Journal of Agriculture and Sustainability
ISSN 2201-4357
Volume 2 (2013), Number 2, 142-159

Feeding Efficacy of Spiders on Sucking Complex of Okra, Abelmoschus Esculentus L.

Hakim Ali Sahito (Corresponding author)
CABI South Asia, Rawalpindi- Pakistan
Muzaffar Ali Talpur
Sindh Agriculture University, Tandojam- Sindh
Muhammad Arif Soomro
Sindh Agriculture University, Tandojam- Sindh
Abdul Hafeez Mastoi
Sindh Agriculture University, Tandojam- Sindh
Khalid Hussain Dhiloo
Sindh Agriculture University, Tandojam- Sindh

Abstract. The experiment was conducted to check the population of sucking insect pests such as; jassid, *A. bigutella bigutella* (Ishida) whitefly, *B. tabacci* (G), thrips, *T. tabaci* (S.) and mites, *T. cinnabarinus* (Boisd.) in a field condition of okra crop. Homogenous seeds of okra were drilled in rows 75cm apart from each other on well prepared seed bed on February 15, 2011. Where as, the feeding potential of predatory spiders on these pests were evaluated in a laboratory condition. Four prominent predatory spider species such as; *Hippasa agelenoides, Cheiracanthium danieli, Argyrodes argentatus* and *Drassodes* sp. were recorded throughout the data collection. Thus, there feeding potential was observed under the laboratory conditions at 25±2°C and the pests were provided. The overall consumption by these two spider species; *C. danieli* and *H. agelenoides* consumed maximum (12.30±1.23) and (10.10±1.07) where as, the minimum (9.65±1.39) and (8.35±2.09) pest population by *A, argentatus* and *Drassodes* sp. The correlation of

all predatory spiders was highly significant with jassid (r^2=0.84**), whitefly (r^2=0.94**), thrips (r^2=0.88**) and mites (r^2=0.94**). But the temperature had the low positive correlation with the population among predatory spiders (r^2=0.45^{ns}), jassid (r^2=0.38^{ns}), whitefly (r^2=0.46^{ns}), thrips (r^2=0.45^{ns}) and mites (r^2=0.53^{ns}). In the behavior of relative humidity had also low positive correlation with the population of predatory spiders (r^2=0.31^{ns}), jassid (r^2=0.14^{ns}), whitefly (r^2=0.25ns), thrips (r^2=0.34^{ns}) and mites (r^2=0.22^{ns}). However, predatory spiders were found abundantly with their carnivorous habits among the population that showed synchronization with the sucking insect pests in okra crop.

Key words: Okra, pests, carnivorous spiders, abiotic factors.

INTRODUCTION:

Okra, *Abelmoschus esculentus* L. belongs to family Malvaceae. It is a warm-season, annual vegetable. The origin of this vegetable is considered as Africa and Asia, and is a good source of vitamins, minerals and has a good caloric value. It is a main Kharif vegetable and the cash crop of Sindh, Pakistan (Sahito and Kamran, 2012). Its fruits can be cooked in a variety of ways, fried in butter or oil with necessary ingredients. In Pakistan, okra vegetable covers an area about 221.4 hectares with an annual production of 2860.0 tones, whereas in Sindh it covers an area about 35.6 hectares with an annual production of 219.7 tones. The loamy soil and warm climate is favorable for cultivation of okra crop. The most destructive insect pests are whitefly, (*Bemisia tabaci* Gennadius) yellow flower thrips, *(Frankliniella sulphurea* Schmutz) jassid, (*Amrasca biguttula biguttula* (Ishida) aphid, (*Aphis gossypii* Glov.) spotted bollworm, (*Earias insulana* Bios.), American bollworm (*Helicoverpra armigera* Hubner) and *Tetranychus cinnabarinus* (Boisd.). Okra crop is infested by many insect pests like cotton crop that suffers to economic loss to the marketable yield.

In natural agro ecosystem they suppress the population of pests and regulate the natural balance of ecosystem (Soomro *et al*., 2012). They attack okra crop from sowing till harvest. Among these insect pests the whitefly is the injurious one which destroys the okra plant by sucking the sap from the leaves and transmitting certain viral diseases. Whitefly and other have a range variety of highly polyphagous nature and have been recorded on a wide range of cultivated and wild plants Sahito *et al*., (2010). However, the magnitude of infestation and the nature of extent of injury vary with plant species, seasons and localities.

Spiders have a wide insect host range and thus can act as biological control agents of insect pests in agro-ecosystems. Five spider species; *Thanatus formicinus* (Clerck), *Oxyopes salticus* (Hentx), *Cheiracanthium erraticum* (Walckenaer), *Philodromus cespitum* (Walckenaer), *Thyene imperialis* (Rossi) were evaluated on four cotton pests (*Bemisia tabaci*, *Aphis gossypii*, *Empoasca decipiens* and *Nezara viridula*) and daily rate of feeding and host preference were recorded for sixty days. Predatory spiders are also among the most abundant and important insect's predators. Fifteen genera representing 9 families were collected. Thomisidae, Araneidae (Argiopidae), Dictynidae and Salticidae were the most commonly collected families. Prey searching ability, wide host range, ease in multiplication and polyphagous in nature make them as a potential predator in biological pest suppression (Rajeswaran *et al.*, 2005). Spiders from native species in Arkansas, California, Colorado, New Mexico, Nevada, Oklahoma and Texas in 1980, the effects of environmental factors on spider communities, spiders inhabiting cold in Central Europe belong to a unique relict community of species requiring cold and stable microclimate. Web-building spiders are an important model system to address questions in a variety of biological fields.

Four species of predatory spiders were recorded in okra crop at the Island of Reunion. Four spider species were namely; *Hippasa agelenoides, Cheiracanthium danieli, Argyrodes argentatus* and *Drassodes* sp. consumed whitefly, thrips, jassids and mites on okra. Two spider species; *Cheiracanthium danieli* (Miturgidae) and *Hippasa agelenoides* (Lycosidae) showed maximum feeding potential against mites, thrips and whitefly. However, *C. danieli* spider showed higher feeding potential against jassid. Where as, Soomro *et al.,* (2012) attributed the ten different species of spiders at SAU, Tandojam and the number of insects killed per unit of time because of their good searching ability, wide host range, adaptation under conditions of food limitation, low metabolic rate, energy conservation mechanism and polyphagous in nature that make them as a model predator in the predatory spiders fauna in sunflower crop. Keeping the above points in view, this experiment was evaluated in the field and their feeding potential on sucking pests in laboratory conditions.

MATERIALS AND METHODS

Study was carried out in the experiment field at Center of Agriculture and Bio-science, International (CABI), South Asia Model farm in field conditions and the feeding potential was evaluated in the laboratory condition at Sindh Horticulture Research Institute (SHRI), Mirpur Khas, Sindh during the year, 2011. The experiment was conducted on Randomize Complete Block Design (RCBD), in a 5 acres plot size; homogenous seeds of okra were drilled in rows 75cm apart from each other on well prepared seed bed on February 15, 2011. There were five rows each row had 3 meters distance for replication of data thus; data was obtained on weekly basis. Just before first irrigation seedlings were thinned and a plant to plant distance of 22.5 cm was maintained.

Recommended dose of nitro phosphate fertilizers was applied in the form of urea and DAP from starting of second irrigation when plant beard 3-5 leaves. The full dose of phosphorus with 1/3 of nitrogen was applied at sowing time (seed bed preparation), while rest of it was split and top dressed at 2nd and 4th irrigation, respectively. The crop was irrigated on weekly basis or need of plant. Other cultural practices i.e. thinning, weeding, most affected plants were rooted out and damaged fruits or fruits became hard were separated as per the recommendation and requirement. However, spray of any kind of insecticide was avoided on and around the experimental area for proper exploitation of predatory spiders only crop was water washed on weekly interval basis or fortnightly. Observations on the population of predatory spiders were recorded on weekly basis as with the obtaining of insect pests data starting from the 3rd week of April 2011. As such for sucking pests three leaves from top, middle and bottom of the plant were observed randomly where as predatory spiders were recorded on whole plant. Further, data on some weather factors were collected from Government Meteorological Center located at Mirpurkhas, Sindh to check the correlation between the pest, predatory spider's population growth and effect in the field condition. Ten leaves were selected from each replication finally the means were calculated form these ten plants on each observation date thus, the data was analyzed statistically.

Consequently to determine the feeding potential of predatory spiders most dominant species were evaluated on different sucking insect pests (jassid, whitefly, thrips and mites) which were collected from the okra field and brought in the laboratory to conduct feeding potential preference. The laboratory temperature was maintained at 25±2^{0}C with 50-65% relative humidity and L16:D8 photoperiod. The temperature and relative humidity was measured through the help of hygro meter hanged over the wall. Four Petri dishes with each size of (15 cm dia, 1 cm height) were used and

predatory spiders were released in these Petri dishes along with 25 adults of each pest. Those were offered to each adult of predatory spider (male and female) in separate Petri dishes for 48 hours and replicated five times for each spider to know the feeding efficiency / most carnivorous specie. The pests fed by predatory spiders were counted and means were calculated. Finally, data was statistically analyzed through a Microsoft Computer Package "MSTATC".

RESULTS:

Population of spiders in okra crop

Mean data on mean population of predatory spiders recorded on okra crop are presented in Table 1, it may be seen from the results that the population of spiders increased gradually and reached to its peak on 9th of June (8.00) and minimum population was (4.00) recorded in the month of April, 22 with the mean population of spider (6.10±0.29) was recorded (Table-1).

Population of insect pests

The maximum (10.00/leaf) Jassid population was recorded in the start of June and minimum (1.00/leaf) was seen during last week of April. The over all mean population of Jassid was (4.18±0.76). Where as highest whitefly population (9.50/leaf) was recorded during 2nd week of June and significantly reduced in the end of season during the month of July, 2011. However the mean population of whitefly was (3.64±0.37). The thrips population appeared in the 1st week of June and gradually increased and reached at the maximum level (7.00/leaf) during the 2nd week of June, finally mean population of thrips was (2.90±0.45). Further, table 1

revealed that maximum (6.00/leaf) mites population was recorded during the 3rd week of June and minimum (1.00/leaf) was recorded during last week of April and over all mean population (5.53±0.65) of mites was calculated.

The results further indicated that when data on predatory spider and sucking pests were analyzed statistically it varied significantly ($P<0.01$). Early or advance phase of okra crop showed lower activity of predatory spiders, while in the middle season the predatory spiders remained more active this might be due to more presence of insect pests in the middle of crops season.

Table 1. Weekly mean population of predatory spiders / plant and sucking insect pests on 3 leaves per plant on okra crop

Dates	Spiders	Jassid	Whitefly	Thrips	Mites
22-4-2011	4.00	1.00	0.00	0.00	1.00
28-4	4.60	1.20	2.00	0.00	1.50
05-05	4.80	2.00	4.00	2.50	2.00
12-05	5.50	3.00	6.00	3.20	3.00
19-05	6.80	4.00	7.00	4.00	4.50
26-05	6.90	9.00	8.00	4.50	4.60
02-06	7.50	10.00	9.00	5.00	5.00
09-06	8.00	8.00	9.50	7.00	5.50
16-06	7.00	7.00	7.00	3.20	6.00
23-06	6.80	5.00	6.00	3.20	4.50
30-06	6.40	4.00	6.50	3.00	4.00
7-07	6.60	3.00	5.50	2.80	3.80
14-07	5.20	2.00	4.20	2.50	3.20

21-07	6.00	2.00	4.80	2.00	3.00
28-07-2011	5.50	1.50	3.50	1.80	3.00
Mean±SE	6.10± 0.29	4.18±0.76	3.64±0.37	2.90±0.45	5.53±0.65

Feeding potential of spiders on sucking pests complex of okra crop

The monitoring of predatory spiders such as (*Hippasa agelenoides, Chiracanthium danieli, Argyrodes argentatus* and *Drassodes* sp.) were determined in the laboratory conditions. The feeding potential of four spider species was evaluated against jassid, whitefly, thrips and mites (Fig. 1). The results indicate that the maximum feeding potential of *Cheiracanthium danieli* with overall mean numbers on Jassid (16.00) was recorded followed by *Argyrodes argentatus* (12.00), *Hippasa agelenoides* (11.40) and same by *Drassodes* sp. (11.40). Similarly, highest feeding potential of *Cheiracanthium danieli* on whitefly (12.00) was recorded followed by *Argyrodes argentatus* (11.40) with overall mean numbers where as, *Drassodes* sp. (10.60) and *Hippasa agelenoides* (10.40), respectively. As such maximum feeding potential of *Cheiracanthium danieli* on thrips (10.60) was recorded followed by *Argyrodes argentatus* (9.00), *Drassodes* sp. (8.80) and *Hippasa agelenoides* (8.60). In case of mites maximum feeding potential (10.60) was recorded by *Cheiracanthium danieli* followed by *Hippasa agelenoides* (10.00), *Drassodes* sp. (6.20) and *Argyrodes argentatus* (2.60). The data revealed that overall consumption of all sucking pests indicate that two spider species, *Cheiracanthium danieli* and *Hippasa agelenoides* consumed maximum pest population (12.30) and (10.10). And the lower number of pests was consumed by *Argyrodes argentatus* (9.65) and *Drassodes* sp. (8.35), respectively. ANOVA results also showed that overall mean number of each pests consumed by each

four spider species varied, statistically significant from each other.

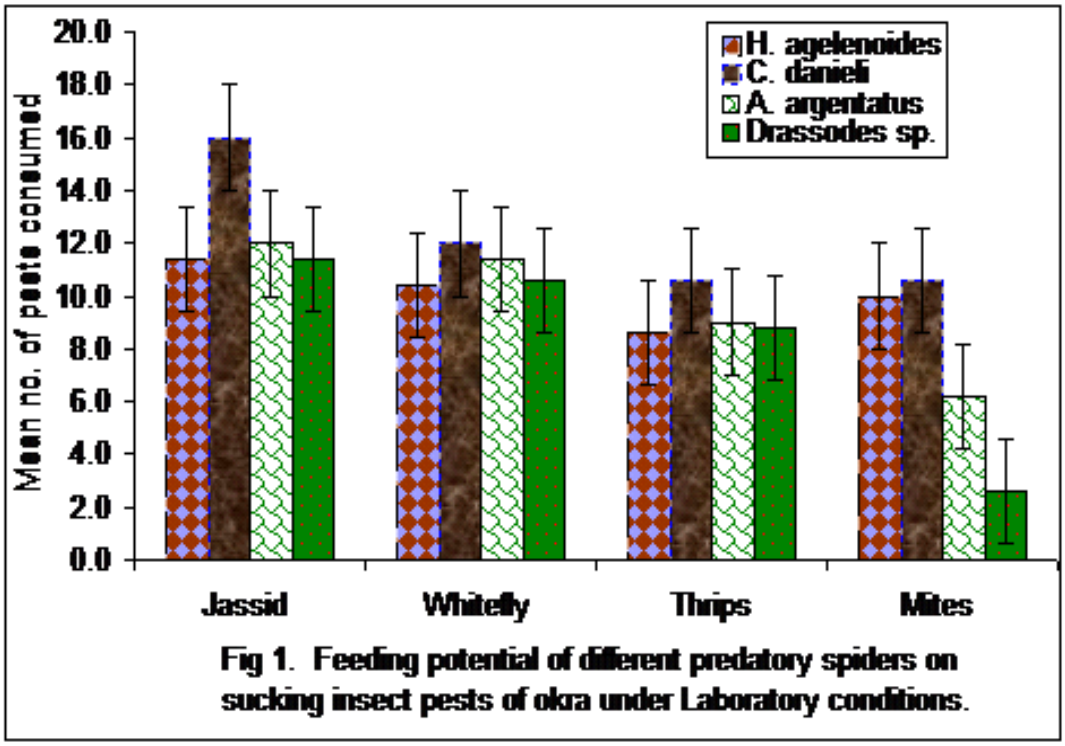

Fig 1. Feeding potential of different predatory spiders on sucking insect pests of okra under Laboratory conditions.

Relationship between population of predatory spiders and abiotic factors

The results of correlation of predatory spiders with sucking insect pests and environmental factors are shown in the table 2 whereas; the weekly mean temperature ^{o}C and relative humidity % are described in table 3, respectively. It may seen from the results that predatory spider highly significant (r^2=0.84**) correlated with jassid, white fly (r^2=0.94**), thrips (r^2=0.88**) and mites (r^2=0.94**). Where as temperature had the high positive correlation with the population of predatory spiders (r^2=0.45^{ns}), jassid (r^2=0.38^{ns}), whitefly (r^2=0.46^{ns}), thrips (r^2=0.45^{ns}) and mites (r^2=0.53^{ns}). The results further showed that relative humidity had low positive correlation with the population of predatory spiders (r^2= 0.31^{ns}), jassid (r^2=0.14^{ns}), white fly (r^2=0.25^{ns}), thrips (r^2=0.34^{ns}) and mites

(r^2=0.22^{ns}), respectively.

Table 2. Coefficient of correlation (r) and coefficient of determination (r^2) among predator, insects, temperature and humidity during, 2011.

Spiders & pests	Spiders		Temperature ^oC		Humidity %	
	Coefficient of correlation (r)	Regression Coefficient (r^2)	Coefficient of correlation (r)	Regression Coefficient (r^2)	Coefficient of correlation (r)	Regression Coefficient (r^2)
Spiders	-	-	0.45^{ns}	0.20	0.31 ^{ns}	0.09
Jassid	0.84**	0.71	0.38 ^{ns}	0.14	0.14 ^{ns}	0.01
Whitefly	0.94**	0.88	0.46 ^{ns}	0.21	0.25 ^{ns}	0.06
Thrips	0.88**	0.77	0.45 ^{ns}	0.21	0.34 ^{ns}	0.12
Mites	0.94**	0.88	0.53 ^{ns}	0.28	0.22 ^{ns}	0.05

ns = non significant, ** = significant at P < 0.01

Table 3. Average weekly meteorological data from experimental period during 2011 (Source: SHRI, Agromet Center, MPK, Sindh).

Observation	Temperature °C			Mean relative humidity (%)
	Min.	Max.	Mean	
22-4-2011	20.50	36.50	28.50	65
28-4	24.50	39.00	31.75	59
05-05	23.50	42.00	32.75	67
12-05	26.00	43.50	34.75	64
19-05	25.50	39.50	32.50	65
26-05	24.50	38.50	31.50	61
02-06	27.50	40.50	34.00	68
09-06	26.50	38.50	32.50	79
16-06	27.00	39.00	33.00	67
23-06	26.50	40.50	33.50	62
30-06	27.50	38.50	33.00	70
7-07	28.50	41.50	35.00	78
14-07	26.50	35.50	31.00	72
21-07	27.50	28.50	28.00	70
28-07-2011	27.50	35.00	31.25	75

Identification of spider species: In present study, four different species of spiders were recorded and identified which belong to four families viz. Wolf spiders, *Hippasa agelenoides* (Lycosidae) and Yellow sac spider, *Cheiracanthium danieli* (Miturgidae), Cob web spider, *Argyrodes argentatus* (Theridiidae), Ground spider, *Drassodes* sp. (Gnaphosidae). The Details of each species are shown in table 4 with picture gallery.

Table 4. Taxonomic position and pictures of different spider species collected from okra crop.

Taxonomic position	Photo gallery of spider species
Genus: *Hippasa* Species : agelenoides Family: Lycosidae T. Name: *Hippasa agelenoides* (Simon 1884)	
Genus: Cheiracanthium Species: danieli Family: Miturgidae T. Name: *Cheiracanthium danieli* (Tikader 1975)	
Genus: Argyrodes Specie: argentatus Family: Theridiidae T. Name: *Argyrodes argentatus* (OP Cambridge 1880)	

Genus: Drassodes Specie: sp. Family: Gnaphosidae T. Name: Drassodes sp. (Westring 1851)	

DISCUSSION:

The results of the study showed that the data were significantly different ($P<0.01$) in the population of predatory spiders in the field of okra crop as well as the sucking insect pests. Besides it was also observed the different insects collected from the okra field to evaluate the feeding potential in the laboratory conditions were also significantly different in the population to each other those were fed by the predatory spiders, Early or advance phase of okra crop showed lower activity of predatory spiders, while in the middle season the predatory spiders remained more active this might be due to more presence of insect pests in the middle of crops season. The population of predatory spiders increased gradually on okra crop and reaches to its peak on 2nd week of June and minimum population was recorded in the month of April, 22-2011. The mean population of spiders was recorded (6.10±0.29) / plant. The highest jassid population was recorded in the starting of June and lowest during last week of April with the overall mean population (4.14±0.76), respectively. Where as, the highest whitefly population was recorded in the second week of June and reduced in the end of the season. How ever, the overall mean population of whitefly observed was (3.64±0.37). The thrips population was appeared in

the first week of June with the maximum level was observed during the second week of June finally, the overall mean population of thrips observed was (2.9±0.45). Further, the highest mite population was observed during the third week of June and lowest was recorded during last week of April and over all mean population (5.53±0.65) of mites was calculated, respectively. Similar results were obtained by Rajeswaran *et al.,* (2005) they reported that general spider's species found in agricultural crops of Tamil Nadu are carnivorous arthropods those consume a large number of preys and do not damage to the plants. They have unique habitat and they live in almost all the environments. Spiders serve as buffers that limit the initial exponential growth of prey populations. Kumar *et al.,* (2005) reported the spiders collected from bhendi were *Xrgitipe pulchefla, Crvhnphorit cictilrdsa (Cyrtophora cicctlrnsa), Crybopharu citricola (Cyrfopharct citricala), Custeracunfha geminam, Gastemeuntha huhlu, llippasa (ycnsma, Leuctuigc ccidtcsiana, Neoscona shillongensis, Neoscona naulica, Oxyopes* sp., *Peucetia prasina, Safucus* sp. and *Zygeilla melnnocrania (ZygieHa inelonocrtuiia)* where as, the Sciilicus spider species were most potential and voracious predators and they consume huge number of sucking insect pests. But that is bit controversial to our study we here found *Hippasa agelenoides* (Lycosidae), *Cheiracanthium danieli* (Miturgidae), *Argyrodes argentatus* (Theridiidae), *Drassodes* sp. (Gnaphosidae) predominant spider species in the okra crop and there feeding potential was confirmed in the laboratory conditions.

The feeding potential of four spider species was observed against jassid, whitefly, thrips and mites. Persons *et al*., (2001) reported that wolf spider feeds with different tactics on prey. The maximum feeding potential of *C. danieli* found on Jassid followed by *A. argentatus*, *H. agelenoides* and *Drassodes* sp. similarly, *C. danieli* on whitefly followed by *A. argentatus, Drassodes* sp. and *H. agelenoides*. As such maximum feeding potential of *C,*

danieli on thrips followed by *A. argentatus*, *Drassodes* sp. and *H. agelenoides*. In case of mites, the maximum feeding potential was recorded by *Cheiracanthium danieli* followed by *Hippasa agelenoides*, *Drassodes* sp. and *Argyrodes argentatus*. Heuts and Brunt, (2001) evaluated the behavioral relationship of predatory spiders in laboratory conditions. The overall consumption of all sucking pests indicated that two spider species, *Cheiracanthium danieli* and *Hippasa agelenoides* consumed maximum pest population in laboratory conditions during the lady fingers season. Where as, the lower number of pests were consumed by *Argyrodes argentatus* and *Drassodes* sp. Our findings are similar with Neena, (1997) reported that the *Neoscona nauticus* (Koch) (Argiopidae: Arachnida) preyed upon *Aphis gossypii*, a polyphagous and sucking insect pest found in different crops. Leite *et al.,* (2007) also reported that predatory spiders are more useful to control the sucking insect pests of okra. Aggnew and Smith, (1989) pointed out some features that make the presence of spiders desirable in an agricultural ecosystem: they prey on a vast range of potential pest species.

The results of correlation of predatory spiders with sucking pests and environmental factors showed that predatory spider highly significant correlated with jassid, whitefly, thrips and mites. Where as temperature had the high positive correlation with the population of predatory spider to insect pests in okra crop. The results further showed that relative humidity had low positive correlation with the population of predatory spiders with sucking insect pests. Results are in agreement with (Downie *et al.,* 2000) who reported that seasonal incidence of Jassid (*Amrasca biguttula biguttula*) and whitefly (*Bemisia tabaci*) populations on okra and their correlation with abiotic factor. The infestation of Jassid and whiteflies started in the fourth week of July and reached peaks in the second and fourth weeks of September, respectively. Correlation of these

insect pests with abiotic factors was also assessed. Peter, (2005) reported that the density of spiders increased during the season reaching a maximum of seven spiders per plant in the autumn shortly before harvest. The spatial distribution changed accordingly, being random in spring and early summer and normal or aggregated toward late summer. Two spider species, *Neottiura bimaculata* and *Theridion impressum* (Theridiidae), dominated throughout the season.

It was concluded that the data of predatory spiders, sucking pest populations and feeding potential were statistically significant with four species of predatory spiders in okra crop. *Cheiracanthium danieli* and *Hippasa agelenoides* spiders had maximum feeding potential against jassid, whitefly, thrips and mites. Predatory spiders had significant positive correlation with sucking pests while temperature and humidity had non-significant but positive correlation with predatory spider and sucking pests. Further, it is suggested that for effective biological control of sucking pest of okra, predatory spiders may be exploited as it prefer mites more and also reduces the population of thrips, jassids and whiteflies. The predatory spiders may be utilized with other IPM strategy to reduce insect pest pressure and attain good quality okra production.

References

- Aggnew CW and Smith, JW. 1989. Ecology of spiders (Araneae) in a peanut agroecosystem. Environ. Entomol. 18, 1, Pp. 30-42.
- Downie IS, I. Ribera, DI. McCracken, WL. Wilson, GN. Foster, A. Waterhouse, VJ. Abernethy and Murphy KJ. 2000. Modelling populations of Erigone atra and E. dentipalpis (Araneae: Linyphiidae) across an agricultural gradient in Scotland. Agri. Ecosys. and Envi. 80 (1-2): 15-28.
- Heuts BA and Brunt TM. 2001. Transitive predatory relationships of spider

species (Arachnida, Araneae) in laboratory tests behavioural processes, 53 (1-2): 57-64.

- Kumar PS, N. Alagarsamv, S. Sevarkodiyone and Baskaran S. 2005. Predatory potential of spiders on some insect pests of Bhendi. Post-graduate and Research Department of Zoology, Bionotes. Ayya Nadar Janaki Animal College, Sivakasi (Tamil Nadu), India. 626-124.
- Leite GLD, M. Picanço, JC. Zanuncio and Gusmao MR. 2007. Factors affecting colonization and abundance of Aphis gossypii Glover (Hemiptera: Aphididae) on okra plantations. Cienciae Agrotecnologia, 31(2): 337-343.
- Neena S. 1997. Predatory potential of spider, Neoscona nauticus (Koch) on three insect pests of cotton and sunflower. J. Pest Management and Econ. Zool. 5 (2): 147-149.
- Peter S. 2005. The diet of the cave spider meta menardi (latreille 1804) (Araneae, Tetragnathidae). J. Arachnol. 33:243–246.
- Persons MH, SE. Walker, AL. Rypstra and Marshall SD. 2001. Wolf spider predator avoidance tactics and survival in the presence of diet-associated predator cues (Araneae: Lycosidae). Animal Behaviour, 61(1): 43-51.
- Rajeswaran J, P. Duraimurugan and Shanmugam PS. 2005. Role of spiders in agriculture and horticulture ecosystem Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbalore, 641 003, Tamil Nadu, India. J. Food, Agri. and Envi. 3 (3-4): 147-152.
- Sahito HA, AG. Lanjar and Mal B. 2010. Studies on population dynamics of sucking insect pests of mustard crop (Brassica campestris). Pak. J. Agri., Agri. Engg., Vet. Sci., 26 (1): 66-74.
- Sahito, HA. and B. Kamran, (2012). Effect of Marginal Quality Water on Okra under Drip Irrigation System. Successful Drip Irrigation System in Okra crop. Lambert Academic Publishing (LAP), Amazon - Germany. Pp- 1-84.
- Sahra G. 2008. The potential of predatory spiders as biological control agents of cotton pests in Tehran provinces of Iran. Asian J. Exp. Sci. 22 (3): 303-306.

• Soomro SP, HA. Sahito, MH. Soomro, MP. Soomro and Dhilo KH. (2012). Studies on activities of araneae on sunflower, Helianthus annuus (L.). Agri. Sci. Res. J. 2(10): 541- 554.