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Population and predatory potency of spiders in brinjal and snake-gourd

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ABSTRACT

The population of spiders and their predatory potency have been studied in *Solanum melongena* (brinjal) and *Trichisanthes anguina* (snake-gourd) fields in two different areas *viz.,* Nangoor (pesticide free area) and Moongilthottam (frequently pesticide used area) of Nagapattinam District, Tamilnadu. Eight species of spiders *viz., Argiope luzona* (Walckenaer) (Argiopidae), *Cyrtophora cicatrosa* (Doleschall) (Arneidae), C*hrysso argyrodiformis* (Yaginuma) (Theridiidae), *Hipossa pantherina* (Thorell) (Lycosidae), *Oxyopes lineatipes* (C.L.Koch) (Oxyopidae), *Oxyopes javanus* (Thorell) (Oxyopidae), *Peucetia viridana* (Thorell) (Oxyopidae) and *Lycosa pseudoannulata* (Boescriberg and Strand) (Lycosidae) were recorded in both the plants in two selected areas. The population of spiders did not show significant difference between areas, plants and number of species of spiders. The predatory potency of web building spiders were estimated in the fields against insects found in the crop fields *viz., Camponotus compressus* (black ant) (Lalit kumar Jha), *Occophylla smaragdina* (tree ant) (Maxwell-Lefroy), *Apis florae* (honey bee) (Stebbing), *Kallima inachus* (butterfly) (Lalit kumar Jha), *Plusia orichalcia* (catterpiller) (Maxwell-Lefroy), *Leuanodes orbonalis* (moth) (Awasthi), *Aphis gossypii* (cotton aphids) (Lalit kumar Jha), *Bemisia pabaci* (whitefly) (Lalit kumar Jha), *Culex quina* (mosquitoe) (Lalit kumar Jha), *Drosophila melanogaster* (fruitfly) (Awasthi), *Musca nebulo* (housefly) (Awasthi), *Amritodus alkinsoni* (mango leaf hopper) (Awasthi), *Macromia magnifica* (dragonfly) (Awasthi), *Epilachna vigintioctopuctata* (beetle) (Awasthi) by counting the number of insects caught in the spider's web and the result indicated that there has been a significant difference observed between the spider's web-type and number of insects caught.

Key words : Brinjal, insecticide, predatory potency, spider, snake-gourd

INTRODUCTION

India has a number of vegetables in cultivation. Brinjal and snake-gourd are some of the common vegetables grown throughout the country. The insect pests of brinjal and snake-gourd are quite complex which indirectly contribute towards low yield. Usage of pesticides for control of insect pests of vegetables is both extensive and intensive. This created serious upset and imbalance in the arthropod complex and the environment causing resurgence, resistance and residues. (Jeyaraj and Regupathy, 1987; Jeyaswal and Singh, 1987; Panda *et al.,* 1996). Moreover, many vegetables have been contami nated with environmentally incompatible poisonous pesticides. Due to these constraints, the research is being done on developing alternative economic and eco friendly methods of insect control.

Spiders, are the most common ubiquitous animals on land, constitute an essential portion of the predatory arthropods in several ecosystems (Plagens, 1983; Meera Guptha *et al.,* 1986; Muralidharan and Chari, 1992; Biswas *et al.,* 1993; Eswaramoorthy *et al.,* 1994; Ghavami, 2004; Rajeswaran *et al.,* 2005; Sebastian *et al.,* 2005; Ghavami *et al.,* 2007; Danisman *et al.,* 2007; Sundararaj, 2008; Ghavami *et al.,* 2008; Chatterjee, *et al.,* 2009).

Spiders serve as buffers that limit the exponential growth of pest populations in various ecosystems by virtue of their predatory potency (Kritani *et al.,* 1972; Mansour *et al.,* 1981; Nyffeler and Benz, 1981; Wolgang, 1983; Young and Edwards, 1990; Eswaramoorthy *et al.,* 1994; Pointing, 1996; Geetha and Gopalan, 1999; Mathirajan and Regupathy, 2003; Ghavami, 2008).

Many formers use chemical pesticides to control pests. An ideal biological control agent, would be one that is tolerant to synthetic insecticides. Although spiders may be more sensitive to insecticides than insects (Thomas *et al.,* 1990; Ravi *et al.,* 2008). Some spiders show tolerance, perhaps even resistance, to some pesticides (Mansour and Nentwig, 1988; Toft and Jenson, 1999; Yardim and Edwards, 1998; Marc *et al.,* 1999; Tanaka *et al.,* 2000). It was observed that immediately after the application of insecticides the spider population was reduced and subsequently, it increased and attained a peak. The above results indicate that, the spiders are ideal predators of insect pests in man made ecosystems. Though insect pests on vegetables have been well studied and catalogued, the spiders received little attention in vegetable field (Vayssieres *et al.*, 2001). Hence, the present study was undertaken to record the population of spiders and their predatory potency in the vegetable crops *viz.*, brinjal and snake-gourd and to investigate the effect of insecticides on the population of spiders.

MATERIALS AND METHODS

Study area

The areas selected for the study *viz.*, Nangoor (pesticide free area) and Moongilthottam (frequently pesticide used area) belong to Nagapattinam district, Tamil Nadu, India. Both areas are the hotspots of paddy, cotton, cereals and vegetables cultivation. The brinjal (*Solanum melongena*) and snake-gourd (*Trichosanthes anguina*) fields are selected for this study. Hostathion (40% EC), Caldan (50% EC) and Dhan Preet (20% EC) were the pesticide used in Moongilthottam field.

Population of spiders

Direct observation method was adopted to assess the population of the different species of spiders. Census of spiders in brinjal and snake-gourd fields of Nangoor and Moongilthottam was undertaken from February to July 2004. In each vegetable field, a total of 20 quadrates (size = 2m x 2m) were selected randomly in different locations. Weekly census was made in each quadrat in the morning from 7am to 9am. In both areas spiders were counted in all the plants which were within the quadrates. A total of 222 census were done in Nangoor and 201 in Moongilthottam. The plants species-wise quadrats were 180 in brinjal and 243 in snake-gourd. In each census, the total number of individuals in each species of spiders were recorded. Whenever, there was an uncertainity in the species identification, one or two individuals of the respective species were collected and stored in Odiman's preservative. Later the identification was done in the laboratory using the manual of Barrion and Litsinger (1995).

Prey collection from the web

Prey selection and quantification of web weavers were investigated in three ways *viz.*, (i) prey entangled in the web, (ii) wrapped packages found in the web and (iii) dead prey's external skeleton in the web. The collected insects and body parts were used to identify the prey species. Identification was done using key of Ramalingam (2003).

Data Analysis

Data are presented as mean ± Standard deviation. The significance of variations between and among the means was tested using student 't' test and ANOVA respectively. For hypothesis testing $P < 0.05$ was considered for the level of significance.

RESULTS AND DISCUSSIONS

During the study, eight species of spiders *viz.*, *Argiope luzona* (Walckenaer) (Argiopidae), *Cyrtophora cicatrosa* (Doleschall) (Araneidae), *Chrysso argyrodiformis* (Yaginuma) (Theridiidae), *Hipossa pantherina* (Thorell) (Lycosidae), *Oxyopes lineatipes* (C. L. Koch) (Oxyopidae), *Oxyopes javanus* (Thorell) (Oxyopidae), *Peucetia viridana* (Thorell) (Oxyopidae) and *Lycosa pseudoannulata* (Boescriberg and Strand) (Lycosidae) belong to five families were recorded in both plants *viz.*, brinjal and snake-gourd in two selected areas. Assemblage of spiders is more effective at reducing prey densities than single species of spider (Greenstone, 1999; Sunderland, 1999). Overall population of spiders in two different areas studied did not showed significant difference, while the mean value of spider populations in Nangoor was higher ($1.2 \pm 0.54/m^2$) (N = 222) than Moongilthottam ($1.1 \pm 0.35/m^2$) (N = 201). This indicates that use of insecticides decreases the density of spiders. This result was confirms the earlier report of Maloney *et al.* (2003).

All the observed species of spiders were found in both areas while individual spider population s varied. In Nangoor (Pesticide free area) *O. lineatipes* followed by *L. pseudoannulata* were found to be more than the others. In Moongilthottam (frequently pesticide used area) *H. pantherina* was more abundant than the other species (Table 1). A statistical analysis (ANOVA) indicated that

Table 1. Area-wise difference in the population of spider species during the study period (Data pooled with regard to plants)

Spider Species	Mean No. of Spiders (Mean ± SD)	
	Nangoor (N = 222)	Moongilthottam (N = 201)
Argiope luzona *	1.5 ± 0.74	1.1 ± 0.38
*Cyrtophora cicatrosa**	1.2 ± 0.41	1.1 ± 0.39
Chrysso argyrodiformis (NS)	1.0 ± 0.001	1.0 ± 0.001
*Hipassa pantherina**	1.1 ± 0.35	1.0 ± 0.001
*Oxyopes lineatipes**	1.3 ± 0.47	1.3 ± 0.47
*Oxyopes javanes**	1.0± 0.25	1.1± 0.40
Peucetia viridana (NS)	1.0 ± 0.001	1.0 ± 0.001
*Lycosa pseudoannulata**	1.4 ± 0.82	1.0 ± 0.001

* - $P < 0.05$; student's 't' test, NS – Not significant

Table 2. Population of different spider species in Brinjal and Snake-gourd during the study period (Data pooled with regards to areas)

Spider Species	Mean No. of Spiders (Mean ± SD)	
	Brinjal (N = 180)	Snake-gourd (N = 243)
*Argiope luzona**	1.2 ± 0.59	1.4 ± 0.66
*Cyrtophora cicatrosa**	1.3 ± 0.47	1.1 ± 0.35
Chrysso argyrodiformis (NS)	1.0 ± 0.001	1.0 ± 0.001
*Hipassa pantherina**	1.3 ± 0.51	1.0 ± 0.001
*Oxyopes lineatipes**	1.3 ± 0.48	1.2 ± 0.46
*Oxyopes javanes**	1.2± 0.41	1.0± 0.23
Peucetia viridana (NS)	1.0 ± 0.001	1.0 ± 0.001
*Lycosa pseudoannulata**	1.4 ± 0.82	1.0 ± 0.001

* - P < 0.05; student's 't' test, NS – Not significant

species-wise variation in spider population was significant (F = 4.05; P < 0.05) while area-wise variation did not show significant difference. The interaction between area and spider population was significant (F = 2.34; P < 0.05). This result was similar to the findings of Tanaka *et al.,* (2000) and Maloney *et al.* (2003). Other studies also suggested that insecticides have little effect on spider population densities (Riechert and Lockley, 1984; Van Den Berg, *et al.,* 1990). Student 't' test were computed for each species of spiders between two areas studied. The result showed that *A.luzona, C.cicatrosa, O.lineatipes, L.pseudoan nulata*, were significantly higher in Nangoor then Moongilthottam. *H.pantherina* and *O. javanus* had higher density in Moongilthottam. This my be the reason of the *H.pantherina* construct funnel web in the ground or bunds and at the time of emergency like spraying insecticides, they hide in the web and later they came out from the web and therefore save them from local extinction. Venturino *et al.* (2006) stated that web weaving spiders may be transported by the wind from agro ecosystem in to the surrounding area during the spraying of insecticides. Thomas *et al.* (1990) also stated population of Linyphiid spiders was reduced after application of insecticides in the field and later it could be recovered from an adjacent unsprayed areas. Toft and Jenson (1999) reported that no negative effect on prey capture and development of spiders. Mansour and Nentwig (1988)

Table 3. Number of pests caught by different spiders types studied (Data pooled with regards to area and plant) (Data within paranthesis indicate the number of sample)

Spiders Web	No. of insects / Web(Mean ± S.D.) N*
Orb web weaver	1.5 ± 0.74 (56)[a]
Dome web weaver	1.4 ± 0.67(46)[b]
Mesh web weaver	1.4+0.59(53)[c]
Cone web weaver	1.0+0.62(66)[d]

* Dissimilar superscripts indicate significant difference.

found out that ambush spider *(Philobromus aureolus)* was completely resistance to about 30 pesticides. An ideal biological control agents, therefore would be one that is tolerant to synthetic insecticides. Spiders show tolerance, perhaps even resistance to pesticides.

Overall population of spiders in two plant species studied did not showed significant difference. 1.2±0.50/m^2 (N = 180) of spiders were recorded in brinjal field and 1.1±0.43/m^2 (N = 243) in snake-gourd. All the eight spiders were recorded in both plants. This may be due to the fact that both plants were cultivated adjacent to one another. The result coincide with Cai *et al.* (2007). They recorded that same insects' guild and natural predators in intercropping vegetable field of China. The present study also revealed that the individual spider population varied among same plant, in brinjal *O. lineatipes, O. javanus*, were recorded more. In snake-gourd *A. luzona* was more abundant than the others (Table 2). Analysis of variance was performed between plant species and population of spider species and the result indicate that both plant species-wise (F = 4.71; P < 0.05), spider species-wise variation in spider population was significant (F = 4.08; P < 0.05). Whereas the interaction between plant and spider species on the spider population was not significant. Student 't' test result showed that except *C.argiodiformis* and *P.viridana* all others spiders had significant difference between the plant studied. *A.luzona* was significantly higher in snake-gourd and remaining spiders were significantly higher in brinjal. This may be due to habitat structure (Johnson, 1995; Hally *et al.,* 1996) and plant architecture (Wise, 1993; Aiken and Coyle, 2000; Raizur and Amaral, 2001).

The predatory potency of four type of web building spiders *viz.,* orb weavers, sheet weavers, cone web weavers and dome web weavers were estimated in the field. Fourteen species of insect *viz., Camponotus compressus* (black ant) (Lalit kumar Jha), *Occophylla smaragdina* (tree ant) (Maxwell-Lefroy), *Apis florae* (honey bee) (Stebbing), *Kallima inachus* (butterfly) (Lalit kumar Jha), *Plusia orichalcia* (catterpiller) (Maxwell-Lefroy), *Leuanodes orbonalis* (moth) (Awasthi), *Aphis gossypii* (cotton aphids) (Lalit kumar Jha), *Bemisia pabaci* (whitefly) (Lalit kumar Jha),, *Culex quina* (mosquitoe) (Lalit kumar Jha),, *Drosophila melanogaster* (fruitfly) (Awasthi), *Musca nebulo* (housefly) (Awasthi), *Amritodus alkinsoni* (mango leaf hopper) (Awasthi), *Macromia magnifica* (dragonfly) (Awasthi),, *Epilachna vigintioctopuctata* (beetle) (Awasthi) belong to seven orders were collected from the spiders web. This indicates that spiders are generalist predator, and they caught wide range of insects (Riechert and Lockley, 1984; Ghavami, 2008). Web type-wise, number of insects caught by the spider is given in Table 3. Overall trend showed significant difference between number of insect caught by the spiders and spider's web types (t > 1.96). This indicates that among the web building spiders different architecture of web influenced the prey capturing. The result also showed that the orb web weavers caught more prey (1.5 $\pm$ 0.74/web, N = 56) than the other types. This result was similar to the findings of Craig and Bernard (1990) and Craig *et al.* (1996). They observed that orb weavers rebuild their web daily and often kill prey in excess of their energy requirements. They also observed that sheet web weavers and funnel web weavers do not renew their nets daily and fed less frequently.

The presence study indicated that all the eight species of spiders have been seen on both the plants studied, can be effective in stabilizing pest population. Moreover, overall population of spiders in two areas studied did not showed significant difference, eventhough Nangoor (pesticides free area) had slightly higher density of spiders than Moongilthottam (frequently pesticides used area). Thus spider presence in vegetable fields should be encouraged and steps must be taken to protect them from harmful chemical insecticides.

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