Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

Journal of Entomology and Zoology Studies

**E-ISSN: 2320-7078**
**P-ISSN: 2349-6800**
JEZS 2017; 5(6): 1157-1162

Received: 07-09-2017
Accepted: 08-10-2017

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# Seasonable abundance of beet armyworm *Spodoptera exigua* (Hubner) infesting Onion with weather factors in Madurai district of Tamil Nadu

**Arulkumar G, Manisegaran S, Nalini R and Mathialagan M**

**Abstract**
The periodical field surveys were carried out from August 2014 to April 2015 (Season I: Aug to Dec'2014; Season II: Jan to Apr'2015) in five different locations in the farmer's holdings in and around Madurai district. Regardless of the seasons and locations surveyed, *S. exigua* (Hub.) was observed as major insect pests on the onion. The damage by *Spodoptera exigua* was the lowest (8.5%) during the second week of August 2014, reached the maximum of 33.4 per cent during the fourth week of October 2014. Thereafter, it increased gradually and attained the maximum during the first week of October 2014. Later, it declined from the first week of November 2014 onwards. The second peak damage was observed 22.2 per cent during the first week of February 2015 and it was gradually declined from the third week of February 2015. Correlation between mean damages of *S. exigua* and weather factors indicated that the maximum and minimum temperatures showed a significant negative correlation, while the relative humidity exhibited a positive correlation. But rainfall had no effect.

**Keywords:** Onion, beet armyworm, weather factors, population dynamics, correlation

## Introduction
Onion (*Allium cepa L.*) is a major bulbous crop among the cultivated vegetable crops in India. It has an extensive culinary, dietary, therapeutic, trading, income and employment generation value [3]. Onions are also rich in flavonoids and alkenyl cysteine sulphoxides which play a part in preventing heart disease and other ailments in humans [4, 6, 7]. It also contains vitamin B, vitamin C, carbohydrate and the small amount of protein. Onion contributes substantially to the national economy apart from overcoming the local demand [9]. India is the second largest onion producing country. It is grown in an area of 1051.5 ha with the annual production of 16813 MT in India. In Tamil Nadu onion is cultivated in 37.70 ha with a productivity of 429.72 MT [12]. The major onion growing states are Maharashtra, Karnataka, Madhya Pradesh, Bihar, Rajasthan, Gujarat, Andhra Pradesh, Tamil Nadu, Orissa and Uttar Pradesh.
Onion is subjected to the attack by many pests including insect, bacterial and fungal disease [2]. Among various pests that attack onion, *Thrips tabaci* (Lind.) is one of the important insect pest, next to beet armyworm *Spodoptera exigua* (Hub.) is a serious polyphagous, multivoltine pest on onion, asparagus, cabbage, pepper, tomato, lettuce, celery, strawberry, eggplant, sugar beet, alfalfa, cotton and some flower crops [5]. The infestation of beet armyworm during the initial stages scrapping of the inner layer of the leaves [13]; later stages, young larvae of *S. exigua* feed gregariously and resulting in skeletonization, while matured larvae eat voraciously and produce irregular holes in foliage with frass [14] (Plate 1).
The severity of beet armyworm is greatly influenced by abiotic factors. Climatic conditions largely influence the pest numbers and activity as well as several predators and parasites either directly or indirectly [1]. For developing a weather-based pest forewarning system, information regarding population dynamics in relation to prevalent meteorological parameters (temperature, relative humidity, sun shine hours, rainfall *etc*.) is needed. Moreover, the same meteorological parameters also influence the growth and development of the crop. Therefore, a thorough understanding of the interaction between the crop growth stage and weather parameters/pest dynamics is a pre requisite for weather-based pest forecasting model. Hence, the present studies were focused on location-specific seasonal occurrence of onion beet armyworm and its relation with weather factors which is of great significance in formulating efficient pest management tactics.

## Materials and methods

Periodical field surveys were carried out from August 2014 to December 2014 (Season I) and January 2015 to April 2015 (Season II) in five different locations *viz.*, Thadagoundanpatti, Kovilur, Kondayampatti, Periya Ilanthaikulam and Kuttimeikampatti in the farmer's holdings from in and around Madurai district. The experiment was laid out in Randomized Block Design (RBD) with five replications. The plot size for each treatment was 5 x 4 m (20 $m^2$) plots. The bulbs were sown at a spacing of 20 x 12 cm. The variety selected for the study was CO 4. Due care was taken to keep these experimental plots devoid of any pesticide spray during the experimental period. The observation on the infestation of beet armyworm was recorded at weekly intervals on ten randomly selected plants from each location in the farmer's fields. The per cent infestation due to armyworm was worked out based on the following formula,

$$\text{Per cent infestation} = \frac{\text{Number of infested leaves}}{\text{Total number of leaves}} \times 100$$

Data on the weather parameters *viz.*, maximum and minimum temperatures ($^0$C), relative humidity (%) and rainfall (mm) were also recorded and these weather parameters were correlated with the onion beet armyworm damage. Microsoft Office Excel 2007 was used to conduct the statistical analysis of simple correlation coefficients.

## Results and Discussion

### Population fluctuation of *S. exigua*

Research results revealed that the damage caused by *S. exigua* was significantly different in all the locations. The highest mean damage of 25.01 per cent was recorded in Thadagoundanpatti followed by 19.48 per cent in Periya Ilanthaikulam. The damage in the rest of the three locations *viz*., Kovilur (16.63%), Kuttimeikampatti (15.89%) and Kondayampatti (15.72%) were on par with each other (Table 1 and Fig. 1). Among different periods of observation, a maximum of 33.4 per cent damage was noticed during the fourth week of October, 2014 in Thadagoundanpatti, while a minimum of 8.5 per cent was noticed during the second week of August 2014 in Kondayampatti (Fig. 2). The data on mean per cent damage during the second season ranged from 12.08 to 15.30 and were significantly different from each other in all the locations (Table 3 & Fig. 1). Among the locations, Periya Ilanthaikulam showed the highest damage by *S. exigua* (15.30%) and the lowest 12.08 per cent in Kovilur. Thadagoundanpatti has recorded 14.57 per cent, while the mean damage in Kuttimeikampatti (13.73%) and Kondayampatti (13.54%) was on par with each other. Between periods, a maximum of 22.2 per cent damage was noticed during the first week of February 2015 in Thadagoundanpatti, while a minimum of 7.1 per cent was noticed during the third week of April 2015 in Kovilur (Fig. 3). *S. exigua* damage steadily increased during the rainy season from mid-August to mid- October 2014 (Season -I). The present finding was in conformity with Kasan *et al.* [8], Monobrullah *et al.* [10], Nadaf and Kulkarni [11], Vinoth [17] who observed that the incidence of *Spodoptera* sp. on cabbage steadily increased in mid-August and reached its peak in mid-October. During the second season, the peak incidence of *S. exigua* (22.2%) was observed during the first week of February in Thodagoundanpatti. This is in conformity with Selvamuthukumar [15], who reported that the *Spodoptera* sp. peak incidence was noticed during the 6$^{th}$ standard week of February in onion.

### Correlation between *S. exigua* infestation and meteorological parameters

Correlation between the damage by *S. exigua* and weather factors showed that both the maximum and minimum temperatures had a significant negative correlation, while relative humidity alone showed a significant positive correlation in all the locations. Rainfall did not have any effect on *S. exigua* damage (Table 2 & 4). Similar findings have been reported by Vinoth [17], that both maximum and minimum temperatures have a negative correlation, while the relative humidity showed a positive correlation with *S. litura* on cabbage. Selvaraj *et al*. [16] also found that relative humidity had the positive association with *S. litura* respectively in cotton. This is also in agreement with the present findings. Selvaraj *et al*. [16] also noticed that rainfall was negatively correlated with the *S. litura*. This was not in line with the present result.

**Table 1:** Seasonal incidence of *S. exigua* in different locations (Season-I)

| | Damage (%)* | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | August'14 | | | September'14 | | | | October'14 | | | | November'14 | | | | December'14 | | | | Mean |
| | II week ($P_1$) | III week ($P_2$) | IV week ($P_3$) | I week ($P_4$) | II week ($P_5$) | III week ($P_6$) | IV week ($P_7$) | I week ($P_8$) | II week ($P_9$) | III week ($P_{10}$) | IV week ($P_{11}$) | I week ($P_{12}$) | II week ($P_{13}$) | III week ($P_{14}$) | IV week ($P_{15}$) | I week ($P_{16}$) | II week ($P_{17}$) | III week ($P_{18}$) | IV week ($P_{19}$) | |
| $L_1$ | 12.5 (20.70)$^c$ | 10.9 (19.28)$^c$ | 11.3 (19.64)$^c$ | 13.1 (21.22)$^c$ | 14.6 (22.46)$^d$ | 13.8 (21.81)$^d$ | 15.2 (22.95)$^d$ | 14.5 (22.38)$^d$ | 18.3 (25.33)$^c$ | 23.2 (28.79)$^c$ | 22.7 (28.45)$^c$ | 21.1 (27.35)$^c$ | 19.3 (26.06)$^c$ | 20.2 (26.71)$^c$ | 21.7 (27.76)$^c$ | 19.7 (26.35)$^c$ | 17.5 (24.73)$^c$ | 14.9 (22.71)$^b$ | 11.4 (19.73)$^d$ | 16.63 (24.06)$^c$ |
| $L_2$ | 15.3 (23.03)$^b$ | 13.5 (21.56)$^b$ | 14.7 (22.54)$^b$ | 16.2 (23.73)$^b$ | 18.6 (25.55)$^b$ | 16.3 (23.81)$^b$ | 18.5 (25.47)$^b$ | 17.7 (24.88)$^b$ | 20.1 (26.64)$^b$ | 23.3 (28.86)$^c$ | 26.6 (31.05)$^b$ | 24.8 (29.87)$^b$ | 21.3 (27.49)$^b$ | 23.1 (28.73)$^b$ | 24.9 (29.93)$^b$ | 22.2 (28.11)$^b$ | 20.3 (26.78)$^b$ | 17.5 (24.73)$^b$ | 15.3 (23.03)$^b$ | 19.48 (26.19)$^b$ |
| $L_3$ | 19.6 (26.28)$^a$ | 17.2 (24.50)$^a$ | 19.5 (26.21)$^a$ | 20.9 (27.20)$^a$ | 23.1 (28.73)$^a$ | 20.7 (27.06)$^a$ | 23.5 (29.00)$^a$ | 22.3 (28.18)$^a$ | 26.1 (30.72)$^a$ | 30.6 (33.58)$^a$ | 33.4 (35.30)$^a$ | 31.7 (34.27)$^a$ | 28.2 (32.08)$^a$ | 30.5 (33.52)$^a$ | 31.3 (34.02)$^a$ | 28.7 (32.39)$^a$ | 26.1 (30.72)$^a$ | 22.2 (28.11)$^a$ | 19.6 (26.28)$^a$ | 25.01 (30.01)$^a$ |
| $L_4$ | 9.6 (18.05)$^d$ | 11.3 (19.64)$^c$ | 9.1 (17.56)$^d$ | 12.4 (20.62)$^d$ | 15.3 (23.03)$^c$ | 14.5 (22.38)$^c$ | 16.1 (23.66)$^c$ | 15.7 (23.34)$^e$ | 17.2 (24.50)$^c$ | 23.6 (29.06)$^b$ | 19.4 (26.13)$^d$ | 18.3 (25.33)$^d$ | 17.5 (24.73)$^e$ | 18.2 (25.25)$^d$ | 20.3 (26.78)$^d$ | 19.1 (25.91)$^d$ | 17.5 (24.73)$^c$ | 14.2 (22.14)$^c$ | 12.6 (20.79)$^c$ | 15.89 (23.49)$^c$ |
| $L_5$ | 8.5 (16.95)$^e$ | 9.1 (17.56)$^d$ | 10.3 (18.72)$^d$ | 12.6 (20.79)$^d$ | 13.2 (21.30)$^e$ | 15.7 (23.34)$^b$ | 14.4 (23.30)$^c$ | 16.1 (23.66)$^c$ | 19.5 (26.21)$^b$ | 20.3 (26.78)$^d$ | 21.7 (27.76)$^c$ | 19.1 (25.91)$^d$ | 17.9 (25.03)$^d$ | 20.1 (26.64)$^c$ | 19.3 (26.06)$^e$ | 18.8 (25.70)$^d$ | 15.2 (22.95)$^d$ | 14.7 (22.54)$^b$ | 12.2 (20.44)$^c$ | 15.72 (23.36)$^c$ |

**$L_1$**- Kovilur, **$L_2$**- Periya Ilanthaikulam, **$L_3$**- Thadagoundanpatti, **$L_4$**-Kuttimeikampatti, **$L_5$**- Kondayampatti

$P_1$ to $P_{19}$-Periods

*Mean of ten observations

Figures in parentheses are arc sine transformed values

Mean in a column followed by same letter(s) are not significantly different by (P=0.05) LSD

**Table 2:** Correlation between *S. exigua* damage and weather factors (Season-I)

| Location | Damage (%) | Temperature | | Relative Humidity (%) | Rainfall (mm) |
|---|---|---|---|---|---|
| | | Maximum ($^0$C) | Minimum ($^0$C) | | |
| Kovilur | 16.63 | -0.699** | -0.532* | 0.663** | 0.274 $^{NS}$ |
| Periya Ilanthaikulam | 19.48 | -0.675** | -0.561* | 0.600** | 0.329 $^{NS}$ |
| Thadagoundanpatti | 25.01 | -0.686** | -0.566* | 0.616** | 0.286 $^{NS}$ |
| Kuttimeikampatti | 15.89 | -0.709** | -0.510* | 0.613** | 0.166 $^{NS}$ |
| Kondayampatti | 15.72 | -0.650** | -0.505* | 0.597** | 0.237 $^{NS}$ |

Correlation Co-efficient 1% = 0.496 5% = 0.388

* - Significant at 5% level ** -Significant at 1% level NS - Non Significant

**Table 3:** Seasonal incidence of *S. exigua* in different locations (Season-II)

| Location | Damage (%)* | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January'15 | | | | February'15 | | | | March'15 | | | | April'15 | | | | Mean |
| | I week ($P_1$) | II week ($P_2$) | III week ($P_3$) | IV week ($P_4$) | I week ($P_5$) | II week ($P_6$) | III week ($P_7$) | IV week ($P_8$) | I week ($P_9$) | II week ($P_{10}$) | III week ($P_{11}$) | IV week ($P_{12}$) | I week ($P_{13}$) | II week ($P_{14}$) | III week ($P_{15}$) | IV week ($P_{16}$) | |
| Kovilur | 13.8 (21.81)$^b$ | 11.2 (19.55)$^d$ | 13.5 (21.56)$^d$ | 15.6 (23.26)$^c$ | 14.1 (22.06)$^d$ | 15.3 (23.03)$^d$ | 16.5 (23.97)$^d$ | 14.7 (22.54)$^d$ | 12.8 (20.96)$^d$ | 10.5 (18.91)$^d$ | 11.7 (20.00)$^c$ | 9.2 (17.66)$^d$ | 10.4 (18.81)$^c$ | 8.5 (16.95)$^b$ | 7.1 (15.45)$^d$ | 8.3 (16.74)$^d$ | 12.08 (20.33)$^d$ |
| Periya Ilanthaikulam | 14.1 (22.06)$^a$ | 17.3 (24.58)$^a$ | 16.5 (23.97)$^a$ | 15.8 (23.42)$^c$ | 18.1 (25.18)$^b$ | 19.6 (26.28)$^{ab}$ | 17.7 (24.88)$^c$ | 18.3 (25.33)$^b$ | 16.8 (24.20)$^a$ | 14.1 (22.06)$^a$ | 13.5 (21.56)$^b$ | 14.2 (22.14)$^a$ | 12.8 (20.96)$^a$ | 9.3 (17.76)$^a$ | 12.1 (20.36)$^a$ | 14.6 (22.46)$^a$ | 15.30 (23.03)$^a$ |
| Thadagoundan patti | 13.4 (21.47)$^{bc}$ | 14.7 (22.54)$^c$ | 15.6 (23.26)$^b$ | 17.9 (25.03)$^a$ | 22.2 (28.11)$^a$ | 20.2 (26.71)$^a$ | 17.4 (24.65)$^{cd}$ | 18.9 (25.77)$^a$ | 15.6 (23.26)$^b$ | 13.3 (21.39)$^b$ | 13.7 (21.72)$^a$ | 11.4 (19.73)$^c$ | 9.2 (17.66)$^d$ | 7.7 (16.11)$^d$ | 10.6 (19.00)$^b$ | 11.3 (19.64)$^b$ | 14.57 (22.44)$^b$ |
| Kuttimeikampatti | 13.9 (21.89)$^b$ | 16.3 (23.81)$^b$ | 14.5 (22.38)$^c$ | 13.8 (21.81)$^d$ | 16.1 (23.66)$^c$ | 17.6 (24.80)$^b$ | 19.7 (26.35)$^a$ | 16.3 (23.81)$^c$ | 14.8 (22.63)$^{bc}$ | 12.1 (20.36)$^c$ | 11.5 (19.82)$^{cd}$ | 12.2 (20.44)$^b$ | 10.8 (19.19)$^b$ | 8.3 (16.74)$^c$ | 10.1 (18.53)$^c$ | 11.6 (19.91)$^b$ | 13.73 (21.74)$^c$ |
| Kondayampatti | 12.9 (21.05)$^d$ | 13.5 (21.56)$^c$ | 15.1 (22.87)$^b$ | 17.4 (24.65)$^b$ | 15.6 (23.26)$^c$ | 16.9 (24.27)$^c$ | 19.4 (26.13)$^{ab}$ | 18.7 (25.40)$^b$ | 15.1 (22.87)$^b$ | 12.8 (20.96)$^c$ | 13.2 (21.30)$^b$ | 10.5 (18.91)$^c$ | 8.7 (17.15)$^e$ | 7.2 (15.56)$^e$ | 10.1 (18.72)$^c$ | 9.5 (17.95)$^c$ | 13.54 (21.59)$^c$ |

$P_1$ to $P_{16}$-Periods

*Mean of ten observations

Figures in parentheses are arc sine transformed values

Mean in a column followed by same letter(s) are not significantly different by (P=0.05) LSD

**Table 4:** Correlation between *S. exigua* damage and weather factors (Season-II)

| Location | Damage (%) | Temperature | | Relative Humidity (%) | Rainfall (mm) |
|---|---|---|---|---|---|
| | | Maximum ($^0$C) | Minimum ($^0$C) | | |
| Kovilur | 12.08 | -0.559* | -0.652** | -0.390 NS | -0.402 NS |
| Periya Ilanthaikulam | 15.30 | -0.538* | -0.658** | -0.424 NS | -0.371 NS |
| Thadagoundanpatti | 14.57 | -0.557* | -0.661** | -0.431 NS | -0.365 NS |
| Kuttimeikampatti | 13.73 | -0.524* | -0.774** | -0.457 NS | -0.417 NS |
| Kondayampatti | 13.54 | -0.532* | -0.723** | -0.471 NS | -0.396 NS |

Correlation Co-efficient 1% = 0.496 5% = 0.388

* - Significant at 5% level ** -Significant at 1% level NS - Non Significant


Plate 1. Symptoms of damage

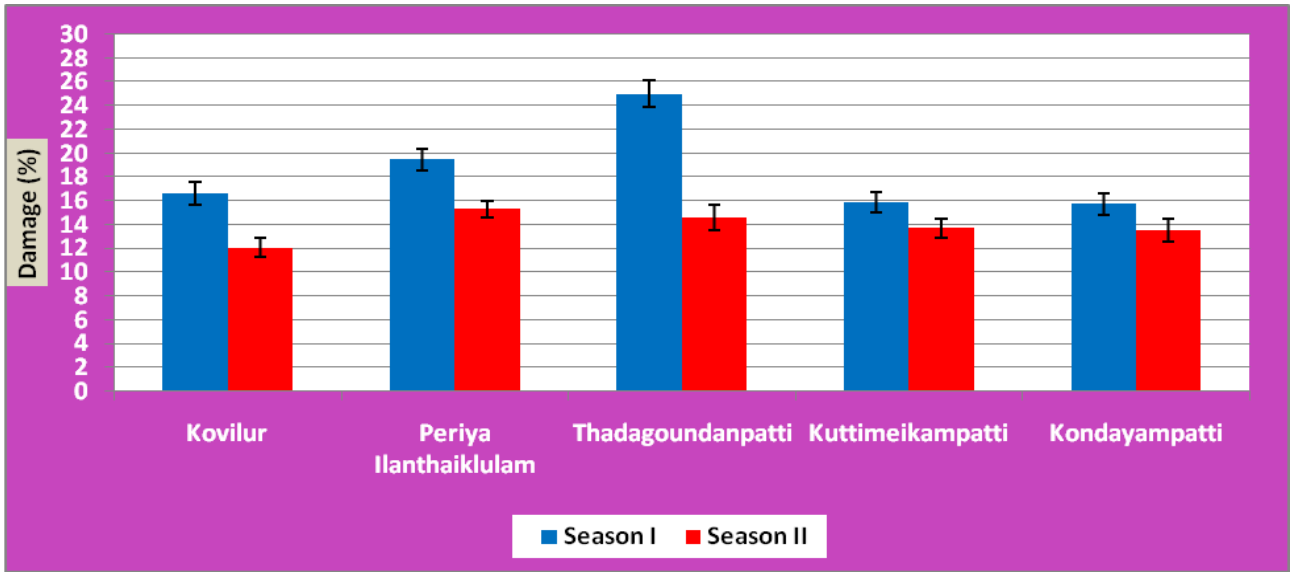


**Fig 1:** Seasonal incidence of *S. exigua* in diferent locotions (Season I & II)

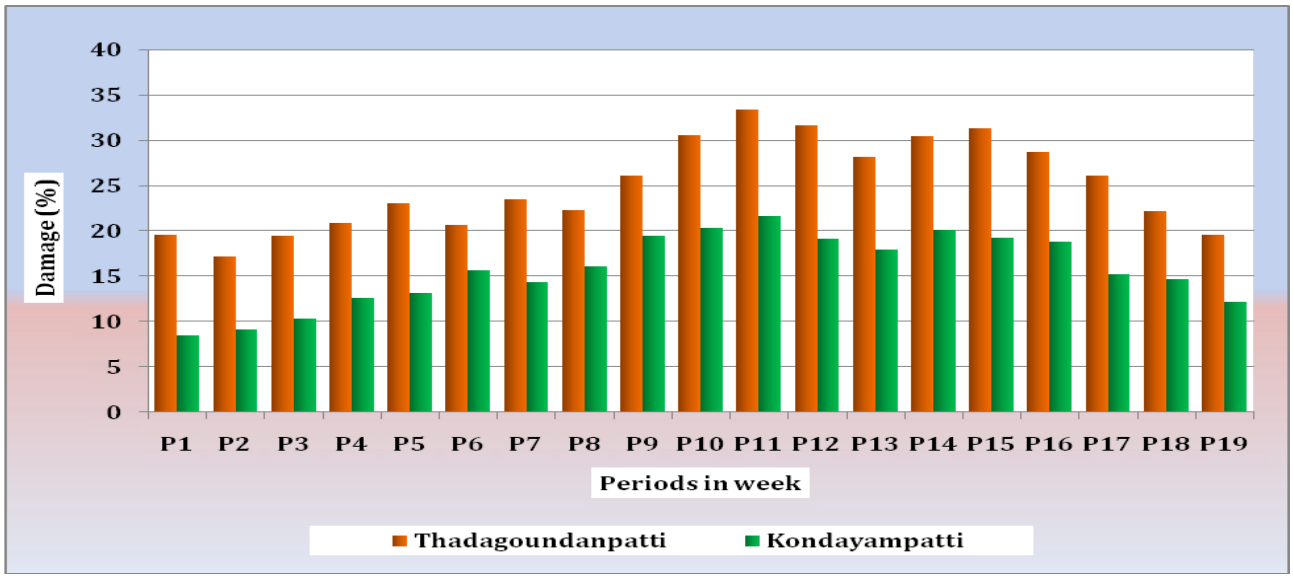


**Fig 2:** Damage potential of *S. exigua* in different periods (Season I)

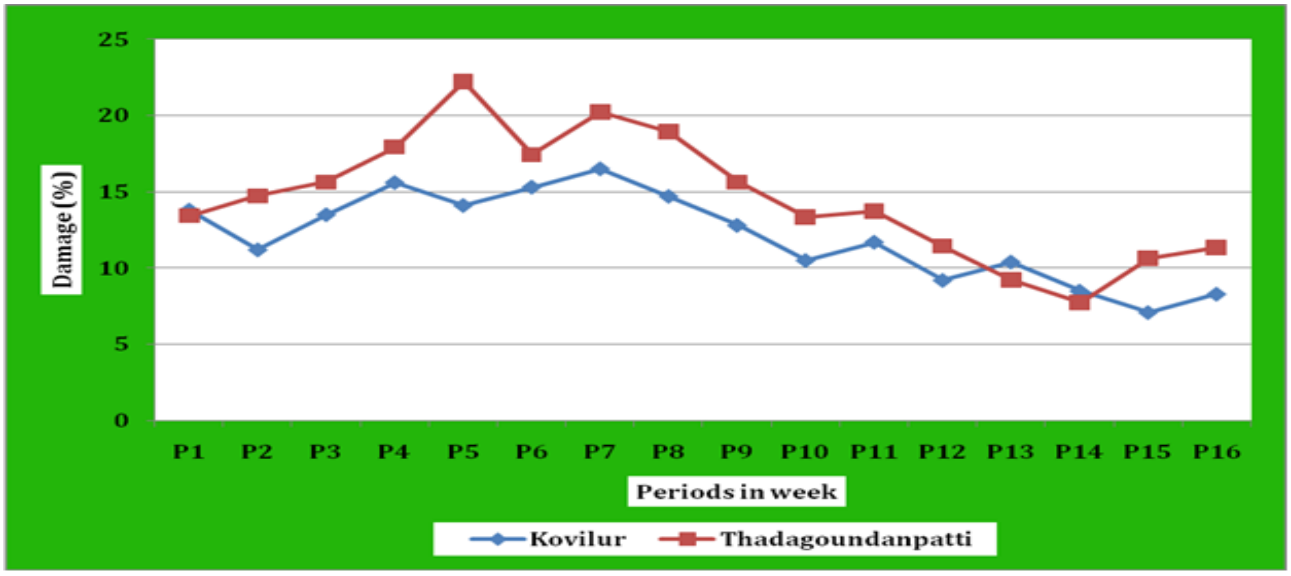


**Fig 3:** Damage potential of *S. exigua* in different periods (Season II)

## Conclusion

The present study opined that beet armyworm, *S. exigua* damage was found on August 2014 to April 2015 in all the five locations of Madurai district. The damage caused by the beet armyworm found to be highest during the fourth week of October (33.4%) and the first week of February (22.2%). The temperature had the negative influence on the damage of beet armyworm while humidity had the positive influence on them. This will help us in scheduling management strategies in onion crop against beet armyworm.

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