

# Harmful effect of insecticides in the population dynamics of spiders on Lady's fingers *Abelmoschus esculentus*(L.) Moench at field level

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## Abstract:

Among the different predators, spider play an important role in the natural suppression of destructive insect pests viz., jassid, aphid, thrips, mites and eggs of many other insect pests infesting vegetable crops. Spider, an important predator in the sub-Himalayan region of north-east India was found very active on different insect pests of lady's fingers *Abelmoschus esculentus* (L.) Moench throughout the growing period. The level of population varied from year to year depending on their host and prevailing weather conditions. The important species of spider dominated in the lady's fingers field are *Argiopeluzona*, *Cryptophoracitrosa*, *Hipassapantherina*, *Oxyopesjavanes* and *Lycosapseudoannulata*. Peak spider activity (3.94 spiders/plant) was recorded in May (20th standard week), when the average temperature, relative humidity and weekly rainfall were 29.71°C, 80.31 % and 25.35 mm, respectively. However, spider population was very high during April-May and August-September (standard weeks 12-21 and 31-39, respectively). Spider incidence showed insignificant positive correlation ( $p= 0.05$ ) with average temperature and relative humidity but insignificant negative correlation with weekly total rainfall. This correlation indicated better activity of spider fauna at higher average temperature associated with relative humidity and low rainfall. In early stage of crop growth different insect pests on vegetable crops can be controlled with protective synthetic insecticides but cause harmful effect to the entomophagous insects as well as our environment. From field evaluation of insecticides on lady's fingers it was revealed that insecticides of biological origin were relatively less harmful to spiders than synthetic ones. The botanical extract, *Polygonum hydropiper* floral part, the pathogens, *Beauveria bassiana* (Bals.) Vuillemin and *Bacillus thuringiensis* Berliner caused significant lower killing of the predator (less than 30 %) whereas the synthetic insecticides, profenophos and methomyl caused significantly higher killing (more than 52 %). Botanical and microbial insecticides are bio-pesticides having less or no hazardous effects on bio-agents, human health and the environment, and therefore, they can be incorporated in IPM programs and organic farming.

**Keywords:** Seasonal Incidence, Predator, Bio-Pesticides, Vegetable IPM, Organic Farming

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## 1. Introduction

Lady's fingers *Abelmoschus esculentus*(L.) Moench is an annual crop belongs to the family Malvaceae and one of the most important vegetable crops grown in various parts of tropical and sub-tropical areas of the globe. Though lady's fingers finds its origin in South Africa, India stands top in area and production, with 3.58 lakh ha area, 35.24 lakh tones production and a productivity of 9.8 t/ha

[1]. In the sub-Himalayan region of north east India lady's fingers is cultivated at a commercial scale but insect and bite pest damage constitutes a limiting factor in successful production [2]. Various predators, parasites and pathogens cause natural suppression of insect pests of vegetable crops. The activity of natural enemy not only depends on prevalent weather conditions but also on the availability and size of host/prey population in crop ecosystem.

In early stage of crop, growth different insect pests on vegetable crops can be controlled with protective insecticides that cause harmful effect to natural enemies of the pests and environment. The control of the pest complex of lady's fingers through the use of synthetic pesticides particularly during the fruit bearing stage is rather difficult as the fruits harvested at frequent intervals, and there is every possibility that, if spray applications are made, harvested fruit would contain toxic residues and may cause health hazards. 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 and residues [3, 4, and 5]. The organochlorine and organophosphorus compounds have reported to pose a potential threat to all types of ecosystem [6]. Use of non persistent alternative chemicals with minimum required dosages should be adopted to protect the natural enemies. Moreover, many vegetables have been contaminated 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 [7-19]. Spiders serve as buffers that limit the exponential growth of pest populations in various ecosystems by virtue of their predatory potency [20-28]. Different species of spider are potential bio-agents, feeding on aphids, thrips, mites and some other insects which are harmful pests of vegetable crops particularly lady's fingers.

Many farmers use chemical pesticides to control pest. Some spiders show tolerance, perhaps even resistance, to some pesticides [29-33]. It was observed that immediately after the application of insecticides the spider population was reduced and subsequently, it increased and attained a peak. The previous results indicated that, the spiders are ideal predators of insect pests in manmade ecosystems. Though insect pest on vegetables have been well studied and catalogued, the spiders received little attention in vegetable field [34]. Hence, the present study was undertaken to record the population of spiders in the vegetable crop viz., lady's fingers and to investigate the harmful effect of insecticides on the population of spiders, and safer measure of bio-pesticides. Under the present investigation an attempt has been made to search some alternative insecticides which are eco-friendly.

## 2. Materials and Methods

Studies were conducted in the Instructional Farm of Uttar Banga Krishi Viswavidyalaya (State Agricultural University) at Pundibari, Coochbehar, West Bengal, India for two years (2010-2011). The experimental area is situated in the sub-Himalayan region of north-east India. This so called terai zone is situated between 25°57' and 27° N latitude and 88°25' and 89°54' E longitude. The soil of the experimental field was sandy loam with pH value 6.9. The climate of this zone is subtropical humid with a short winter spell during December to February.

### 2.1. Population dynamics of spiders:

The lady's fingers variety 'Nirmal-101' was grown round the year except winter when lady's fingers cultivation is not possible in this area, during 2010-2011 in both years under recommended fertilizer levels (120:60:60 kg NPK/ha ) and cultural practices in 4.8 m x 4.5m plots at a spacing of 75 cm x 35 cm. The treatments were replicated five times in a Randomized Block Design (RBD), without adopting any plant protection measures. Observation on the population of spiders as a whole (irrespective of species) was recorded on 5 randomly selected plants from each replicated plots at seven days (Standard Meteorological Week) interval during lady's fingers growing seasons in both the years. Data obtained over two years were presented graphically with important weather parameters viz. temperature, relative humidity. These spider incidence data were correlated ( $r$ ) with corresponding meteorological data for ambient temperature, relative humidity and rainfall, collected throughout the study period to find out influence of weather on population fluctuation.

### 2.1. Harmful effect of insecticides on spiders:

This two year (2010-2011) study of the harmful effect insecticides on spiders at field level was conducted at the instructional farm of Uttar Banga Krishi Viswavidyalaya (State Agricultural University) at Pundibari, Cooch Behar, West Bengal, India. The lady's fingers variety 'Nirmal-101' was grown during the post-kharif (early September) season in both years under recommended fertilizer levels (120:60:60 kg NPK/ha ) and cultural practices in 4 m x 5m plots at a spacing of 75 cm x 35 cm. The treatments were replicated three times in a Randomized Block Design.

Five bio-pesticides and two synthetic chemical insecticides were evaluated under this program. One botanical insecticide neem, (Neemactin 0.15 EC; 2.5 ml/L), one botanical extract, *Polygonum hydropiper* floral part extract @ 5.0 %, two microbial insecticides *Bacillus thuringiensis* Berliner (Biolep 5 x 10<sup>7</sup> spores/ml; 1.0g/L), and *Beaveria bassiana* (Bals.) Vuillemin

(Biorin 10<sup>7</sup>conidia/ml; 1.0ml/L) and one microbial toxin, avermectin (Vertimec 1.9 EC; 0.5 ml/L) were evaluated as compared with synthetic chemical insecticides profenophos (0.05%) (Carina 50EC; 1ml/L) and methomyl (0.05%) (Dunet 40 SP; 1.25 g/L). Four sprayings were made at an interval of 13 days. For 1<sup>st</sup> and 2<sup>nd</sup> spray 260 liter water and for 3<sup>rd</sup> and 4<sup>th</sup> spray 350 liter water were used to cover one hectare lady's fingers field. The *Polygonum hydropiper* plant's floral parts were extracted in methanol as follows. After washing with water, the plant parts were powdered in a grinder. The powder (50 g) samples of tested plant parts were transferred to a conical flask (500 ml) and dipped in 250 ml methanol. The material was allowed to stand for 72 hours at room temperature with occasional stirring. After 72 h, the extract was filtered through Whatman 42 filter paper and residues were washed twice with methanol.

Observations of spider population on lady's fingers were recorded at 3, 8 and 12 days after each spraying. The total populations per plant from 5 randomly selected plants per replication were recorded. The data were computed as percentage suppression over control and analyzed statistically. The results were expressed as spider population suppression (%) compared to densities recorded on the control treatment. Percent reduction of spider population over control was calculated by the following formula [35]:

$$Pt = \frac{Po - Pc}{100 - Pc} \times 100$$

Where, Pt = Corrected mortality, Po = Observed mortality and Pc = Control mortality.

Percent reduction over control =

$$\frac{\text{Percent reduction in treatment} - \text{Percent reduction in control}}{100 - \text{Percent reduction in control}} \times 100$$

Data were analyzed by using INDO-STAT-software for analysis of variance following randomized block design (RBD) treatment means were separated by applying CD Test (critical difference) at 5 % level of significance.

**Table 1.** Correlation co-efficient between weather parameters and incidence of spider

Environmental parameter		Correlation co-efficient (r)	Co-efficient of determination (R <sup>2</sup> )	Regression equation
Temperature °C	Maximum	0.041	0.001	Y = 0.040X+32.54
	Minimum	0.327*	0.107	Y = 0.830X+22.50
	Difference	(-)0.333*	0.110	Y = (-)0.788X+10.02
	Average	0.287	0.082	Y = 0.435X+27.52
Relative Humidity (%)	Maximum	0.107	0.011	Y = 0.778X+80.06
	Minimum	0.185	0.034	Y = 2.04X+69.05
	Average	0.158	0.024	Y = 1.406X+74.57
Weekly rainfall	Total	(-)0.040	0.001	Y = (-)2.310X+64.26

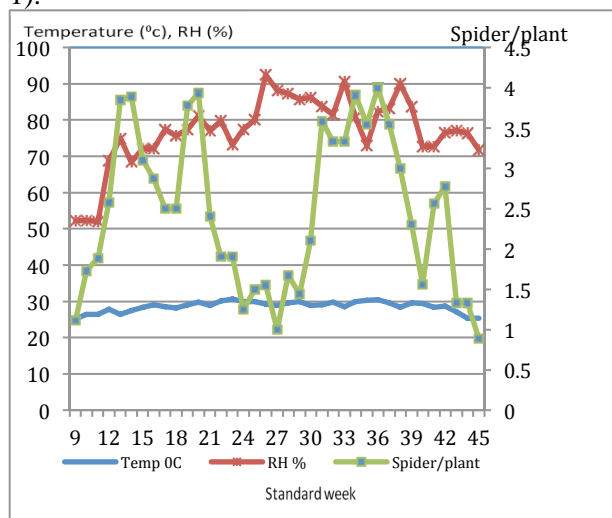
\*Significant at 5% level of significance

### 3. Results and Discussion

#### 3.1. Population dynamics of spider:

Analysis of pooled mean data on spider incidence for both the two years revealed that the predator was active throughout the growing season of lady'sfingers (Fig. 1). The important species of spider found dominated in the lady'sfingers field are *Argiopeluzona*, *Cryptophoracicatrosa*, *Hipassapantherina*, *Oxyopesjavanes* and *Lycosapseudoannulata*. However, from the very beginning occurrences of spider was higher and increased gradually with the rise of temperature and fall down during June- mid July, after that high population was maintained until 1<sup>st</sup> week of October.

Again, with the fall of temperature (i.e., from middle of October) and with the maturity of crop which promotes low density of prey, spider activity declined up to the end of lady's fingers growing season. Peak spider activity (3.94 spider/plant) was recorded on May(20<sup>th</sup> standard week), when the average temperature, relative humidity and weekly rainfall were 29.71<sup>o</sup> C, 80.31 % and 25.35 mm, respectively. However, spider population was very high during April-May and August-September (standard weeks 12-21 and 31-39, respectively) (Fig. 1).



**Fig1.** Incidence of spider as influence by temperature and RH

Correlation between spider incidences with weather parameters (Table 1) showed that spider incidence had an insignificant positive correlation with maximum and average temperature and significant positive ( $p=0.05$ ) correlation with minimum temperature but significant negative with temperature gradient. The correlation was positive but insignificant with relative humidity (maximum, minimum and average) and negative but insignificant with weekly total rainfall. Very high population of spider was observed in April-May and August-September which indicated that sprays of insecticides should be avoided at that period to save the predator, spider population in lady's finger field. As their population is high they constitute an essential portion of predatory population which is supported by [7,8,9,10]. Spider may serve as buffer that limit the exponential growth of pest in lady's finger field by virtue of their predatory potency [20,21,22]. The correlation studies indicated better activity of spider fauna at higher average temperature associated with higher relative humidity and low rainfall.

### 3.2. Harmful effect of insecticides on spiders

It is revealed that none of the insecticides was found safer to spider population. Although differences in toxicity of insecticides to spider, their relative persistency at different days after spraying was significant (Table-2). Among the seven insecticides evaluated under present investigation the insecticides from biological origin (bio-pesticides) were relatively less harmful to spider population than synthetic ones. The plant extract, *Polygonumhydropiper* floral part extract was found safest to the predator, spider recorded only 23.07 % suppression of the spider population and significantly different from all other treatments. The two microbial insecticides *Beauveriabassiana* and

*Bacillus thuringiensis* were less harmful and resulted significant lower killing of the predator (25.30 % and 27.97 % respectively). The two synthetic insecticides methomyl and profenophos were found very harmful and caused significant higher killing (55.33% and 52.57 % respectively) of the predator.

Three days after spraying the plant extract, *Polygonum hydropiper* and the two microbial insecticides *B. bassiana* and *B. thuringiensis* were found less harmful and resulted significant lower killing of the predator (32.16%, 31.36 % and 32.32 %, respectively). Three days after spraying the two synthetic insecticides methomyl and profenophos were found very harmful and caused significant higher killing (72.93% and 68.26 %, respectively) of the predator. Similar type of action of the *P. hydropiper* and the two microbial insecticides was maintained seven days after spraying. Twelve days after spraying the *P. hydropiper* and the two microbial insecticides were found safer to the predators as compared to other sprayings and resulted significant lower killing, 13.13%, 16.34 % and 24.13 %, respectively. In all sprayings the *P. hydropiper* was found safer to the predators as compared to all other treatments and the two synthetic insecticides were most harmful. The organochlorine and organophosphorus compounds have reported to pose a potential threat to all types of ecosystem [6]. Use of non persistent alternative chemicals with minimum required dosages should be adopted to protect the natural enemies. Biopesticides like plant extracts and microbial pesticides may be used as alternatives of chemical pesticides to protect the predators in lady's finger field. *P. hydropiper* was found safer to the predator, spider in lady's finger field recorded very lower killing of the spider.

**Table 2.** Mortality of spiders in lady's fingers field due to action of insecticides

	Suppression of spider population (%)											
	3 DAS			3 DAS			3 DAS			Grand mean		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Profenophos (0.05%)	69.20 (56.74)	67.32 (55.23)	68.26 (55.98)	45.43 (42.35)	57.56 (49.36)	51.49 (45.84)	32.73 (34.82)	43.17 (41.05)	37.95 (37.93)	49.12 (44.64)	56.02 (48.55)	52.57 (46.59)
Methomyl (0.05%)	76.69 (61.26)	69.18 (56.36)	72.93 (58.81)	48.96 (44.40)	52.87 (46.67)	50.91 (45.53)	39.15 (38.66)	45.15 (42.18)	42.15 (40.42)	54.93 (48.11)	55.73 (48.40)	55.33 (48.25)
Neem (2.5 ml/L)	44.98 (42.12)	39.10 (38.67)	42.04 (40.39)	38.25 (38.16)	36.48 (37.10)	37.36 (37.63)	24.52 (29.55)	20.06 (26.51)	22.29 (28.03)	35.92 (36.61)	31.88 (34.09)	33.9 (35.35)
<i>Bacillus thuringiensis</i> (1.0 g/L)	41.01 (39.77)	23.44 (28.93)	32.32 (34.53)	27.76 (31.73)	27.16 (31.35)	27.46 (31.54)	21.21 (27.34)	27.09 (31.27)	24.13 (29.34)	29.99 (32.95)	25.90 (30.52)	27.97 (31.80)
<i>Beauveria bassiana</i> (1.0 ml/L)	39.61 (38.97)	23.12 (28.67)	31.36 (34.01)	32.86 (34.91)	23.52 (28.95)	28.18 (32.00)	16.57 (23.94)	16.13 (23.62)	16.34 (23.78)	29.68 (32.61)	20.92 (27.08)	25.30 (29.93)
Avermectin (0.5 ml/L)	46.18 (42.79)	39.59 (38.96)	42.88 (40.88)	51.48 (45.86)	32.61 (34.79)	42.04 (40.40)	32.48 (34.70)	26.63 (31.02)	29.00 (32.88)	43.38 (41.11)	32.94 (34.92)	38.16 (38.05)
<i>Polygonum (5.0%)</i> 50 ml/L	32.86 (34.92)	31.46 (33.38)	32.16 (34.15)	22.68 (28.36)	25.18 (29.94)	23.93 (29.15)	15.45 (23.0)	10.81 (19.05)	13.13 (21.02)	23.66 (28.76)	22.48 (27.46)	23.07 (28.11)
Untreated check (Control)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)

	2010			2011			Mean		
	A	B	AxB	A	B	AxB	A	B	AxB
S.Em (±)	1.05	1.36	2.53	0.83	1.05	1.92	0.84	1.18	2.05
CD at 5%	3.15	3.93	7.51	2.52	3.03	5.76	2.41	3.40	N.S.

Figure in parenthesis indicate angular transformed values

DAS, Days after spraying

A, Days after spraying; B, Insecticides; A x B, Interaction of DAS with insecticides

## 4. Conclusion

Pesticide spray should be done carefully to the crop when population of the predator is abundant in the field. Based on their moderate to high efficacy levels, as well as low toxicity to natural enemies and minimum impact on human health and environment, we conclude that microbial and botanical insecticides (both bio-pesticide) can be incorporated in IPM programme and organic farming in vegetable cultivation.

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