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Change in the population dynamics of spiders with the seasonal variations in the Sugarcane fields

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Abstract

In the present study, spider diversity and seasonal variation in the population dynamics was studied. A total of 192 specimens were recorded from the sugarcane fields located in the district Faisalabad (habitat-1). These specimens belong to 21 species, 10 genera and 6 families. In district Okara (habitat-2),a total of 164 specimens belong to 23 species, 11 genera and 7 families. The pitfall trapping methods was used for capturing from July through December. Maximum spider diversity was recorded in the month of August due to maximum humidity (65-70%) and temperature (35°C) suitable for the breeding of mature spiders. Lycosidae being active predator of pests was found most abundant in both studied habitats with 59.38% in Habitat-1 and 60.37% in the habitat-2. Salticidae was the second most abundant family in the both habitats. Oxypidae was considered least abundant and only one species was recorded from habitat-2. Ecological parameters including Species Richness (R), Shannon Diversity Index (H), Palou's Evenness Index (E), and Simpson Diversity Index (D) were 27.75±2.56, 2.62± 0.23, and 0.94±0.04, 0.92±0.03 respectively for habitat-1 and 23.28±0.91,2.75±0.50, 0.91±0.071, 0.93±0.06 respectively for habitat-2. It was concluded the spiders are the predominant creatures in the sugarcane. If we recognize the feeding preference of individuals family, they could be successfully use in the agro-ecosystem for controlling the pest species.

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Introduction

The weather conditions of Punjab not only support varieties of crops but also favor the development of phytophagous insects on vegetables, fruit trees, and agricultural crops, wild and ornamental plants. The use of insecticides is the only reliable method to control in Pakistan (Ghafoor *et al.*, 2011; Khan *et al.*, 2016). The extensive and non-selected use has adverse effects on the non-target organisms which deplete biodiversity essential for ecological stability. Therefore, biological control of the pests using natural predators needs to be encouraged.

Spiders are most abundant and diverse invertebrate fauna found in every habitat (Mohsin *et al.*, 2015; Maqsood *et al.*, 2016). They are distributed on all the proportion of all continents except Antarctica, in every ecological environment, except air and open sea (Foelix, 1996). Up till now 114 families, 3,935 genera and 44,906 species have been described (Platnick, 2015). Being generalist predator of pests in agricultural land, spiders can be effectively used in pest control (Penney, 2013; Khan *et al.*, 2015; Tahir *et al.*, 2015). It can effectively predate the pests in grasslands, forest and fields (Rodrigues *et al.*, 2009; Bukhari and Naeem, 2012). This methodology not conserves the biodiversity but also minimize dependence on pesticide (Bale *et al.*, 2008; Ghafoor and Mohmood, 2011). Therefore, the use of the spider is the best options in controlling the pest s population (Khuhro *et al.*, 2012). Predatory role of spider species in controlling lepidopteron (Hooks *et al.*, 2003), leafhopper (Jeyaparvathi *et al.*, 2013), aphids and mites of cotton is well established (Khuhro *et al.*, 2012). Through biological control we can control not only the insect pests but can also save a worth of foreign exchange used to purchase pesticides (Ghafoor and Mohmood, 2011; A Ghafoor *et al.*, 2011).

Before use of spiders as potential predator, the study of habitat structure, where they have been found, abundance and identification of the species or type of spider family is very important in the given agro-ecosystem (Hore and Uniyal, 2008; Butt and Sherawat, 2012; Sherawat and Butt, 2014; Khan *et al.*, 2015). The diversity in foraging strategies habitat preference, ease of collection as well as high relative abundance is the topics of current studies.

Therefore, it was aimed to contribute to rising knowledge on the ecology and distribution of spider families in sugarcane of two habitats through this study.

Materials and methods

Sampling

We sampled 8 randomly selected plots, each in different sugarcane fields, located around Faisalabad (31.4187°N, 73.0791°E) designated as habitat-1 and Okara (30.8090° N, 73.4508° E) designated as habitat-2, Pakistan during July-December, 2014, when maximum and minimum temperatures ranged between 25-42°C and 21-40°C, receptively, and relative humidity varying between 63-86%. None of the plots received insecticides/herbicides treatment during the study.

The activities of spiders were investigated using pitfall method of trapping for 5 successive days of 1st week every month throughout the growing season. The pitfall trap was consisted of glass jar of 6 cm in diameter and 12 cm deep. 20 traps were installed diagonally along the transect line 5 meters apart from each other in each habitat. Four jars in the Centre and four jar in each corner of field buried in such a way that mouth leveled the ground. Ethyl alcohol (70%; 250ml) small amount of kerosene oil and few drops of liquid detergent (1%) were added to each trap to preserved the specimen and break the surface tension of solution. A poly wood rain cover (16×16cm) supported by 9cm long three nails and placed 35 cm above the mouth of each jar. Captured spiders were washed in xylene and placed in small jars having 70% ethanol. Finally the specimens were preserved in solution vials, with 70% ethanol and glycerin. The spiders were identified up to species following Tikader and Biswas (1981), Tikader and Malhotra (1980), Barrion and Litsinger (1995).

Statistical Analyses

The data was analyzed for relative abundance of species and other diversity indices through Species Richness Margalef Index (Clifford and Stephenson, 1975), Pielov's Evenness (Pielou, 1966) and Simpson's Diversity Index (Simpson, 1949)

Results

We collected 356 spider specimens from sugarcane fields of district Faisalabad (designated as habitat-1) and Okara (designated as habitat-2), belonging to 7 families, 11 genera and 25 species (Table 1). 192 Specimens were collected from selected fields of sugarcane of District Faisalabad using eight trapping sessions from July through December. Spider abundance was higher in sugarcane (192) of habitat-1 compared to habitat-2 (164). The highest recorded family was Lycosidae including the genera of *Hippasa, Pardosa* and *Lycosa*. With 32 species, *Pardosa birmanica* was most abundant species in the habitat 1. Indices of diversity i.e. evenness, richness, Simpson's index and Shannon index were 0.92, 55.50, 0.93 and 2.80 respectively in the 1st habitat (Table 2). 164 spider specimens were recorded in all trapping session of habitat 2. This study site contained 7 families, 11 genera and 23 species.

Family lycosidae was again abundant with 99 recorded specimens and belonging to 3 genera and 8 species. 20 specimens of *Pardosa birmanica* was recorded in this habitat. Indices of diversity i.e. evenness, richness, Simpson's index and Shannon index were 0.90, 46.56, 0.93 and 2.83 respectively (Table-2). Less number of spiders was recorded in the month of July due to high rainfall and high temperature around 44°C. Fig.1 shows that maximum number of spider diversity was recorded during the month of August in the sugarcane of Habitat when humidity was 65 to 70% and temperature was 30 to 35°C.

The comparison of the spider fauna shows that abundance was slightly high in the sugarcane fields of Faisalabad as compared to the Okara. The data of all family was significantly different except the family Lycosidae (Fig. 3).

Table 1. Spider species diversity and abundance in sugarcane fields of Habiat-1 and Habitat-2 during July-December, (2014) collected by pitfall trapping method.

Species	Habitat-1	Habitat-2
Family Araneidae		
Cyclosa bifida	3	1
Cyclosa punjabiensis	-	1
Neoscona bengalensis	8	2
Neoscona mukerjei	-	15
Family: Clubionidae		
Clubiona sp.	4	2
Family: Gnaphosidae *Gnaphosa harpax*	3	2
Gnaphosa eucalyptus	4	3
Family: Lycosidae		
Hippasa holmerae	18	7
Hippasa madraspatna	6	10
Lycosa kempi	11	19
Lycosa madani	15	12
Lycosa mackenziei	2	15
Lycosa tista	16	6
Pardosa birmanica	32	20
Pardosa leucopalpis	1	-
Pardosa oakleyi	13	10
Family: Salticidae		
Marpissa carinata	5	3
Marpissa mirabilis	5	-
Marpissa tenebrosa	14	2
Plexipus bengalensis	18	9
Plexipus pakulli	7	10
Family Thomicidae		
Thomisus bulani	4	4
Thomisus elongates	3	4
Thomisus pugilis	-	3
Total	192	164

Table 2. Spider diversity indices of sugarcane fields of habitat-1 and habiat-2 during July-August 2014.

Component	Habitat-1	Habitat-2
Pielou's Evenness Index (E)	0.94±0.04	0.91±0.071
Shannon Diversity Index (H)	2.62± 0.23	2.75±0.50
Simpson Diversity Index (D)	0.92±0.03	0.93±0.06
Species Richness (R)	27.75±2.56	23.28±0.91

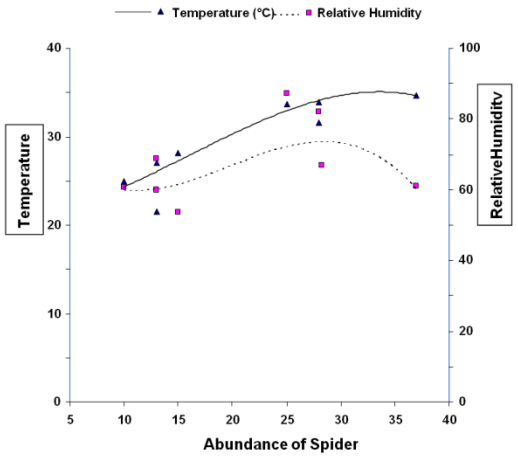

Fig. 1. Correlation of Spider Abundance with Temperature and Relative Humidity in Sugarcane fields of Habitat 1.

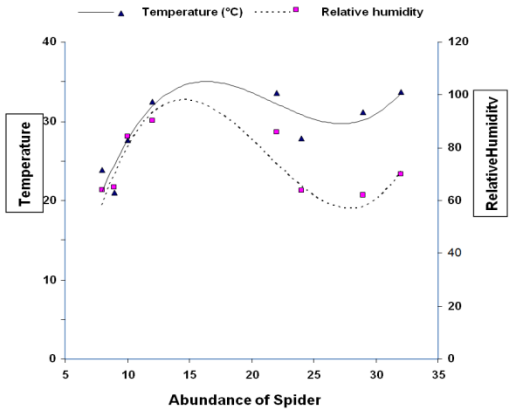

Fig. 2. Correlation of Spider Abundance with Temperature and Relative Humidity in Sugarcane fields of Habitat 2.

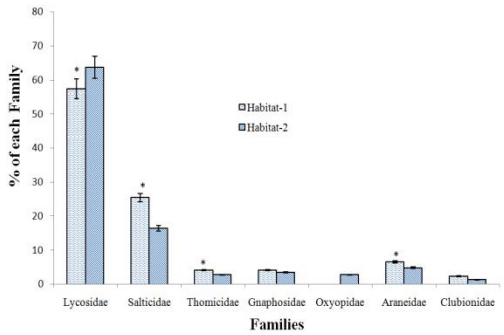

Fig. 3. Comparison of spider fauna between two habitats (Asterisk represents significantly different values between two crops at 5% level).

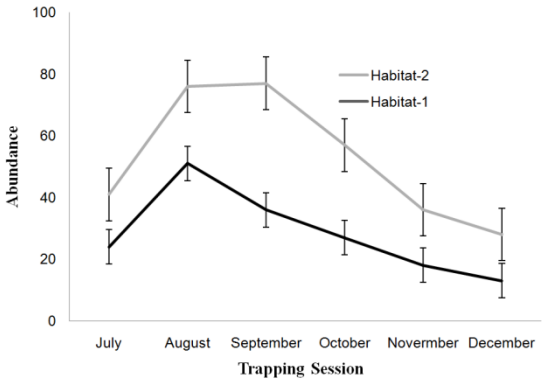

Fig. 4. Abundance of spiders with trapping success in different calendar months.

Discussion

The present study reported 6 families, 10 genera and 21 species from sugarcane of Faisalabad and 7 families, 11 genera and 23 species from District Okara. The spiders belong to Lycosidae family showed overall dominance in both crops along with maximum percentage in each trapping month as recorded by Ghafoor and Mohmood (2011). These spiders represent 57% of total captured spiders in habitat-II and 63% in the habitat-II. It is due to the fact that, lycosids spider actively predates the pests of different crops and their population increases in response to pest population. Sherawat and Butt (2014) found out two lycosids spiders (*Lycosa terretris* and *Pardosa birmanica*) in suppression of wheat aphids. Three genera i.e. *Lycosa, Pardosa* and *Hippasa* were mostly dominantly recorded in both agro-ecosystems. *Pardosa birmanica* was most dominantly recorded in the sugarcane fields with 32 specimens out of 192 and similar in the case of habitat-2 (Table 1). Ghafoor and Mohmood (2011) and Tahir *et al.* (2011) recorded the similar observations of diversity in their study. The survey of the other fields represented similar dominancy which shows that the spider fauna is not only dominated the sugarcane but also the other fields. Tahir *et al.* (2015) recorded the

seasonal dynamics spiders and pests in the Citrus Orchards of Sargodha locality. They recorded a total of 2665 spiders representing 12 families, 23 genera and 43 species.

Salticidae was the 2nd most abundant family after Lycosidae in the both habitats with 25.52% and 14.63% in the fields of habitat-I and habitat-II respectively (Table 2 Fig. 3). The other families were Thmomicidae, Gnaphosidae, Araneidae and Clubinoidae with moderate less percentage in both habitats. The family oxipidae with only one species and 4 specimens was recorded form the habitat-II alone (Table I). The recoded species was the *Oxyopes ratnae*. These findings were supported by the studies of Ghafoor and Mohmood (2011) in the rice and sugarcane fields.

The month of August with favorable temperature relative humidity and rain fall was most suitable for populations of spider to gather in the sugarcane fields. The maximum numbers of specimens were recorded in this month (Fig.1, 4). The high abundance in this month might also be due to fact that a verity of pest populations attacks the crops which increase the food availability (Khan *et al.*, 2014). However in the sugarcane fields of habitat-II, maximum specimens were captured in the month of September (Fig. 2, 4). The relative low abundance in month of December might be due to food unavailability and low average temperature (Marchetti, 2014). The Fig.1 and 2 clearly show variations in spider abundance with fluctuating temperature and relative humidity. Positive correlation was found between spider abundance ecological parameters including temperature, relative humidity. Slightly high temperature and humidity favors these predatory creatures to flourish in the fields. However, high rainfall might also influence the spider abundance due to disturbance in habitats structure (Tahir *et al.*, 2015). The field structure field's management practices and trapping method might also change the abundance of captured spiders. The field structure of sugarcane and use of fertilizers might reduce the capture success in this study.

Species Richness (R) was found higher in habitat I (27.75±2.56) as compared to habitat-II (23.28±0.91). Pielou's Evenness Index (E) was also slightly higher in Habitat-1 (0.94±0.04). However, Shannon Diversity Index (H) was found slightly higher in Habitat-2 (2.75±0.50). Simpson Diversity Index (D) was also higher in Habitat-2 (Table 2). Similar observation was recorded by Ghafoor and Mohmood (2011) in their study. As the study was carried out in large varied environmental conditions from hot summer to cold winter there was highly variable abundance of male, female and immature spiders (Fig. 5, 6). The immature was found slightly higher percentages as the spiders were passing through the breeding season and large number of immature were wondering in the both crops.

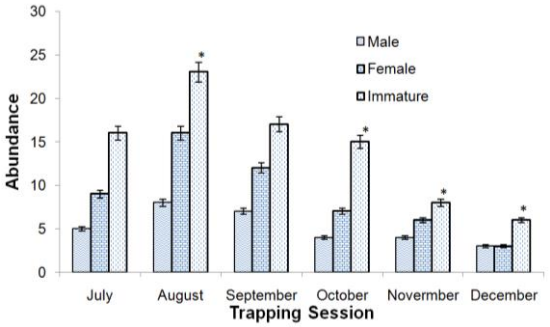

Fig. 5. Abundance of male, female and immature spiders collected form Habitat-1 July through December.

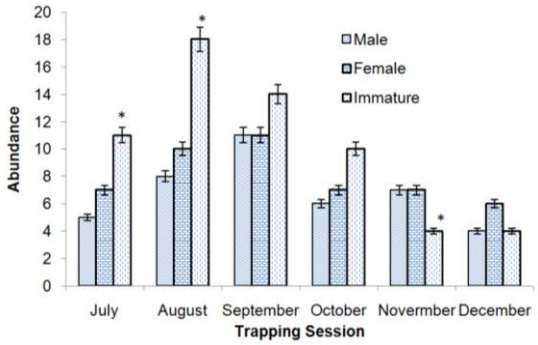

Fig. 6. Abundance of male, female and immature spiders collected form Habitat-2 July through December.

Conclusion

There was no much difference of spider species in both habitats which proved that spiders are migratory and cosmopolitan in nature and easily moves to the next fields when food sours are available.

Moreover the environmental factors such as temperature, relative humidity and rainfall might also have influences on the abundance of spider populations. It was further concluded that the less number of specimens recorded in the study was due to complex crop and filed structure. This study could be the base of biological control of pest through aranied fauna in the different agro-ecosystems if the predatory potential of these identified species recorded in the future studies.

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