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RESEARCH ARTICLE

BIO-ECOLOGICAL ANALYSIS TO IDENTIFY THE CRITICAL STAGE OF DEVELOPMENT OF MANGO DEFOLIATOR CRICULA TRIFENESTRATA (LEPIDOPTERA: SATURNIIDAE)

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ABSTRACT

Mango defoliator (*Cricula trifenestrata* Helfer) has been emerging as the important pest of mango in recent times in West Bengal, India. In terai region of West Bengal it completes four generations in a year. All the developmental stages were found to vary significantly over seasons. The total larval period was found 36.40 days to 45.30 days. Pupal diapause was recorded during summer and winter. Wide variation in male and female pupal period was recorded (24.40-89.40 days and 25.74-93.20 days respectively). The life cycle was completed in 77.00-146.00 days; depending upon the duration of pupal period in different generations. Temperature and RH gradient played significant role in the different life stages. The pupal stage has been identified as the most critical stage of the development of the species which determines the number of generations to be completed in a year and thereby intensity of infestation and crop loss caused by the pest spp.

INTRODUCTION

Mango (Mangifera indica L.) belonging to Family Anacardiaceae is the most important commercially grown fruit crop in India. India has the richest resource of mango cultivars. It is the most popular fruit among millions of people in the orient and has a great economic importance in the tropical and sub-tropical regions (Mondol *et al*., 2004). One the most important reasons for declining of mango production are the infestation of different insect-pests. It has been reported that over 175 species of insects infests mango regularly (Fletcher, 1970; Veva, 1969 and Nayar *et al*., 1976). Mango hopper, mealy bugs, bark-eating caterpillars, stem borers, scale insects, fruit flies, stone weevils, gall midges, mango defoliator etc. are the common insect pests of mango. Among them, mango defoliator (Cricula trifenestrata Helfer) has been emerged as one of the important destructive insect-pests of mango in recent times. Its caterpillar is a major pest of mango and destroying 13 to 51 % leaves (Ahmad and Alam, 1994). The damage to mango consists of partial to complete defoliation and a decrease in number of inflorescences in the flowering season (January-February) if defoliation continues up to October and November (http://www.plantwise.org). In the years of heavy outbreak approximately 65% of mango trees in affected areas are infested and on average one-third of the foliage of infested trees is lost (Alam and Hazarika, 1953).

Recently, mango defoliator has been found to cause serious damage to the mango plants in different parts of West Bengal. Management of this pest is now of great concern to the mango growers. Before developing suitable control measures for any pest, detailed information regarding the life system including morphology, biology, leaf consumption behavior of the larvae is most essential. But the life system study of Cruicula trifenestrata and its control measures have not been studied much and therefore, information is rather inadequate. Therefore, an attempt has been taken to study the biology of

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mango defoliator in this region with an ultimate objective to formulate a management program of such a serious pest causing enormous loss to the crop in the area under consideration.

MATERIALS AND METHODS

The experiment was carried out in the laboratory, Department of Agricultural Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal during 2012 to 2013. Freshly laid eggs were collected from the mango orchard and put in the petriplates carefully for hatching. The newly hatched larvae were isolated and placed in a separate petriplate using a soft brush. The tender mango leaves were provided to the newly hatched larvae. Ten (10) larvae were placed in a petriplate and replicated five times. Fresh mango leaves were supplied to the larvae once during morning and another during evening at 12-hour interval. The first and second instars were reared in petriplates, but third and fourth in plastic jars while fifth and sixth instar larvae were reared in plastic buckets. Wet cotton was used to maintain leaf moisture.

The cocoon on full formation were removed and kept on paper in well-aerated cage till adult emergence. After emergence of adults, the male and female moths were isolated based on their wing spots and size, and finally placed couple-wise in the cage containing mango leaves to provide normal environment. Data were taken carefully to record the time of moulting on the basis of casting exuviae, number and duration of the instars. Observations were also recorded on incubation period; larval and pupal period and adult longevity and life cycle *ie*. the total duration from egg to adult.

The experiment was conducted using Completely Randomized Design (CRD) with 5 replications. Correlation coefficient between weather parameters and duration of time taken for different stages of life cycle were worked out. All the statistical analysis was done by EXCEL and INDOSTAT.

RESULTS AND DISCUSSION

It is observed from the table (1&2) that the insect has completed four (4) generations in a year in terai region of West Bengal. Huq *et al*., (1991) also reported that *Cricula trifenestrata* passed through four generations in a year.

The duration of all the developmental stages was found to vary significantly over the seasons. The incubation period, the period of embryonic development, was ranged from 10.30-10.80 days at 28.18-32.15^{0}C maximum and 14.69-24.37^{0}C minimum temperature and 96.64-99.00% maximum and 41.42-74.33% minimum RH as prevailed during March to October. The duration was significantly longest 15.80 days in the cooler month of January at 22.87-32.15^{0}C of maximum and 7.99-8.01^{0}C of minimum temperature and 99.00% maximum and 49.65-50.69% minimum RH. Huq *et al*., (1991) reported that the incubation period of this insect was 9.00 to 10.00 days in Bangladesh while Yadav and Kumar (2003) reported 10.40 days in Sikkim. The result under present investigation is in conformity with the early workers. The different parameters of temperature (maximum, minimum and average) had significantly negative and gradient of temperature and RH had significantly positive role in embryonic development.

It was observed that the larvae of *C. trifenestrata* passed through six instars with five moults and duration of all the different instars varied significantly among the different seasons. But there are reports of five larval instars (Huq *et al*., 1991, Hossain *et al*., 2004, Yadav and Kumar, 2003, Ahmed and Alam, 1993). The duration of 1st, 2nd, 3rd, 4th, 5th and 6th instars was 4.60-7.50 days ,5.30-6.40 days, 4.90-8.10 days, 5.40-7.50 days, 6.00-7.30 days and 7.60-8.50 days respectively in different generations completed throughout the year in terai region of West Bengal. The total larval period was found to vary from 36.40 days to 45.30 days in different seasons. The larva took shortest time to become fully developed in March-May to undergo pupation in 36.40 days. The maximum duration was recorded during January-April (45.30 days) which was significantly the longest of other seasons, followed by October-January and May-October (38.60 days and 37.80 days respectively).The total larval period recorded by different workers in Bangladesh was 27.40 days (Huq *et al*., 1991); 25-29 days (Hossain, 1989), 41 days (Ali and Karim, 1991) and in Sikkim 47-52 days (Yadav and Kumar, 2003) which are more or less similar to the our findings and environmental variations at different places might be the reason for such difference. All the temperature parameters (maximum, minimum and average) showed significant negative relation with larval period while temperature gradient showed significant positive relation indicating longer larval duration in winter season. Similarly RH maximum and RH gradient showed positive and significant relation with larval duration indicating optimum growth in summer season.

The pupal duration was recorded maximum in May-October generation. The period was found little longer in females over the male counterpart for the purpose of development of ovary and store energy for oviposition which was ranged between 24.40 days to 89.40 days for male and 25.74 to 93.20 days for female respectively. The duration was found minimum (24.40 to 24.60 days) for male and (25.74 to 26.20 days) for female in March-May and January to April. The period was significantly the maximum (89.40 days and 93.20 days respectively) for male and female in May-October which was followed by (54.00 days and 60.40 days respectively) for male and female in October-January generation. Ali and Karim (1991) reported that pupal period of this pest was 26 days which confirms the findings under present investigation during March-May and January-April seasons. Yadav and Kumar (2003) recorded the pupal period of 67.22 ±12.12 days which also confirms the findings under present investigation in October-January season. The pupal duration was found 89.40-93.20 days during July to October due to summer diapause. The finding of Yadav and Kumar (2003) is also in conformity with the result under present investigation, where the pupal period lasted from August to October in Sikkim agro-climatic conditions. Both temperature and RH gradient was found to have significant and negative relation with the pupal development. This might be the reason of variation in the pupal duration which was longer (89.40-93.20 days) in summer *ie*. during July to October at

31.18-31.25^{0}C maximum and 25.18-25.55^{0}C minimum temperature and 98.99% maximum and 73.82-74.82% minimum RH and the period was shortest 24.60-26.20 days during January-April at 30.72-31.70^{0}C maximum and 17.46-21.72^{0}C minimum temperature and 95.58-98.92% maximum and 38.23-65.25% minimum RH. The pupal diapause of 54.0060.40 days was observed during cooler months of November-December.

The adult longevity was observed significantly minimum during March-May (2.25 days) for male and (3.60 days) for female respectively followed by 3.30 days in both May-October and October-January season for male and (3.80-3.90 days) in October-April for female respectively. The male longevity was significantly the maximum 3.60 days in January-April that of female of 4.60 days in May-October. The adult female longevity was observed shortest during the month of January-April (3.40 days) closely followed by March-May (3.60 days) and October-January (3.90 days) and January-April (3.80 days). The duration was found maximum of 4.60 days in May-October. Hossain *et al*., (2004) reported male and female longevity of 3 days and 4 days respectively which are at par with the findings of present investigation.

The life cycle of *Cricula* depends mainly on pupal stage. The mango defoliator was found to complete its life cycle in 77.00-146.0 days in different seasons. The insect took significantly shortest time to complete the life cycle during March-May (77.00 days) closely followed by January-April (90.44 days) and October-January (113.20 days). The duration was found maximum in May-October (146.00 days). The period of life cycle was recorded 76.75 days by Hossain *et al.* (2004), 61-125 days by Huq *et al.* (1991), and 76 to 92 days by Hossain (1989) which confirms the findings under present experiment.

The duration of life cycle showed significantly negative relation with temperature gradient and significantly positive correlation with maximum, minimum and average RH, suggested longer duration in life cycle during summer to autumn (May-October) and Autumn to winter (October-January).

Upon critical analysis of the results as described above it can be concluded that mango defoliator (*Cricula trifenestrata* Helfer) has been emerged as the most important pest of mango in this region for recent times. It completes four generations in a year of which May-October season needed longer time due to prolonged pupal period for about 3 months. Significantly negative correlation with temperature gradient and RH gradient might be the important reasons in hot and humid weather during the period of activities. The adult moth emerging from the pupa of this generation laid eggs on mango leaves.

The larvae upon hatching consumed the new flushes of leaves leading into defoliation of plants. This severely affects the bearing of inflorescence from such affected leaves. In general the photosynthates of these leaves would supply nutrient to the inflorescence and subsequent development of fruits. Hence, this generation was directly responsible to lower fruit production. Moreover, the length of pupal period of aforesaid generation also determined the number of subsequent generations in a year. Similarly, during October-January generation the pupal period lasted for 60 days. The larvae emerged during January feed the remaining leaves which further deteriorate the plant conditions. These generations continued till April and passed longer larval period of 45 days when the inflorescence are also emerged. The voracious larvae of late instars completely destroyed the inflorescence severely affecting the bearing of mango fruits. Therefore, management of this pest shall be directed towards killing of summer diapausing and early winter hibernating pupa resting on

Table 1 Duration of different developmental stages of Cricula trifenestrata as influenced by different seasons in terai region of West Bengal

Seasons	Duration (Days)												
	Egg	Larva						Total Larval period	Pupa		Adult		Life cycle
		1st	2nd	3rd	4th	5th	6th		Male	Female	Male	Female	
March-May	10.80	4.60	6.40	5.60	6.00	6.20	7.60	36.40	24.40	26.20	2.25	3.60	77.00
May-October	10.40	6.40	5.40	5.60	5.40	7.20	7.80	37.80	89.40	93.20	3.30	4.60	146.00
October-January	10.30	6.40	5.30	4.90	6.20	6.00	9.80	38.60	54.00	60.40	3.30	3.90	113.20
January-April	15.80	7.50	6.40	8.10	7.50	7.30	8.50	45.30	24.60	25.74	3.60	3.80	90.44
SEm±	0.453	0.367	0.311	0.315	0.363	0.464	0.279	1.028	1.269	6.180	0.305	0.322	1.305
CD @5%	0.987	0.788	0.677	0.686	0.791	1.010	0.609	2.239	2.765	13.466	0.664	0.700	2.842

Table 2 Correlation of duration of different developmental stages with the climatic conditions

Stages of life cycle	Temperature				Relative Humidity (RH)			
	Maximum	Minimum	Average	Gradient	Maximum	Minimum	Average	Gradient
Egg	-0.912*	-0.850*	-0.876*	0.739*	0.247	-0.423	-0.381	0.469*
1st instar larva	-0.576*	-0.300	-0.389	0.093	0.837*	0.135	0.172	-0.010
2nd instar larva	-0.149	-0.479*	-0.407	0.530*	-0.130	-0.519*	-0.383	0.472*
3rd instar larva	-0.730*	-0.521*	-0.660*	0.215	0.205	-0.066	-0.065	0.066
4th instar larva	-0.728*	-0.760*	-0.821*	0.581*	0.244	-0.358	-0.522*	0.552*
5th instar larva	0.274	0.184	0.207	-0138	0.465*	0.188	0.226	-0.150
6th instar larva	-0785*	-0.752*	-0.772*	0.703*	0.450*	-0.625*	-0.601*	0.647*
Total larva	-0.853*	-0.662*	-0.725*	0.525*	0.470*	-0.415	-0.367	0.461*
Male pupa	-0.139	0.306	0.132	-0.764*	0.515*	0.700*	0.694*	-0704*
Female pupa	-0.360	0.027	-0.132	-0.545*	0.537*	0.576*	0.582*	-0.567*
Adult male	-0.311	-0.235	-0.267	0.084	-0.066	-0.197	-0.186	0.207
Adult female	-0.019	0.064	0.032	-0.177	0.244	0.096	0.122	-0.063
Life cycle	0.150	0.434	0.346	-0.635*	0.902*	0.696*	0.733*	-0.654*

damaged twigs.

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