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RESEARCH PAPER

Journal of Biodiversity and Environmental Sciences (JBES)

ISSN: 2220-6663 (Print) 2222-3045 (Online)

Vol. 8, No. 5, p. 147-154, 2016

<http://www.innspub.net>**OPEN ACCESS**

Assessment of Variance Indices of Araneid Fauna Grasped from Sugarcane Field by different trapping Methods at Faisalabad, Pakistan

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Article published on May 27, 2016

Key words: Araneid fauna, Biodiversity, Temperature, Rainfall, Relative humidity.

Abstract

Spiders play integral ecological favor for regulating integrated pest management population. Despite, there is restricted research data on the species richness, evenness and relative abundance in Faisalabad, Pakistan. Abundance of spiders were captured by pitfall, hand picking, foliage sampling and beat netting. We sampled seven families of araneid fauna and the most dominant families were Lycosidae, Thomisidae and Salticidae. The maximum araneid fauna was collected in the month of June when temperature 43.5°C, relative humidity (R.H) 63.2% and average rainfall 35mm while lowest were captured at relative humidity (R.H) 65.5%, temperature 29°C and rainfall 24mm in the month of September. Pielou's evenness index (E), Simpson diversity index (D), Shannon diversity index (H) and species richness were used to extract the results. It was clarified that araneid fauna asymmetrical in different season of a year and were totally dependent on environmental factors like rainfall, temperature and relative humidity. These data indicated that use of pitfall trap, foliage collection and integrated pest management could be valuable tactics to determine the abundance of araneid fauna.

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Introduction

Sugarcane is most suitable crop for Punjab climate but abundant use of insecticides remove pest community also harmful to human being and other animals. Today, farmers consisting maximum on insecticides for inhibiting the insect pest population. Therefore, agricultural field is being loaded with poisonous elements via the use of these toxicants whose inauspicious affect on human beings still unknown. The multiple uses of insecticides, runoff natural organic matters that disturb ecosystem. Once agro-ecosystem disturb, constant use of insecticides becomes essential for crop protection. Otherwise, pest population would harm the field. Retardless, use of insecticides critically affected the agro-fauna that most important for stability of ecosystem. In agro-ecosystem of Pakistan, multiple crop practice is very common naturally biodiversity is much greater than monocultures (H M Tahir and A Butt, 2009). (A Sankari and K Thiyagesan, 1999) examined araneid fauna and their predatory efficacy on solanummelongena (Brinjal) and *Trichisanthesanguina* (snake-gourd) field in two separate habitat viz. Nangoor (pesticides free habitat) and Moongilhottam (frequently pesticides used habitat) of Nagapattinam District, Tamilnadu. The araneid fauna represented remarkable difference between habitats, plants and number of spider fauna. Spiders can maintain insect pest population because have vast variety of prey, can capture significant number of individual. Frequently, use of toxicants seems to eliminate the spider species from sugarcane field. Their predatory range can have a symbiotic effect in abolishing insect pest population when they are used to supplement effect of insecticides (M Bukhari *et al.*, 2012b). Convergence of spider species diminishes pest population consisting aphids in spring barley, leafhoppers in sugarcane field. They also studied the role of araneid fauna of northern temperate zone of Europe. They captured aphids from web sheet of linyphiidspider. In US, many hunter families of araneid fauna like Lycosidae, Oxyptidae, Salticidae and Thomisidae that have variety of prey (consisting lepidopteran and heteropteran) found in

many habitats. Araneid fauna of US and Europe is different in homology but have same capability of predation. They discussed that araneid fauna more essential in integrated pest management and also helpful of the stability of agro-ecosystem. (M Nyffeler and K D Sunderland, 2003) Represented landscape heterogeneity and farm practices directly impact on biodiversity of agro-ecosystem. They also examined two variables in both landscape and farm management of biodiversity. They measured species richness of different flora and fauna in semi-natural meadows at 16 farms in central East Sweden (A C Weibull *et al.*, 2003). (D Maloney *et al.*, 2003) discussed that diverse territories engaged are meadows, ditches, soil, plants, and cropland and even have utilized bilateral life. According to some authors, araneid fauna can be adequately used in integrated pest management. (S Braaker *et al.*, 2014) revealed that low-mobile (carabids and spiders) while high-mobile colonies were affected by local environmental factors. They examined green roof of urban area spider's species also adopted amphibious life. A number of spider species in agriculture field of Pakistan still unidentified. The prime purpose of the study was to characterize araneid fauna in sugarcane field of District Faisalabad, Punjab. Four different habitats in four different locality of Faisalabad were compared bio-diversity of araneid fauna. This study will provide supreme assessment of spider symbiosis like integrated pest management of sugarcane field in this area.

Materials and methods

Faisalabad is situated at 31.42 north latitude, 73.08 east longitude and 175 meters above from the sea level. The atmosphere of district can see climax, with a summer maximum record. The temperature of summer 48°C was observed and a winter temperature of -1°C. The mean maximum and minimum temperature in summer are 39°C and 27°C respectively. In winter it around 21°C and 6°C respectively. The summer season starts from April till October. The hottest months are May, June and July. The winter season starts from November till March.

The coldest months are December, January and February.

Pitfall sampling

The massiveness of spider in sugarcane field was investigated using two types of sampling modes (hand picking and pitfall traps) in a week from end of February to start of September 2011. To collect ground spider, in each plot, 30 pitfall net consisted of broad mouth glass bottles (5cm in diameter × 10 cm immersed) were settled diagonally.

Four pitfall traps (6 × 6 m modular grid pattern) were settled at each edge of location and 4 in the middle .These traps were entombed into ground surface for a week .Ethylene glycol (95%; 30 ml) and 3 drops of 1% liquid detergent were poured to each bottle to break the surface tension. A rain cover (20 × 20) manufactured of 0.7 cm plywood and staked by 4 nails (9cm long) was placed over each trap (the height of rain cover over the mouth of bottle was 24 cm).

Foliage sampling

For foliage collection, Vacuum sucker (SIEMENS VK 20C01) was applied to captured the spiders from foliage of sugarcane plants. Fifty plants were randomly pointed from each habitat. All the sampling was done in early morning of day due to highest activity of spiders. Foliage organisms (spiders and other invertebrate) were also collected through hand picking from March to October.

Beating method

Beating method was fitted in sugarcane field due to small branches. First, took a plastic tray that was umbrella like shaped outward from corners. Tray was rectangular shaped 12 inches in square. Then hold the plants, shake branches with one hand and placed tray beneath the branches with other hand. A suited number of spiders collected after beating the plants that have dropped into tray before they get away.

Labeling and identification

All bottles were emptied after a week. Spiders from each bottle were collected and brought to the laboratory. Captured spiders were washed in xylene, put in small vials having seal cap with 70% ethyl alcohol and transported to the archeology laboratory Government College University Faisalabad for categorize and identification. Ultimately, spiders were preserved in vials, containing a solution of 70% ethyl alcohol and glycerin. All the vials put into refrigerator for 1-2 hours for preserve the spiders without wilt. Spider species were dominant, if reported for 1% of the total population whereas most dominant, if they reported more than 10% of the total collection (M H Schmidt and T Tschardt, 2005).

The preserved spiders prepared for ecological studies, all species were distinguished upto species level by using appropriate materials supplied by (S Dyal, 1935); (B Tikader and M Malhotra, 1980); (A T Barrion and J A Litsinger, 1995) and (J Proszynski, 2003). The genus and species of spiders were labeled on the vials with a marker. Data attained was statistically analyzed for the species percentage, relative abundance, species evenness index, species richness Margalef index, Pielov's evenness index, Simpson index and Shannon diversity index. Calculation has been made through MS Excel 2013.

Statistical analysis

The data obtained was analyzed for the species relative abundance and other diversity indices. For the estimation of Species Richness Margalef Index was used which is represented by

$$R = S-1 / \ln(n).$$

where 'S' is the total number of species in a community and 'n' is total number of individuals observed in that community.

Evenness is a measure of the relative abundance of the different species making up the richness of an area. For the evaluation of Evenness, Pielov's Evenness was used which is represented as

$$E = H / \ln(S).$$

where ‘H’ is Shannon’s Index and ‘S’ is the number of species.

Shannon Diversity Index

$$H = -\sum P_i \ln P_i$$

$$p_i = n_i/N$$

Where p_i is the proportion of the number of organisms in the i^{th} species (n_i) to the total number of organisms in the sample (N).

Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

$$D = 1 - \frac{\sum_{i=1}^S n_i(n_i - 1)}{N(N - 1)},$$

Where S is the number of species

N is the total percentage cover or total number of organisms

n is number of organisms of a species.

Result and discussion

A total of 252 specimens have respect to seven families 8 genera and 21 species were collected by using, Foilage collection, Beating method, sweep net, handpicking and pitfall trap method.

Four species of Family lycosidae(36.5%) were maximum dominant among all captured species like *Lycosamackenziei*, *Lycosakempi*, *Lycosamadani* and *Pardosabirmanica* while rest was less redundant.

Table 1. Occurrence of araneid fauna trapped from sugarcane field (4 habitats) at district Faisalabad, Punjab, Pakistan.

Family	Genus	Species	Number of species	%
Lycosidae	Lycosa	<i>Lycosa mackenziei</i>	38	36.1
		<i>Lycosa tista</i>	15	
		<i>Lycosa madani</i>	10	
		<i>Pardosa birmanica</i>	8	
	Pardosa	<i>Pardosa oakleyi</i>	6	
		<i>Lycosa kempi</i>	4	
		<i>Lycosa nigricans</i>	5	
		<i>Lycosa maculata</i>	5	
		<i>Thomisus elongates</i>	21	
Thomisidae	Thomisus	<i>Thomisus bulani</i>	19	24.2
		<i>Thomisus pugilis</i>	12	
		<i>Thomisus cherapunjeus</i>	9	
		<i>Marpissa tenebrosa</i>	14	
Salticidae	Marpissa	<i>Marpissa carinata</i>	9	12
		<i>Marpissa mirabilis</i>	5	
		<i>Marpissa tigrina</i>	2	
		<i>Gnaphosa lucifera</i>	15	
Gnaphosidae	Gnaphosa	<i>Gnaphosa eucalyptus</i>	8	11.1
		<i>Gnaphosa harpax</i>	5	
		<i>Cyclosa bifida</i>	10	
Araneidae	Cyclosa	<i>Neoscona bengalensis</i>	4	10.7
		<i>Neoscona excelus</i>	4	
	Neoscona	<i>Neoscona rumfi</i>	6	
		<i>Neoscona theis</i>	3	
Clubionidae	Clubiona	<i>Clubiona sp.</i>	9	3.6
Oxyopidae	Oxyopes	<i>Oxyopes ratnae</i>	4	2.4
		<i>Oxyopes javanus</i>	2	
		Total	252	

Family Thomisidae(24.2%) characterized by genus Thomus and species i.e., *Thomisusbulani* and *Thomisusbelongates*.Family salticidae(12%) contained of genus marpissa,species *Marpissacarinata*, *Marpissatenebrosa* and *Marpissamirabilis*.FamilyGnaphosidae(11.1%)represented genusGnaphosa and species*Gnaphosa eucalyptus* and *Gnaphosalucifura* and *Gnaphosaharpax*.FamilyAranidae(10.7%)represented by two genera i.e. Cyclosa species*Cyclosa bifida* and Neoscona species *Neosconabengalensis*.Family Clubionidae consisted (3.6%) of total population and represented species Clubiona spp.Family Oxiopidae (2.4%) comprised only one species *Oxyopesratnae*.

Family Lycosidae was remained on top with four generai.e.*Lycosamackenziei*,*Lycosamadani*,*Lycosake mpi* and*Pardosabiemanica* comprised of 91 spiders.*Lycosamackenziei* was the most dominant species among the other three species of Family Lycosidae. Family Clubionidae and Oxiopidae were recorded less number of spiders. The abundant spiders of Family Lycosidae collected (70.5%) of total population as shown in table 1.

Indicia of diversity i.e. simpson’s diversity index (D) species richness(R) Shannon index(H) and Pielou’s evenness(E) were 00.88,61.2, 3.52 and 00.90 respectively.

Table 2. Diversity indices of Araneid Fauna collected from Sugarcane Field at District Faisalabad.

Component	Values
Pielou’s evenness (E)	0.9
Shannon Diversity index (H)	3.52
Simpson Diversity index (D)	0.88
Species richness (R)	61.2

(M Bukhari *et al.*, 2012a) determined that maximum araneid fauna with highly favorable environment factors in June and least number recorded in October. Maximal number of spiders was captured in the month of June when relative humidity (%), temperature(°C) and average rain fall (mm) 70.1, 43.5 and 41 were noted. Minimum number of spiders collected when average temperature (°C), relative humidity (%) and average rainfall (mm) were noted 23.5, 64.21 and 23.00 respectively.In March and April (30) and (31) spiders were trapped that shows same number of spider fauna.Mohsinet *al.* (2012) demonstrated that spider population varied in different months of a year and depends on environment factors such as rainfall, temperature and relative humidity.

Organic practice may add diversity to soil structure and increase the abundance of prey and in turn the abundance of spider. An overview on the collected data represented that Family Lycosidae was dominant throughout the whole experiment.

The dominance of Families was Lycosidae>Thomiidae> Salticidae>Gnaphosidae>Aranidae>clubionidae and Oxiopidae.The spider population maximize during the months of April, May and June due to suitable environmental factors like humidity, rainfall and temperature. The highest ratio of spider’s i.e. 24.5% was collected during months of May and June. Data represented that gradually increase in humidity and temperature from March to June increase the number of specimen .In addition, heavy rainfall in the month of July and August badly effect the spider population whereas other climatic factors were quite high. The araneid fauna is reciprocal of rainfall.Araneid fauna directly dependent on climatic factors like increase in temperature and relative humidity till June number of spiders increased while increase in rainfall(mm) from July to October, decrease in temperature and relative humidity suppressed spider population. (M Bukhari *et al.*, 2012a, M S Khan *et al.*, 2015) discussed that temperature and relative humidity did not boost up spider population until the rainfall average.They also gathered data of pesticides

concentration that directly proportional to araneid fauna.(H M Tahir *et al.*, 2011) analyzed the spider density collected from citrus garden at Lahore and also observed three families of araneid fauna was most dominant like Lycosidae(68.85%), Gnaphosidae (10.38%) and Salticidae (8.38%) respectively.(S B

Mohsin *et al.*, 2015)figure out predatory efficacy of female spider higher than male because of brood care, egg laying and reproduction. They concluded that in the trapping session number of female spider more than male fauna.

Table 3. Analysis of variance (ANOVA) for the families of Araneid fauna, temperature(C),relative humidity(%) and rainfall (mm) noted from sugarcane field at District Faisalabad,2012.

SOV	df	SS	MS	F Calculated	P Value
Families(F)	5	2634.2	460.77	17.10 *	0.0216
Temperature(T)	1	223.1	223.1	8.29 *	0.008
Relative humidity(R.H)	1	430.5	430.5	15.69 **	0.002
FXT	5	410.4	67.1	2.50NS	0.22
FXR.H	5	130	22.4	0.79NS	0.131
TXR.H	1	315.21	323.25	11.78*	0.0512
FXTXR.H.	5	840.99	135.88	4.54NS	0.293
Error	1	28.3	28.3	-	-
Make a line here					
Total	24	-	-	-	

(A Ghafoor and A Mahmood, 2011) collected 178 specimens comprised of seven families, ten genera and 22 species from March to October in the rice field situated at district Gujranwala, Pakistan. The gathered (92) spiders Family Lycosidae (65.7%) of total araneid fauna.In June,(20.7%) spiders collected due to favorable climatic factors like average rainfall (40mm),relative humidity (61.4%) and temperature (35.1°C) were noted.(M Zabka *et al.*, 2002) reported 30 genera and 200 species of family salticidae from New Zealand. He also reported that listed species

suited verification and documentation so difficult but showed clearly correlation between family salticidae of New Zealand and Australia were bounded a representative of Clynotis, Holoplatys, Jotus, Hypoblemum, Helpis and Ocrisiona. Average rainfall, relative humidity and temperature were favorable in June and highest fauna captured during this month. Shannon diversity index (H),Species richness(R),Simpson diversity index (D) and Pielou's evenness (E) 3.52,61.2,00.88 and 00.90 were recorded.

Table 4. Correlation coefficient (r) among spider fauna with rainfall(mm),temperature(C) and relative humidity examined from the sugarcane field at District Faisalabad.

Parameters	Families	Temperature (C)	Humidity (%)	Rainfall (mm)
Families	1	-	-	-
Temperature(°C)	0.830**	1	-	-
Relative humidity (%)	0.240 ^{NS}	0.877**	1	-
Rainfall (mm)	0.341	0.493NS	0.22	1

Analysis of variance among families of araneid fauna with respect to environmental factors like temperature, relative humidity and rainfall as shown in.

and 222 specimens were recorded. He showed that most dominant *Pardosa birmanica*,*Lysocsa madani* and *Lycosakempi* whereas rest of them was less populated. Family salticidae consisted genus plexipus and marpissa. Family lycosidae was its top with three genera i.e. Hippasa,Paradosa and lycosa.

(M Bukhari *et al.*, 2012a) total 10 genera, 22 species

Diversity of spiders i.e. Simpson's index (D) 0.93, Shannon index (H) 2.83, Pielou's evenness 0.91 and species richness (E) 57.58 were measured. Diversity indices of district Gujranwala and Faisalabad were very close to each other. Spider population peaked and was on its peak in June because of favorable environmental factors like temperature, relative humidity and rainfall. The maximum collection of spiders i.e. 25% was captured in June as correlation coefficient depicted in Table 4. The purpose of research was to characterize that how the environmental factors impact on the araneid fauna and suppress the population through a year. The statistical analysis showed highest temperature and humidity in June directly proportional to araneid fauna while rise in rainfall from July to October crush the spiders. (H M T Butt, Abida, 2008) collected 17658 individuals belonging to 44 species, 30 genera and 12 families were noted. He showed most dominant species from overall data were *Lycosaterrestis* (86.61%) *tetragnathajavana* (27.10%) recorded. Male and female spiders of family Lycosidae with maximum ratio were captured in June whereas highest proportion of immature fauna was trapped in early November. The purpose of research was to identify the araneid fauna from sugarcane field at district Faisalabad.

The data showed us density, diversity and composition ranged within habitat and how spider population effected by ecological factors throughout the year. Correlation and comparison were formed between colonies of couple sites.

The data represented a bit degree of variability. From the present data, it was concluded that the environmental factors like temperature, relative humidity and rainfall directly proportional to araneid fauna in sugarcane field. Further research in the field of biodiversity indices may be tested on different crops, fruits and vegetable fields.

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