



## Biological control potential of spiders on the selected cotton pests

S. Jeyaparvathi\*, S. Baskaran and Ga. Bakavathiappan

Post Graduate & Research, Dept. of Zoology, Ayya Nadar Janaki Ammal College, Sivakasi - India

### 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), *Oxyopes 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 °C, 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).

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°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

### \* Corresponding Author

E.mail: sjpwomenscientist@gmail.com

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 ( $0.8 \pm 0.79$ ) than *P. latikae* ( $0.39 \pm 0.47$ ) and *O. salticus* ( $0.6 \pm 0.52$ ). 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* ( $1.3 \pm 0.67$ ) followed by *P. viridana* ( $0.8 \pm 0.79$ ) and *O. salticus* ( $0.6 \pm 0.52$ ).

*P. viridana* consumed more number of leaf hopper ( $1.1 \pm 0.57$ ) followed by *O. birmanicus* ( $0.7 \pm 0.67$ ) and *P. latikae* ( $0.49 \pm 0.52$ ). When *A. gossypii* was supplied to *P. viridana*, it consumed more number of prey ( $13.63 \pm 3.44$ ) followed by *O. birmanicus* ( $1.1 \pm 0.32$ ) and *O. salticus* ( $0.33 \pm 0.53$ ). In both the preys, (*S. litura* and *A. gossypii*) *P. latikae* consumed less number of preys ( $0.39 \pm 0.47$ ) and ( $0.29 \pm 0.41$ ). 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).

### **Acknowledgements**

The author's express profound thanks to the Management, Principal and Head of the Department of Zoology, Ayya Nadar Janaki Ammal College (Autonomous), Sivakasi for providing facilities to carry out this work. One of us (Dr. S. Jeyaparvathi), grateful to the Department of Science and Technology (DST), New Delhi for providing financial assistance under Women Scientist Scheme (WOS-A).

### **References**

1. Agnew, C.W. and J.W. Smith. 1989. Ecology of spiders (Araneae) in a peanut agroecosystem. *Environ. Entomol.*, **18**: 30-42.
2. Amalin, D.M., Peña, J.E., McSorley, R., Browning, H.W. and J.H. Crane. 2001.

Comparison of different sampling methods and effect of pesticide application on spider populations in lime orchards in South Florida. *Environ. Entomol.*, **30**: 1021-1027.

3. Balarin, I. and A. Polenec. 1984. Spiders, natural enemies of the Sycamore lace bug. *Zastita Bilja.*, **35(2)**: 127- 134.
4. Birnie, L., Shaw, K., Pye, B. and I. Denholm. 1998. Considerations with the use of multiple dose bioassays for assessing pesticide effects on non-target arthropods. In *Proceedings, Brighton Crop Protection Conference. Pests and Diseases.*, 16-19 November, Brighton, UK. pp. 291-296.
5. Bogya, S., and V. Markó. 1999. Effect of pest management systems on ground-dwelling spider assemblages in an apple orchard in Hungary. *Agric. Ecosyst. Environ.*, **73**: 7-18.
6. Brown, K.C., Lawton, J.H. and S. Shires. 1983. Effects of insecticides on invertebrate predators and their cereal aphid (Hemiptera: Aphidae) prey: laboratory experiments. *Environ. Entomol.*, **12**: 1747-1750.
7. Dean, D.A., Sterling, W.L. and Hornner, N.V. 1982. Spiders in eastern Texas cotton fields. *J. Arach.*, **10(1)**: 251-260.
8. Edwards, C. A., Bultler, C.G. and Loftly, T.R., 1976. The invertebrate fauna of the park grass plots ii. surface fauna. Rep. Rothamsted. *Exp. Stn. Part.*, **2**: 63-89.
9. Fagan, W.F., Hakim, A.L., Ariawan, H. and S. Yuliyantiningsih. 1998. Interactions between biological control efforts and insecticide applications in tropical rice agroecosystems: the potential role of intraguild predation. *Biological Control: Theory and Applications in Pest Management.*, **13**: 121-126.
10. Fagan, W.F. and L.E. Hurd. 1991. Direct and indirect effects of generalist predators on a terrestrial arthropod community. *Am. Midl. Nat.* **126**: 380-384.
11. Feber, R.E., Bell, J., Johnson, P.J., Firbank, L.G. and D.W. MacDonald. 1998. The effects of organic farming on surface-active spider (Araneae) assemblages in wheat in southern England, UK. *J. Arachnol.*, **26**: 190-202.
12. Geetha, N. and M. Gopalan. 1999. Effect of interaction of predators on the mortality of nymphs of brown plant hopper, *Nilaparvata lugens* Stal. *J. Ent. Res.*, **23**: 179-181.

13. Ghavami, S. 2004. The role of spiders in biological control in Iran. *Sonbol. J. Agri. Sci.*, **135**: 24-25.
14. Ghavami, S. 2006a. Investigation spider fauna of citrus orchards in northern part of Iran. Plant Pests and Diseases Research Institute. Final report of project. 36pp.
15. Ghavami, S. 2006d. Abundance of spiders (Arachnida: Araneae) in olive orchards in northern part of Iran. *Pak. J. Bio. Sci.*, **9**(5): 795-799.
16. Ghavami, S. and Ghanadamooz, S. 2008b. Investigation of spider (order Araneae) fauna of citrus orchards in the northern part of Iran. *Journal Applied Biological Sciences.*, **2**(1): 73-76.
17. Ghavami, S. and Nematollahi, M. 2006c. Investigation spider fauna of rose orchards in Kashan. *Proceedings of 17th Iranian Congress on Plant Protection.*
18. Ghavami, S., Amin, G.A., Taghizadeh, M. and Karimian, Z. 2008a. Investigation of abundance and determination of dominant species of spider species in Iranian cotton fields. *Pak. J. Bio. Sci.*, **11**(2): 181- 187.
19. Ghavami, S., Mohammadi Damghan, M., Soodi, S., Javadi, S., Ghannad Amooz, S. 2007b. Investigation spider fauna of olive orchards in northern part of Iran. *Pak. J. Bio. Sci.*, **10**(15): 2562-2568.
20. Hayes, J.L. and T.C. Lockley. 1990. Prey and nocturnal activity of wolf spiders (Araneae: Lycosidae) in cotton fields in the delta region of Mississippi. *Environ. Entomol.*, **19**: 1512-1518.
21. Holland, J.M., Winder, L. and J.N. Perry. 2000. The impact of dimethoate on the spatial distribution of beneficial arthropods in winter wheat. *Ann. Appl. Biol.*, **136**: 93-105.
22. Huusela-Veistola, E. 1998. Effects of perennial grass strips on spiders (Araneae) in cereal fields and impact on pesticide side-effects. *J. Appl. Ent.*, **122**: 575-583.
23. Kumar, M.G., and R. Velusamy. 1997. Prey preferences of commonly encountered spiders in the rice agro-ecosystem. *Madras Agric. J.*, **84**: 481-483.
24. Lang, A., Filser, J. and J.R. Henschel. 1999. Predation by ground beetles and wolf spiders on herbivorous insects in a maize crop. *Agric., Ecosyst. Environ.*, **72**: 189-199.
25. Laub, C.A. and J.M. Luna. 1992. Winter cover crop suppression practices and natural enemies of armyworm (Lepidoptera, Noctuidae) in no-till corn. *Environ. Entomol.*, **21**: 41-49.
26. Marc, P., Canard, A. and F. Ysnel. 1999. Spiders (Araneae) useful for pest limitation and bioindication. *Agric., Ecosyst. Environ.*, **74**: 229-273.
27. Marc, P. and A. Canard. 1997. Maintaining spider biodiversity in agroecosystems as a tool in pest control. *Agric., Ecosyst. Environ.*, **62**: 229-235.
28. Marc, P., Canard, A. and Ysnel, F. 1999. Spiders (Araneae) useful for pest limitation and bioindication. *Agriculture, Ecosystems and Environment.*, **74**: 229-273.
29. Nyffeler, M. and G. Benz. 1988. Feeding ecology and predatory importance of wolf spiders (*Pardosa* spp.) (Araneae, Lycosidae) in winter wheat fields. *J. Appl. Ent.*, **106**: 123-134.
30. Nyffeler, M., Sterling, W.L. and D.A. Dean. 1994a. How spiders make a living. *Environ. Entomol.*, **23**: 1357-1367.
31. Riechert, S. E. and Bishop, L. 1990. Prey control by an assemblage of generalist predators: spiders in garden test systems. *Ecology.*, **71**: 1441-1450.
32. Riechert, S.E. and K. Lawrence. 1997. Test for predation effects of single versus multiple species of generalist predators: spiders and their insect prey. *Entomol. Exp. Appl.*, **84**: 147-155.
33. Roach, S.H. 1987. Observations on feeding and prey selection by *Phidippus audax* (Hentz) (Araneae: Salticidae). *Environ. Entomol.*, **16**: 1098-1102.
34. Rypstra, A.L., Carter, P.E., Balfour, R.A. and S.D. Marshall. 1999. Architectural features of agricultural habitats and their impacts on the spider inhabitants. *J. Arachnol.*, **27**: 371-377.
35. Sebastian, P.A., Sudhikumar, A.V., Davis, S. and Jose, K.S. 2002. Observations on the biology of *Cheiracanthium melanostoma* (Thorell) (Aranaeae: Clubionidae) occurring on cotton. *Entomon.*, **27**(2): 225-229.
36. Sunderland, K. D., Fracer, A. M. and Dixon, A. F. G., 1986. Field and laboratory studies on money spiders (Linyphiidae) as predators of cereal aphids. *J. Appl. Ecol.*, **23**: 433 - 447.



37. Sunderland, K.D. 1999. Mechanisms underlying the effects of spiders on pest populations. *J. Arachnol.*, **27**: 308-316.
38. Tanaka, K., Endo, S. and H. Kazano. 2000. Toxicity of insecticides to predators of rice planthoppers: spiders, the mired bug, and the dryinid wasp. *Appl. Entomol. Zool.*, **35**: 177-187.
39. Whitman, D.W., Orsak, L. and E. Greene. 1988. Spider mimicry in fruit flies (Diptera: Tephritidae): Further experiments on the deterrence of jumping spiders (Araneae: Salticidae) by *Zonosemata vittigera*(Coquillett). *Annals Entomol. Soc. Am.* **81**: 532-536.
40. Yardim, E.N. and C.A. Edwards. 1998. The influence of chemical management of pests, diseases and weeds on pest and predatory arthropods associated with tomatoes. *Agric., Ecosyst. Environ.*, **70**: 31-48.
41. Young, O.P. and G.B. Edwards. 1990. Spiders in United States field crops and their potential effect on crop pests. *J. Arachnol.*, **18**: 1.27.

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

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