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DIVERSITY AND POPULATION DYNAMICS OF SPIDERS IN AGROECOSYSTEMS

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ABSTRACT

The biodiversity of spiders in agroecosystem was studied at the Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during kharif (2019) and rabi (2019-20). The spiders were collected at weekly intervals using in situ counts, net sweeping, pitfall traps and litter sampling. A total of 30 species under 22 genera, 15 families were observed. Biodiversity indices viz., Shannon-Weiner Index (2.809- kharif and 2.766- rabi), Simpson Index (0.926- kharif and 0.909- rabi), Margalef Index (4.135- kharif and 4.22- rabi) and Pielou's Index (0.104- kharif and 0.095- rabi) were computed. Regression with weather parameters during kharif 2019, were non-significant for *Thomisus* sp. (0.107), *Pardosa sumatrana* Thorell (0.146), *Oxyopes javanus* Thorell (0.190), *Tetragnatha javana* Thorell (0.213) and *Tetragnatha mandibulata* Walckenaer (0.347); and during rabi 2019-20, for *T. javana* (0.516), *Argiope anasuja* Thorell (0.619) showed significance and *O. javanus* (0.192), *Lycosa bistriata* Gravely (0.370), *T. mandibulata* (0.437), these values were non-significant.

Key words: Karaikal, kharif, rabi, agroecosystem, spiders, biodiversity indices, population dynamics, correlation, regression, dominance, species richness, abundance

Arachnids are the largest and successful group of chelicerates. Among the arachnids, the order Araneae is the largest group (Thompson, 2015). They are the most diversified group amongst invertebrates with 48,901 species under 4,184 genera and 128 families (WSC, 2020). About 1,909 species belonging to 488 genera and 64 families are from India (WSC, 2019). Spiders play an important predatory role in agroecosystem by lowering insect densities, as well as stabilizing pest populations (Saranya et al., 2019). Spiders have been evidenced as bio-indicators in environmental habitats that could be helpful for conservation purposes (Gerlach et al., 2013). Benamu (2020) stated that studies on spider's diversity in agroecosystem have increased, demonstrating their potential to be used as biological control agents in IPM, and it can reduce the indiscriminate use of pesticides. Spiders are very sensitive to the variations in abiotic conditions, and Pitilin et al. (2019) observed that spiders influence the pest populations in the field and these are also influenced by the weather factors. Hence, it is essential to know the population dynamics in relation to weather factors and the present study evaluates the same under agroecosystem at Karaikal, U T of Puducherry.

MATERIALS AND METHODS

The present study was conducted at the Eastern farm at (10°55'N,79°49'E, 8 masl) of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U T of Puducherry. Spider fauna were collected in the early hours (08:00- 10:00 hr.), in the afternoon (14.00- 15.00 hr.) and in late evening (17:00- 18:00 hr.) at weekly intervals using different methods viz., in situ count, net sweeping (Pandit and Pai, 2017), pitfall trap and litter sampling from crops like cotton, maize, rice, ragi and pigeon pea. Pitfall traps (5 no.) were placed at five random spots with 2- 3 drops of liquid soap as trapping fluid and specimens were collected next morning (Bukhari et al., 2012). Litter sampling was done by manual searching of spiders under the leaf litters at weekly intervals (Jose et al., 2018). Following Engelmann (1978), the families were distinguished with the relative abundance as- subrecedent, recedent, subdominant, dominant and eudominant. The collected specimens were killed and preserved in glass vials containing 70% alcohol before labeling. Tikader and Bal (1981) was used for the identification of species.

Diversity indices like Shannon-Wiener index (Hughes, 1978), Simpson' diversity index (Simpson, 1949), Margalef index (Margalef, 1958) and Pielou's evenness index (Pielou, 1966) were computed using standard methodology (https://www.alyoung.com/labs/biodiversity_ calculator.html). The weather factors viz., maximum and minimum temperature, morning and evening relative humidity (RH), bright sunshine hours and rainfall obtained were correlated with the occurrence of spiders with correlation coefficients and regression ($p \leq 0.05$ (*) and ≤ 0.01 (**)).

RESULTS AND DISCUSSION

The study revealed a total of 30 spider species with 1,366 individuals under 22 genera and 15 families; Araneidae was the richest with 5 species followed by Oxyopidae with 4 species, Salticidae, Thomisidae and Tetragnathidae (3 species each), Lycosidae and Sparassidae (2 species each), and families Clubionidae, Corinnidae, Eutichuridae, Gnaphosidae, Philodromidae, Pisauridae, Theridiidae and Zodariidae with 1 species each (Table 1). Ambily and Antony (2016) stated that family Araneidae dominated the agroecosystem of Ernakulum, district of Kerala with 8 species. During kharif 2019 and rabi 2019-20 all the families except Corinnidae (*Castianeira zetes*) (kharif and absent during rabi), Theridiidae (*Argyrodes argentatus*) (kharif absent; rabi present), Thomisidae (*Platythomisus sudeepi*) (kharif absent; rabi present), *Tmarus fasciolatus* (kharif absent; rabi present) were observed. The relative abundance of spider fauna during kharif 2019 and rabi 2019-20 revealed that family Tetragnathidae was dominant (21.81%) followed by Oxyopidae (21.53%) and Araneidae (15.23%); Lycosidae (10.03%), Salticidae (7.68%), Thomisidae (5.48%) and Eutichuridae (4.69%) were subdominant. Pisauridae (0.44%), Theridiidae (0.15%) and Corinnidae (0.07%) were subrecedent; Philodromidae (3.66%), Gnaphosidae (3.00%), Clubionidae (2.71%), Zodariidae (2.20%) and Sparassidae (1.31%) were grouped as recedent (Table 2). Sebastian et al. (2005) stated that the Tetragnathidae was found to have high relative abundance in the irrigated rice ecosystem of Central Kerala. Ranjini (2016) also observed that Tetragnathidae (50%) was the dominant in the rice ecosystem of Palakkad district.

The biodiversity analysis indices revealed that the following viz., Shannon-Weiner Diversity Index (H’) (was 2.809 in kharif and 2.766 in rabi), Simpson Dominance Index (D) was (0.926 in kharif and 0.909 in rabi), Margalef Richness Index (α) was (4.135 in kharif and 4.22 in rabi) and Pielou’s Evenness Index (E1) was (0.104 in kharif and 0.095 in rabi). These indicate that the species diversity and evenness indices during kharif was more abundant compared to that of rabi; and species richness were more or less equal and exhibited a similar diversification in both the seasons. Anitha and Vijay (2016) reported that the Shannon Wiener Index (H’) value was 1.53 and 1.81, Simpson Index (D) value was 0.29 and 0.19, Margelef species richness index value was 1.00 and 1.10, Pielou’s Evenness Index (E1) was 0.69 and 0.76 in kharif and rabi, respectively in the rice ecosystem of Rajendranagar, Telangana.

Table 1. List of spiders observed in agroecosystems (Karaikal)*

1.	Araneidae	Orb web spiders	*Argiope catenulata* (Doleschall)
			Argiope anasuja (Thorell)
			Larinia chloris (Audouin)
			Larinia sp.
			Neoscona theisi (Walckenaer)
2.	Clubionidae	Sac spiders	*Clubiona drassodes* (O. Pickard-Cambridge)
3.	Corinnidae	Ant mimic sac spiders	*Castianeira zetes* (Simon)
4.	Eutichuridae	Yellow sac spiders	*Cheiracanthium melanostomum* (Thorell)
5.	Gnaphosidae	Ground spiders	*Zelotes* sp.
6.	Lycosidae	Wolf spiders	*Lycosa bistriata* (Gravely)
			Pardosa sumatrana (Thorell)
7.	Oxyopidae	Lynx spiders	*Oxyopes javanus* (Thorell)
			Oxyopes shweta (Tikader)
			Oxyopes sunandae (Tikader)
			Peucetia viridana (Stoliczka)
8.	Philodromidae	Running crab spiders	*Thanatus* sp.
9.	Pisauridae	Nursery web spiders	*Dolomedes fimbriatus* (Clerck)
10.	Salticidae	Jumping spiders	*Carrhotus viduus* (Koch)
			Carrhotus sannio (Thorell)
			Hyllus semicupreus (Simon)
11.	Sparassidae	Giant crab spiders	*Olios lamarcki* (Latrielle)
			Olios milleti (Pocock)
12.	Tetragnathidae	Long jawed spiders	*Tetragnatha mandibulata* (Walckenaer)
			Tetragnatha javana (Thorell)
			Tetragnatha viridorufa (Gravely)
13.	Theridiidae	Comb- footed spiders	*Argyrodes argentatus* (O. Pickard-Cambridge)
14.	Thomisidae	Crab spider	*Platythomisus sudeepi* (Biswas)
			Thomisus sp.
			Tmarus fasciolatus (Simon)
15.	Zodariidae	Ant spider	*Malinella* sp.

Table 2. Relative abundance of spider fauna in agroecosystem (July 2019 to February 2020)

S. No.	Family	No. of Genera	No. of species	Nos.	Relative abundance (%) kharif	rabi	Dominance
1	Araneidae	3	5	208	9.5	5.73	Dominant
2	Clubionidae	1	1	37	1.45	1.26	Recedent
3	Corinnidae	1	1	1	0.07	0	Subrecedent
4	Eutichuridae	1	1	64	2.65	2.04	Subdominant
5	Gnaphosidae	1	1	41	1.6	1.4	Recedent
6	Lycosidae	2	2	137	6.28	3.75	Subdominant
7	Oxyopidae	2	4	294	12.03	9.5	Dominant
8	Philodromidae	1	1	50	2.1	1.56	Recedent
9	Pisauridae	1	1	6	0.23	0.21	Subrecedent
10	Salticidae	2	3	105	4.29	3.39	Subdominant
11	Sparassidae	1	2	18	0.92	0.39	Recedent
12	Tetragnathidae	1	3	298	15.2	6.61	Dominant
13	Theridiidae	1	1	2	0	0.15	Subrecedent
14	Thomisidae	3	3	75	3.38	2.1	Subdominant
15	Zodariidae	1	1	30	1.6	0.6	Recedent
	Total	22	30	1366			

* RA below (1.3)- subrecedent; (1.3 - 3.9) - Recedent; (4 - 12.4) - Subdominant; (12.5 - 39.9) - Dominant and (40 - 100) - Eudominant (Engelmann, 1978).

Correlation with weather parameters during kharif 2019 revealed that *O. javanus* showed negatively significant correlation with bright sunshine (-0.06); similarly *P. sumatrana* with evening RH, and bright sunshine (-0.02, -0.08), and positively significant (0.04) with total rainfall; *T. javana* showed a positively significant one with maximum temperature and total rainfall (0.01, 0.02) and a negatively significant one with morning and evening RH (-0.01, -0.03); *Thomisus* sp. showed a positively significant one with minimum temperature, bright sunshine (0.05, 0.02) and a negative one with morning and evening RH, and total rainfall (-0.07, -0.09, -0.03). There existed a non-significant regression with the weather parameters for *O. javanus* (0.190), *T. mandibulata* (0.347), *T. javana* (0.213), *P. sumatrana* (0.146) and *Thomisus* sp. (0.107). Correlation with weather parameters during rabi 2019-20, showed *L. bistriata* being positively and significantly correlated with total rainfall (0.01); *O. javanus* with a positively significant (0.01) one with minimum temperature and a negatively significant one with total rainfall (-0.07); with *T. javana*, a positively significant (0.08, 0.01, 0.08) correlation with morning and evening RH and total rainfall; *T. mandibulata* showed a positively significant correlation with minimum temperature, and morning and evening RH (0.04, 0.02 and 0.50).

Yadav et al. (2017) reported that maximum RH had a significant and positive impact on the population of the *Oxyopes* sp. in rice agroecosystem of Bihar; Sidar et al. (2017) reported a non-significant positive correlation with maximum (0.074) and minimum temperature (0.28), morning (0.27) and evening RH (0.15), whereas rainfall (-0.20), wind velocity (-0.39) and sun shine hours (-0.14) showed a non-significant negative correlation with maize in Chhattisgarh. Patel et al. (2020) reported that morning and evening RH and rainfall exhibited a positive correlation with spiders in cotton. In Telangana, the abundance of spiders revealed a positive correlation with RH and a negative one with temperature and rainfall in rice (Laxman et al., 2016).

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Table 3. Population dynamics of spider species (kharif 2019, rabi 2019-20)

Spider species	Kharif 2019						Spider species	Rabi 2019-20					
	Temperature (°C)		Relative humidity (%)		Bright sunshine	Total rainfall (mm)		Temperature (°C)		Relative humidity (%)		Bright sunshine	Total Rainfall (mm)
	Maximum	Minimum	Morning	Evening				Maximum	Minimum	Morning	Evening		
Oxyopes javanus	-0.34	-0.32	0.39	0.32	-0.06*	0.12	*Argiope anasuja*	0.60	0.46	-0.68	-0.38	-0.39	-0.27
	$Y = -19.92-1.18X_1+1.40X_2+0.62X_3-0.31X_4-0.22X_5-0.06X_6$ (0.190 NS)							$Y = 65.11-0.19X_1+0.89X_2-0.85X_3-0.13X_4+1.18X_5+0.14X_6$ (0.619*)					
Pardosa sumatrana	0.12	0.13	0.02	-0.02**	-0.08*	0.04**	*Lycosa bistriata*	-0.44	-0.19	0.26	0.22	-0.19	0.01**
	$Y = -50.09+0.90X_1+0.03X_2+0.21X_3+0.08X_4-0.18X_5-0.04X_6$ (0.146 NS)							$Y = 22.01-1.77X_1+1.05X_2+0.13X_3+0.02X_4-0.29X_5-0.16X_6$ (0.370 NS)					
Tetragnatha javana	0.01**	0.12	-0.01**	-0.03**	-0.26	0.02**	*Oxyopes javanus*	0.11	0.01**	0.22	-0.14	0.18	-0.07*
	$Y = 2.80-1.83X_1+2.29X_2+0.35X_3-0.34X_4-0.71X_5-0.05X_6$ (0.213 NS)							$Y = -137.3+0.25X_1+1.29X_2+1.34X_3-0.29X_4+0.89X_5+0.11X_6$ (0.192 NS)					
Tetragnatha mandibulata	-0.28	-0.24	0.31	0.39	-0.37	0.43	*Tetragnatha javana*	0.26	0.41	0.08*	0.01**	-0.32	0.08*
	$Y = -33.62+3.64X_1-3.38X_2-0.53X_3-0.86X_4-1.02X_5-0.07X_6$ (0.347 NS)							$Y = -56.18-0.71X_1+2.12X_2+0.84X_3-0.51X_4-1.41X_5-0.04X_6$ (0.516*)					
Thomisus sp.	0.11	0.05*	-0.07*	-0.09*	0.02**	-0.03**	*Tetragnatha mandibulata*	-0.16	0.04**	0.02**	0.50*	-0.27	0.44
	$Y = -9.31+0.71X_1-0.60X_2-0.03X_3+0.088X_4-0.01X_5-0.03X_6$ (0.107 NS)							$Y = -53.36+3.54X_1-3.24X_2-0.84X_3+1.31X_4+0.96X_5-0.01X_6$ (0.437 NS)					

* = Significant at p=0.05; ** at p=0.01; NS - Not significant; X_1 = Maximum temperature; X_2 = Minimum temperature; X_3 = Morning relative humidity; X_4 = Evening relative humidity; X_5 = Bright sunshine hours; X_6 = Rainfall

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