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Determining the Abundance of Spider Population Inhabiting the Orchards in Citrus Valley of District Sargodha, Pakistan

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Abstract: Two hundred and twenty three specimens were collected from the citrus orchard of district Sargodha belonged to seven families and eleven genera. The order of araneid fauna captured during the current studies was Lycosidae > Saltisidae > Aranidae > Thomisidae > Clubionidae > Gnaphosidae> Oxiopidae. The most dominant genus were *Lycosa*, *Pardosa* and *Marpissa*. The average temperature, relative humidity and average rain fall consistently increased till the months of July, Septermber and August. The maximum degrees of the above environmental factors were not favored to capture of araneid. The most specimens were collected on June whereas the least ones were gathered on October at 30°C, 59% (r.h.) and average rainfall 19.2 mm. Species richness, Shannon diversity index, Pielou's evenness index and Simpson diversity index were 67.57, 2.83, 0.91 and 0.93, respectively. It was concluded that spider population varied in different months of a year and were strictly dependent on the environmental factors like temperature, relative humidity and rainfall.

Key words: Temperature · Rainfall · Seasons · Indices · Diversity · Families

INTRODUCTION

Majority of insecticides used for inhibiting the pest population are toxic to man and other animals. In the absence of other alternate effective means, farmers are relaying on more and more insecticides for ridding their crops of insect pests. Consequently, agro-ecosystem is being loaded with toxicants through the use of these chemicals, whose adverse impact on human health and agro-ecosystem is not fully known. Once the natural constraints against pests' species are weakened, a sustained use of insecticides becomes essential otherwise the pest populations would buildup and the crops would suffer losses on larger scales. Zabka *et al*. [1] recorded 30 genera and 200 species of Salticidae from New Zealand. The fauna was highly endemic, both on a generic and specific levels. Spiders belong to the most numerous invertebrate predators of arable land in Europe [2]. Although they are generalists, a diverse spider fauna contribute to the limitation of on various pest species. As the great majority of spiders are polyphagous, i.e. feeding on a variety of invertebrates, they are not able of prey population tacking that is a typical of specialized predators. Nevertheless, they contribute to the suppression of pests and have a potential to limit Lepidopterans, including *O. nubialis* [2]. Approximately, 120,000 species of spiders occur worldwide and only 30000 of the total fauna has been classified and named. Up till now 110 families, 3542 genera and 38432 species of spiders have been described [3]. The various habitats occupied are soil, houses, forests, meadows, woodlands, croplands, the petals of flowers and even they may have adopted amphibious life. According to some researchers spiders can be effectively used in pest control [4]. Spiders are considered the most important predators in the agricultural ecosystems. Pearce *et al*. [5] checked the potential of different spiders belonging to family Lycosidae, Clubionidae, Salticidae and Thomisidae to contribute to biological control of *Helicoverpa* spp. in soybean field. They found that spiders are the most abundant predators in grain crops. They are voracious predators and combined with their high abundance, may play an important role in the reduction of pest populations. In order to conserve biodiversity and

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minimize dependence on pesticide integrated management program need to be encouraged [6]. Ecological diversity plays very important role in natural check. So, biological control through spiders is one of the best options to reduce the use of chemical pesticides as well as the populations of the insect pests. Through biological control not only we can control insect pests but also we can save a worth of foreign exchange used to purchase pesticides. Spiders occupy an important part of the overall predatory arthropod fauna in different terrestrial ecosystems. They are also known to play pivotal role in the regulation of pest species in agriculture. They are important enemies of pest species including aphids, mites, lepidopteran larvae and their eggs [7]. Spiders feed on insect pests and kill as much as 50 times the number of prey they actually consume. Due to their diversity and abundance, they significantly reduce plant damage caused by insects in number of ways other than direct feeding on them e.g., top down effect [8] and wasteful killing [9]. Spiders are important biological control agents used as natural enemies of pests in several crops [10]. Spiders not only prey upon the larvae and adults of insect pests, but also cause mortality in them by disturbing their eggs. Further, spiders are more resistant to some pesticide as compared to many species of predatory insects [10]. An intelligent application of insecticides having less adverse effect on spiders in the paddy and cotton fields resulted in controlling the pest insect populations to acceptable levels [11]. Spiders have also been used in the study of habitat structure, where they have been found to vary with moisture levels and canopy cover [12] as well as in the study of rare habitats, such asEuropean peat bogs, where they're densities and distributions may be communicative of the state of that community. The present study aimed to determine the distribution and ecology of spider communities from citrus valley of district Sargodha. It will provide the new milestones for the new researchers interested in studying and in the explorations of new fields related to the importance araneid fauna and their role in the biological controls.

MATERIALS AND METHODS

This study was conducted during March to October, 2010 in the citrus orchards of city Bhalwal situated in the citrus valley of district Sargodha. The activity density of spiders throughout the growth period of the crop was investigated every week using 2 types of sampling methods (pitfall traps and hand picking). For the collection of ground spiders in each plot, 20 pitfall traps consisted of wide-mouth glass jars (6 cm in diameter × 12 cm deep) were installed diagonally. Four pitfall traps (on a 5 × 5 m grid pattern) were installed at each corner of the plots and 4 in the center. These traps were buried into ground with the mouth of jars leveled to the ground surface for seven days. Ethylene glycol (95%; 250 ml) and 2 drops of 1% liquid detergent were added to each trap to break the surface tension. A rain cover (18 × 18 cm) constructed of 0.6 cm plywood and supported by 3 nails (9 cm long) was placed over each trap (the height of rain cover over the mouth of the glass jar was 30 cm). All traps were emptied after seven days. Spiders collected from each trap were brought to the laboratory. Captured spiders were washed in xylene, placed in small jars with 70% ethanol and transported to the arachnology laboratory Government College University, Faisalabad for sorting and identification. Finally spiders were preserved in vials, containing a solution of 70% ethanol and glycerin and prepared for ecological studies. Specimens were identified by materials provided by Tikader and Biswas [13] and Barrion and Litsinger [14]. The data obtained was analyzed for the species relative abundance and other diversity indices. For the estimation of Species abundance the Richness Margalef Index, Evenness, Shannon Diversity Index and Simpson's Diversity Index were evaluated.

RESULTS AND DISCUSSION

Two hundred and twenty three specimens of spiders were captured by the pitfall method belonged to seven families, 11 genera and 22 species were recorded. Of the total species three were the most dominant and three dominant. The most dominant species were *Lycosa madani* (26) and *Lycosa berminica* (35). *Pardosa oakleyi* (18), *Plexipus bengalensis* (21) and *Hippasa holmerae* (10) were dominant species while the remaining was less frequent. Family Thomicidae represented by genus *Thomisus* with two species i.e. *Thomisus bulani* (19), *Thomisus elongates* (29). Family Araneidae consisted upon two genera *Cyclosa* and *Neoscona* while Family Gnaphosidae contained of two species i.e. *Gnaphosa harpax* and *Gnaphosa eucalyptus* whereas specimens belonged to family Oxyopidae with single species i.e. *Oxyopes ratnae*. Not even a single spider of Family Clubionidae and Family Gnaphosidae was recorded from site under research. Tahir *et al*., [15] mentioned 1098 araneid population including 38 species, 22 genera and 9 families. Lycosidae was the most common family but Gnaphosidae covered the maximum number of spiders.

Family Salticidae comprised of genus *Marpissa* and *Plexipus* with 23 and 12 specimens. Indices of diversity i.e. richness, evenness, Shannon index and Simpson's were calculated 65.67, 0.91, 2.83 and 0.93, respectively.

The maximum spiders i.e. 37 spiders were collected during the month of June, when average rainfall (mm), maximum temperature (°C) and relative humidity (%) recorded were 42, 42.5 and 61, respectively as depicted in the Fig. 1. Ghafoor and Mahmood [16] collected 178 specimens having 7 families, 10 genera and 22 species captured from March till October, 2010 from the fields of rice and sugarcane situated at Gujranwala, Pakistan. Tahir *et al*., [15] in their reports elaborated that araneid inhabitants showed unswerving increasing trends amongst the populations of immature and adults from the month of January to August. Furthermore they institute five most plentiful species of Lycosidae family comprised of 67.77% of the total araneid population. The maximum temperature was recorded 43.2 °C in July, which favours the spider population to increase. But high rainfall (165 mm) during the same month hindered spider population to grow. The least number of spiders i.e. 13 was trapped when rain fall was 19.4 mm, relative humidity was 59 (%) and maximum temperature was 30.4°C as shown in the figure 1. Tahir *et al*., [15] reported that adult spiders amplified from month of January upto April. Their inhabitant starts decreasing in the months after April than again found augmented in June as given in the Table 1.

Results clearly demonstrated that increase in temperature and relative humidity favored spider population to increase through March to June. But on the other hand increase in rainfall suppressed spider population in the months of July and August while temperature and relative humidity were quite high. July was recorded as the month of highest temperature and average rainfall but with decline in the number of spiders. June with its climatic conditions i.e. average rainfall, temperature and relative humidity found to be more suitable for spider population to increase because highest proportion of spiders i.e. 21.12% was trapped during this same month. Ecological factors found boosting the spider population till June with high temperature and relative humidity then slowly decreased through July to October because of decrease in temperature and due to increased rainfall. Ghafoor and Mahmood [16] verified that humidity and temperature privileged the population of spider from March (15) to June (37). They further reported that temperature and rainfall found higher in the month of July but both parameters did not favor araneid population as depicted in the Figure 1. The possible inclusion of additional diversity measures in subsequent studies may yield more fitting or consistent results, as no single index can perfectly reflect the diversity of a given species [17]. It is important to note that the degree of significance of diversity indices often corresponded to a particular measure. Simpson index for instance, suggest that contained same degree of diversity, while the result with those of the other studies carried out in the agro-ecosystem of the Central Punjab [18]. Ghafoor and

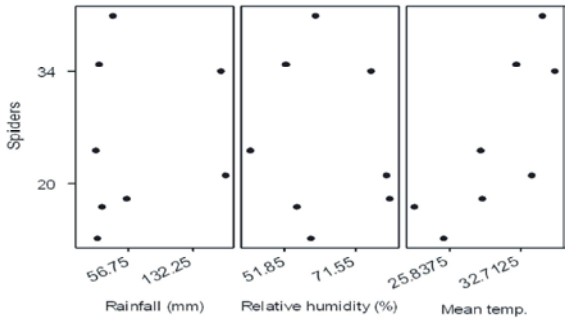

Fig. 1: Draftsman plot showing the diversity of Araneid fauna against the temperature, relative humidity (%) and rainfall (mm) in the citrus orchards situated at the citrus valley of district Sargodha during 2010.

Table 1: Distribution of Spider species, number of families and families (%) collected from the research areas situated at citrus valley of district Sargodha, 2010

Family	% of families	Species
Araneidae	5.91	3
Clubionidae	2.95	1
Gnaphosidae	2.95	2
Lycosidae	61.08	9
Oxiopidae	2.46	1
Saltisidae	18.71	4
Thomisidae	6.40	2

Table 2: Analysis of variance (ANOVA) for the families of Araneid fauna, temperature (°C), relative humidity (%) and rain fall (mm) trapped from citrus orchards at district Sargodha, 2010.

SOV	df	SS	MS	F calculated	P value
Families (F)	6	2842.10	473.69	16.27*	0.0217
Temperature (T)	1	212.10	212.10	7.26**	0.0079
Relative humidity (R.H.)	1	429.53	429.53	14.70**	0.0021
FXT	6	401.50	66.91	2.29^{NS}	0.2180
FXR.H.	6	128.72	21.45	0.73^{NS}	0.1290
TXR.H.	1	312.19	321.19	10.99*	0.0422
FXTXR.H.	6	724.95	120.82	4.13^{NS}	0.2130
Error	1	29.20	29.20	-	-
Total	28	-	-	-	-

*, ** and NS showing the significance at 5%, 1% and non-significances respectively.

Beg [18] provide a foundation for future studies of ground dwelling and arboreal spider communities in the agro-ecosystem and relevant to search on the biological control of insect pest population in the ecosystem of Pakistan.

When establishment of territories begin inter-and intra-species competition act and reduce the number of spiders with the normal phenological progression [19]. Ali and Regan [20] stated that it may be possible that this phenomenon acted during the study and specimens of Lycosa derived out genera and become dominant or may effect seasonal changes. Recent studies have also discussed the possibility that applying diversity indices to invertebrate studies may posses intrinsic shortcomings, since the rate of capture is linked with individual activity and detectability. Abundance of Lycosids and remaining families clearly demonstrate this point: both species abundances and diversity varied with time of collection. Ghafoor [21] gathered 74% of Gnaphosidae from the cotton fields. Similarly Maqsood [22] collected 62% and 55% from fruit fields and guava gardens, respectively. Furthermore, Tahir *et al*., [15] analyzed the activity density of spider fauna captured from the citrus fields situated at Lahore, Pakistan. They ascertain three dominant families 68.85% Lycosidae, 8.38% Saltisidae and 10.38% Gnaphosidae. From the current studies, it was accomplished that the environmental factors like light, temperature, humidity and rainfall etc. effect the spider populations in crops. Further studies on their diversity indices (Shannon diversity index, Pielou's evenness index and Simpson diversity index) may be accommodating in exploring the significance of araneid fauna inhabiting the diverse crops, fruits and vegetable fields for the biological control crop damaging pests.

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