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Biology and seasonal activity of semilooper, *Dichromia orosia* (Cramer) (Lepidoptera: Noctuidae) on anthmool, *Tylophora asthmatica* Wight and Arn.

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Abstract

Dichromia orosia (Cramer), a near monophagus pest was observed to cause severe defoliation to its host plant, anthmool (*Tylophora asthmatica* Wight and Arn.), an important medicinal plant used in Ayurvedic formulations to treat asthma world over. Biology and seasonal activity of the pest was studied during 2009-10 at Anand, Gujarat. Though incidence was observed throughout the year, however, the pest activity was more during July, August, December, January and February months. The pest completed its life cycle in 24.53±0.40 days (Eggs 3-4, larvae 10-14 and pupae 6-7 days). The longevity of the male and female was 15.70±0.68 and 19.70±0.42 days, respectively. Each female laid an average of 178.5±17.66 eggs, mostly on the under surface of the leaves in 12.20±0.49 days of oviposition period. The larvae developed through five instars in 12.9±0.35 days and pupal period lasted for about 6.8±0.11 days. Correlation of peak pest population periods with corresponding and previous Standard Meteorological Weeks (SMW) revealed that prevalence of maximum temperature (27.5-30.2^{0}C) mean temperature 29.31 ^{0}C, high RH and low rainfall recorded in increase of larval population.

Key words: *Dichromia orosia*, *Tylophora asthmatica*, biology, seasonal activity, longevity

Introduction

Tylophora asthmatica Wight and Arn. (Synonym *T. indica* (Burm. f) Merr.) (Asclepiadaceae) is a climbing perennial plant indigenous to India. It grows wild in the southern and eastern regions and has a long-standing reputation as a remedy for asthma. Its leaves and roots are used as laxative, expectorant, diaphoretic, and purgative. The plant is also used for the treatment of bronchitis, colds, diarroahea, dysentery and joint pain (Prajapati *et al.*, 2003). Over exploitation and lack of organized cultivation led to a rapid decline in the wild population of this species. Besides, the plants were reported to be severely defoliated by a semi looper, *Dichromia orosia* (Cramer) (=*Hypena sagitta* (Fabricus)) (Devaiah *et al.*, 1983). The pest was observed to cause severe defoliation in the host plant throughout the year in the Herbal gardens of Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat, India. Since there was no previous report of this pest from Western India, its identity was confirmed by the Insect Identification Service, Indian Agricultural Research Institute, New Delhi (Registered under RRS No.67-69/10) as *Dichromia orosia* (Carmer).

Except for preliminary information on biology, feeding preference and predation of larvae by a pentatomid bug (*Canthecona parva*) (Sridhar and Jhansi Rani, 2003 and 2010), no other information is available. In view of this, systematic investigation on life traits, nature of damage, and seasonal abundance in relation to climatic factors was carried out. The present investigation certainly contributes to plan the strategy for effective management of the pest on *T. asthmatica*.

Material and methods

Studies on biology: The larvae of *D. orosia* (Noctuidae: Lepidoptera) were collected from field and reared on the host plant in laboratory in 20x15 cm plastic jars covered with muslin cloth. The food to larvae was replenished every day till the pupation. The pupae were collected from the jars and kept separately in a jar for adult emergence. The freshly emerged adults were sexed based on abdomen size and black markings at the tip of the abdomen of male insects. Ten pairs of male and female adults were kept in mating jars (15 x10 cm) provided with pieces of cotton soaked in 50 per cent honey fortified with few drops of multivitamin syrup and 2 to 3 twigs of *T. athmatica* dipped in water filled vials for egg laying. The twigs were carefully replaced with fresh twigs daily. The observations on fecundity, duration of oviposition and longevity of adults were recorded daily until the death of both the adults.

The fresh batches of eggs were monitored regularly to find out incubation period. The neonate larvae (15 nos.) were carefully picked up with the help of a fine brush and transferred individually on the excised fresh leaves of *T. asthmatica* kept in 90 mm transparent plastic Petri dishes lined with moistened blotting paper to prevent the desiccation of leaves. Fresh leaves were replenished daily until the larvae reached pupal stage. The larvae were monitored regularly and moulting was confirmed by the presence of exuviae and head capsules. The duration and number of larval instars were determined. The newly formed pupae were moved to 200 mL plastic jar covered with muslin cloth and checked daily to record the adult emergence. The diameter of eggs, body length and width of I and II instar larvae and head capsule width of all the instars were determined with the help of ocular micrometer (calibrated with stage micrometer) fitted to a microscope. The body length and width of 3rd, 4th and 5th instar larvae, pre pupa, pupa and adults stage were measured using standard measuring scale. The width was taken from the thickest part of the body which coincided at the central part of it. The experiment was conducted in BOD incubator at 30±1 °C and 70±5 % RH.

Studies on seasonal activity: The observation on the seasonal abundance of *D. orosia* was carried out on *T. asthmatica* plants grown in herbal garden of Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat during 2009-10. The experimental plot area was kept free from any plant protection measures throughout the study period to encourage natural insect incidence. The plot was divided into 6 quadrats (1m^2 each) and total number of larvae feeding in each quadrat (includes larva present on plant as well as on the ground) was counted at weekly interval. The observation was taken at early hours of the day as the larvae tend to move to the soil surface and hide under plant debris, soil clods and crevices during the later part of the day. The relation between the weekly distribution of immature stages and prevailing weather parameters *viz.*, rainfall, maximum and minimum temperature and relative humidity was assessed by simple correlation analysis using MS excel.

Results and discussion

Studies on biology

Adult stage: Both male and female adults were nearly identical except in size, where males (32±0.17 mm at wing expanse) were slightly bigger than female (30±0.23 mm at wing expanse). The thorax was with grayish scales and abdomen was yellow coloured. Fore wings were grey with a large sub-triangular black patch with pale edges occupying the medial area, but not reaching the inner margin. Hind wings were yellow in colour with apical area dark brown. The female moths lived longer (19.70±0.42 days) than male moths (15.70±0.68 days) and the sex ratio was in favour of females (1: 1.1) (Table 1 and 2). Sridhar and Jhansi Rani (2010) reported adult longevity of 21.5±1.69 days.

Eggs stage: Gravid female laid eggs mostly in groups and some time singly on the under surface of the leaves (often at the point where the leaf blade joins the petiole or either along side a major vein) and tender twigs. On an average, each female laid 178.5±17.66 eggs during the oviposition period of 12.20±0.49 days. The eggs were pale yellowish in colour, spherical and sculptured with a diameter of 0.75±0.01mm. The eggs hatched in 3-4 days. Soon after hatching the neonate larvae fed on epidermal tissue of leaves. Sridhar and Jhansi Rani (2010) reported duration of egg stage as 4-5 (av. 4.4±0.49) days and fecundity per female was 172.4 eggs.

Larval stage: The Ist instar lasted for 2-3 (av. 2.3±0.13) days. Larvae grown to a length of 2.48±0.23 mm and width of 0.34±0.01 mm before moult. Its colour was pale yellow with pale black tubercles all over the body. Head was very minute with a head capsule width of about 0.34±0.01 mm. Instar II also lasted for 2-3 (av. 2.5±0.13) days and attained a length of 4.6±0.71 mm and width of 1.18 ± 0.22 mm. The head capsule width was 0.53±0.07 mm. The IIIrd instar was yellow in colour with prominent black coloured warts, this instar lasted for an average of 2.2±0.17 days. The length and width of the body was 11.8±0.87 and 1.7±0.49 mm, respectively and the width of the head capsule was about 1.0±0.13 mm. The IVth instar lasted for 1-3 (av. 2.2±0.14) days, its length and width were 16.5±1.0 and 2.5±0.34 mm, respectively and the head capsule width measured about 1.5±0.11 mm. The Vth instar lasted for 2-4 (av. 3.6±0.16) days, grown to a length of 21.7±1.73 mm and a width of 3.7±0.32 mm. The colour of the larvae were dark yellow having dark black warts all over body with setae. The head was now quite distinct and measured about 1.8±0.22 mm (Table 1 and 2). The larvae is a semilooper having three pairs of true jointed legs just behind the head and four additional pairs of fleshy legs called 'prolegs', three pairs on the abdominal segments 4th,5th and 6th and fourth pair on the final abdominal segment. They move with a characteristic "looping" motion. Larvae were pale to dark yellow. The head and somites were having series of small black tubercles from where spines arisen. The larvae passed through five instars in 12.9±0.35 days and reached pupal stage. Sridhar and Jhansi Rani (2010) reported a total larval period of 25.5±0.65 days. The different instars lasted as, Instar-I, 3-4 days; Instar-II, 4-5 days; Instar-III, 4-6 days; Instar-IV, 5-7 days and Instar-V, 6-9 days.

Nature of damage: All the instars inflicted severe damage to the host plants. On hatching, the neonate larvae immediately moved

Table 1. Duration of different life stages and reproductive phases of *D. orosia* on anthmool at 30±1°C and RH 75±5%

Stages	Range (days)	Mean ± SE
Egg period (days)	3-4	3.4±0.13
Larval period (days)		
1st Instar	2-3	2.3±0.13
2nd Instar	2-3	2.5±0.13
3rd Instar	1-3	2.2±0.17
4th Instar	1-3	2.2±0.14
5th Instar	2-4	3.6±0.16
Total larval period (days)	10-14	12.9±0.35
Pre-pupal period (days)	1-2	1.4±0.13
Pupal period (days)	6-7	6.8±0.11
Total life cycle (days)	21-26	24.53±0.40
Longevity of Adults		
a. Male	12-18	15.70±0.68
b. Female	18-22	19.70±0.42
Pre- oviposition period (days)	4-6	4.6±0.22
Oviposition period (days)	10-15	12.20±0.49
Post oviposition period (days)	2-5	2.9±0.0.28
Fecundity (Nos.)	88-292	178.5±17.66

Table 2. Morphometrics of different stages of *D. orosia* on anthmool (Mean ± SE)

Stage	Width of head capsule (mm)	Length of body (mm)	Width of body (mm)	Wing expanse (mm)	Diameter (mm)
Egg					0.75±0.01
Larva					
1st Instar	0.34±0.01	2.48±0.23	0.34±0.01		
2nd Instar	0.53±0.07	4.6±0.71	1.18±0.22		
3rd Instar	1.0±0.13	11.8±0.87	1.7±0.49		
4th Instar	1.5±0.11	16.5±1.0	2.5±0.34		
5th Instar	1.8±0.22	21.7±1.73	3.7±0.32		
Pre-pupa		18.0±1.87	4.1±0.22		
Pupa		12.2±0.65	3.9±0.2		
Adult					
a.Male				32±0.17	
b.Female				30±0.23	

to the under surface of leaf and started feeding on tender leaves. The larvae of Ist to IIIrd instars scrapped the under surface of the leaves leaving the upper epidermal layer intact. It was observed that 5 to 6 early instar larvae were feeding on a single leaf. These larvae fed mainly on the chlorophyll content of the leaves from under surface of the leaves and leaving the upper epidermis intact. In a badly infested situation, the climbers presented a look, as if the plant had been scorched. Such leaves quickly dried up and fallen to the ground, resulting in complete denudation of the climber. The late instar larvae (IVth and Vth instars) fed voraciously on the entire leaf tissues leaving major leaf veins. When the population of late instar larvae were high, the climber defoliated completely and giving the appearance as it was grazed by the cattle.

Pupal stage: During the pre-pupal period of 1-2 days the full grown larvae stopped feeding. The body contracted and larvae settled in a place and spun cocoon with the help of silken threads, plant/leaf debris and excreta. The pre-pupae measured 18.0±1.87 mm in length and 4.1±0.22 mm in width. It transformed into pupae within 1-2 days. The pupae were brown in color and pupal

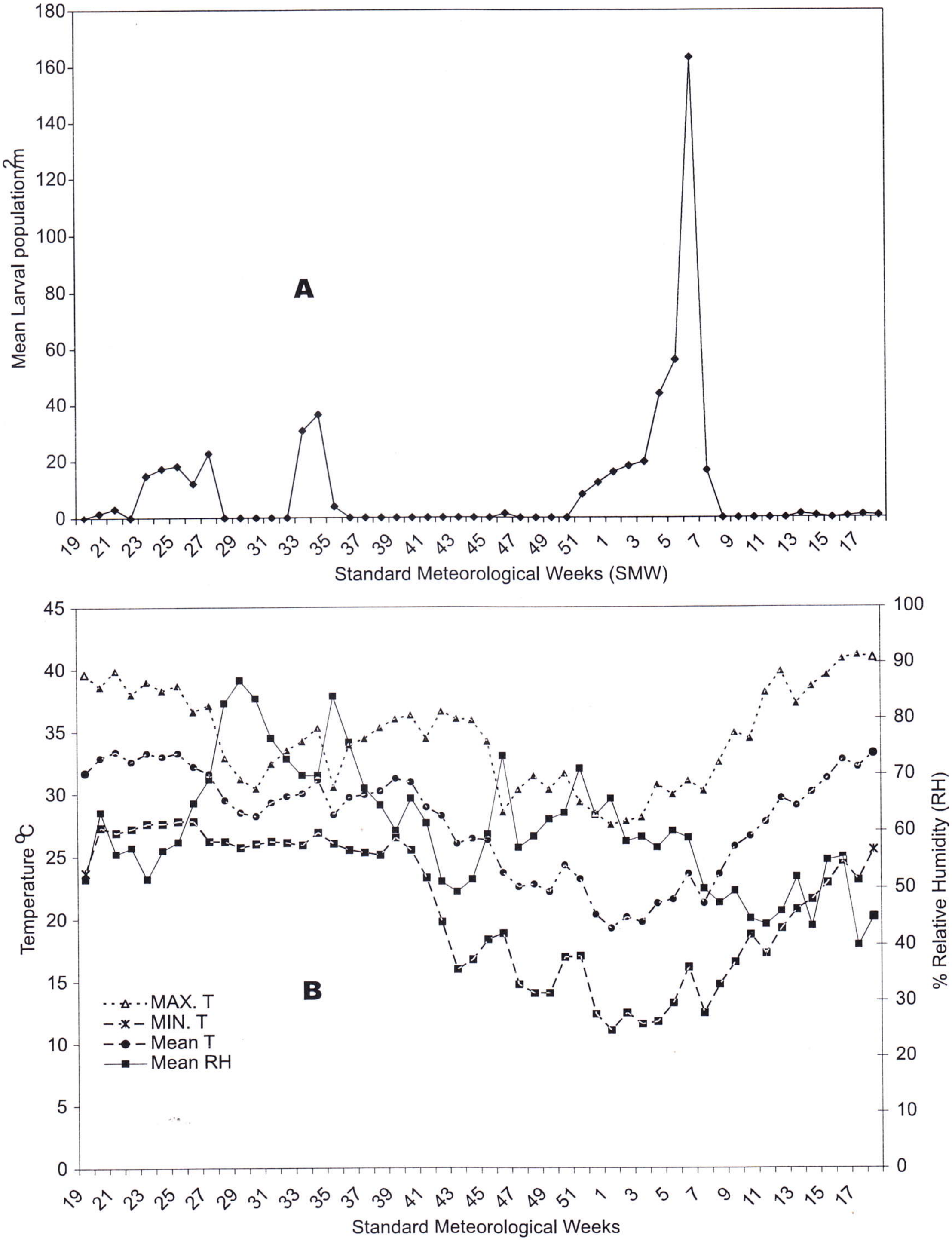

Fig.1. A. Average weekly incidence of *Dichromia orosia* on *Tylophora asthamatica* B. Environmental variables during the pest incidence period.

Table 3. Correlation between mean weekly larval population (19-52nd & 1-18th SMW) and corresponding weekly weather parameters

Weather Parameters	Maximum Temperature	Minimum Temperature	Mean Temperature	Relative humidity	Rain fall
Correlation coefficient	-0.238	-0.210	-0.247	+0.016	-0.080

Table 4. Correlation between peak pest population periods (1st- 7th SMW) with corresponding week (1st- 7th SMW) weather parameters

Weather Parameters	Maximum Temperature	Minimum Temperature	Mean Temperature	Relative humidity	Rain fall
Correlation coefficient	+0.644**	+0.933**	+0.887**	+0.057	0.0000

Table 5. Correlation between peak larval population and previous week weather parameters (46-52nd SMW)

Weather Parameters	Maximum Temperature	Minimum Temperature	Mean Temperature	Relative humidity	Rain fall
Correlation coefficient	-0.048	+0.348*	+0.281*	+0.469**	-0.26

stage lasted for about 6-7 (av. 6.8±0.11) days (Table 1 and 2). It measured 12.2±0.65 mm in length and 3.9±0.2 mm in width at the broadest end. Sridhar and Jhansi Rani (2010) reported pupal period of 7-9 days (av. 7.7±0.64 days).

The characters of full grown larvae observed in the present study are in conformity with those observed by Sridhar and Jhansi Rani (2010). The total development period from egg to adult emergence was determined as 24.53±0.40 days at about 30°C, thus permitting a maximum of 8 to 9 overlapping broods per year. This behavior is in line with the expectation of tropical butterflies to have a short life cycle, and multiple broods over the year. The developmental period of some stages determined in present study are not in conformity with the study made by Sridhar and Jhansi Rani (2010) on similar species under Bangalore, India conditions. Since climatic factors influence the instar duration and the overall development time (Mathavan and Pandian, 1975; Palanichamy *et al.*, 1982; Pathak and Pizvi, 2003; Braby, 2003), the present findings may vary in other parts, depending upon prevailing climatic conditions. However, the development period of 24.53±0.40 is in good agreement with development period of related species *H. laceratalis* on lantana (Visalakshy and Jayanth, 1990).

Seasonal activity: The mean incidence of *D. orosia* on anthmool is presented in Fig.1. The infestation of semilooper was first observed in 20th standard meteorological week (SMW), when the larval population was 1.6 larvae/m². The maximum and minimum temperature during the week were 38.6 and 27.3°C, respectively and relative humidity (RH) was 63.0 per cent. The population increased slightly in 21st SMW to 3.2 larvae/m² and reached to 22.67 larvae/m² in 27th SMW, during this period slight rainfall (1.4 mm) in 24th SMW reduced the summer temperature to some extent and increased the RH from 51.6 to 69.3 per cent. Prevailing weather condition along with availability of foliage favoured the build up of larval population. This increased density of larval population at this particular point of time, resulted in complete defoliation of the climbers. Non availability of food and shelter coupled with monsoon rains (233.7 mm total rainfall during 27, 28, 29 and 30th SMW) resulted in mortality and forced pupation of larvae and hence nil population was observed from 28th to 32nd SMW. However, rainfall during these weeks increased the humidity up to 83.7 per cent (30th SMW), which resulted in rejuvenation of fresh flush of leaves. The congenial condition, like high RH (av. 74.80 per cent), nil rainfall and presence of fresh foliage triggered the emergence of adult from hibernating pupae, which resulted into increased egg laying, as egg mass and early instar larvae were abundant during 33th SMW (30.7 larvae/m²). In the subsequent 34th SMW population of late instar larvae was maximum (36.5 larvae/m²). Abundance of larvae per unit leaf area, left no space for adult moth to lay eggs. In general, some lepidopterans especially discriminate the egg load, larval competition on their host plants or relative abundance of host plants (Charnov, 1982; Wellings, 1991; Mugrabi and Moreira, 1996) either directly by vision (Wiklund and Ahrberg, 1978; Shapiro, 1981) or chemically through the presence of deterrent pheromones (Schoonhovan *et al.*, 1990; Theiry *et al.*, 1992). It was found that due to the scarcity of leaf tissues, the late instar larvae forcibly entered into pupal stage, as large number of pupae were observed among the dried leaves and on the soil surface during the period (35th SMW). Moreover, heavy down pour (131 mm) during the end of 35th SMW caused mortality in remaining larvae. The rain has been shown to cause the death of wide variety of insects in the pre imaginal as well as adult stages (Sappington and Showers, 1983). Owing to severe defoliation and denudation, the climbers did not recoup until 44th SMW. During 46th SMW few early instar larvae were seen (1.5 larvae/ 1m²quadrat) on the newly emerged flushes, the maximum and minimum temperature during the week were 28.5 and 18.9°C, respectively and relative humidity was 73.4 per cent. The precipitation (4.8 mm) received during the later part of the 46th week resulted in mortality of those early stage larvae. Thereafter, the pest did not appear until 50th SMW. The intermittent precipitation and absence of pest activity for about 14 weeks favoured the climbers to recoup fully, which resulted in abundance of fresh foliage. The pest again appeared in 51st SMW, initially with the population of 8.2 larvae/m², which increased steadily and a maximum of 163.2 larvae/m² was observed during 6th SMW. At the end of that week the pest population was mixture of early (1-3rd instars) and late instars (4th-5th instars). During the week maximum and minimum temperature were 31.0 and 16.2 °C, respectively and RH was 58.8 per cent. The abundance of pest completely defoliated or denuded the climbers and in the want of food and shelter the larval population declined to 16.7 larvae/m² in 7th SMW due to mortality and forced pupation. As a result, during the period (7th SMW) large number of pupae was observed on the soil surface and among the dried leaves. Due to lack of green tissue, no pest population was observed upto 12th SMW. The moderate activity of pest was again observed from 13th SMW (1.33 larvae/m²), when fresh flush of leaves again rejuvenated and it remained continued upto 18th SMW. The temperature and humidity during the period ranged between 29.0 to 33.2 °C and 39.9 to 51.9 per cent, respectively. The correlation analysis between pest population and maximum, minimum and mean temperature (r= -0.24, -0.21 and -0.25, respectively) showed negative correlation. Relative humidity showed non-significant positive correlation (r=0.0164) (Table 3). Though rainfall could influence the insect population negatively (r= -0.081), but the correlation was not significant. Correlation of peak pest population periods with corresponding and previous SMW, revealed that out of 5 weather parameters tested 3 parameters *viz.* maximum temperature, RH and rain fall during 46-52nd and 1st -7th SMW were found to be effective in determining the level of infestation. The analysis inferred that prevalence of maximum temperature (27.5-30.2°C), mean temperature 29.31 °C, high RH and low rainfall recorded in maximum increase of number of larval population (Table 4 and 5).

The year round presence of immature stages on the host plant, *T. asthmatica*, showed that *D. orosia* breeds continuously. Weather conditions, especially RH and temperature though favoured the population build up of pest, yet their impact was non-significant, which contradicts the finding of several authors (Kaul and Kesar, 2003; Atluri *et al.*, 2004 and 2010; Selvaraj *et al.*, 2010), who found a significant effect of RH and temperature on population buildup of different lepidopteran pests. However, host abundance (particularly new flushes) and host quality favoured the population buildup of pest, as new flush facilitate the performance of larvae due to the likely higher levels of nitrogen and water content (Slansky and Feeny, 1977; Scriber, 1977; Mattson, 1980; Price, 2000; Awmack, 2002). Correlation of peak pest population periods with corresponding and previous SMW, revealed that prevalence of maximum temperature (27.5-30.2^{0}C), mean temperature 29.31°C, high RH and low rainfall recorded in maximum increase of number of larval population. However, the overall effect of weather on population trends is complex and difficult to predict, as also expressed by Pollard (1988).

The semilooper, *D. orosia* has emerged as serious pest of anthmool, *T.asthmatica* and active almost round the year. The pest could generate another generation in 21-27 days. The weather parameters did not have significant effect on the built up of the pest. However, presence of new flushes favoured population built up. This knowledge on the pest will be helpful in formulating effective pest management strategies.

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