Coleoptera while Orthoptera had the least of the pest species. The collected data was further analyzed to study the diversity indices to estimate the species richness and species diversity (Fig 1 and 2). Environmental factors and flora diversity all affect variations in the abundance of individual arthropod species and lower arthropod diversity is caused by a decrease in vegetation cover and/or a shift in vegetation pattern toward tiny, widely distributed vegetation (Zayadi *et al*., 2013; Meloni *et al.,* 2020; Ikhsan *et al.,* 2022). Shannon-Wiener diversity index (H) is an indicator of diversity of arthropods, our results showed that the Shannon diversity index ranged from 0.11 to 0.30 in the first year and 0.14 to 0.34 in the second year. Shannon's index interpreted both Lepidoptera and

Table 1: Fauna of spiders collected in LPU Research Farm, Punjab.

Order	Common name	Scientific name	Family	Class	Host
Araneae	Nursery web spiders	*Pisaurina* sp.	Pisauridae	Arachnida	Generalist feeder
	Spotted orb-weavers	*Neoscona* sp.	Araneidae	Arachnida	
	White crab spiders	*Thomisus spectabilis*	Oxyopidae	Arachnida	
	long jawed spider	*Tetragnatha* sp.	Tetragnathidae	Arachnida	
	Spinybacked orbweaver	*Gasteracantha cancriformis*	Araneidae	Arachnida	
	long jawed orb weaver	*Leucauge* sp.	Tetragnathidae	Arachnida	
	Lynx spider	*Oxyopes* sp.	Thomisidae	Arachnida	
	Wolf spider	*Lycosa* sp.	Lycosidae	Arachnida	
	Silver Argiope	*Argiope* sp.	Araneidae	Arachnida	

Table 2: Fauna of bio-control agent collected in LPU Research Farm, Punjab.

Order	Common name	Scientific name	Family	Class	Host
Coleoptera	7-spotted lady bird beetle	*Coccinella septempunctata*	Coccinellidae	Insecta	Aphids,whiteflies *etc*.
	Parthenium/ Mexican Beetle	*Zygogramma bicolorata*	Chrysomelidae	Insecta	*Parthenium hysterophorus*
	Rove beetle	*Paederus fuscipes*	Staphylinidae	Insecta	Generalist feeder
	6 spotted ziz-zag lady bird	*Cheilomenes sexmaculata*	Coccinellidae	Insecta	Coccinellidae Aphids mealybugs *etc*
	Transverse lady bird	*Coccinella transversalis*	Coccinellidae	Insecta	Aphids, mealybugs *etc.*
Hymenoptera	Paper wasp	*Polistes* sp.	Vespidae	Insecta	Insectivores
	Mud dauber	*Sceliphron* sp.	Sphecidae	Insecta	Insectivores
	Cutworm wasp	*Podalonia* sp.	Sphecidae	Insecta	Insectivores
	Yellow ichneumon wasp	*Xanthopimpla punctata*	Ichneumonidae	Insecta	Larval and Pupal parasitoid
Diptera	Hoverfly	*Pipiza* sp.	Syrphidae	Insecta	Insectivores
Odonata	Wandering wisp	*Agriocnemis pygmaea*	Coenagrionidae	Insecta	Generalist feeder
	Bi-coloured damsel	*Ceriagrion cerinorubellum*	Coenagrionidae	Insecta	Generalist feeder
	Yellow waxtail	*Ceriagrion coromandelianum*	Coenagrionidae	Insecta	Generalist feeder
	Orange waxtail	*Ceriagrion rubiae*	Coenagrionidae	Insecta	Generalist feeder
	Pixie dartlet	*Ischnura nursei*	Coenagrionidae	Insecta	Generalist feeder
	Ground skimmer	*Diplacodes trivialis*	Libelluidae	Insecta	Generalist feeder
	Ditch jewel	*Brachythemis contaminata*	Libelluidae	Insecta	Generalist feeder
	Pied paddy skimmer	*Neurothemis tullia*	Libelluidae	Insecta	Generalist feeder
	Green marsh hawk	*Orthetrum sabina*	Libelluidae	Insecta	Generalist feeder
	Scarlet skimmer	*Crocothemis servilia*	Libelluidae	Insecta	Generalist feeder
	Globe skimmer	*Pantala flavescens*	Libelluidae	Insecta	Generalist feeder
	Long legged marsh glider	*Trithemis pallidinervis*	Libelluidae	Insecta	Generalist feeder
	Coral tailed cloudwing	*Tholymis tillarga*	Libelluidae	Insecta	Generalist feeder
	Lined hook-tailed	*Paragomphus lineatus*	Gomphidae	Insecta	Generalist feeder

Hemiptera to be the most diverse ordersand Hymenoptera to be the least diverse order with an index of 0.30 and 0.11 in the first year. In the second year, Lepidoptera was the most diverse order and Hymenoptera was the least diverse order with an index of 0.34 and 0.14 respectively. Margalef's index indicated odonata to be the order with highest species richness in both the first and the second year with an index of 2.66 and 2.72 respectively. Majority of the individuals

Table 3: Fauna of insect pest.

Order	Common name	Scientific name	Family	Class	Host
Lepidoptera	Fall armyworm	*Spodoptera frugiperda*	Noctuidae	Insecta	Maize, sorghum *etc.*
	Internode borer	*Chilo sacchariphagus*	Crambidae	Insecta	Sugarcane
	Cabbage butterfly	*Pieris brassicae*	Pieridae	Insecta	Crucifers
	Rice skipper	*Pelopidas mathias*	Hesperiidae	Insecta	Sugarcane
	Armyworm/cutworms	*Mythimna* sp.	Noctuidae	Insecta	Cereals *etc*.
	Painted lady butterfly	*Vanessa cardui*	Nymphalidae	Insecta	Asteraceae
	Common grass yellow butterfly	*Eurema hecabe*	Pieridae	Insecta	Legumes, Cucurbits *etc*.
Hemiptera	Slender rice bug	*Cletus trigonus*	Coreidae	Insecta	Rice, other grasses *etc*.
	Zigzag leaf hopper	*Recilia*/*Maiestas dorsalis*	Cicadellidae	Insecta	Rice, sugarcane, *etc*.
	Sugarcane leaf hopper	*Pyrilla perpusilla*	Lophopidae	Insecta	Sugarcane
	Green Shield Bug	*Nezara virudila*	Pentatomidae	Insecta	Vegetables, legumes *etc*.
	Pod bug	*Clavigralla scutellaris*	Coreidae	Insecta	Rice, sugarcane, *etc*.
	Black bug	*Dimorphopterus* sp.	Blessidae	Insecta	Sugarcane, *etc*.
	Big-eyed bug	*Geocoris* sp.	Geocoridae	Insecta	Sugarcane, *etc*.
	Moringa horned treehopper	*Leptocentrus moringae*	Membracidae	Insecta	Moringa
	Wheat aphid	*Macrosiphon* sp	Aphididae	Insecta	Wheat
	Red cotton bug	*Dysdercus cingulatus*	Pyrrhocoridae	Insecta	Cotton, okra *etc*.
	Stink bug	*Euschistus* sp.	Pentatomidae	Insecta	Cotton, okra *etc*.
	Stink bug	*Podisus* sp.	Pentatomidae	Insecta	Cotton, okra *etc*.
Coleoptera	White spotted flea beetle	*Monolepta signata*	Chrysomelidae	Insecta	Polyphagous pest.
	Flea beetle	*Altica sp.*	Chrysomelidae	Insecta	Cucurbits, crucifers *etc*.
	3-striped lady-beetle	*Brumoides*	Coccinellidae	Insecta	Polyphagous pest
	Sap beetles	*Stelidota*	Nitidulidae	Insecta	Polyphagous pest *etc*.
	Red pumpkin beetle	*Aulacophora foveicollis*	Chrysomelidae	Insecta	Pumpki, crucifers *etc*.
	12 spotted lady bird beetle	*Epilachna indica*	Coccinellidae	Insecta	Polyphagous pest
	Ash weevil	*Myllocerus sp.*	Cucurlionidae	Insecta	Polyphagous pest
	Darkling beetle	*Gonocephalum* sp.	Tenebrionidae	Insecta	Rice, crucifers *etc*.
Diptera	wheat stem maggot	*Meromyza americana*	Chloropidae	Insecta	Wheat, rye *etc*.
	oriental fruit fly	*Bactrocera dorsalis*	Tephritidae	Insecta	Fruits
	melon fly	*Bactrocera cucurbitae*	Tephritidae	Insecta	Vegetables
Orthoptera	Rice grasshopper	*Hieroglyphus banian*	Acrididae	Insecta	Rice, wheat *etc*.
	Rice grasshopper	*Oxya sp.*	Acrididae	Insecta	Rice, wheat *etc*.

belonged to family Libelluidae (8 species) followed by Coenagrionidae (5 species) and Gomphidae (1 species). The richness of Libelluidae and Coenagrionidae was reported by many works earlier. Sharma and Joshi (2007) reported 18 species of Libelluidae and 6 species of Coenagrionidae in Hoshiarpur district of Punjab, India. Mishra and Rastogi (2020) and Singh *et al.* (2020) also reported spiders from different families such as Salticidae, Araneidae and Oxyopidae during a nine year survey in Punjab. The present study also showed significant variations in the population density, species richness and diversity among the different species of spiders which is in accordance with the findings of Jeetikasiddhu *et al.* (2021). Pielou's index interpreted Orthoptera to be the most evenly

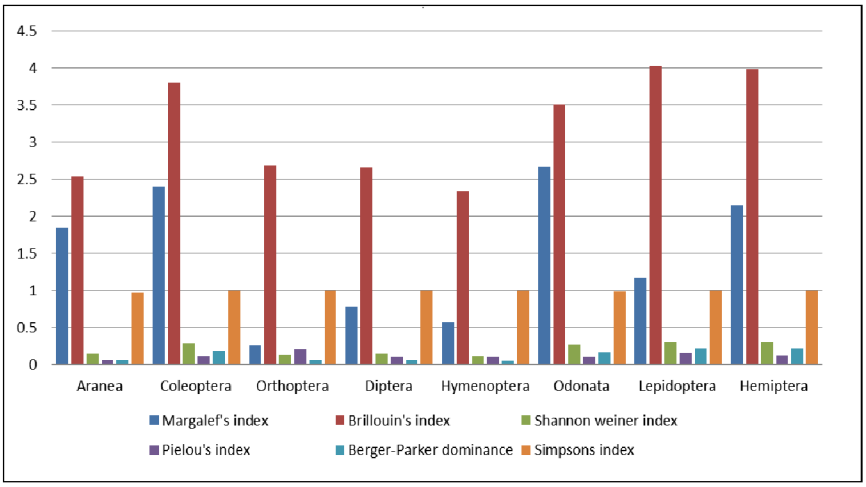

Fig 1: Diversity indices of various insect and spider fauna assessed in Punjab during 2022.

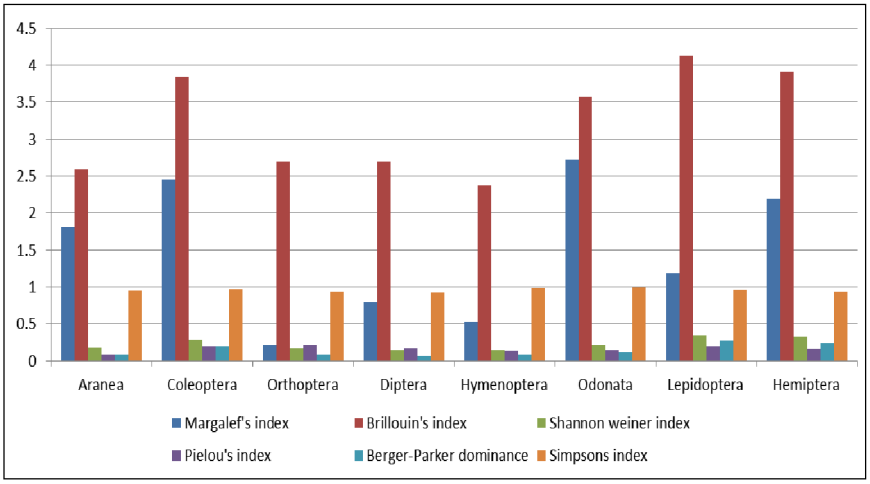

Fig 2: Diversity indices of various insect and spider fauna assessed in Punjab during 2023.

distributed order in the farm with an index of 0.20 and 0.22 respectively in the first and the second year. It included the species belonging to a single family, Acrididae. Due to the abundance of wheat and sugarcane, which are mostly preferred by the observed species, they might have thrived in the region, making Orthoptera the most evenly distributed order constituting a homogenous distribution pattern of the species (Ravi *et al.*, 2022). The wide presence of acridids is confirmed by the similar findings of Das (2023): Kumar and Usmani (2012). Berger-Parker dominance percent interpreted Hemiptera to be the most dominant order, with a percentage of 0.21%, making it the most abundant order in the first year. However, in the second year, Lepidoptera was found to be the most abundant order with a percentage of 0.27%. All the individuals observed were pests of different crops in the farm. The dominance was because of the abundance of crops in vegetative and reproductive phase as similar results matched the findings of Zurbrügg and Frank (2006), with higher bug population in floral regions. Brillouin's index interpreted Lepidoptera to be the most diverse order in both the years data, with an index of 4.03 and 4.12 respectively. All the species were pests of the field crops. The synchronization of the Lepidopteran pests with the vegetative and reproductive phase of the crops helped in resulting Lepidoptera to be the most diverse order. The synchronized availability of flowers of the spring season might have boosted the Lepidopteran adults (Kumar *et al.,* 2017). Simpson's index showed that all the collected species from different insect order were highly diverse during the study and the index ranged from 0.97-0.99 and 0.92-0.99 in the first and the second year respectively.

CONCLUSION

Based on the survey, the population of spiders and insect faunas were prevalent throughout the research period. Spiders being a generalist feeder were recorded in high abundance with diverse species and habitat. Furthermore, the biodiversity of Insect pest fauna and natural enemies reported also were of significant in the region. The

importance of spiders and insect as natural enemies cannot be overlooked, through their utilization as an important IPM tools can help in the minimum usage of hazardous chemicals. Furthermore, this survey also aids in information of insect pest species prevalent in the region which assist in awareness on key pest of the crops and also precautionary steps incase of invasive pest

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Conflict of interest

All authors declared that there is no conflict of interest.

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