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Feeding Ecology of Spiders in Rice Ecosystem at Alagar Hill, Melur Taluk, Madurai District, Tamil Nadu, India.

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Abstract
As attempt was made to elicit and assess the diversity of spider and feeding ecology of spider in Rice field in Alagar Hill, Melur Taluk, Madurai District, Tamil Nadu India were studied in these areas spiders were collected and identified and prey preference and predatory of potency of spiders various crops in rice ecosystem. The study found that the spider population was influenced by the fluctuations in the insect pest population. Spiders exhibited a positive correlation with insect pest's population. They increased functionally and numerically towards the insect pest populations. Insecticides caused a maximum mortality of spiders and neem formulations were found to be safer to spiders.

Keywords
Biodiversity, Insect species, Chemical pesticides, Food chain, Hills

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INTRODUCTION:
Spiders are among the most abundant macro invertebrate predators in agro-ecosystems [1]; [2]. Most of them are polyphagous predators and feed on various insect pests of agricultural crops [3]. They significantly reduce prey densities in agricultural fields due to their top-down effects, microhabitat use, prey selection, polyphagy, wasteful killing, functional response, numerical response and obligatory feeding strategies [3] *and* [2]. In addition to killing pest directly they cause pest mortality indirectly by dislodging them from plants or trapping them in their webs [4]. They can achieve equilibrium in pest control, after which their own numbers are necessary.
To evaluate the role of spiders in regulating insect-pest populations in agro-ecosystems, it is vital to know their reactions when faced with fluctuations in prey population densities [5].
Spiders often capture and kill more prey than they actual consume even when satiated [6] and [5] reported that a spider may kill as many as 50 times the number of prey it consumes. Some web-weaving spiders may also trap more insects than they are able to consume. A large number of insects may be present in a web at a given moment, and many of them might be ignored by the spider [7], [6]. Small pests, such as thrips, midges and aphids, may die by being caught in the webs of large spiders, even when they are ignored by the spiders [8] and [9].
Spiders are abundant in rice fields throughout the world and they attack all stages of rice insects. Family lycosidae *(wolf* spiders) is probably the most important predatory group in rice fields in Asia. One wolf spider can eat up to 45 hoppers a day [10]. Wolf spiders reduced densities of sucking herbivores (Delphacidae and Cicadellidae) in tropical rice paddies [11]; [12]. Several studies have shown that

insect populations significantly increase when released from predation by spiders.

MATERIALS AND METHODS:

The present investigations were carried out on the whole to assess the biodiversity of spiders in alagrkoivl hills. Sampling was conducted once a month in each of the three selected sites for duration of 20 months (Apr 2009 to Nov 2010). Spiders were collected by adopting standard sampling methods [13].

1. Pitfall trapping
2. Net sweeping
3. Beating
4. Active search/Hand Collection

Location of the study area:

The Alagar Hills located at 22 km North East of Madurai city (Latitude 12°18' N; Longitude 76°42'E; altitude: 275m above mean sea level). The deciduous forest of Alagar Hill is composed of both disturbed and protected vegetation.

Feeding ecology and Predatory potency of spiders in Rice ecosystem:

The study of feeding ecology of spiders was carried out in the Rice field (ADT 36) located at the foot hills of Alagar hills area during the period from June -2009 to September-2009. The observations were made in the Rice field at two different areas viz, field frequently sprayed with insecticides such as, Chlorpyirphos, Monocrotophos and Endosulfan, and ecofriendly management practices applied fields. The survey was carried out over an area of 654 sq. m (5 cents). The foliage insect pests such as, Green leafhopper (*Nephotettix irescens*), Leaf folder (*Cnaphalocrocis mainsails*)**,** Brown plant leafhopper (*Nilaparvata lugens*)**,** White backed plant hopper (*Sogatella furcifera*) and Rice ear head bug (*Leptocorisa acuta*) and spiders were sampled with sweepnets. A total of five sweeps were made diagonally across each field and also in the bunds, the collected spiders were placed separately in plastic containers. Thus, the samples were taken at fortnight interval from the initiation to till harvest. In addition, 5 dip net sweeps were diagonally made across the Rice field and collected specimens were flushed into labeled vials containing 70% ethyl alcohol for sampling the aquatic arthropod population.

Direct observations on the hunting spiders were made in the irrigated fields (13, 080 sq. m (one acre)) which are not treated with insecticides or herbicide. The direct observations were made for one-hour duration with an interval of 2 hours from 6 am to 6 pm such as 06:00, 08:00, 10:00, 12:00, 14:00, 16:00, and 18:00. This observation was conducted totally for 36 hours period. It was carried out in the field randomly, and whenever a spider was found eating a prey, both the spider and prey were collected and identified. Unidentified pests/remains of pests, if available, were brought to the laboratory for confirmation of the order to which they belong. Spider-pest encounters were also observed in the field but not documented (pest not identified) were included to calculate the predation rate of individual hunting spider but not in prey preference.

RESULT AND DISCUSSION:

The preferable prey of spider species in rice ecosystem were indicated in Table-1. The results showed that Hunting spider (Wolf spider), *Lycosa* sp. fed on Plant Hopper, Leaf hopper and Stem borer moths. Whereas, *Oxyopes* sp. fed on Moths. *Leucauge decorata and Plexippus* sp. were fed on *Plant hoppers* and *leaf hoppers.* While orb web building spiders, *Argiope catenulata* and Long jawed spider, *Tetragnatha maxillosa* were fed on leaf and plant hoppers in addition to moths and flies. While comparing the percentage of consumption or killing of insects belong to various orders by hunting spiders, the results revealed that, the insects belong to order Hemiptera (32.97%) was consumed more, and followed by Lepidoptera (21.98%), Orthoptera (13.19%), others (12.09%) Heteroptera (10.99%) and Diptera (8.79%) and Arenea (3.3%) (Figure-1).

Feeding ecology of spiders was carried out in the paddy field for duration of 120 days with an interval of 15 days at 8 spells (15 days, 30 days, 45 days, 60 days, 75 days, 90 days, 105 days and 120 days) of observation. The observations were made and values were recorded from the paddy fields both in the field not sprayed with insecticides (eco-friendly management practices applied field) (Figure-2) and the field frequently sprayed with insecticides (Figure-3). The dominant species of spider observed from the paddy field (not sprayed with insecticide) was *Oxyopes* sp. (34) followed by *Lycosa* sp. (33) and *Tetragnatha maxillosa* (26) and remaining species were in the range of 4 to 13 numbers. Whereas, in case of paddy field frequently sprayed with insecticides, the number of spiders recorded were less (*Oxyopes* sp. (15), *Lycosa* sp. (9), *Tetragnatha maxillosa* (8) and remaining species were in the range of 2 to 5 numbers) when compared to ecofriendly management practices applied field. Besides, the total numbers of spider specimens recorded were also less (64) in the paddy field sprayed with insecticide compared to the paddy field not sprayed with insecticide (189). It was also noticed that, the hunting spider population was more when compared to web spinning spiders in both the fields.

In the present investigation the prey preference analysis of spiders in rice field indicated that, the insects belong to order Homaptera was consumed more by the spider species which was followed by Lepidoptera and Orthoptera*, Tetragnatha* sp. were fed on leaf and plant hoppers in addition to moths and flies. Similar observation was made by [14]. He reported that *Tetragnatha javanas* was one of the common spider found in rice ecosystem and which effectively reduce the population of Green leaf hoppers and Brown plant hoppers. *Pardosa pseudoannulata* and *Atypena formosana* are considered as the important predators of Green leaf hopper. Moreover *P. pseudoannulata* is the vital predator against Brown planthopper and can also effectively regulate the pest population of Leaf hoppers, Plant hoppers, Whorl maggot flies, Leaf folders, Case worms and Stem borers [15], [16].

In rice ecosystem, the hunting spiders are more predominant than the webspining spiders. In rice field hunters are usually active predators which follow a "pursue and kill" foraging strategy, while web builders follow a passive "sit and wait" strategy [17]. Furthermore, the webbing sites of web builders are easily affected by environmental factors. In addition, when the web spaces overlap, there is competition with and between species of web builders. Therefore, hunters probably are more effective predators than web builders.

Hunting spiders are considered to be of particular importance as predators of the various stages of crop pests. They are mobile foragers that actively patrol the plant surface in search of larvae and adults of lepidopterans and heteropterans. Potentially, they are highly beneficial because of their efficient foraging behaviour enabling them to discover and seize smaller instars of various species of lepidopteran and heteropteran pests.

Table 1. Feeding ecology of spiders in rice ecosystem:

Spiders in rice ecosystem	Host insects
Hunting spider, Wolf spider, *Lycosa pseudoannulata*	Plant Hopper, Leaf hopper and Stem borer moths
Lynx spiders, *Oxyopes javanus*	Moths
Jumping spider, *Phidippus sp*	GLH and small Insects
Dwarf spider, *Atypena (Callitrichia sp)*	Nymphs of Leaf hopper and planthopper
Orb spiders, *Argiope catenulata*	Plant Hopper, Leaf hopper and flies
Long jawed spider, *Tetragnatha sp*	Plant Hopper, Leaf hopper, flies and moths
Leucauge decorata	Plant Hopper, Leaf hopper
Plexippus sp	Plant Hopper, Leaf hopper

Figure-1. Percentage of consumption or killing of insects belong to various orders by hunting spiders in rice ecosystem

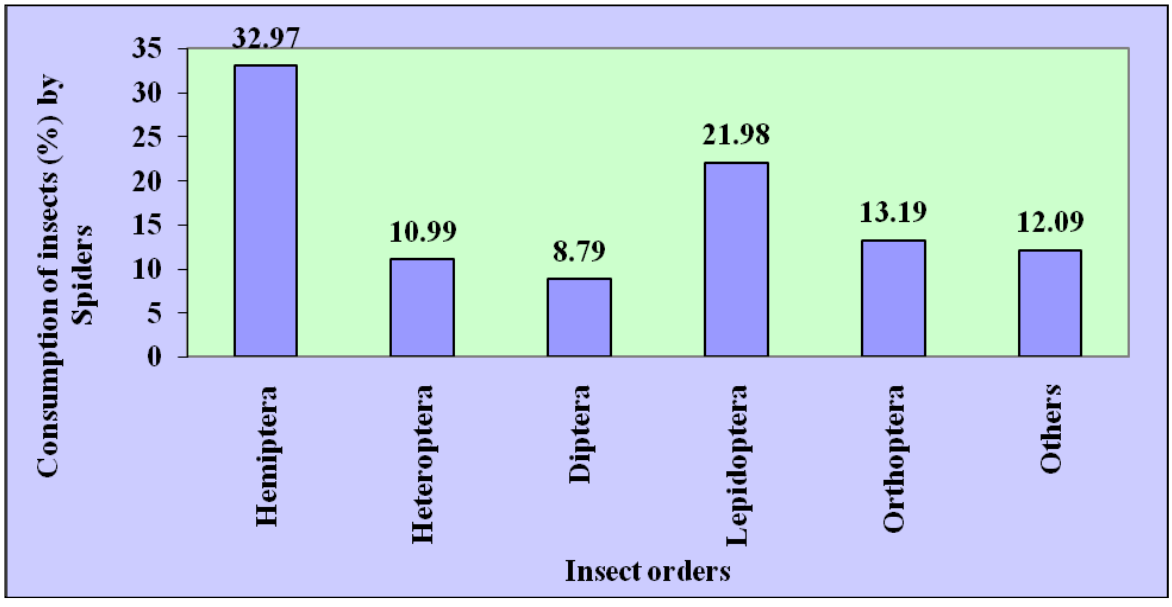


Figure-2. Diversity of spider fauna recorded in the rice field (Not sprayed with and insecticides ecofriendly management practice applied field)

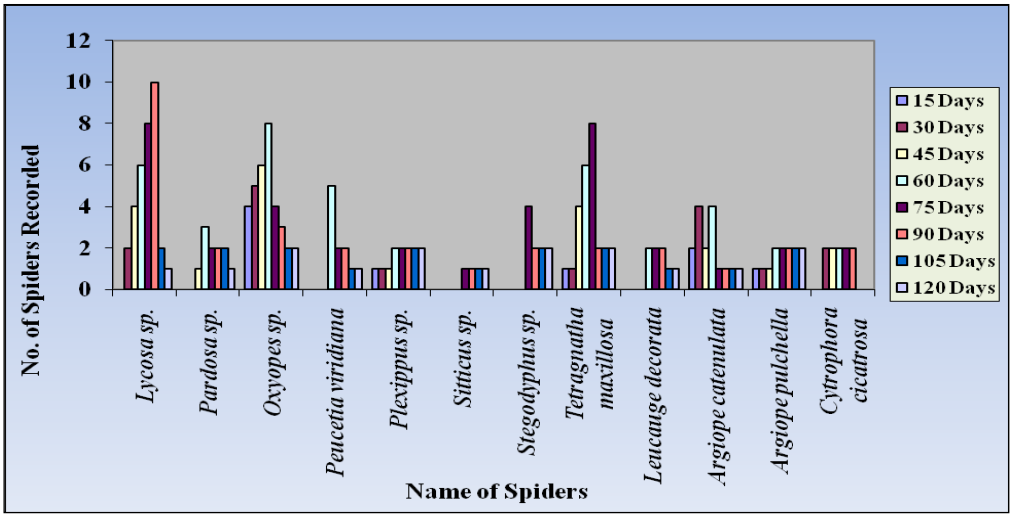
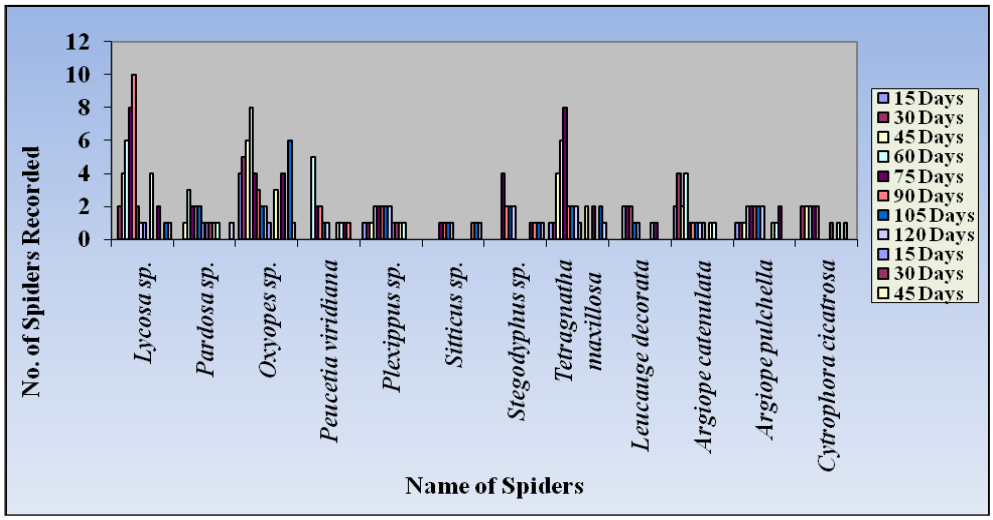


Figure-3. Diversity of spider fauna in the rice field frequently sprayed with insecticides rice field



CONCLUSION:

The prey preference and predatory potential studies on spiders in rice ecosystem, cotton ecosystem, vegetable ecosystems and fruit ecosystems revealed that, the sucking pests were consumed by all the instars whereas, caterpillars were fed only by late instars and adult spiders. The spider population was influenced by the fluctuations in the insect pest population. Spiders exhibited a positive correlation with insect pest's population. They increased functionally and numerically towards the insect pest populations. Insecticides caused a maximum mortality of spiders and neem formulations were found to be safer to spiders. Hence the study suggested that natural insecticides will be found as not harm to the spider.

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