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Bio-ecology of Tea Mosquito Bug, *Helopeltis Theivora* (Waterhouse), an Emerging Pest of Red Cherry Pepper *Capsicum annum* Var. Cerasiforme in Sikkim Himalaya

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ABSTRACT

The bio-ecology of tea mosquito bug, Helopeltis theivora (Waterhouse) an emerging pest of Red Cherry pepper Capsicum annum var. Cerasiforme was studied during 2010-2014 both in the field and laboratory conditions at ICAR Sikkim Centre, Tadong. Maximum no. of spots per day (97.8) was produced by the first instar nymph of H. theivora whereas the adult female caused maximum damage on the leaves (296.36 sq. mm/day). First leaf (youngest leaf) was most preferred by the first instar nymphs whereas second and third leaves were preferred by the second and third instar nymphs and fourth instar nymph and adults, respectively. The incubation period recorded was 7.8±0.78 days. The duration of first, second, third and fourth in stars were recorded as 3.3±0.48, 4.2±0.62, 3.2±0.58 and 4.8±0.64 days, respectively. It was observed from the study that the male survived for longer period 17.7±2.86 days in comparison to the female (15.3±2.50 days). The average life cycle of male and female was 41.0 ± 3.36 days and 38.6±3.12 days, respectively during July-August. The pre-oviposition period (4.6±0.51 days), oviposition period (9.6±1.23 days) and fecundity (81.5±5.32) were recorded in Red Cherry pepper. Hatching %, adult emergence %, reproductive success % and total growth index of H. theivora were recorded as 44.4±5.57, 48.4±6.18, 20.8±2.25 and 3.12±0.34, respectively. The correlation studies revealed that minimum temperature, relative humidity (maximum and minimum), total rainfall and no. of rainy days had significant positive correlation with the bug population and their feeding intensity whereas the duration of sunshine hours showed significant negative relation. Besides Red Cherry pepper, 13 another new alternate hosts of H. theivora have been identified in Sikkim.

1. Introduction

Chilli (*Capsicum* spp.) is an important commercial spice and vegetable crop for small and marginal farmers in Asia, Africa and South America. In India, it is cultivated in area of 801,500 ha with a total production of 1.3 million t of dry fruits and 6800 t of fresh fruits. Average yield of dry chilli harvest was around 1.6 t/ha compared to those of 8.5 t/ha for green chilli (FAOSTAT, 2012). Pepper market types prevalent in India can broadly be grouped into four categories *viz.* fresh market, fresh processing, dried spice and industrial extracts (Reddy *et al*., 2014). The Red Cherry pepper, *Capsicum annum* var. Cerasiforme, a highly pungent, round to oval shaped fruit bearing crops popularly known as the (*Dalle Khorsani*, vernacular Nepali) in Sikkim as well as Kalimpong,

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West Bengal is one of the most important chilli crops. It is an essential ingredient of the pungent chutney that accompanies the dimsums (momo) in these hilly regions. The thick flesh of the Red Cherry pepper makes them unsuitable for drying; most commonly today they are utilized fresh in culinary applications and commercially as pickled pepper. In Sikkim, the area under chilli cultivation is 90 hectares with production 315 MT and productivity 34.99 q/ha (Anonymous, 2014). The market price of this chilli has always remained higher than Rs. 200/kg and a farmer can easily earn more than Rupees 5.0 lakh per hectare with proper management. The cultivation of this valuable crop is limited and usually restricted to homestead gardening in these regions. Among several factors associated with low production of this crop, infestation of insect pests is the major factor. In Sikkim, the infestation of tea mosquito bug, *Helopeltis theivora* (Waterhouse) has been recorded for the first time in this important and unique spice crop of Sikkim in 2009 (Kalita *et al*., 2010).

Tea Mosquito Bug, *H. theivora* has been the major pest of tea in the past as well as in recent times in northeast India and West Bengal which along with red spider mite *Oligonychus coffeae* Nietner (Acarina: Tetranychidae) can cause substantial yield loss (10-50%). If populations of these pests are not controlled, they can cause total loss of yield (Gurusubramanian *et al.,* 2008). In northeast India out of 4.36 lakh hectares of total tea plantation, 80% of tea plantations are infested with *H. theivora* (Roy *et al*., 2009). Recently its havoc has been more prominent in North Bengal tea plantations due to environmental changes (Mukhopadhyay and Roy 2009). It attacks only the young shoots which yield the actual crop of tea (Rahman *et al.,* 2005). Due to sap feeding of nymphs and adults, infested buds or shoots become curled, dried and black reducing the growth of the plant and ultimately affecting the yield. The multiplication rate of *H. theivora* is very high, within short period it can spread over a large area. The intrinsic rate (0.152), finite rate of increase (1.164) and weekly multiplication rate (2.90) in susceptible host of tea, TV_1 were recorded by Kalita *et al*. (1996). Considering the importance of the pest in tea plantations of Assam and West Bengal as well as the intensity of damage caused in Red Cherry pepper it has the potential to create havoc in the near future for the cultivation of this crop both in Sikkim and Kalimpong. During surveys the infestation of *H. theivora* has already been observed in the crop in different areas of the state. As this pest has wide host range it will be very difficult to manage in organic state like Sikkim. Therefore, it is the right time to make in-depth study on bio-ecology which will be helpful in the development of appropriate management strategies in organic state like Sikkim.

2. Materials and Methods

2.1 Mass rearing of H. theivora

A mass culture of *H. theivora* was maintained in the laboratory at 26 ± 4°C temperature and 70-90 % RH on detached Red Cherry pepper shoots inside rearing cages. Shoots were renewed every alternate day. Shoots containing eggs were separated from the rearing cage and kept in separate chamber for hatching.

2.2 Biology of tea mosquito bug, H. theivora

Ten numbers of freshly laid eggs inside *Dalle Khorsani* shoots were kept separately for hatching to determine the incubation period. Immediately after hatching ten nymphs were kept inside the cage separately providing shoots for feeding. The shoots were changed when required till the emergence of adult. The longevity of different instars (first, second, third and fourth) were recorded. To estimate the hatching %, adult emergence %, per cent reproductive success and total growth index 50 nos. of eggs were kept inside the glass chamber (26 cm x 18 cm x 15 cm) for hatching. The shoots were changed as and when required till the emergence of adult. The no. of nymphs hatched and no. of adults emerged from the nymphs were recorded. The percent reproductive success and total growth index were calculated by the formulae as given by Dhawan *et al*. (1993).

		Number of adults emerged	
Per cent reproductive success	=	----------	x 100
		No. of eggs laid	

		Adult emergence %	
Total growth index	=	----------	x 100
		Mean total developmental period (days).	

To determine the pre-oviposition period, oviposition period, fecundity and adult longevity of *H. theivora* one pair of freshly emerged male and female were released to each glass cage providing shoots for feeding and was replicated 10 times. The no. of eggs laid by the female was recorded daily by changing the shoots. The information on pre-oviposition and oviposition periods, adult longevity and fecundity was recorded.

Helopeltis in Red Cherry pepper			
			
Nymphs of *Helopeltis*	**Damage of *Helopeltis***	**Female and male of Helopeltis**	**Red Cherry Pepper**

Table 1. Feeding Intensity of *Helopeltis theivora* Waterhouse.

Stages	Longevity (days)	Rate of feeding Spots/day	Area damaged/day (sq.mm)
First instar	3.3±0.48	97.8	37.26
Second instar	4.2±0.62	76.4	63.42
Third instar	3.2±0.58	62.6	121.04
Fourth instar	4.8±0.64	70.3	220.54
Adult			
Male	17.7±2.86	43.5	237.26
Female	15.3±2.50	57.7	296.36

2.3 Feeding behaviour of H. theivora

Immediately after hatching one nymph was released to the cage providing five shoots for feeding. The shoots were changed daily and number of spots, longevity of different nymphal instars and adults (male and female) were recorded. The diameter of the spots was measured with general scale and the area under damage was calculated. For determination of feeding site preference of different stages the number of spots produced by different instars and adults in first leaf (youngest), second leaf, third leaf and tender stem were recorded separately and then converted into percentage. The experiment was replicated ten times. Data was analyzed statistically.

2.4 Effect of weather parameters on population buildup of H. theivora

The population build-up of *H. theivora* was observed in Red Cherry pepper in 2010 and 2011 at ICAR Research Complex, Sikkim Centre, Tadong. Local cultivar was selected for this study and no pesticide was applied to the plants during the entire period of observation. Ten numbers of plants were randomly selected and number of *H. theivora* (nymphs and adults) was recorded visually in each plant *insitu*. Percent of infested shoots was recorded from randomly selected 20 plants covering the entire plot. Population counts were performed during morning time. Both the observations were taken monthly. The meteorological data was recorded at the same time for correlation studyies.

2.5 Alternate host of H. theivora

To find out the alternate hosts of *H. theivora* regular survey was done in different vegetations including weeds, hedges and crops at ICAR farm and some areas of Sikkim. If the infestation of the insect was found on any plant, conformity test was carried out by releasing the insects to the fresh shoots of the healthy plant in the laboratory.

3. Result and Discussion

The feeding rate of nymphs and adults of *H. theivora* was calculated from the spots and areas damaged by an individual per day (Table 1). Spots (number) produced by nymphs and adults were in the order of first instar (97.8), second instar (76.4), third instar (62.6) fourth instar (70.3), adult female (57.7) and adult male (43.5). The number of spots produced by early instars were more but the total damaged area caused by these instars was less in comparison to later instars and adults. While comparing spots produced by fourth instar, adult female and male of *H. antonil*, Sathiamma (1977) observed that the fourth instar produced the highest number of spots (114) followed by the female (97) and male (25) per day. Similar trend of feeding rate of nymphs and adults of *H. theivora* was observed in tea by Kalita *et al*. 1996. Table 1 revealed that the damaged area caused by nymphs and adults ranged from 37.26 to 296.36 sq. mm. The area damaged by the female was the maximum which was followed by the male, fourth, third, second and first instar nymphs.

Table 2. Feeding site preference of different stages of *Helopeltis theivora*

Feeding Sites	Mean % of spots				
	First instar	Second instar	Third instar	Fourth instar	Adult
1st leaf	68.8	43.5	22.9	5.0	4.8
2nd leaf	26.4	47.5	48.5	44.2	38.4
3rd leaf	4.8	9.0	28.6	49.5	54.6
Stem	0.0	0.0	0.0	1.3	2.2

Table 3. Biology of *Helopeltis theivora* Waterhouse.

Stages	Duration (in days)
Incubation period	7.8±0.78
First instar	3.3±0.48
Second instar	4.2±0.62
Third instar	3.2±0.58
Fourth instar	4.8±0.64
Male longevity	17.7±2.86
Female longevity	15.3±2.50

This result is similar to the observations of Anonymous (1994) and Kalita *et al*. (1996) who also observed that full grown nymph and adult had caused severe damage. Table 2 reveals that first leaf (youngest leaf) was preferred most by the first instar nymphs whereas second and third leaves were preferred by the second and third instar nymphs and fourth instar nymph and adults, respectively. However, the fourth instar nymphs and adults sucked sap from the stem to a lesser degree. Early instar nymphs of *H. theivora* prefer the younger shoots in comparison to later instars and adults (Kalita *et al*., 1996). This might be attributed to the differential capacity of probing of insect at different age and nutritional variation. Sathiamma (1977) also observed that inflorescence panicles and developing nuts of cashew were more utilized by *H. antonii* for feeding in comparison to the leaves and stems of young shoots. The female lays eggs inside the tender shoots. The pronotal region of male insect is black in colour and the female has distinct orange colour. The nymphs are orange red in colour. After hatching, nymphs complete the nymphal period through four instars. The incubation period of 7.8±0.78 days was recorded. The duration of first, second, third and fourth in stars were recorded as 3.3±0.48, 4.2±0.62, 3.2±0.58 and 4.8±0.64 days, respectively. It was observed from the study that the male survived for longer period 17.7±2.86 days in comparison to female (15.3±2.50 days). The average life cycle of male and female was 41.0 ± 3.36 days and 38.6±3.12 respectively during July-August (Table 3.). The pre-oviposition period (4.6±0.51 days), Oviposition period (9.6±1.23 days) and fecundity (81.5±5.32) were recorded in Red Cherry pepper under laboratory conditions.

Hatching %, adult emergence %, reproductive success % and total growth index of *H. theivora* were recorded as 44.4±5.57, 48.4±6.18, 20.8±2.25 and 3.12±0.34, respectively. All these parameters directly influence the population build-up of *H. theivora*. The data on the population of *H. theivora* and their intensity of infestation in Red Cherry pepper from April to October during 2010 and 2011 are presented in Table 5. It was observed from the study that the infestation of *H. theivora* started in April in Red Cherry pepper in Sikkim. It started infestation from a small area and then spread to the entire area. It caused damage of shoots in the range of 6.6-29.4 per cent. The population started increasing gradually and reached its peak in August (3.0 and 2.7 insects/plant) followed by July (2.6 and 2.2 insects/plant) in 2010 and 2011, respectively. This might be attributed to the prevailing of congenial weather conditions for rapid multiplication of the pest during this period. With the increase of *H. theivora* population, the intensity of their infestation also increased. Severe infestation was noticed during the month of August and July in both the years accounting (29.4 and 27.4 % in 2010) and (29.0 and 24.0 % in 2011) of infested shoots, respectively. The results corroborate with the findings of Kalita *et al*. (1998), Kumar and Naik (2002) and Chakraborty and Chakraborty (2005). The correlation studies revealed that minimum temperature, relative humidity (maximum and minimum), total rainfall and no. of rainy days had significant positive correlation with the bug population and their feeding intensity whereas, the duration of sunshine hours showed significant negative relation (Table 6). These findings are fairly supported by Kalita *et al*. (1998). Tea mosquito bug is a destructive polyphagous pest and has a wide host range *viz*. cashew nut (*Anacardium occidentale*), guava (*Psidium guajava*), mango (*Mangifera indica*), bitter vine

Table 4. Some important biological parameters of *Helopeltis theivora* Waterhouse.

Pre-oviposition period	4.6±0.51
Oviposition period	9.6±1.23
Fecundity	81.5±5.32
Hatching %	44.4±5.57
Adult emergence %	48.4±6.18
Per cent reproductive success	20.8±2.25
Total Growth Index	3.12±0.34

(*Mikania micrantha)*, kadam *(Anthocephalus cadamba)*, jasmine *(Gardenia jasminoides),* Malabar melastome (*Melastoma malabathricum),* jambu *(Eugenia jambolana)* and *rose (Rosa sinensis)* (Kalita *et al*., 2000). Recently besides Red Cherry pepper, 13 other alternate new hosts have been identified in Sikkim *viz*. large cardamom, red hibiscus (*Hibiscus* spp.), *Dahlia*, *Solanum* spp., *Salvia* spp., Duranta (*Duranta* spp.), ornamental sweet potato (*Ipomoea batatas*), bathua (*Chenopodium album), Chlerodendron* spp., *Houtoenia cordifolia*, *Chrysanthemum* spp., *Ficus hookeri* and ridge gourd (*Luffa acutangula*) *etc.* Considering the intensity of damage caused by the pest, and wide host range it has the potential to create havoc in the near future for spice production in Sikkim. Therefore, this information will form basis for developing management strategies for this pest in Red Cherry pepper plantations in organic state like Sikkim

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Table 5. Population build-up of *Helopeltis theivora* Waterhouse

Month of observation	Red Cherry pepper			
	No. of *H. theivora (nymphs/adults)*		% of infested shoots	
	2011	2012	2011	2012
April	0.8	1.0	8.4	6.6
May	1.2	1.2	15.2	12.2
June	1.9	1.6	26.6	20.4
July	2.6	2.2	29.0	24.0
August	3.0	2.7	29.4	27.4
September	2.5	2.3	25.2	23.6
October	1.4	1.1	16.4	19.2
Mean	1.91	1.72	21.88	19.06

Table 6. Correlation between population build-up of *H. theivora* and certain meteorological parameters

Weather parameters/population and infestation	Red Cherry pepper			
	No. of *H. theivora (nymphs/adults)*		% of infested shoots	
	2010	2011	2010	2011
Temperature (max.)	0.3579	0.2631	0.5558	0.3727
Temperature (min.)	0.9064**	0.8101**	0.9511**	0.8366**
RH (maximum)	0.6546*	0.6890*	0.6426*	0.9425**
RH (minimum)	0.9736**	0.6305*	0.9669**	0.8893**
Total rainfall	0.6516*	0.6851*	0.8778**	0.6410*
No. of rainy days	0.6510*	0.6406*	0.6258*	0.6369*
Duration of sunshine	-0.8038**	-0.8270**	-0.8791**	-0.6820*

*- Significant at (P=0.05) and **-Significant at (P=0.01)

References

Anonymous (1994). Pest of tea in North-East India and their control. Memorandum No. 27, Second edition, Tocklai Experimental Station, Jorhat, Assam, 116.

Anonymous (2014). Comprehensive Progress Report, Sikkim Organic Mission, Food Security and Agriculture Development Department and Horticulture and Cash Crop Development Department, Govt. of Sikkim, 2014.

Chakraborty U, and N Chakraborty (2005). Impact of environmental factors on infestation of tea leaves by Helopeltis theivora, and associated changes in flavonoid flavor components and enzyme activities, *Phytoparasitica* 33(1): 88-96.

Dhawan PK, Singh SP, Verma AN, and DR Arya (1993). Antibiosis mechanism of resistance to shootfly, Atherigona soccata (Roundani) in sorghum, *Crop Research* 6(2): 306-310.

FAOSTAT (2012). http://faostat.fao.org/site/339/ default. aspx

Gurusubramanian G, Sarmah M, Rahman A, Roy S, and S Bora (2008). Pesticide usage pattern in tea ecosystem, their retro¬spects and alternative measures: A review. *Journal of Environmental Biology* 29(6): 813–826.

Kalita H, Deka MK, and Karan Singh (2000). Diet breadth of tea mosquito bug. *Crop Research*. 19(1): 126-127.

Kalita H, Rahman H, and A Kumar (2010). Tea mosquito bug, *Helopeltis theivora*: an emerging pest of Dalle Khorsani in Sikkim, Sikkim Express, 16th May, 2010.

Kalita H, Singh K, and R Handique (1996). Growth of population of tea mosquito bug, *Helopeltis theivora* Waterhouse on tea*, Two and a Bud*, 43 (2): 33-36.

Kalita H, Singh K, and R Handique (1998). Effect of certain weather parameters on population build-up of tea mosquito bug, *Helopeltis theivora* Waterhouse, *Crop Research* 16(1): 106-108.

Kumar S, and LK Naik (2002). Seasonal incidence of *Helopeltis antonii* Signoret (Heteroptera: Miridae) on Guava, *Karnataka Journal of Agricultural Sciences* 15(3): 530-533.

Mukhopadhyay A, and S Roy (2009). Changing dimensions of IPM in the tea plantations of the North Eastern Sub Himalayan region. p. 290–302. In: Proc. of National Symposium on IPM Strategies to Combat Emerging Pest in the Current Scenario of Climate Change (V.V. Ramamurthy, G.P. Gupta, S.N. Puri, eds.). Collage of Horticulture and Forestry, Central Agricultural University, Pasighat 791002, Arunachal Pradesh, India, 28–30 January 2009.

Rahman A, Sarmah M, Phukan AK, Roy S, Sannigrahi S, Borthakur M, and G Gurusubramanian (2005). Approaches for the management of tea mosquito bug, *Helopeltis theivora* Waterhouse (Miridae: Heteroptera). p. 146–161. In: Proc. of 34th Tocklai Conference – Strategies for Quality (A.K. Barooah, M. Borthakur, J.N. Kalita, eds.). Tocklai Experimental Station, TRA, Jorhat, Assam, India.

MK Reddy, Srivastava A, Kumar S, Kumar R, Chawda N, Ebert AW, and M Vishwakarma, (2014). Chilli (*Capsicum annuum* L) Breeding in India: An overview. *SABRAO Journal of Breeding and Genetics* 46(2): 160-173

Roy S, Gurusubramanian G, and A Mukhopadhyay (2009). Neem based Integrated Approaches for the Management of Tea Mosquito Bug, *Helopeltis theivora* Waterhouse (Miridae: Heteroptera) in Tea – a useful quality control criterion. *IJAVMS,* 3: 4-11.

Sathiamma B (1977). Nature and extent of damage by Helopeltis antonii S the tea mosquito on cashew. *J. Plant Crops* 5(1): 58-59.