Journal of Entomology and Zoology Studies 2017; 5(4): 1520-1525

Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(4): 1520-1525

Received: 24-05-2017
Accepted: 25-06-2017

Kalaiyarasi L
Department of Zoology, Madras Christian College, Chennai, Tamil Nadu, India

Ananthi Rachel Livingstone
Department of Zoology, Madras Christian College, Chennai, Tamil Nadu, India

Madhanagopal R
Department of Statistics, Madras Christian College, Chennai, Tamil Nadu, India

Correspondence
Ananthi Rachel Livingstone
Department of Zoology, Madras Christian College, Chennai, Tamil Nadu, India

Effect of Weather Parameters on the incidence of different life stages of a serious pest *H. vigintioctopunctata* (Fab.) on Brinjal in Chennai locality, India

Kalaiyarasi L, Ananthi Rachel Livingstone and Madhanagopal R

Abstract
The pest population of *H. vigintioctopunctata* varies from region to region based on their climatic conditions and shows different peak activity in different locations. The present study was carried out to know the actual infestation rate of Epilachna population and effects of weather parameters on the growth of its population. For this study, a well-designed pesticide free plot was formulated and its major host plant *S. melongena* variety was grown well. Different stages of pest population and its relationship associated with weather parameters were also noted. The peak incidence of mean egg population was 14.83 when the mean minimum and maximum temperature, both morning and evening relative humidity and weekly pressure were recorded as 29.5ºC, 39.5ºC, 61.8%, 56.4 % and 1007mbar. When the peak incidence of mean grub population was 25.80, the mean weather parameters were 31.0 ºC, 39.8 ºC, 50.5%, 44.5% and 1003mbar respectively. Similarly, when the peak incidence of the mean pupal population was 4.86, the mean weather parameters were 30.2 ºC, 35.4 ºC, 52.5%, 48.7%, 1005mbar. Likewise, when the peak incidence of the mean adult beetle population was 12.5, the mean weather parameters were 30.2 ºC, 38.1 ºC, 53.2%, 48.7% &1005mbar. Thus, from this study, the different life stages of Epilachna beetle is positively correlated with (minimum, maximum and mean) temperature and negatively correlated with (morning, evening and mean) relative humidity and mean pressure.

Keywords: *H. vigintioctopunctata*, peak incidence, *S. melongena*, weather parameters

1. Introduction

Insects are poikilothermic animals that are largely affected by various environmental factors [1]. Among all the climatic factors, the temperature has probably the greatest effect on insect development [2]. The temperature influences various biological characteristics of insects such as sex ratio, adult life span, survival, fecundity and fertility [3-6]. As a result, temperature profoundly affects colonization, distribution, abundance, behavior, life history, and fitness of insects [7-10]. Beetles belonging to *Epilachninae*, constitute one sixth of the known species of the family Coccinellidae. The genus *Epilachna* has nearly 500 phytophagous species, and is widely distributed in South East Asia, Australia, Sri Lanka, East Indies, Malaya, America, Siberia, China and India. In India, the beetle is present in higher hills and in plains of Jammu and Kashmir, Punjab, Himachal Pradesh, Utter Pradesh, Karnataka, Bengal, Tamilnadu and also in the plains of other regions [11, 12].

Henosepilachna vigintioctopunctata is one of a group of closely related herbivorous ladybird beetles that have diversified greatly in external morphology and host plant use in and around Indian sub-continent. It is a polyphagous plant feeder and destructive pest of many cultivated and wild crops belonging to Solanaceae, Cucurbitaceae, Fabaceae, Convolvulaceae and Malvaceae families such as brinjal, tomato, potato, tobacco, melon, cucumber, gourds, and pumpkin in Jammu and Kashmir and in other parts of India [13, 14]. Thus, *Henosepilachna vigintioctopunctata* is a very important pest in Asia that commonly attacks solanaceous plants. Both the grubs and adult of the pest scrap the green matter of leaf in a characteristic manner and skeletonize the leaves. The affected leaves drop prematurely resulting in retardation of the plant growth and thereby reduce the bearing of the plants [15]. Brinjal *Solanum melongena* L. is an important crop of sub-tropics and tropics. The fruits contain low in calories and fats, mostly water, some protein, fiber and carbohydrates. It is one of the frequently grown vegetable crops in large amounts in India. It is adapted to a wide range of climatic conditions [16]. In India, brinjal is cultivated since last 4000 years and food production accounted as 8.7 million MTs with an area of 0.53 million hectares. The prominent species of brinjal refer to *S. melongena, S. aethiopicum* and *C.* macrocarpum are interfertile with their respective wild ancestors [17]. Although several varieties of brinjal are cultivated, the expected yield of the crop is not achieved so far because of the crop damage caused by the insect pests. Insect pests are most limiting factors for accelerating crop yield. The brinjal is attacked by a variety of insect pests such as fruit and stem borers, defoliators, cell sap suckers, stem girdlers, etc. During different stages of its growth in most of the tropical countries including India, the incidence of these pests varies from season to season depending upon environmental factors [18, 19]. In recent years researchers have dealt with powerful, novel, target-selective, and environment-friendly pesticides to control the pest. There are more studies on *H. vigintioctopunctata* to control its infestation [20-23]. The environmental factors pertaining to pest population gives an idea as to when the pesticides could be applied in the field [24]. Information on the incidence of *H. vigintioctopunctata* in this region is very low. The present study was undertaken, to understand the pest status, and also to investigate the effect of temperature, relative humidity and pressure on the population of this insect pest of brinjal in an unsprayed condition.

2. Materials and Methods

Studies were conducted at the Madras Christian College Farm, Madras Christian College, Tambaram, Chennai, Tamil Nadu during the summer season from March to June 2017. *Solanum melongena* variety BM–102–3 was sown on the 4th week of March (22/3/17) at a spacing of 60 x 60cm in the plot size of 33m x 7.5m^2. The infestation of the pest on the plants was noted from the 15th day after the crops were sown. The data was collected from this unsprayed plot which was subdivided into 5 plots. For the present study, around 50 plants were screened from each plot. Thus 250 plants were examined widely to know the actual percentage of infestation in the field.

Observations on the pest population ware recorded at weekly intervals in the early morning hours on the selected 50 plants, from each replicated plots, on the basis of the number of eggs, grubs, pupae and adult per plant throughout the period of study. Similarly, the data of important weather parameters namely temperature (minimum, maximum, & mean), relative humidity (morning, evening & mean) and pressure (mean) were obtained. Correlation co-efficient was worked out between the number of eggs, grubs, pupae and adult Epilachna beetle with the important parameters namely, temperature, relative humidity and pressure during the period to find out the effect of physical factors on the population dynamics of that particular pest in a pesticide free plot.

3. Results

The present study was designed to monitor the effect of temperature and relative humidity and pressure on the population of different stages of one of the major pest on brinjal. The incidence of *H. vigintioctopunctata* is found active throughout the year. The extent of damage and incidence of the different stages of the pest varied over the period of study in every plot (Table 1). Observation on measurement revealed that the infestation of the insect pest *H. vigintioctopunctata* started from the 2nd meteorological week of crop sowing.

During this study, the incidence of egg population was started from 2nd MW (05/04/2017). Analysis of pooled mean data for the incidence of egg population revealed that low level of the population was recorded on 2nd MW & was about 0.74, 2.0, 1.36 (eggs/50 plants) respectively in plot1, plot 4 and 5. No more egg population was recorded on plot 2&3. The average of total egg population in all the plots during the starting period was about 0.82 (Table 3). Thereafter the egg population has been increased gradually in every meteorological week and reached the peak activity on 8th MW to about 25.16, 14.04, 15.0, 13.48, 6.48 respectively when the average minimum and maximum temperature, morning and evening relative humidity and weekly pressure were 29.5ºC, 39.5ºC, 61.8%, 56.4 % and 1007.1mbar (Table 2). The mean of total egg population for all the plots during the peak activity was about 14.83 respectively. Further, the incidence of egg population was gradually decreased and finally reached zero level on 12th and 13th meteorological weeks.

The activity of grub population started from the 3rd meteorological week (12/04/2017). The mean value for the incidence of grub population was recorded during 3rd MW was about to be 0.14 and 0.14 (eggs/50 plants) in plot 1 and 5. No grub population was found on the plots 2, 3 &4. The average of total grub population in all the plots during the starting period was about 0.05 (Table 3). Similarly, then the grub population was gradually increased during every meteorological week. The peak incidence of grub population noted on 10th MW was about 37.44, 35.08, 21.62, 12.06, 22.82 respectively when the average minimum and maximum temperature, morning and evening relative humidity and weekly pressure would be 31.0 ºC, 39.8 ºC, 50.5%, 44.5% and 1003.5mbar (Table 2). The average grub population for all the plots during the peak period was about 25.80 respectively. Simultaneously, the grub population completely dropped down in a few weeks.

The pupal population started to appear only from 4th MW. Till that all the plots showed zero number of pupal populations. During the 4th MW, among 5 plots, only one plot showed the pupal population to be about 0.04 respectively (Table 1). Except plot 4 all the others showed zero activity. The average of the total pupal population in all the plots during the starting period was about 0.008 (Table 3). The peak activity of pupal population was noted on the 11th meteorological week. The average population in all the plots were 9.98, 6.24, 2.76, 2.12, and 3.22 when the weather parameters such as minimum and maximum temperature were 30.2 ºC, 35.4 ºC, morning and evening relative humidity were 52.5%, 48.7% and the pressure was 1005.8mbar (Table 2). The average pupal population for all the plots during the peak period was about 4.86. The population has been found to decrease day by day.

The adult stage of Epilachna beetle was found throughout the period of study in all the plots. Except for other 4 plots, plot no 4 showed 0.02 adult populations during the starting period of study as 2nd MW (Table 1). Average adult population for all the plots during the starting period was 0.008. Then the population level has been increased regularly and showed the peak activity on the 12th meteorological week. The average population in all the plots were 14.90, 14.36, 11.22, 11.66, 10.36 respectively when the minimum and maximum temperature, relativity humidity for morning and evening and pressure was about 30.2 ºC, 38.1 ºC, 53.2%, 48.7% &1005.8mbar. The average adult activity for all the plots during the peak period was 12.5. Thereafter the population started to decrease.

Correlation studies between weekly mean populations of egg, grub, pupa and adult stages of Epilachna beetle and important weather parameters revealed that population of every stage of Epilachna beetle was positively correlated with mean, minimum & maximum temperature and is negatively correlated with mean, morning and evening relative humidity and with pressure (Table 4). Therefore, it could be understood that the pest is most active when the temperature is at its peak. The higher the temperature there is an increase in pest population and lowers the temperature there is a decrease in the pest population.

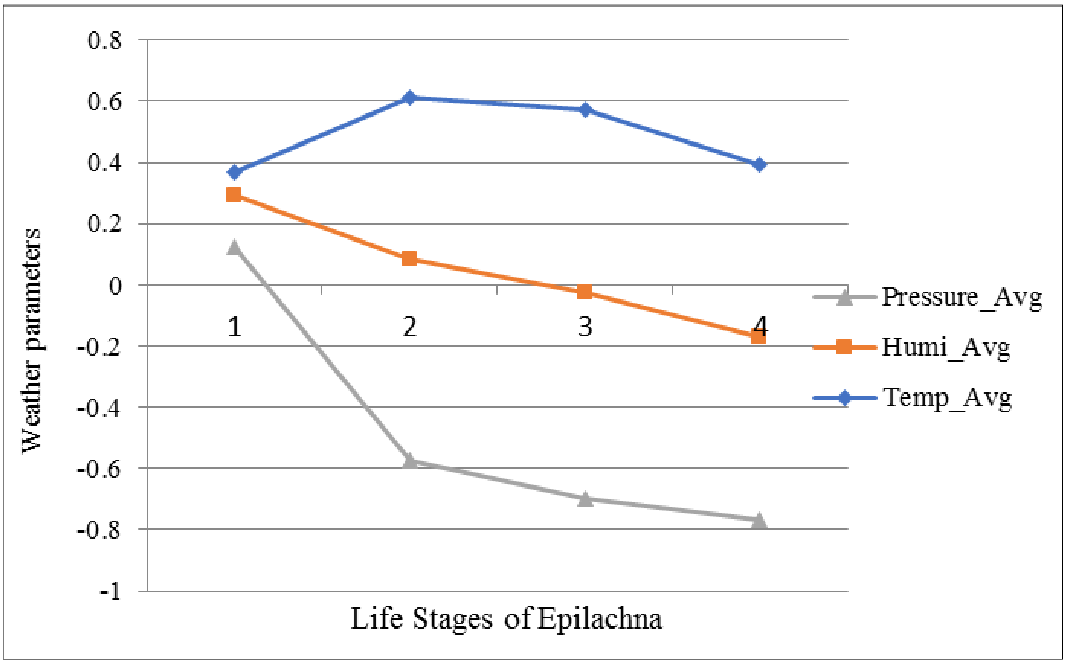

Fig.1 The graphical representation of the correlation between weather parameters and the incidence of the pest population.

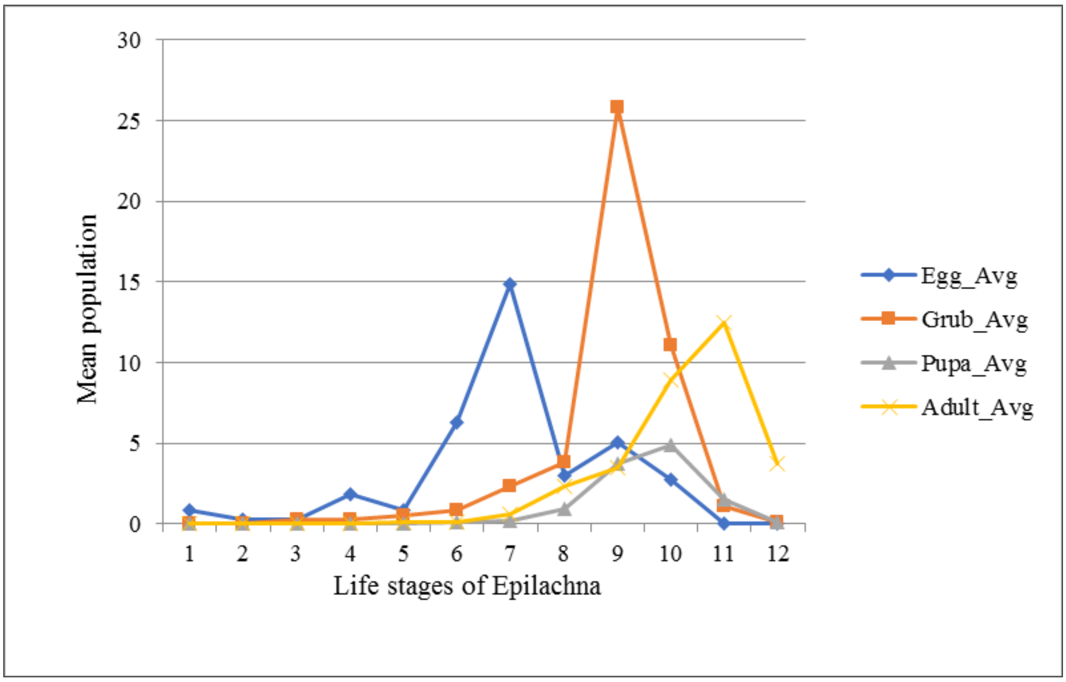

Fig 2. The incidence of different life stages of Epilachna beetles population during the study period in the region of Chennai

Table 1: Correlation between important parameters and the incidence of different stages of *H. vigintioctopunctata*.

S. No	Life stages of pest	Temperature (°C)			Relative Humidity (%)			Pressure (Mean)
		Minimum	Maximum	Mean	Morning	Evening	Mean	
1	Egg	0.293	0.408	0.370	-0.013	-0.166	-0.078	-0.168
2	Grub	0.660	0.542	0.610	-0.390	-0.581	-0.524	-0.661
3	Pupa	0.663	0.473	0.571	-0.451	-0.647	-0.596	-0.675
4	Adult	0.534	0.268	0.394	-0.349	-0.746	-0.562	-0.598

Table 2: Mean±Standard Deviation (n=50) values for the incidence of total pest population of selected 50 plants grown in each replicated plots during every meteorological week.

MW	Egg(mean±S.D)					Grub(mean±S.D)					Pupa(mean±S.D)					Adult(mean±S.D)				
	plot 1	plot2	plot3	plot4	plot5	plot1	plot2	plot3	plot4	plot5	plot1	plot2	plot3	plot4	plot5	plot1	plot2	plot3	plot4	plot5
2mw	0.74±5.23	0.00	0.00	2.0±7.59	1.36±5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02±0.14	0.00
3mw	0.44±3.11	0.00	0.00	0.00	0.82±5.79	0.14±0.98	0.00	0.00	0.00	0.14±0.70	0.00	0.00	0.00	0.00	0.00	0.02±0.14	0.00	0.02±0.14	0.00	0.00
4Mw	0.86±6.08	0.00	0.00	0.32±2.26	0.12±0.84	0.58±4.10	0.00	0.00	0.62±3.01	0.00	0.00	0.00	0.00	0.04±0.28	0.00	0.20±0.14	0.00	0.00	0.00	0.02±0.14
5mw	2.38±7.26	1.60±6.14	3.20±7.17	1.04±3.39	0.82±4.15	0.54±2.48	0.00	0.00	0.52±2.69	0.08±0.56	0.00	0.00	0.00	0.04±0.28	0.00	1.60±6.14	0.02±0.14	0.02±0.14	0.02±0.14	0.00
6mw	2.04±6.33	1.26±7.59	0.96±2.89	0.18±1.27	0.00	0.24±1.55	2.08±8.93	0.00	0.00	0.14±0.75	0.04±0.19	0.00	0.00	0.00	0.00	0.14±0.40	0.00	0.00	0.20±0.63	0.00
7mw	7.0±17.80	2.0±9.90	3.62±14.50	17.66±25.01	1.24±6.93	2.22±7.66	1.04±5.77	0.00	1.10±4.44	0.00	0.80±0.39	0.34±2.01	0.00	0.00	0.00	0.14±0.40	0.08±0.44	0.06±0.31	0.16±0.54	0.06±0.31
8mw	25.16±30.22	14.04±25.59	15.0±26.51	13.48±23.67	6.48±18.27	1.46±4.36	2.28±11.24	2.70±6.92	2.52±7.84	2.50±9.57	0.00	0.00	0.00	1.04±6.66	0.00	1.22±2.83	0.82±1.64	0.32±0.62	0.60±0.98	0.16±0.54
9mw	6.80±17.38	2.69±11.80	3.09±12.19	4.86±14.75	1.44±7.98	5.32±16.0	5.06±19.23	3.04±11.41	2.10±6.36	3.21±13.04	0.29±1.26	0.49±2.29	0.43±2.12	0.68±3.15	0.63±2.76	0.58±1.74	0.35±1.92	0.59±2.37	0.66±2.23	0.50±2.29
10mw	15.82±21.90	2.64±11.36	1.98±7.55	4.20±13.32	0.68±4.80	37.44±27.86	35.08±41.41	21.62±24.57	12.06±10.55	22.82±28.96	2.24±2.88	3.58±5.25	3.46±5.11	4.36±4.42	5.04±6.30	3.14±2.74	1.92±2.28	4.32±5.38	4.36±4.42	3.76±5.47
11mw	4.26±11.19	2.48±9.35	2.34±8.41	3.88±10.63	0.82±5.79	19.16±10.91	11.38±9.26	8.58±7.03	6.18±4.23	9.82±7.21	9.98±9.06	6.24±5.92	2.76±3.55	2.12±2.19	3.22±3.68	11.42±6.66	7.78±5.73	7.42±5.61	9.34±5.12	8.54±5.61
12mw	0.00	0.00	0.00	0.00	0.00	1.36±1.39	1.50±1.47	1.18±1.79	0.50±0.70	0.96±1.04	3.38±4.47	1.66±1.82	0.94±1.51	0.74±1.27	0.96±1.24	14.90±8.29	14.36±9.78	11.22±6.56	11.66±7.12	10.36±7.28
13mw	0.00	0.00	0.00	0.00	0.00	0.26±0.63	0.10±0.30	0.20±0.14	0.60±0.23	0.02±0.14	0.08±0.34	0.20±0.14	0.04±0.19	0.04±0.19	0.16±0.42	4.86±3.67	4.02±4.20	3.28±2.45	3.54±6.16	3.12±4.24

Table 3: Mean data of weather parameters during the period of study

S. No	MW	Duration	Temperature (ºC)			Relative Humidity (%)			Pressure (mbar)
			Minimum (Av.)	Maximum (Av.)	Mean	6-12am (Av.)	12-6pm (Av.)	Mean	
1	2	05/04/2017	27.2	35.5	31.35	70.8	57.0	48.9	1012.1
2	3	12/04/2017	28.4	36.4	32.4	69.2	58.7	63.95	1009.7
3	4	19/04/2017	27.8	37.1	32.45	67.8	56.2	62.0	1008.4
4	5	26/04/2017	29.2	38.4	33.8	672	56.2	61.7	1008.5
5	6	03/05/2017	29.1	37.1	33.1	63.5	53.5	58.5	1011.2
6	7	10/05/2017	28.8	37.0	32.9	61.7	54.5	58.1	1011.2
7	8	17/05/2017	29.5	39.0	34.25	61.8	51.0	56.4	1007.1
8	9	24/05/2017	30.5	40.8	35.65	48.1	46.2	47.15	1005.2
9	10	31/05/2017	31.0	39.8	35.4	50.5	44.5	47.5	1003.5
10	11	07/06/2017	30.2	35.4	34.2	52.5	48.7	50.6	1005.8
11	12	14/06/2017	30.2	38.1	34.15	53.2	43.4	48.3	1005.7
12	13	21/06/2017	28.5	37.0	32.75	64.8	51.5	58.15	1007.1

Table 4: Mean value of the total population of all replicated plots during every meteorological week.

MW	Duration	Egg (Av.)	Grub (Av.)	Pupa (Av.)	Adult (Av.)
2MW	05/04/2017	0.82	0	0	0.008
3 MW	12/04/2017	0.25	0.05	0	0.008
4 MW	19/04/2017	0.26	0.24	0	0
5 MW	26/04/2017	1.80	0.22	0	0.016
6 MW	03/05/2017	0.88	0.49	0	0.068
7 MW	10/05/2017	6.30	0.87	0.08	0.1
8 MW	17/05/2017	14.83	2.29	0.20	0.62
9 MW	24/05/2017	3.00	3.83	0.95	2.33
10 MW	31/05/2017	5.06	25.80	3.73	3.5
11 MW	07/06/2017	2.75	11.02	4.86	8.9
12 MW	14/06/2017	0	1.1	1.53	12.5
13 MW	21/06/2017	0	0.09	0.06	3.76

4. Discussion

From the present study, *H. vigintioctopunctata* is considered as a serious pest of brinjal. Results (Table1, 2, 3, 4) also showed that temperature plays a vital role in the growth of pest population vigorously. Meanwhile, relative humidity and pressure parameter have no effect on the influence of pest population. The peak period of pest infestation varied from season to season, and region to region. From our findings egg and grub populations showed highest population rate during the month of April -May meanwhile pupal and adult beetle population rate was highest during May-June.

A similar observation was recorded by Manjoo and Swaminathan (2007) under Udaipur condition; they recorded positive correlation of atmospheric temperature with the grub and adult population of the pest [25]. A significant positive correlation between peak pest population and atmospheric temperature and relative humidity was recorded by Venkatesha (2006) under Bangalore condition [26]. Similarly, Raghuraman and Veeravel (1999) recorded a significant positive correlation between the peak population of *E. vigintioctopunctata* and maximum atmospheric temperature and average relative humidity on brinjal during February and March [27]. A significant positive correlation existed between beetle population and maximum atmospheric temperature infesting aubergine [28].

According to Saljoqi and Khan, minimum RH had a negative effect on the incidence of beetle while maximum RH showed a positive correlation with the incidence of beetle [29]. Rajak (2000) reported the same that the relationship of pest population with the temperature was positive and that with relative humidity was negative [30]. Both the temperatures showed positive correlation but only minimum temperature exerted significant influence on the growth of Epilachna population [31-33]. According to Sagarika (2017), maximum relative humidity showed a negative correlation with the Epilachna beetle while minimum relative humidity held positive correlation with the incidence of Epilachna beetle but was not significant [34]. High temperature, relative humidity and weekly rainfall that prevailed during July-August favored activity of Epilachna beetle leading into the higher population. Although the pattern of incidence varied with region, the peak period of activity of the beetle was generally in July-August. Suresh *et al*. (1996) reported that the activity of the pest attained peak in the first week of August in Manipur [35].

5. Conclusion

Therefore it can be concluded that, the effect of single weather parameter does not influence the population growth of any insect pest because usually abiotic factors show an effect when in close combination with other. The temperature threshold increases with the lower of relative humidity and pressure value. The overall result of current research work showed that temperature plays an important role in the rapid multiplication of *H. vigintioctopunctata* population. When compared to the three stages of pest, grub stage usually shows more tolerance to highest temperature. So it is concluded that the peak activity of *H. vigintioctopunctata* on brinjal is able to withstand the highest temperature in this region. Thereby, it can be suggested that the pest avoidance technique and pesticide usage can be adopted by understanding the role of temperature that has a correlation with the development of pest population.

6. Acknowledgement

The authors are grateful to the authorities and the farm in-charge for permitting them to use the farm premises for this research work.

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