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# Studies on the Spider Fauna of Sugarcane Ecosystem in Southern Peninsular India

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**ABSTRACT**

**Surveys conducted in three states of southern peninsular India revealed the occurrence of 57 species of spiders belonging to 13 families of Araneae in the sugarcane ecosystem. Of these, only two species *viz.*, *Hippasa greenalliae* Blackwall (Lycosidae) and *Cyrtophora cicatrosa* Stoliczka (Araneidae) were abundant, while six species were less abundant and 49 species were rare in occurrence. The spiders were found to colonize the sugarcane crop 40-45 days after planting. The population of the wolf spider *H.greenalliae* which comprised more than 70% of the total population increased with age of the crop upto 180 days. There was no significant variation in the population of *H.greenalliae* in sugarcane cropped field and adjacent fallow land. The orb-weaver spider *C.cicatrosa* started colonizing the crop 100 days after planting of the crop and its population increased upto 240 days. Population of *H.greenalliae* and that of all the species had negative association with maximum temperature and rainfall and positive association with relative humidity. A reverse trend was noticed in *C.cicatrosa*. Soil and foliar application of insecticides recommended for the suppression of shoot borer, *Chilo infuscatellus* Snellen in the early stage of the crop growth did not exert any significant influence on the colonization of spiders. Among the five insecticides tested as foliar sprays at six month old crop, quinalphos, monocrotophos and endosulfan significantly reduced the spider population.**

KEY WORDS : Sugarcane ecosystem, spiders, *Hippasa greenalliae*, *Cyrtophora cicatrosa*

In India, sugarcane, a long duration field crop is infested by a number of insect pest species at different phases of its growth (David and Nandagopal, 1986). However, the physical characteristics of the crop limit the use of insecticides once the canopy has closed (Fewkes and Greathead, 1978). Consequently, the insecticide pressure is less in sugarcane. In India only 2-3 per cent of the total insecticide consumption is on sugarcane (David, 1981). As a result, a large number of arthropod predators are active in the sugarcane ecosystem (Easwaramoorthy *et al.*, 1988). But no systematic study has been carried out on the spider fauna inhabiting sugarcane fields. In the present study, attempts were made to determine the species complexity of spiders, their seasonal abundance and influence of weather, and insecticides on colonization and population build up of spiders.

## MATERIALS AND METHODS

Surveys were conducted at fortnightly intervals during 1988-91 at Sugarcane Breeding Institute, Coimbatore, Tamil Nadu. Additional surveys were made at Kannur (Kerala) during October and December 1989 and at Nellore (Andhra Pradesh) during October 1990. During the survey, the plant and soil surfaces were examined carefully for the presence of spiders. In addition, the plant whorls were also examined. Only the adult spiders were collected in plastic tubes (10 x 2.5 cm) while the nymphs were let free as they were not suitable for identification. During the survey, searches were made for a duration of 4 man hours each time. Apart from this, at Coimbatore, pit fall traps

**Table 1. List of species of spiders encountered in sugarcane fields**

| Family | Species | Status | Habitat |
|---|---|---|---|
| | HUNTING SPIDERS | | |
| Clubionidae | *Cheiranthium daneili* Takader | Rare | under stones, trashes and in crevices |
| | *C. himalayansis* Gravely | Rare | |
| | *C. ludhianaensis* Tikader | Less abundant | |
| Lycosidae | * *Hippasa* sp. | Rare | on the ground with or without small webs |
| | *H. agelenoides* Simon | Rare | |
| | *H. greenalliae* Blackwall | Abundant | |
| | *H. pisaurina* Blackwall | Less abundant | |
| | *Lycosa indagatrix* Walckenaer | Rare | |
| | *L. mackenziei* Gravely | Rare | |
| | *L. mahabaleshwarensis* Tikader | Rare | |
| | *L. tista* Tikader | Rare | |
| | *Pardosa birmanica* Simon | Less abundant | |
| | *P. mysorensis* Tikader and Mukerji | Rare | |
| | *R. sumatrana* Thorell | Rare | |
| Oxyopidae | *Oxyopes ratnae* Tikader | Rare | leaf spindle and lamina |
| | *O. shweta* Tikader | Rare | |
| | *O. sunandae* Tikader | Rare | |
| | *Pecutia viridana* Simon | Rare | |
| | *P. latikae* Tikader | Rare | |
| Salticidae | *Marpissa* sp. | Rare | leaves and leaf sheaths |
| | *M. bengalensis* Tikader | Rare | |
| | *M. calcuttaensis* Tikader | Rare | |
| | *M. decorata* Tikader | Rare | |
| | *M. kalapani* Tikader | Less abundant | |
| | *Mymarahne* sp. | Rare | |
| | *Phidippus* sp. | Rare | |
| | *Phidippus bengalensis* Tikader | Rare | |
| | *P. indicus* Tikader | Rare | |
| | *P. pateli* Tikader | Rare | |
| | *P. punjabensis* Tikader | Rare | |
| | *Plexippus pateli* Audouin | Rare | |
| | *P.paykullii* Audouin | Rare | |
| | AMBUSHING SPIDERS | | |
| Thomisidae | *Thomisus projectus* Tikader | Rare | leaf spindle |
| | WEB-BUILDING SPIDERS | | |
| Araneidae | *Argiope aemula* Walckenaer | Rare | In large webs interconnecting the leaves of adjacent plants in the row or sometimes between rows |
| | * *A.anasuja* Thorell | Rare | |
| | *Cyrtophora cicatrosa* Stoliczka | Abundant | |
| | *Gasterocantha germinata* Fabricius | Less sbundunt | |

**Table 1. (Contd.)**

| Family | Species | Status | Habitat |
|---|---|---|---|
| | *G. hasseltii* Koch | Rare | |
| | *Gea corbetti* Tikader | Rare | |
| | *Leucauge decorata* Blackwall | Rare | |
| | * *L. pondai* Tikader | Rare | |
| | *L. tessallata* Thorell | Rare | |
| | ** *Neoscona rumpfi* Thorell | Rare | |
| | *N. theis* Walckenaer | Rare | |
| Theridiidae | * *Argyrodes* sp. | Rare | in webs on the upper portion of the plants |
| | * *A. projeles* Tikader | Rare | |
| | *Theridion tikaderi* Patel | Rare | |
| | MISCELLANEOUS GROUPS | | |
| Eresidae | *Stegodyphus pacipicus* Pocock | Rare | |
| | *S. sarasinorum* Karch | Rare | |
| Heteropodidae | *Olios* sp. | Rare | |
| | *O. obesulsus* Pocock | Rare | |
| Lyssomanidae | * *Lyssamanes* sp. | Rare | |
| | *L. andamanensis* Tikader | Rare | |
| Pholcidae | *Crossopriza lyoni* Blackwall | Rare | |
| | * *Pholcus phalangioides* Fuesslin | Rare | |
| Pisauridae | *Euprosthenopes ellioti* Cambridge | Rare | |
| Tetragnathidae | *Tetragnatha fletcheri* Gravely | Rare | |

* Additional species collected from Kannur (Kerala)
** Additional species collected from Nellore (Andhra Pradesh)

containing ethylene glycol were set on the ridges in sugarcane fields at a distance of 20 metres and the ground dwelling spiders that were trapped and killed were collected on alternate days. The spiders were preserved in 70 per cent ethyl alcohol. The specimens were identified by Dr.B.H. Patel, Professor and Head, Department of Zoology, Sir P.P. Institute of Science, Bhavanagar, Gujarat, India.

For studying the seasonal abundance of spiders, sugarcane (variety CoC 671) was cultivated in an area of 0.4 ha during the main cropping season. Normal agronomic practices were followed and no insecticide was applied. The field was divided into quadrats consisting of 5 rows of 6 meter length of sugarcane. During each observation, spider population was sampled in 5 quadrats, four on the four sides of the field and one at the centre. The sampling units were changed randomly for each observation. The plants in the entire quadrat area and the soil surface were examined thoroughly during each observation for recording the spider population. Following the same procedure, the population of *H.greenalliae,* the dominant species, was estimated in sugarcane field and adjoining fallow land during November 1990 to March 1991. The data on spider population collected during 1989-90 and 1990-91 crop seasons were correlated with weather parameters like maximum temperature, minimum temperature, forenoon relative humidity, afternoon relative humidity and rainfall that prevailed during the previous fortnight.

Two field experiments were conducted during 1989-90 and 1990-91 crop seasons to study the influence of insecticides on the initial colonization and population build up of spiders. Seven insecticides commoly recommended for the control of shoot borer, *Chilo*

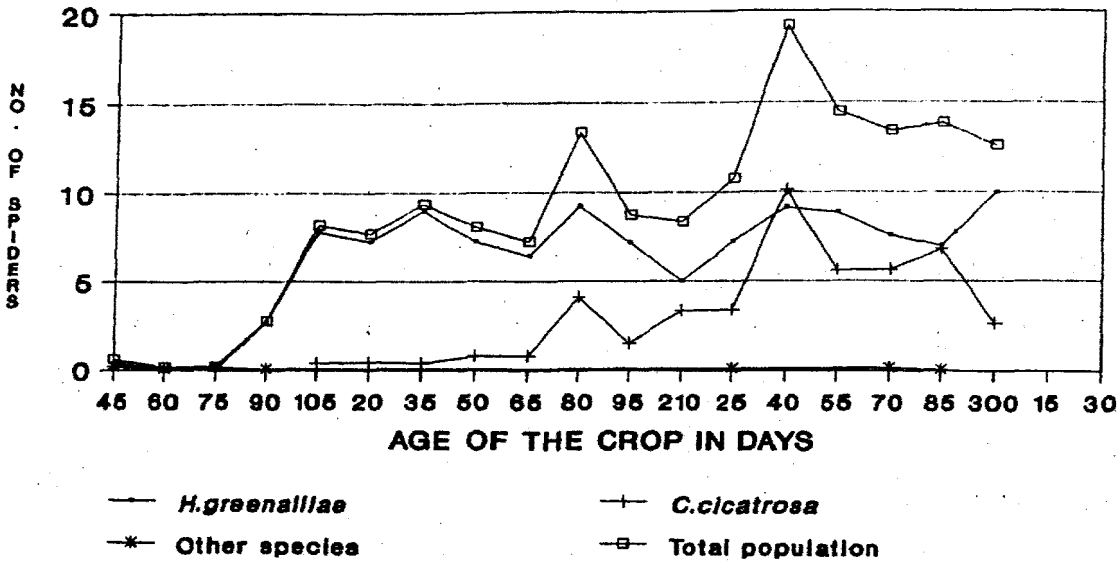


**Fig.1. Estimated population of spiders ('000) in one hectare of sugarcane field during 1989-90 crop season**

*infuscatellus* Snellen, the most important pest of sugarcane in peninsular India, were tested. The experiments were carried out (variety CoC 671) during the main cropping season in randomised block design (RBD) with eight treatments and three replications. Each plot measured 20 x 6 metres with an inter row spacing of 90 cms. Aldrin (aldrex 30 EC, NOCIL, Bombay) 1 kg a.i./ha, and Lindane (Lindag 20 EC, Coromandel Indag, Madras) 1 kg a.i./ha were applied at planting as soil treatment. Soil application of Sevidol (Carbaryl: Lindane 4:4; Sevidol 8G Rhone- Poulenc Agrochemicals, Bombay), Chlorpyriphos 10G (Coromandel Indag, Madras) and cartap hydrochloride (Padan 4G, Coromandel Indag, Madras) all at 1 kg a.i./ha and foliar application of endosulfan (Thiodan 35 EC, Excel Industries, Bombay) 0.1 per cent and decamethrin (Decis 2.8 EC, Hoechst, Bombay) 0.0014 per cent were made on 35th day of planting. Observations were recorded on the population of spiders form 45th day of planting upto 90th day during 1989-90, and upto 135th day during 1990-91.

During 1990-91 crop season the influence of five foliar insecticides commonly recommended for the control of sucking pests like scale insects, mealy bugs, leaf hopper and whiteflies on the population of spiders was studied. The experiment (variety CoC 671) was conducted in RBD with six treatments and three replications. The plot size was 20 x 6 metres. Malathion (Corothion 50 EC, Coromandel Indag, Madras), dimethoate (Rogor 30 EC, Rallis India, Bombay), Endosulfan (Thiodan 35 EC, Excel Industries, Bombay), monocrotophos (Corophos 40 EC, Coromandel Indag, Madras), and quinalphos

**Table 2. Correlations between spider population and weather parameters during 1989-90 and 1990-91**

| Spider species | Max. Temp. | | Min. Temp. | | Forenoon R..H. | | Afternoon R.H. | | Rainfall | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1989-90 | 90-91 | 1989-90 | 90-91 | 1989-90 | 90-91 | 1989-90 | 90-91 | 1989-90 | 90-91 |
| *H. greenalliae* | -.470* | -.715* | NS -.219 | -.702* | .871* | .507* | NS -.087 | .653* | NS -.280 | NS .057 |
| *C. cicatrosa* | .821* | NS -.368 | NS .330 | -.482* | -.896* | NS .128 | .896* | NS .411 | .791* | NS .013 |
| All species | -.536* | -.719* | NS -.205 | -.715* | .646* | .513* | NS -.400 | .657* | -.553* | NS .053 |

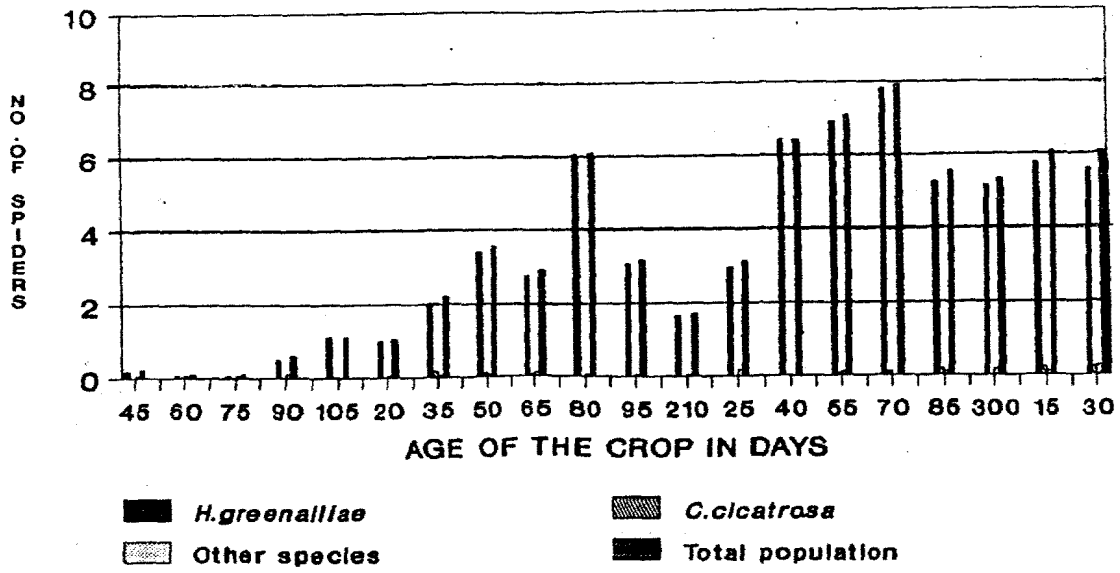


**Fig.2. Estimated population of spiders ('000) in one hectare of sugarcane field during 1990-91 crop season**

(Ekalux 25 EC, Sandoz, Bombay) all at 0.1 per cent were applied at 6th month age of the crop. Observations on the spider population were made before the application of insecticides and 2,7 and 15 days following the application.

The data on spider population were analysed (using analysis of variance) in factorial randomised block design (Panse and Sukhatme, 1967).

## RESULTS AND DISCUSSION

Surveys conducted in southern peninsular India during 1988-91 revealed the occurrence of 32 species of hunting spiders belonging to Clubionidae, Lycosidae, Oxyopidae and Salticidae; one species of ambushing spider belonging to Thomisidae; 14 species of web-building spiders belonging to Araneidae and Theridiidae and 10 other miscellaneous species (Table 1) indicating the dominance of hunting spiders. In an earlier study made at Gujarat, India, it was observed that 66.7 per cent of the spider population in the sugarcane ecosystem were hunting spiders (Anon. 1987). In Louisiana also, hunting spiders formed the major group (Negm *et al.*, 1969). In wheat

**Table 3. Influence of insecticides on colonization and build up of spider population during 1989**

| Insecticides | No. of spiders observed on day | | | | |
|---|---|---|---|---|---|
| | 45 | 60 | 75 | 90 | Mean |
| Aldrin (30 EC) 1 kg a.i./ha | 1.0 | 2.0 | 2.3 | 4.3 | 2.4 |
| Sevidol (8G) 1 kg a.i./ha | 1.7 | 1.0 | 2.7 | 4.3 | 2.4 |
| Lindane (20 EC) 1 kg a.i./ha | 0.7 | 1.3 | 0.7 | 1.3 | 1.3 |
| Endosulfan (35 EC) 0.1% | 1.0 | 1.3 | 0.7 | 2.0 | 1.7 |
| Chlorpyriphos (10G) 1 kg a.i./ha | 0.3 | 1.0 | 1.7 | 1.3 | 1.1 |
| Padan (4G) 1 kg a.i./ha | 2.7 | 1.7 | 0.7 | 2.7 | 1.9 |
| Decamethrin (2.8 EC) 0.0014% | 1.7 | 0.0 | 1.3 | 1.7 | 1.2 |
| Untreated check | 3.0 | 0.7 | 0.7 | 0.7 | 1.3 |
| Mean | 1.5 | 1.1 | 1.3 | 2.3 | |

Between treatments N.S.
Between periods C.D. = 0.8 (P=0.05)
Treatment x period N.S.

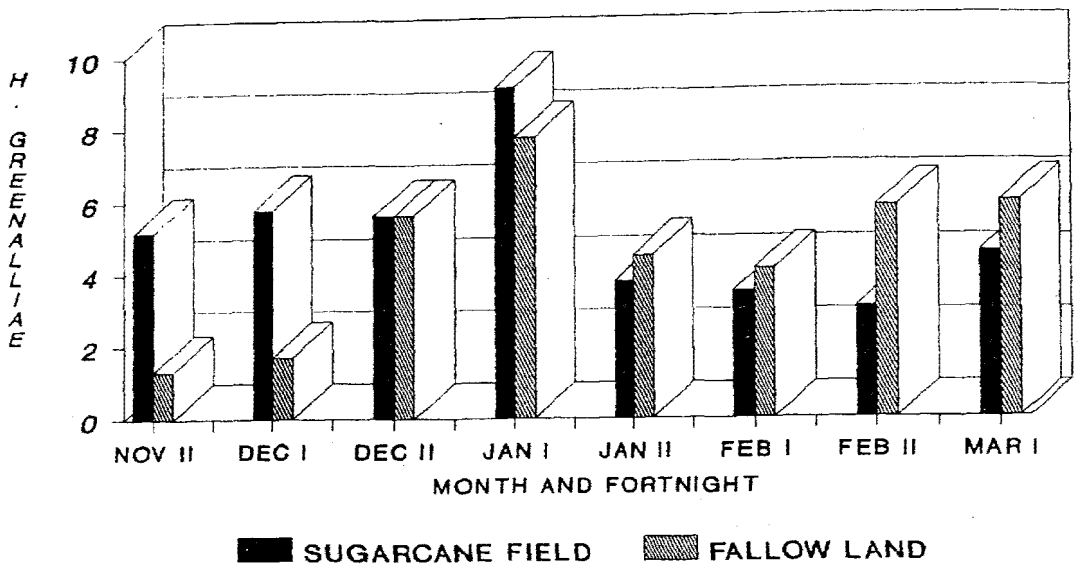


**Fig.3. Estimated population of *H.greenalliae* in ('000) in one hectare of sugarcane cultivated and fallow land**

fields in Canada, lycosids were predominant both in the field and field borders (Donae and Dondale, 1979). The surveys further revealed that only two species, *H. greenalliae* (Lycosidae) and *C. cicatrosa* (Araneidae) were abundant in sugarcane fields at Coimbatore. Six species, two of Lycosidae, one each of Glubionidae, Oxyopidae, Salticidae and Araneidae occurred in less numbers. The remaining 49 species were rarely encountered in the sugarcane fields. The lycosids were abundant and accounted for more than 70 per cent of the spider population at Coimbatore. In Gujarat, lycosids formed only 26.3 per cent of the total collection and 39.4 per cent of the hunting group of spiders (Anon., 1987). The lycosid *H.greenalliae* accounted for more than 70 per cent of the collection at Coimbatore, whereas in Gujarat, this species was not found indicating wide variation in the species complexity and diversity between agroclimatic regions. The habitats of sugarcane field-dwelling spiders varied widely. The species of Clubionidae were generally found inside the leaf sheaths and leaf whorls. Different species of web-spinners constructed their web at different heights of the cane plant (Table1).

**Table 4. Influence of insecticides on colonization and build up of spider population during 1990.**

| Insecticides | No. of spiders observed on day | | | | | |
|---|---|---|---|---|---|---|
| | 75 | 90 | 105 | 120 | 135 | Mean |
| Aldrin (30 EC) 1 kg a.i./ha | 0.7 | 1.0 | 9.7 | 8.0 | 8.3 | 5.5 |
| Sevidol (8G) 1 kg a.i./ha | 0.3 | 2.0 | 3.7 | 7.0 | 6.7 | 3.9 |
| Lindane (20 EC) 1 kg a.i./ha | 0.0 | 0.3 | 4.3 | 6.7 | 8.0 | 3.9 |
| Endosulfan (35 EC) 0.1% | 0.0 | 1.3 | 4.3 | 7.7 | 7.3 | 4.1 |
| Chlorpyriphos (10G) 1 kg a.i./ha | 0.0 | 0.3 | 3.0 | 9.0 | 7.7 | 4.0 |
| Padan (4G) 1 kg a.i./ha | 0.0 | 0.3 | 5.3 | 10.7 | 10.3 | 5.3 |
| Decamethrin (2.8 EC) 0.0014% | 0.3 | 0.3 | 2.3 | 7.3 | 10.7 | 4.2 |
| Untreated check | 0.7 | 2.3 | 4.3 | 5.0 | 4.7 | 3.4 |
| Mean | 0.3 | 1.0 | 4.6 | 7.7 | 8.0 | |

Between treatments : N.S.
Between periods C.D. = 1.9 (P=0.05)
Treatment x period N.S.

**Table 5. Influence of foliar application of insecticides on spider population**

| Insecticides | Pre-treatment spider population | Per cent reduction / increase (+) in spider population on day | | | |
|---|---|---|---|---|---|
| | | 2 | 7 | 15 | Mean |
| Malathion (50 EC) 0.1% | 40 | 40.0 | 25.0 | 2.5 | 22.5 |
| Dimethoate (30 EC) 0.1% | 48 | 27.0 | 22.9 | 4.2 | 18.0 |
| Endosulfan (35 EC) 0.1% | 47 | 44.7 | 34.0 | 23.4 | 34.0 |
| Monocrotophos (40 EC) 0.1% | 41 | 80.5 | 70.7 | 53.7 | 68.2 |
| Quinalphos (25 EC) 0.1% | 64 | 54.8 | 61.3 | 53.1 | 56.4 |
| Untreated check | 44 | 2.3 | 13.6 | (+)25.0 | (+)3.0 |
| Mean | 47.3 | 41.6 | 37.9 | 18.6 | |

Between treatments C.D. = 3.6 (P = 0.05)
Between periods C.D. = 3.3 (P=0.05)
Treatment x period N.S.

It was further confirmed that the wolf spider, *H.greenalliae* was the single dominant species (Fig. 1 and 2). It accounted for an average of 70.5 per cent (range 25.0-98.9) of spider population encountered during 1989-90 and 96.1 per cent (range 50.0 - 100.0) during 1990-91. The orb-weaver spider, *C. cicatrosa* accounted for 29.0 and 1.6 per cent, while all other species totalled only 0.5 and 2.3 per cent of the population during the respective years.

The spiders started colonizing the sugarcane fields 40-45 days after planting when the sprouting of the crop was complete. Only hunting spiders and some miscellaneous groups were noticed upto 100 days of the crop. The web-building spiders started colonizing the sugarcane fields after 100 days, when the canopy became dense. The population of the spiders increased steadily upto 180 days and thereafter it got fairly stablized. The population reached the peak of 19250 spiders per hectare by 240 days during 1989-90 and 7920 spiders per hectare by 270 days during 1990-91 (Fig.1 & 2). Significantly less population of spiders especially the web- building ones observed during 1990-91 may be attributed to the poor crop growth. The initial cultural operations like field preparation, weeding, earthing-up, manuring etc. may be the reasons for the delay in the initial colonization of spiders in sugarcane fields from adjacent fallow lands and bunds.

Interestingly, the population of *H.greenalliae* observed in a 9-12 month's old sugarcane field and an adjoining land left fallow for one year did not differ significantly (Fig.3). Similarly, the population of *C.cicatrosa* in the sugarcane cropped area and fences in the field borders did not show much variation. Similar results were obtained in rice fields and bund surveys. The most dominant species *Lycosa pseudoannulata* Bosemberg colonized equally in rice fields and border areas(Nirmala, 1990). According to Barrion and Litsinger (1981) grassy border areas harboured more spider population than did the rice fields and field bunds.

The total spider population was found to be negatively influenced by maximum temperature, minimum temperature and rainfall. It showed positive relationship with forenoon and afternoon relative humidity (Table 2). The trend was similar in the case of *H. greenalliae*. However, *C. cicatrosa* showed almost a reverse relationship. Its population was positively influenced by maximum temperature, afternoon relative humidity and rainfall. Many weather factors like temperature (Barnes and Barnes, 1954), relative humidity (Jones, 1941), sunlight (Pointing, 1965) and air-currents or winds (Cherrett, 1964) were known to influence the spiders. Studies conducted in rice fields at Coimbatore revealed that maximum temperature and afternoon relative humidity exhibited

positive influence while forenoon relative humidity and number of rainy days had negative influence on the population of *L. pseudoannulata*. However the population of *Tetragnatha javana* Thorell in the same fields was not influenced by weather conditions (Nirmala, 1990). In the case of wolf spider *H. greenalliae* which inhabits the soil surface, rainfall and subsequent flooding of the fields might have affected its population adversely, which may not be so in the case of orb-weaver spider *C.cicatrosa*. However, the influence of weather factors on the population build up of spiders needs further study.

The experiments conducted during 1989 and 1990 revealed that soil and foliar application of insecticides in the early stages of crop growth for the control of shoot borer *C.infuscatellus* did not adversely affect the colonization and population build up of spiders (Table 3 and 4). During 1989 spiders started colonizing the field by 45th day but during 1990 colonization was noticed only in certain plots by 75th day. As the insecticides were applied well before the time by which the spiders started colonizing the sugarcane fields, there was no significant influence of these insecticides on colonization and build-up of spider population.

Foliar application of insecticides against sucking pests at 180 days after planting affected the spider population. The per cent reduction in the population was greatest on the second day after pesticide application. But by 15th day, the spider started recolonizing the plots as indicated by increase in the population. Monocrotophos and quinalphos were highly toxic to spiders. The per cent reduction in spider population was 80.5 and 54.8 on the second day in monocrotophos and quinalphos-sprayed plots respectively (Table 5). Even on the 15th day, the population reduction was 50 per cent indicating poor recolonization in these plots. In the rice ecosystem also, quinalphos was considered to be highly toxic to spiders (Rajendran, 1987; Nirmala, 1990) as the recolonization of wolf spider *L. pseudoannulata* was poor even ten days after spraying. Monocrotophos, another highly toxic chemical in the present study, was earlier found to be less toxic to *Lycosa* sp. (Chu *et al.*, 1976 a,b). *Oedothorax* sp. (Chiu and Cheng, 1976) and *L. pseudoannulata* (Salim and Heinrichs, 1985; Fabellar and Heinrichs, 1986). However, according to Nirmala (1990) monocrotophos-treated rice plots exhibited poor recolonization of *L.pseudoannulata* indicating high persistence of the insecticide.

The present survey conducted in southern peninsular India, revealed 57 species of sugarcane field-dwelling spiders. However, the ecosystem was dominated by *H.greenalliae* throughout the crop growth period. According to Coppel and Mertins (1977), the hunting spiders are aggressive and often remain in specific habitats and if these coincide with the habitat of a particular insect species, the results could be important in population suppression. *H. greenalliae* inhabit around the basal portion of the sugarcane shoot and this may have a direct influence on the population of shoot borer *C. infuscatellus* in the early stage of the crop growth as the young larvae are wind dispersed and wander around the basal portion of the plants before settling at the first leaf sheath region. Cage experiments (Easwaramoorthy *et al.*, unpubl.) showed that the spiders could reduce the infestation of the borer. In laboratory tests, the spiders fed readily on various life stages of shoot borer and other sugarcane pests infesting the later stages of the crop. However, the extent of control offered by the spiders needs further study.

The dominant species, *H. greenalliae* is found to colonize the sugarcane field, fallow land and field bunds equally. This may be beneficial, as spiders harboured in fallow lands and bunds are not subjected to the toxic hazards of pesticides and later they can invade and colonize the sugarcane fields. The population build up of the spiders is not affected by the insecticides applied before their colonization. However, foliar application of insecticides after their colonization adversely affected the

spider population. Recolonization is faster in plots applied with certain insecticides like dimethoate and malathion indicating the need to screen pesticides for their selectivity to the predators.

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