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Research Article

Diversity of spider fauna in lucerne (*Medicago sativa* L.)

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ABSTRACT: The spider fauna of lucerne (*Medicago sativa* L.) was studied at Anand district, Gujarat during summer of 2000 and 2001. A total 2943 specimens of spiders were collected comprising of 61species belonging to 37 genera and 12 families. Using quadrate sampling method, 48 species belonging to 29 genera and 10 families were collected, whereas, in pitfall trap, 35 species belonging to 25 genera and 10 families were collected. Thirty-two species were common in both the collection methods whereas, 16 species were exclusively found from the quadrate method and three (3) species were exclusively recorded from pitfall trap. Additional 10 species were recorded from general collection from the other lucerne fields. Araneidae was the largest family qualitatively followed by Thomisidae and Salticidae. Overall species richness, diversity index and evenness were almost same during both the years. During both the years, species richness and diversity indices showed increasing trend up to harvesting.

KEY WORDS: Lucerne, *Medicago sativa*, spider fauna, Araneidae, species diversity, distribution, Gujarat

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INTRODUCTION

More than 34,000 species of spiders have been described from a vast range of habitats and spiders are the dominant insectivorous arthropods in many natural ecosystems and crop (Sunderland, 1999). There is increasing evidence to suggest that polyphagous predators, to which spiders belong, play an important role in the regulation of a number of insects (Whitecomb *et al*., 1963; Kiritani, 1979; McDaniel and Sterling, 1979, 1982). In foreseeable future, biological control of pests by spiders will be part of integrated management systems (Sunderland, 1999). The spider fauna of several crops have been studied in Gujarat (Patel *et al*., 1986; Anonymous, 1987; Muralidharan and Chari, 1992; Patel, 2000). Some information is also available on the spider fauna of paddy (Ambalagan and Narayanasamy, 1999; Sebastian *et al.,* 2005; Sudhikumar *et al.,* 2005), cotton (Battu and Singh, 1974; Baldev Prashad *et al*., 1981) and sugarcane (Vennila and Eashwaramoorthy, 1995) from other parts of the country. However, there is no detailed study or information on the spider fauna of lucerne (*Medicago sativa L)* from any state of India.

Usually, lucerne is available throughout the year in field and as it is used as a fodder crop and generally no pesticide is sprayed on the crop. Since, the crop is kept free from the pesticides, it should support diverse spider fauna and serve as a repository within the agricultural landscape. Therefore, purpose of this study was to find out spider fauna occurring in lucerne and to make a complete inventory and to work out various diversity indices.

MATERIALS AND METHOD

Methods

Present study was carried out during two summer seasons of 2001 and 2002 in two lucerne growing fields of Forage Research Farm of Anand Agricultural University, Anand (22° 32' N, 73° 00' E), Gujarat. The study site had an area of 43 m x 40 m and 63 m x 36 m in respective years. On three sides of the selected plot, there were lucerne fields whereas, the fourth side had a tobacco field. The source of irrigation during entire season was tube well water and the variety of lucerne grown was GAUL-1 grown for seed production. Sowing was done in the last week of December and the crop was harvested in the second week of May.

Population estimation and ground activity

Quadrate method was used to measure the population dynamics on lucerne plants and pitfall trap method was

used to measure activity of spiders on the ground. Besides this, general collections were made from other fields around Anand to enrich the species inventory.

a) Quadrate method

The population dynamics of different species of spiders was studied by making collection of spiders from 20 quadrates of 75 x 75 cm area, 10 quadrates each from periphery and core area of the selected field. Collections were made at weekly intervals in the morning hours during both the years.

The spiders which were much conspicuous through their size, colour and webs on top of the plants were collected and then each plant was searched from top to bottom on leaves, tillers and flowers. The ground area near the plants within each quadrate was also searched. Spiders were easily collected by leading them into a plastic tube (5 cm diameter and 10 cm length) from the ground stratum and from the terminals of plants or by picking them with hand. All the collected specimens were preserved in 70% ethyl alcohol with proper labeling of locality, date and area of the field (core areas or periphery). Field records were maintained throughout the study period.

b) Pitfall Trap method

Pitfall method was used to study the ground activity of spiders. Plastic bowls having 10.5 cm diameter and 11 cm depth were placed in the soil in such a way that its opening remained parallel to the surface level. Formaldehyde solution (5%) was used as a preservative filling the bottom of the bowl up to 2 cm height. Traps were placed equi-distance from each other. The spiders and insects falling in the trap were collected twice in a week (one collection after four days and second was after three days) and preserved in 70% ethyl alcohol with proper labeling of trap number and date.

c) General collection

For general collections, fields other than the one chosen for population dynamics study were selected and less common spiders were selectively collected. Such collections were made every week. All the specimens were preserved in 70% ethyl alcohol and labeled.

Identification

Adult males and females collected from the fields were identified up to the species level with the help of available literature (Tikader and Malhotra, 1980; Tikader, 1982). The immature stages of spiders were identified only to the generic level. After careful cleaning, each specimen was examined under zoom stereoscopic trinocular microscope (Olympus, Japan) having 10x eye piece and 11.5x to 144x objective lenses.

Analysis of the data

a) Diversity indices of the species

Quantitative estimation of different species and number of individuals at weekly intervals starting from a two weeks after sowing of the crop to the harvesting of the crop was made by subjecting the data derived from the study fields to the formula furnished below.

i) Species richness was calculated using the formula:

Species richness (S) = Number of species collected.

ii) Species diversity (H') was computed based on Shannon-Weiner index of diversity (Shannon, 1948).

Species diversity (H') = $-\sum_{i=1}^{k} P_i \ln pi$

where,

p_i = Proportion of i^{th} species in sample.

p_i = fi/n

n = Total number of specimen in sample

fi = Number of specimen of the i^{th} species

k = Total number of species

ln = Natural logarithm (log e)

iii) Species evenness or equitability (E) was calculated using the formula (Krebs, 1975).

$$E = \frac{H'}{H'_{max}}$$

where,

H'_{max} = Natural logarithm of the number of species present

$0 < E \leq 1$, the maximum value being possible in a community in which all species are equally abundant.

Any logarithmic base i.e. e, 10 and 2 may be used to compute H' and E, the evenness value remains the same.

RESULTS AND DISCUSSION

Occurrence of spiders during study period

A total of 2943 specimens were collected from the lucerne field during two years of which 1234 were collected from quadrate, 995 from pitfall trap and 714 from general collection. A total of 61 species, 37 genera

and 12 families were recorded. Using quadrate method, 48 species belonging to 29 genera and 10 families were collected; whereas, in pitfall trap, 35 species belonging to 25 genera and 10 families were collected. This difference in species richness was due to the effect of different sampling methods used. Thirty two species were common in both the methods whereas 16 species were exclusively found from quadrates. Three species namely *Cyclosa* sp. *Evippa* sp. and *Rhene* sp. were exclusively recorded from pitfall trap and 10 species were recorded from the general collection from the other fields (Table 1). Araneidae was the largest family qualitatively which consisted of 6 genera and 13 species followed by Lycosidae (10 species, 4 genera) Thomisidae (8 species, 6 genera), Salticidae (7 species, 5 genera), Clubionidae (6 species, 4 genera), Theridiidae (5 species, 4 genera), Gnaphosidae (4 species, 2 genera), and Oxyopidae (3 species, 3 genera). The other families were represented only by 1 genera and 1 species except Uloboridae with 2 species. Lyxoscelidae and Scytodidae family were found only in general collection. Some species, i.e. *Argiope* sp., *Neoscona* sp., *Pardosa* sp. and *Theridion* sp. are considered as separate species because they represent the juveniles which may be any species from the given list or a new one.

Family Araneidae was the most dominant in the rice fields of South and South-East Asia (Barrion and

Table 1. Families, genera and species of spiders collected from Lucerne crop

Family	No. of genera	No. of species	Species	Quadrate	Pitfall	General collection
Araneidae	6	13	*Neoscona theis* (Walckenaer)	√	√	
			N. mukerjei Tikader	√		
			Neoscona sp.	√	√	
			Argiope anasuja Thorell	√		
			Argiope sp.	√		
			Cytrophora cicatrosa (Stoliczka)	√		
			Cytrophora sp.	√		
			Leucauge decorata (Blackwall)			√
			L. pondae Tikader	√		
			Leucage sp.	√		
			Chorizopes sp.			√
			Cyclosa hexatuberculata Tikader			√
			Cyclosa sp.		√	
Lycosidae	4	10	*Pardosa birmanica* Simon	√	√	
			P. annadalei (Gravely)	√		
			P. sumatrana (Thorell)	√	√	
			Pardosa sp.	√	√	
			Lycosa madani Pocock			√
			L. poonaensis Tikader and Malhotra	√	√	
			Lycosa sp.	√	√	
			Hippasa pisaurina Pocock	√	√	
			Hippasa sp.	√	√	
			Evippa sp.		√	
Thomisidae	6	8	*Thomisus cherapunjeus* Tikader	√	√	
			T. projectus Tikader	√	√	
			Thomisus sp.	√	√	
			Misumena sp.	√	√	
			Misumenoides sp.	√		
			Monaeses sp.			√
			Thanatus sp.	√	√	
			Oxyptila sp.	√	√	

Family	No. of genera	No. of species	Species	Quadrate	Pitfall	General collection
Clubionidae	4	6	*Clubiona*			√
			Clubiona sp.	√	√	
			Chiracanthium melanostoma (Thorell)	√		
			Chiracanthium sp.	√		
			Castianelra sp.	√	√	
			Micara sp.	√	√	
Salticidae	5	7	*Plexippus paykullii* (Audanin)	√	√	
			Plexippus sp.	√	√	
			Phidippus sp.	√	√	
			Myrmarachne lactus (Thorell)			√
			Myramarachne sp.	√	√	
			Rhene sp.		√	
			Salticus sp.	√		
Theridiidae	4	5	*Argyrodes dipali* Tikader	√		
			Argyrodes sp.	√	√	
			Theridion sp.	√	√	
			Cyllognatha sp.	√	√	
			Letrodectus hasseltii Thorell	√		
Gnaphosidae	2	4	*Gnaphosa poonaensis* Tikader	√	√	
			Gnaphosa sp.	√	√	
			Scotophinus maindroni Simon	√	√	
			Scotophinus sp.	√	√	
Oxyopidae	2	3	*Oxyopes wroughtoni* Pocock	√		
			Oxyopes sp.	√	√	
			Peucetia sp.			√
Lyxoscelidae	1	1	*Lyxoscelus kinsukus* Patel			√
Scytodidae	1	1	*Scytodes* sp.			√
Zodariidae	1	1	*Storena* sp.	√	√	
Uloboridae	1	2	*Uloborus danolius* Tikader	√	√	
			Uloborus sp.	√		
Total Families (12)	37	61		48	35	10

√ – Present

Listinger, 1995). In paddy, Araneidae was the largest family qualitatively at Anand, Gujarat (Patel, 2000).

During each observation, spider density was recorded from 10 quadrates of periphery and as well as core area. A comparison of density estimates between peripheral and core area showed that there was no significant difference in the density between two strata of the field either during 2001 (t = 0.1183, df = 17, P > 0.05) or 2002 (t = 0.0932, df = 17, P > 0.05). This result disproved the hypothesis that spider density may be different in two strata. The experimental plot was surrounded by lucerne on three sides and tobacco on fourth side. As the experimental plot was in middle of a large agricultural landscape, there may not be any edge effect in distribution of spiders.

Species diversity over period

Using quadrate sampling, 38 species were recorded in 2001 and 39 species were recorded in 2002, making a total of 48 species during the entire study period. Various

diversity indices of spider species collected at weekly intervals during both the years (2001 and 2002) were worked out (Table 2 & 3).

a) Summer 2001

At the time of first observation, species richness was 5 which slowly increased with time but suddenly rose from 9th week onwards and reached to maximum (18) on 18th week (Table 2). From the entire crop period 38 species were recorded. Diversity index (H') reached to its maximum (2.2808) during 18th week. The evenness value (E) ranged between 0.4679 (7th week) and 0.9681 (3rd week). High value of evenness in the beginning of crop indicate that all the species were in almost equal proportion. However, when species richness became maximum, evenness value became minimum.

b) Summer 2002

At the time of first week of observation, species richness was 3 which increased progressively and suddenly started increasing from 14th week (Table 3). It reached its peak (17) at the time of harvest. During the entire season, total 39 species were recorded. It appeared that some sort of species succession is taking place. Species diversity (H') progressively increased with time and was highest (2.4260) during 18th week. Fluctuations in evenness (ε) value were not correlated with period and did not show any trend.

c) Comparison between summer 2001 and 2002

From the Table 2 & 3 it is evident that there were some differences in species richness during the initial crop periods in both the years (2001 and 2002). Overall species richness, diversity index and evenness were almost same during both the years. Species richness and diversity index showed increasing trend up to harvesting during both the years. The species richness was slightly reduced twice, as the crop was cut to increase tillering of the crop.

Linyphiidae, Thomisidae and Salticidae showed definite decline after removal of lucerne crop (Howell and Pinkowski, 1971). Lucerne harvest was always followed by a decline in species richness (Culin and Yeargan, 1983).

Lucerne is an ideal crop for the conservation of the spiders and other natural enemies as no pesticide is sprayed on it. The farmers should be educated about the importance of spider fauna in an agro-ecosystem and their role as predators and population regulating agents of several

Table 2. Diversity indices of spider species collected at weekly interval during summer 2001

Weeks of observation	Total no. of specimen collected	Species richness (S)	Species diversity (H')	Evenness (E)
1	35	5	1.4162	0.8799
2	36	8	1.9180	0.9223
3	11	4	1.3421	0.9681
4	30	5	1.3582	0.8439
5	31	9	1.7264	0.7857
6	21	6	1.7035	0.9507
7	26	9	1.0281	0.4679
8	14	6	1.6731	0.9338
9	20	8	1.9002	0.9138
10	21	9	1.8725	0.8522
11	31	11	2.2294	0.9297
12	50	12	1.6516	0.6646
13	51	15	2.0127	0.7432
14	52	16	2.1576	0.7782
15	55	17	2.2957	0.8102
16	51	17	2.3463	0.8281
17	64	17	2.2026	0.7774
18	62	18	2.2808	0.7891

Table 3. Diversity indices of spider species collected at weekly interval during summer 2002

Weeks of observation	Total no. of specimen collected	Species richness (S)	Species diversity (H')	Evenness (ε)
1	19	3	0.9551	0.8693
2	18	5	1.2094	0.7514
3	19	9	2.1322	0.9794
4	16	5	1.4201	0.8823
5	18	9	2.0621	0.9385
6	22	8	1.9091	0.9181
7	29	9	1.9064	0.8722
8	32	9	1.9252	0.8762
9	19	10	2.0520	0.8912
10	22	10	2.1241	0.9225
11	23	10	2.1749	0.9445
12	34	11	2.0754	0.8655
13	37	11	1.9107	0.7968
14	43	12	2.1542	0.8669
15	46	14	2.1410	0.8112
16	52	15	2.3137	0.8543
17	61	16	2.3684	0.8542
18	62	17	2.4260	0.8562

insect pests. Disruption (pesticide use) of the system should be minimized and favorable microclimate should be maintained in the agro ecosystem to get maximum benefits from spiders.

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