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**Research Article**

# Seasonal incidence of *Earias* spp. and their natural predators on okra [*Abelmoschus esculentus* (L.) Moench] in Hiper arid region of Rajasthan

**Surendra Kumar Yadav, K.C. Kumawat and Nema Ram**



## ABSTRACT

The seasonal incidence of borer, *Earias* species and their predator on okra were studied at an experimental farm of College of Agriculture, Bikaner Rajasthan. The commencement of shoot borer on okra was observed in the 2nd and 3rd week of August during 2013 and 2014 respectively. The shoot borer reached its peak in the 3rd and 5th week of September during 2013 and 2014, respectively. The infestation of shoot borer disappeared from shoots during 3rd and 4th week of October during 2013 and 2014, respectively. The correlation between shoot borer infestation and maximum, minimum temperature and relative humidity showed non-significant effect in both the years. The fruit damage commenced in the 34th SMW (fourth week of August) and reached peak both number and weight basis in third week of November during both the years of study. The correlation of borer on fruits based on number basis exhibited a negative and significant effect with maximum temperature (r= -0.76) minimum temperature (r= -0.92) and mean relative humidity (r= -0.56) during 2013. The infestation of fruit borer based on number basis showed quite similar trend of correlation during 2014, which was significant negative with maximum temperature (r= -0.81), minimum temperature (r= -0.77) and mean relative humidity (r= -0.70). A negative significant correlation were observed between maximum temperature (r= -0.76), minimum temperature (r= -0.93) and mean relative humidity (r= -0.57) during 2013 on weight basis. Similar observations were recorded during 2014 *i.e.*, maximum, minimum temperature and mean relative humidity showed negative significant correlation with fruit damage on weight basis (r=-0.81, r=-0.79 and r=-0.70 respectively). The population of predator, *Coccinella* spp. started in the first week of August and reached to its maximum in the fourth week of September during 2013 and 2014. The populations of *Chrysoperla* commenced in 33rd and 32nd SMW during 2013 and 2014 respectively and reached peak in the fourth week of September during both the years. The nonliving factors i.e., abiotic factors did not affect the predator in present investigation during 2013 and 2014 except the rainfall exhibited (r= -0.61) negative significant effect on *Chrysoperla* population during 2013.

**Keywords:** Okra, seasonal incidence, shoot and fruit borer and predator

## INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] commonly known as bhindi or lady's finger, is an important vegetable crop of the tropical and sub-tropical regions of the world belong to family Malvaceae and originated from Africa. It is grown as a summer and rainy season vegetable crop throughout the world. The fruit of okra is not only nutritionally very rich but it also provides 35 calories. It is one of the most important and multipurpose cash crop paying high returns to the farmers. However, this crop is also known to provide shelter many insect pests and diseases which require special attention to combat with at proper time and manner. The major insect pests which causing damage

Surendra Kumar Yadav[1](✉), K.C. Kumawat[2] and Nema Ram[3]

[1]Assistant Professor (Entomology), College of Agriculture (SKRAU) Bikaner, Rajasthan, India

[2]Professor, SKNAU, Jobner, Jaipur, Rajasthan, India

[3]Assistant Professor (Entomology), College of Agriculture, Sumerpur (AU Jodhpur), Rajasthan, India

Email: yadavravivihar@gmail.com

to this crop are leaf hopper, *Amrasca biguttula biguttula* (Ishida); shoot and fruit borer, *Earias insulana* (Boisd.), *Earias vittella* (Boisd.); leaf roller, *Sylepta derogata* Fab; whitefly, *Bemisia tabaci* (Genn.); Aphid, *Aphis gossypii* Glov. and mite, *Tetranychus cinnabarinus* (Boisd.) (Dangi & Ameta, 2005; Meena & Kanwat, 2005). The leaf hopper, *A. biguttula biguttula* is one of the most devastating pest of this crop, sucks the cell sap from lower surface of the leaves and insert toxic substance in it, resulting in yellowing and curling of leaf margins downward and stunted plant growth. The typical symptoms are burning of leaves which fall down latter, this results 40-60 per cent decrease in yield (Narke & Suryawanshi, 1987). The okra whitefly not only sucks the cell sap from the leaves but also transmits the vein clearing disease of okra, which lowered vitality of the plants. It excretes honeydew on the leaf surface. Which facilitate the development of sooty mold, which interferes with the process of normal photosynthesis. Consequently, the growth of plant is also adversely affected (Nath et al., 1992). The shoot and fruit borer, *E. insulana* and *E. vittella* are one of the most serious and dangerous pests of lady finger. The greyish larvae bore into the terminal shoots, floral buds, flowers and fruits of okra, causing in cessation, withering, drying, drooping of infested shoots, tender leaves and heavy shedding of floral buds and flowers on the ground. The affected fruits become deformed and are rendered unfit for human consumption as well as for procurement of the seeds. The borer causes 24.6 to 26.0 per cent damage to okra shoots (Pareek et al., 1986 & Zala et al., 1999) and 40 to 100 per cent loss to fruits (Dhawan & Sindhu, 1984; Kumawat, 1997; Shah et al., 2001; Pareek & Bhargava, 2003 & Shinde et al., 2007).

The natural predators of this pest have received very less attention as natural control agents because of the lack of the awareness in the growers. The okra ecosystem provide shelter to many beneficial insects like, predators and parasites in numbers that frequently do partial to satisfactory pest control. Therefore, the use of predators, parasitoids and pathogens as a natural enemy may be better choice among various groups of bio-agents for the management of major insect pests of okra. It is well known fact that a very little attention has been paid to quantify the response of natural enemies against insect pests of okra crop. *Menochilus sexmaculatus* Fab; *Coccinella septempunctata* Linn. *Chrysoperla carnea* St. and *Syrphus* sp., are the major predators in okra ecosystem. (Stansty et al., 1997; Omkar et al., 1997; Abd-Rabou, 1998). The other predator like reduviid (*Acanthaspis pedistirs* and *Isyndus heros*) and many spiders also play a very important predatory role in the okra ecosystem along with preying mantid, *Mantis religiosa*, which prey on the caterpillars and moving insects (Sahayaraj & Ambrose, 1997).

## MATERIALS AND METHODS

The okra variety Parbhani Kranti, was sown on 5$^{th}$ July in the plots of size 3.0 x 2.25 m$^2$ having simple layout with row to row and plant to plant distance of 45 and 30 cm, respectively during 2013 and 2014. The seasonal incidence was studied in five plots, were continuous to one another and situated at a distance of 5 meters from the plots of other experiments. The data on seasonal incidence of insect pests and predator were observed on okra, at weekly interval right from germination to last picking of the fruits. The observation on shoot and fruit borer, *Earias* spp. was recorded in five tagged and randomly selected plants throughout the crop period by visual counting of the plant in which the top portion was damaged, started after two week of sowing and continued to last picking of the fruits. The per cent shoot damage was computed by counting the total number of shoots and the number of damaged shoots. The fruit borer observations were recorded on per cent infestation of fruits both on number and weight basis at each picking starting from 13$^{th}$ August, 2013 and 15$^{th}$ August, 2014 till last picking of fruits. The per cent infestation of fruits on number basis was computed by counting the infested

and healthy fruits separately from selected tagged plants. The per cent infestation of fruits were computed by taking the weight of both healthy and infested fruits. The observations of both insect pests and their natural enemies were recorded on the same tagged plants at the same time interval. The data on natural enemies of pests were recorded soon after their commencement to till harvesting of the crop. To explain the results of seasonal incidence of major borer of okra and their natural enemies, simple correlation was computed between pest population, damage and abiotic factors, *i.e.* the minimum and maximum temperature, relative humidity and rainfall.

The data on incidence of the fruit and shoot borer were statistically analyzed to find out the coefficient of correlation with maximum & minimum temperature, relative humidity and rainfall. A simple correlation was worked out between the population of borers, *Earias* species and abiotic factors by using the below mentioned formula.

$$r_{xy} = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

X = Independent variable i.e. abiotic factors (max. & min. temperature, relative humidity and rainfall)

Y = Dependent variable i.e. Mean number of pests population

n = Number of paired observations

## RESULTS AND DISCUSSION

The seasonal incidence of okra shoot and fruit borer was conducted at niche area of excellence at SKRAU, Bikaner during *kharif* 2013 and 2014. Major borers which were causing damage to okra crop were shoot and fruit borer, *Earias vittella* (Fab.) and *E. insulana*

Table 1: Effect of abiotic factors on shoot infestation and their natural enemies during *kharif*, 2013

| SMW | Date of observation | Temperature (°C) | | Mean relative humidity (%) | Total rainfall (mm) | Shoot infestation (%) | Mean population/five plants | |
|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | | | | *Coccinellids* | Green lace wing |
| 31 | 04.08.2013 | 36.2 | 22.7 | 68.8 | 5.0 | 0.00 | 0.80 | 0.00 |
| 32 | 11.08.2013 | 35.5 | 22.2 | 62.8 | 42.0 | 1.40 | 2.80 | 0.00 |
| 33 | 18.08.2013 | 33.3 | 21.6 | 80.6 | 51.4 | 2.00 | 3.60 | 1.80 |
| 34 | 25.08.2013 | 37.0 | 23.5 | 63.9 | 19.3 | 3.20 | 4.00 | 2.60 |
| 35 | 01.09.2013 | 36.0 | 23.7 | 58.7 | 0.0 | 5.10 | 4.80 | 3.00 |
| 36 | 08.09.2013 | 36.3 | 24.6 | 53.2 | 0.0 | 7.80 | 3.80 | 4.00 |
| 37 | 15.09.2013 | 39.2 | 25.1 | 44.3 | 0.0 | 9.00 | 5.60 | 3.80 |
| 38 | 22.09.2013 | 36.8 | 24.2 | 55.8 | 5.0 | 10.60 | 5.80 | 4.20 |
| 39 | 29.09.2013 | 33.4 | 22.0 | 67.9 | 1.0 | 9.50 | 4.00 | 3.00 |
| 40 | 06.10.2013 | 35.6 | 22.3 | 64.7 | 1.0 | 7.10 | 4.60 | 3.80 |
| 41 | 13.10.2013 | 34.7 | 22.0 | 58.7 | 0.0 | 5.80 | 3.00 | 4.00 |
| 42 | 20.10.2013 | 35.9 | 18.2 | 45.6 | 0.0 | 4.10 | 3.80 | 3.20 |
| Max. temperature (r) | | | | | | NS | NS | NS |
| Min. temperature (r) | | | | | | NS | NS | NS |
| R.H. (r) | | | | | NS | NS | NS | |
| Rainfall (r) | | | | | NS | NS | -0.61 | |

SMW = Standard meteorological week; *Significant at 5 per cent level; NS: Non significant

(Boisd.). On account of high population and damage, pests were categorized as major pests. The present results are in partial agreement with those of Pareek et al. (1986), Choudhary & Dadheech (1989); Kumawat et al. (2000); Meena & Kanwat (2005); Sharma & Jat (2010); Singh et al. (2014) who also reported borer as pests of okra crop in *kharif* season.

The incidence of shoot and fruit borer on shoots of okra started in the second and third week of August with a shoot damage of 1.40 and 2.50 percent cent during *kharif* 2013 and 2014, respectively (Table 1 and 2). In the beginning, the damage on shoots was low, which slowly increased and reached to peak 10.60 per cent during first year and 11.20 per cent during second year in the third and fifth week of September, 2013 and 2014, respectively. Some week after fruit formation, the population of the pest on the shoots gradually declined and disappeared during third and fourth week of October in *kharif* 2013 and 2014, respectively. Similar results were reported by Sharma & Jat (2010) who reported infestation of this pest on shoots of okra in the second week of August and reached to its peak in the last week of September, corroborates the present finding.

The present results got support from the result of Pareek et al. (1986) who reported that attack of shoot borer on okra crop in the first week of August and increased to the maximum during September and declined thereafter but Dhawan & Sidhu (1984) reported maximum damage of spotted bollworm on okra in the end of October, partially support the present findings. The difference in onset of infestation may probably be due to the difference in environmental conditions and date of sowing of crop of the locality. The populations of shoot and fruit borer on shoots of okra crop commenced when weekly

Table 2: Effect of abiotic factors on shoot infestation and their natural enemies during *kharif*, 2014

| SMW | Date of observation | Temperature (°C) | | Mean relative humidity (%) | Total rainfall (mm) | Shoot infestation (%) | Mean population/five plants | |
|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | | | | *Coccinellids* | Green lace wing |
| 31 | 05.08.2014 | 34.3 | 18.1 | 73.1 | 175 | 0.00 | 0.80 | 0.00 |
| 32 | 12.08.2014 | 37.4 | 26.3 | 64.1 | 0.2 | 0.00 | 1.20 | 1.00 |
| 33 | 19.08.2014 | 36.1 | 19.6 | 57.7 | 0 | 2.50 | 3.00 | 2.00 |
| 34 | 26.08.2014 | 38.7 | 20.8 | 47.8 | 0 | 3.80 | 4.20 | 3.20 |
| 35 | 02.09.2014 | 33.1 | 19 | 78.9 | 138 | 4.10 | 4.80 | 4.60 |
| 36 | 09.09.2014 | 34 | 20 | 85.0 | 81.7 | 5.80 | 4.00 | 4.80 |
| 37 | 16.09.2014 | 37.7 | 22.1 | 75.0 | 0 | 8.00 | 5.60 | 3.00 |
| 38 | 23.09.2014 | 37.5 | 23 | 65.9 | 0 | 9.70 | 6.00 | 5.00 |
| 39 | 30.09.2014 | 36 | 23.8 | 56.0 | 0 | 11.20 | 4.20 | 4.20 |
| 40 | 07.10.2014 | 35.6 | 23.2 | 50.6 | 0 | 10.30 | 3.80 | 3.80 |
| 41 | 14.10.2014 | 36.9 | 25.1 | 33.2 | 0 | 7.90 | 2.60 | 3.00 |
| 42 | 21.10.2014 | 34.1 | 20.0 | 43.7 | 0 | 6.00 | 3.00 | 3.20 |
| 43 | 28.10.2014 | 35.6 | 19.1 | 42.30 | 0 | 4.70 | 2.30 | 1.40 |
| Max. temperature (r) | | | | | | NS | NS | NS |
| Min. temperature (r) | | | | | | NS | NS | NS |
| R.H. (r) | | | | | NS | NS | NS | |
| Rainfall (r) | | | | | NS | NS | NS | |

SMW = Standard meteorological week; *Significant at 5 per cent level; NS: Non significant

maximum, minimum temperature, relative humidity and rainfall were 35.5°C, 22.2°C, 62.8 per cent and 42.0 mm, respectively, during 2013 and while 2014 borer commenced at 36.1°C, 19.6°C, 57.70 per cent maximum, minimum temperature and mean relative humidity respectively. The maximum damage (10.60%) was registered at 36.8°C, 24.2°C, 44.3% and 5mm, maximum, minimum temperature mean relative humidity and rainfall during 2013; during 2014 maximum infestation 11.20 per cent was recorded at 36.0°C, 23.2°C and 56.00 per cent, maximum, minimum temperature and relative humidity, respectively.

The correlation coefficient among maximum, minimum temperature and relative humidity had shown non-significant effect with shoot infestation in both the years except correlation between rainfall and shoot infestation (r= -0.72) depicted negative significant correlation in 2013. Rainfall and shoot borer infestation had negative correlation in present finding corroborated with the findings of Aziz et al. (2011) who reported negative correlation with the rainfall.

The fruit borer infestation on fruits started at 37.00°C, 23.50°C, 63.90 per cent and 19.30 mm maximum, minimum temperature, mean relative humidity and rainfall during, 2013 respectively. While during 2014 it was observed at 38.70°C maximum and 20.80°C minimum temperature and 47.80 per cent mean relative humidity (Table 3 and 4).

**Table 3:** Effect of abiotic factors on abundance of shoot and fruit borer, *Earias* spp. infesting okra during *kharif*, 2013

| SMW | Date of observation | Temperature (°C) | | Mean relative humidity (%) | Total rainfall (mm) | Shoot damage (%) | Mean infestation of fruits (%) | |
|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | | | | Number basis | Weight basis |
| 32 | 11.08.2013 | 35.5 | 22.2 | 62.8 | 42.0 | 1.40 | - | - |
| 33 | 18.08.2013 | 33.3 | 21.6 | 80.6 | 51.6 | 2.00 | - | - |
| 34 | 24.08.2013 | 37.0 | 23.5 | 63.9 | 19.3 | 3.20 | 6.00 | 5.00 |
| 35 | 31.08.2013 | 36.0 | 23.7 | 58.7 | 0.0 | 5.10 | 6.50 | 5.15 |
| 36 | 07.09.2013 | 36.3 | 24.6 | 53.2 | 0.0 | 7.80 | 7.20 | 6.00 |
| 37 | 14.09.2013 | 39.2 | 25.1 | 44.3 | 0.0 | 9.00 | 10.10 | 8.70 |
| 38 | 21.09.2013 | 36.8 | 24.2 | 55.8 | 5.0 | 10.60 | 11.90 | 10.20 |
| 39 | 28.09.2013 | 33.4 | 22.0 | 67.9 | 1.0 | 9.50 | 12.80 | 11.30 |
| 40 | 05.10.2013 | 35.6 | 22.3 | 64.7 | 1.0 | 7.10 | 16.70 | 13.90 |
| 41 | 12.10.2013 | 34.7 | 22.0 | 58.7 | 0.0 | 5.80 | 19.00 | 16.50 |
| 42 | 19.10.2013 | 35.9 | 18.2 | 45.6 | 0.0 | 4.10 | 20.90 | 20.00 |
| 43 | 26.10.2013 | 34.6 | 15.1 | 41.1 | 0.0 | 0.00 | 23.60 | 21.55 |
| 44 | 02.11.2013 | 33.3 | 13.1 | 39.5 | 0.0 | 0.00 | 24.50 | 23.50 |
| 45 | 09.11.2013 | 27.1 | 10.8 | 55.0 | 0.0 | 0.00 | 26.13 | 23.80 |
| 46 | 16.11.2013 | 26.7 | 9.3 | 40.4 | 0.0 | 0.00 | 30.00 | 28.70 |
| Max. temperature (r) | | | | | | NS | -0.76* | -0.76* |
| Min. temperature (r) | | | | | | NS | -0.92* | -0.93* |
| R.H. (r) | | | | | NS | -0.56* | -0.57* | |
| Rainfall (r) | | | | | -0.72 | NS | NS | |

SMW = Standard meteorological week; *Significant at 5 per cent level; NS: Non significant

Table 4: Effect of abiotic factors on abundance of shoot and fruit borer, *Earias* spp. infesting okra during *kharif*, 2014

| SMW | Date of observation | Temperature (°C) | | Mean relative humidity (%) | Total rainfall (mm) | Shoot damage (%) | Mean infestation of fruits (%) | |
|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | | | | Number basis | Weight basis |
| 33 | 19.08.2014 | 36.1 | 19.6 | 57.70 | 0 | 2.50 | - | - |
| 34 | 26.08.2014 | 38.7 | 20.8 | 47.80 | 0 | 3.80 | 5.20 | 4.80 |
| 35 | 02.09.2014 | 33.1 | 19 | 78.95 | 138 | 4.10 | 6.60 | 5.20 |
| 36 | 09.09.2014 | 34 | 20 | 85.05 | 81.7 | 5.80 | 8.50 | 7.10 |
| 37 | 16.09.2014 | 37.7 | 22.1 | 75.00 | 0 | 8.00 | 10.00 | 9.00 |
| 38 | 23.09.2014 | 37.5 | 23 | 65.95 | 0 | 9.70 | 12.10 | 11.20 |
| 39 | 30.09.2014 | 36 | 23.8 | 56.00 | 0 | 11.20 | 13.00 | 13.00 |
| 40 | 07.10.2014 | 35.6 | 23.2 | 50.60 | 0 | 10.30 | 17.20 | 14.90 |
| 41 | 14.10.2014 | 36.9 | 25.1 | 33.20 | 0 | 7.90 | 19.50 | 17.20 |
| 42 | 21.10.2014 | 35.6 | 19.1 | 43.70 | 0 | 6.00 | 21.50 | 21.40 |
| 43 | 28.10.2014 | 19.1 | 15.1 | 43.70 | 0.0 | 4.70 | 23.00 | 22.60 |
| 44 | 04.11.2014 | 19.9 | 15.0 | 55.25 | 0.0 | 0.00 | 24.10 | 24.00 |
| 45 | 11.11.2014 | 18.6 | 15.1 | 46.70 | 0.0 | 0.00 | 26.50 | 25.10 |
| 46 | 18.11.2014 | 12.0 | 14.6 | 34.50 | 0.0 | 0.00 | 32.70 | 30.00 |
| Max. temperature (r) | | | | | | NS | -0.81* | -0.81* |
| Min. temperature (r) | | | | | | NS | -0.77* | -0.79* |
| R.H. (r) | | | | | NS | -0.70* | -0.70* | |
| Rainfall (r) | | | | | NS | NS | NS | |

SMW = Standard meteorological week; *Significant at 5 per cent level; NS: Non significant



The correlation coefficient between maximum and minimum temperature and fruit borer infestation both on number and weight basis showed significant negative correlation r= -0.76, -0.76, -0.92 and -0.93 during 2013 and 2014 respectively. The present findings are in agreement with those of Ahmad et al. (2000); Meena (2004a) who also depicted significant negative correlation between maximum temperature and fruit borer infestation. The results of present study are in close agreement with the findings of Choudhary (2002) who also found negative significant correlation between fruit borer infestation and minimum temperature.

A negative significant correlation was depicted between fruit borer infestation both on number and weight basis with relative humidity in both the years of study i.e., 2013 and 2014. Lal (1997); Zala et al. (1999); Mohanasundaram & Sharma (2011) reported negative significant correlation between fruit borer infestation and relative humidity, support to present findings.

The fruit borer infestation depicted non-significant correlation with rainfall in present study in both the year. This result is in agreement with those of Choudhary (2002) who also showed that rainfall had a non-significant correlation with fruit borer infestation both on number and weight basis. Similarly, Sharma & Jat (2010) also observed non-significant correlation with rainfall confirm the present finding.

The populations of predatory lady bird beetle, *C. septempunctata* began in the first week of August with a population of 0.80/ five plant in 2013 and 2014. The incidence of lady bird beetle gradually increased in the

subsequent observations and attained its maximum population in the fourth week of September with a count of 5.80 and 6.00/ five plants in kharif 2013 and 2014, respectively. After attaining the peak, the population of coccinellids started to decline from the last week of September during both the years. Boopathi et al. (2011) observed coccinellids population during the cropping period corroborate the present result. The appearance of Coccinellid on lady finger began at 36.2°C 22.7°C, 68.8 per cent and 5.0 mm, maximum, minimum temperature, mean relative humidity and rainfall during 2013 respectively. While during 2014 the incidence of predators Coccinellid appeared at 34.3°C, 18.1°C, 73.1 per cent and 175 mm, maximum, minimum temperatures, mean relative humidity and rainfall respectively during 2014. The maximum Coccinellid populations was observed at 36.8°C, 24.2°C, 55.8 per cent and 5.00 mm maximum, minimum temperature, mean relative humidity and rainfall respectively in the first year *i.e.*, 2013, and during second year *i.e.*, 2014 the highest population was recorded at 37.5°C maximum and 23.0°C minimum temperature and 65.9 per cent relative humidity. A non-significant correlation was observed among coccinellid population and maximum, minimum temperature, mean relative humidity and rainfall in present findings in both the years, which in conformity with the findings of Meena (2004) who also reported the non-significant correlation among maximum temperature, rainfall and coccinellid population. The incidence of green lacewing with the population of 1.80/ five plant on okra crop started at 33.30°C maximum and 21.6°C minimum temperature, 80.6 per cent mean relative humidity and 51.4 mm rainfall during 2013 and at 37.4°C, 26.3°C, 64.1 per cent and 0.2 mm, maximum, minimum temperature, mean relative humidity and rainfall respectively when population of green lacewing was 1.00/ five plants during 2014.

The incidence of green lacewing attained its peak in the fourth week of September during both the years of study. During 2013 at the time of peak population of green lacewing (4.20/ five plant), maximum and minimum temperature, mean relative humidity and rainfall were 36.8°C, 24.2°C, 55.8 per cent and 5.0 mm, respectively. The incidence of green lacewing increased gradually during 2014, attained its peak population with 5.00 green lacewing/ five plants in 38th SMW, when maximum, minimum temperature and mean relative humidity were, 37.5°C, 23.0°C and 65.9 per cent respectively prevailed. The green lacewing population showed a non-significant correlation with all the abiotic factors in two consecutive years *i.e.*, 2013 and 2014, except with rainfall which depicted a significant negative correlation (r= -0.61) in 2013. Yadav et al. (2009) observed *C. carnea* preying on nymph and adult of *Amrasca biguttula biguttula* corroborate the present findings.

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