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Biological control potential of spiders on the selected cotton pests

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Abstract

Spiders have a wide insect host range and thus can act as biological control agents of insect pests in agro-ecosystems. In the present study, the four species of spiders like (*Peucetia viridana* (Stoliczka), *Oxyopes birmanicus* (Thorell), *Oxypes salticus* (Hentz) and *Peucetia latikae* (Tikader) were predominant in the cotton fields of Achamthavirthan, Virudhunagar district, Tamil Nadu, India. which are capable of controlling cotton pests. The four species of oxyopidae spiders were collected from the cotton fields of Achamthavirthan. These were determined during the 2011 cropping season. Effects of the spider on major cotton insect pests were studied under laboratory conditions (32 ºC, 65% RH and photoperiod of 13:12 (L: D) hours). The predatory potential of four oxyopidae spider species (*P. viridana*, *O. birmanicus*, *O. salticus* and *P. latikae* were evaluated on three major cotton pests cotton pests (*Aphis gossypii*, *Spodoptera litura* (Fab.) and Leafhopper) and daily rate of feeding and host preference were recorded for ten days. Results indicated that the maximum predation was recorded in *P. viridana* on key cotton pests.

Key-Words: Spiders, Feeding, Cotton, Predation.

Introduction

Spiders are among the most abundant predators of insects of terrestrial ecosystems (Edwards *et al.*, 1976). Spiders play an important role as stabilizing agents or regulators of insect populations in agro, forest and other terrestrial ecosystems. Thus their presence in an ecosystem may well influence the population dynamics of other arthropods present. They are generalist predators, can kill a large number of insects per unit time and hence of great importance in reducing and even in preventing outbreaks of insect pests in agriculture (Sunderland *et al.*, 1986). Spiders are feed on insects and some other arthropods. They can play important roles in pest's control. 35000 species of spiders have been identified in the world and a total of 244 species of spiders are known in Iran (Ghavami, 2006a, 2007b). Most of investigations on spiders are in agricultural ecosystems in Iran. For instance, some researches were performed on spider fauna and abundance of rice fields (Ghavami, 2004), olive orchards (Ghavami, 2006d and Ghavami *et al.*, 2007b), Rose fields (Ghavami and Nematollahi, 2006c) citrus orchards (Ghavami, 2006 a, b; Ghavami and Ghanadamooz, 2008b) and cotton fields (Ghavami *et al.*, 2007b and 2008a and Ghavami, 2007a).

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In the present study, the biological control potential of the four species of oxyopidae spiders like *P. viridana*, *O. birmanicus*, *O. salticus* and *P. latikae* on three cotton pests such as *A. gossypii*, leafhopper and *S. litura* were evaluated.

Material and Methods

Spiders and pests were collected from cotton fields of Virudhunagar district. They were maintained in plastic container (1 liter) on their natural hosts under laboratory conditions (30- 32^{0}C, 65 – 75 RH and 13L: 11D). The study was conducted in the summer of 2010 for 10 days in 10 replicates. In order to performance of determination number of feeding tests, each spiders species put on a cotton bush that cultivated in the vase and enclosed by clear isinglass's. The four cotton pests (*S. litura, A. gossypii* and Leafhopper) were collected from the cotton fields. They were then reared on cotton balls inside cages. A total of 5 of each of the four cotton pests were put inside cages at the ratio of 5 cotton pest to 1 spider. This was done daily and the rate of predation was taken every 24. The four different cotton pests were put in cages with each spider species and counted number of pests that have fed by each spider species daily and calculated mean of them (Balarin and Polenec, 1984; Sebastian *et al.*, 2002).

Results and Discussion

The results presented in table 1 revealed that the predatory potential of *P. viridana* female spiders were higher. For instance, *P. viridana* female significantly consumed more *A. gossypii* and leaf hopper. The predatory rate of *P.viridana* on *S.* litura was also revealed that female consumed more number of preys (0.8 ± 0.79) than *P. latikae* (0.39 ± 0.47) and *O. salticus* (0.6 ± 0.52). Similar observation was also observed in *O. birmanicus* on *A. gossypii* and leaf hopper. Among the three spiders, *O.birmanicus* consumed more number of *S. litura* (1.3 ± 0.67) followed by *P. viridana* (0.8 ± 0.79) and *O. salticus* (0.6 ± 0.52).

P. viridana consumed more number of leaf hopper (1.1 ± 0.57) followed by *O. birmanicus* (0.7 ± 0.67) and *P. latikae* (0.49 ± 0.52). When *A. gossypii* was supplied to *P. viridana*, it consumed more number of prey (13.63 ± 3.44) followed by *O. birmanicus* (1.1 ± 0.32) and *O. salticus* (0.33 ± 0.53). In both the preys, (*S. litura* and *A. gossypii*) *P. latikae* consumed less least number of preys (0.39 ± 0.47) and (0.29 ± 0.41). However, statistical comparison of these four spiders, the predatory potential of *P. viridana* was significant and *P. latikae* was insignificant. Among the four spiders, *P. viridana* consumed more number of *A. gossypii*.

According to the results, when had given one kind of pests to each spider species, the maximum predation of them belonged to *A. gossypii* by *P. latikae* and the less of predation related to *A. gossypii* by *P. latikae* and when had given three kinds of pests together to them the most predation were belonged to *A. gossypii* followed by *S. litura* and the less were related to leafhopper. According to comparison of outcomes of feeding of *O. birmanicus* and *O. salticus* on *S. litura* and *Leafhopper* it was found that *both of these predators* had more ability in predation *S. litura* followed by leafhopper than *A. gossypii*. Therefore, we can conclude that *P. viridana* had the most tendencies to *A. gossypii* and Leafhopper and the fewer propensities to *S. litura*.

As per, the most predation occurred by *O. birmanicus* on *S. litura* and the less accomplished by *P. latikae* on *S. litura*. Balarin and Polenec (1984) estimated quantity of feeding of *C. mildei* on cotton bugs. The average of feeding of *C. mildei* was 8.2 bugs but in this study, the average of feeding of *C. erraticum* was 7.24. In other probes, *O. salticus* was dominant species in Texas and Massachusetts cotton fields (Bardwell and Averill, 1997; Dean *et al*., 1982). Many studies have demonstrated that spiders can significantly reduce prey densities. Lang *et al*. (1999) found that spiders in a maize crop depressed populations of leafhoppers (Cicadellidae), thrips (Thysanoptera), and aphids (Aphididae). The three most abundant spiders in winter wheat, *Pardosa agrestis* (Westring) and two species of Linyphiidae, reduced aphid populations by 34% to 58% in laboratory studies (Marc *et al*., 1999). Both web-weaving and hunting spiders limited populations of phytophagous Homoptera, Coleoptera, and Diptera in an old field in Tennessee (Riechert and Bishop, 1990). Spiders have also proven to be effective predators of herbivorous insects in apple orchards, including the beetle *Anthonomus pomorum* Linnaeus, and Lepidoptera larvae in the family Tortricidae (Marc and Ysnel, 1999). In no-till corn, wolf spiders (Lycosidae) reduce larval densities of armyworm, *Pseudaletia unipunctata* (Haworth) (Laub and Luna, 1992). Wolf spiders also reduced densities of sucking herbivores (Delphacidae and Cicadellidae) in tropical rice paddies (Fagan *et al*., 1998). Spiders are capable of reducing populations of herbivores that may not be limited by competition and food availability in some agroecosystems (Sunderland, 1999). Several studies have shown that insect populations significantly increase when released from predation by spiders. Riechert and Lawrence (1997) reported that plots in an old field from which spiders had been removed had significantly higher herbivorous insect numbers than in those plots that contained spiders. In Tennessee, vegetable garden plots from which spiders had been removed had higher pest numbers than those in which spiders remained (Riechert and Bishop, 1990). Agricultural fields that are frequently sprayed with pesticides often also have lower spider populations (Bogya and Markó, 1999; Feber *et al*., 1998; Huusela-Veistola, 1998; Yardim and Edwards, 1998; Holland *et al*., 2000; Amalin *et al*., 2001). In general, spiders are more sensitive than many pests to some pesticides, such as the synthetic pyrethroids, cypermethrin and deltamethrin; the organophosphates, dimethoate and malathion; and the carbamate, carbaryl. A decrease in spider populations as a result of pesticide use can result in an outbreak of pest populations (Brown *et al*., 1983; Birnie *et al*., 1998; Huusela-Veistola, 1998; Yardim and Edwards, 1998; Marc *et al*., 1999; Holland *et al*., 2000; Tanaka *et al*., 2000).

Spiders can lower insect densities, as well as stabilize populations, by virtue of their top-down effects, microhabitat use, prey selection, polyphagy, functional responses, numerical responses, and obligate predatory feeding strategies and we aim to review the literature on these topics in the following discussion. Nevertheless, as biological control agents, spiders must be present in crop fields and prey upon specific agricultural pests. Indeed, they are present and do eat pest insects. Spiders of several families are commonly found in agro ecosystems, and many have been documented as predators of major crop pest species and families (Roach, 1987; Nyffeler and Benz, 1988; Agnew and Smith, 1989; Hayes and Lockley, 1990; Riechert and Bishop, 1990; Young and Edwards, 1990; Fagan and Hurd, 1991; Laub and Luna, 1992; Kumar and Velusamy, 1997; Geetha and Gopalan, 1999). Spiders may be important mortality agents of crop pests such as aphids, leafhoppers, planthoppers, fleahoppers, and Lepidoptera larvae. However, the same species of spider that feeds mostly on pests in one location may feed mostly on beneficial insects in another. Further research is needed to determine the extent of spider predation in a multitude of crops and climates under a variety of management practices before general conclusions about their efficacy as biological control agents can be justified (Nyffeler *et al*., 1994a, Rypstra *et al*., 1999). In some agro ecosystems, spiders may be unable to capture important pest species. In non-commercial cranberry bogs, hunting spiders comprised 61% of the total spider fauna, 87% of the hunters being lycosids. These spiders preyed predominately upon Collembola and small Diptera, which are not pests of cranberry. Very few hunting spiders captured pest insects such as cranberry weevils or Lepidoptera larvae. Many of these spiders occupy microhabitats on or near the ground surface so predominantly captured prey located on the ground (Bardwell and Averill, 1997). Jumping spiders (Salticidae) may be ineffective predators of tephritid fruit flies, including major pest species such as apple maggot (*Rhagoletis pomonella* (Walsh)). Patterns on and specific movements of their wings make these flies resemble other salticids. Jumping spiders will respond to these displays by tephritids by backing away or giving threat or even courtship displays, allowing the fruit fly time to escape (Whitman *et al*., 1988).

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Table 1: Predatory rate (no/day/spider) of four spiders on three cotton pest

Spiders	Sex	*S. litura*	Leafhopper	*A. gossypii*
P. viridana	Female	0.8 ± 0.79	1.1 ± 0.57	13.63 ± 3.44
O. birmanicus		1.3 ± 0.67	0.7 ± 0.67	1.1 ± 0.32
O. salticus		0.6 ± 0.52	0.33 ± 0.53	0.33 ± 0.53
P. latikae		0.39 ± 0.47	0.49 ± 0.52	0.29 ± 0.41