Hyblaea puera Cramer (Lepidoptera: Hyblaeidae) infestation on *Tectona grandis* Linn F. in Aizawl District, Mizoram

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Abstract: Seasonal activity of Lepidopteran insect of *Hyblaea puera* Cramer conducted during three years during of 2016 - 2018 on two aspects of eastern and western sites of Aizawl District, Mizoram. *Hyblaea puera* Cramer is the most wide spread and serious pest. Outbreaks occur almost every year in India over extensive areas. During these outbreaks in the early flushing period of teak, trees usually suffer a total defoliation, sometimes there is partial defoliation later in the growth season.

The present investigation revealed that for bringing out a systematic documentation regarding the damage caused by different insect pests attacking teak plantation in area as well as to find out the relationship of different climatic factors with their incidence.

Keywords: Geographical bearing , Hyblaea puera Cramer, *Insect Pests, Infestation, Tectona grandis* Linn.F.

Introduction

Teak (*Tectona grandis* L.f.), a valuable timber species, is attacked by a number of insect pests Mathur,(1960); Mathur and Singh,(1960) ; Baksha,(1990), (1993); Chaiglom,(1975); Menon,(1963). But only one insects-teak defoliator, *Hyblaea puera* Cramer cause major defoliation of teak in Mizoram. About 187 insects species have been found feeding on living Teak tree in India, Hutacharern and Tubtim, (1995) Amongst the foliage feeders, the teak defoliator, *Hyblaea puera* Cramer (Hyblaeidae, Lepidoptera) and teak skeletonizer, *Eutectona machaeralis* Walker (Pyralidae: Lepidoptera) are the most widespread and serious pests.

Tectona grandis Linn.F is an economically important plant known as Sagun and Sagwan. It belongs to family Verbenaceae. It is a large deciduous tree which is light demander and sensitive to frost, drought, coppices and pollards vigorously Troup, (1921).

A survey of insect pests attacking teak plantation was carried out in Karnataka. A total of 45 species were recorded from the teak plantations Katagal et al., (2000). Appanch et al. (2000) reported a total of 45 species; 22 defoliators, 19 sucking and 4 bark feeders. The differences between the findings of the present and earlier workers may be due to difference in ecological setting, area covered and period involved. Three species of insects, viz., Cicadellid (*Tettigoniella ferruginea F*.), teak defoliator (*Hyblaea puera* C.), teak skeltonizer (*E. macheralils*) have been found causing severe damage to teak.

In India, teak grows naturally in 9 million hectares of southern tropical deciduous forests of Peninsular India Seth and Kaul, (1978) Currently1.5 million hectares of teak plantations exists in India and around 50,000 hectares are planted annually (Subramanian et al., 2000) *Hyblaea puera* Cramer has also become an economic pest in non-native teak countries such as Costa Rica and Brazil, where outbreaks appeared all of a sudden during 1995 and 1996, respectively (Nair, 2007) Studies in young teak plantations at Nilambur of Kerala in South India showed that defoliation by *Hyblaea puera* Cramer caused loss of 44.1% of the potential wood volume increment over a 5 year cumulative period, Nair et al., (1996)

Literature review

In the present investigation, the incidence of *Hyblaea puera* Cramer was recorded from May to December during 2003-05 in the entire Forest Divisions of two aspects. The larval population was negligible from October to April and there was a sudden increase in their population during the first fortnight of June in both the years The present observations made on the peak incidence of *Hyblaea puera* Cramer corroborate with the report of (Khan et al. 1988) who have also observed its peak incidence during July and August while least active period was from September onwards. The occurrence of higher population of larvae during June and July in the present study was in agreement with the report of Nair and Sudheendrakumar (1986), Nair and Mohandas (1996) and Loganathan and David (1999) opined that the outbreak of *Hyblaea puera* Cramer occurred on teak following the early seasonal shower during May-June.

Defoliation has a direct effect on leaves and thus affect the growth of plant. The leaf area is reduced depending on the number of larvae feeding. Under light to moderate defoliation the tree survives following the production of new flush of leaves but repeated defoliation results in serious adverse effect. The defoliation has a significant effect on the terminal growth. Sometimes defoliation can cause rapid and significant crown die back Staley, (1965) and Nicholas, (1968). Teak defoliator is an important insect pest of teak. Outbreak of *Hyblaea puera* Cramer occurs every year over large areas in plantations during the rainy period. The larvae feed on leaves and cause severe retardation of growth of the tree. Beeson (1941) described that, teak defoliator, *Hyblaea puera* Cramer was noticed at the commencement of the monsoon season causing extensive damage by means of defoliation of new flush of foliage during the active growth period of the host plant.

The first instar larva feeds first on the soft parenchyma of the young leaves, but acquires soon the power of biting through the smaller veins and then cuts a small semi-circular or rectangular flap on the edge of the leaf which it pulls over and fastens to the upper leaf surface. (Nair 1988) observed that the first and second instars feed mainly on the leaf surface, whereas third instar larva cuts out a leaf flap, usually at the edges of the leaf, folds it over, fasten it with silk and feeds within leaf. While, fourth and fifth instar larvae feed within the shelter of leaf folds.

Further, the observation made by Katagall (1991) indicated that, first and second instar larvae were found to skeletonise the leaves, whereas third, fourth and fifth instar larvae consumed tender leaves entirely. Similar observation was recorded by Roychoudhury and Joshi (1995), but in addition they found that, the larva also feed on bud of tender and lateral shoots under starvation condition. Whereas, Nachane et al. (1999) observed that, the feeding habit of the larvae changed progressively from surface scraper or trench marker during first instar to hole feeding through trenches during second instar, followed by semi circular or rectangular flap hole feeding, having flaps fastened over leaf surface with silken strands and skeletonising the leaves during third instar. The earlier two instars larvae were preferred young leaves, while later three instar were damaged to fully developed leaves.

In another study, Pandey et al. (2009) reported that, teak defoliator, *Hyblaea puera* Cramer appeared in Faizabad during second fortnight of June to first fortnight of the October. The highest population was observed as 2.2 caterpillar/plants, 1.3 caterpillar/plant and 1.5 caterpillar/3 branches on two, three and thirteen year old plants, respectively during first fortnight of August. Whereas, Prajapati (2011) reported that the infestation of *Hyblaea puera* Cramer on teak was as high as 51.36 per cent in month of July in Gujarat. While, it was 49.42 per cent in the month of August and declined towards the end of September second fortnight and thereafter disappeared during the rest of months.

MATERIALS AND METHODS

Mizoram is Situated in the North Eastern part of India, Mizoram covers geographical area of 21,081 sq km, which is 0.64% of the geographical area of the country. The State lies between 21°56'N to 24°31'N latitude and 92°16'E to 93°26'E longitude. The State has a climate ranging from moist tropical to moist sub-tropical. The annual rainfall ranges between 2,100 mm to 3,500 mm and the annual temperature during winter, 11°C to 24°C and in summer between 18°C to 29°C. It rains heavily from May to September. (SFI, 2019)

Different Teak plantation in Aizawl District will be selected which include – two aspects eastern and western sites of Teak Plantation of each, division a Quadrat of 10m X 10m will be randomly laid out at regular monthly. Observations were recorded at fortnightly interval along with major weather parameter viz., wind velocity, wind direction, temperature, relative humidity and rainfall at each location. 25 sampling sites were identified on the surveyed area during the period of January to December, 2018 and The meteorological data such as Average Relative Humidity, Temperature Wind Velocity and Rainfall were recorded.

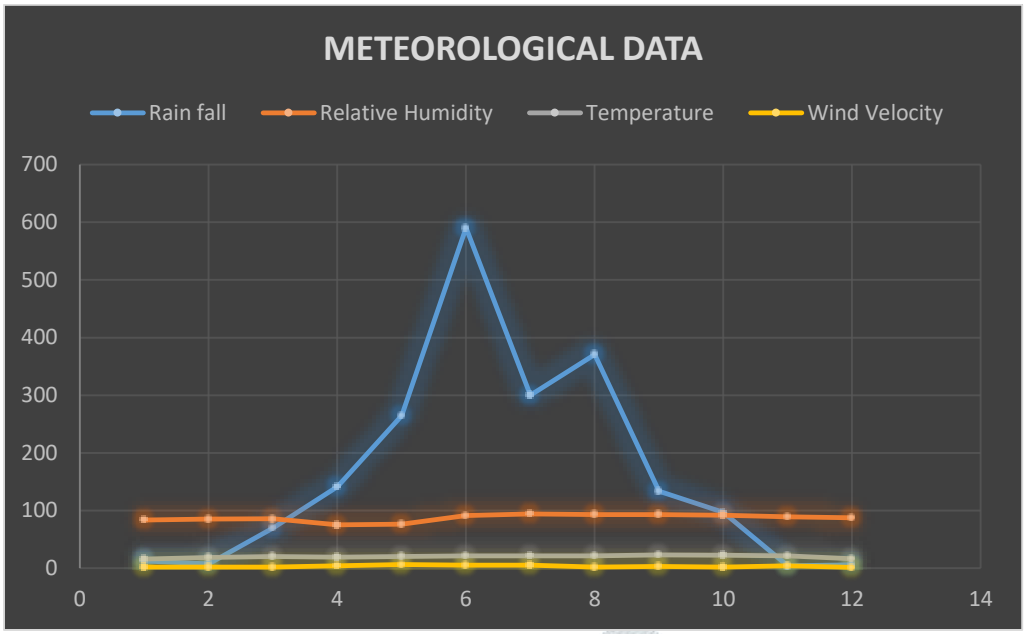

Fig1. : Annual meteorological data during the period of study at Eastern and Western aspects of Aizawl district, Mizoram (January, 2018 to December, 2018)

Insects pest of teak *Tectona grandis* Linn.F have been studied from riparian level of Tuirial, Seling and Tuirini Riparian and non Riparian level of Sairang, and Sihhmui Teak

Plantation by visiting various study spots and noting pest insects at monthly interval. Nature of damage of insects towards teak crop have been studied in field condition by spot observation.

Investigations carried out not pest out break during January to May and June to September, 2018 revealed that outbreaks of the defoliator *Hyblaea puera* Cramer occurred on teak following early seasonal rainfall. Weather showed a significant positive relationship between defoliator incidence and rainfall, which therefore appeared to be the probable cause of the defoliator outbreak - delay in the rainfall lead to delay in defoliator infestation and vice-versa.

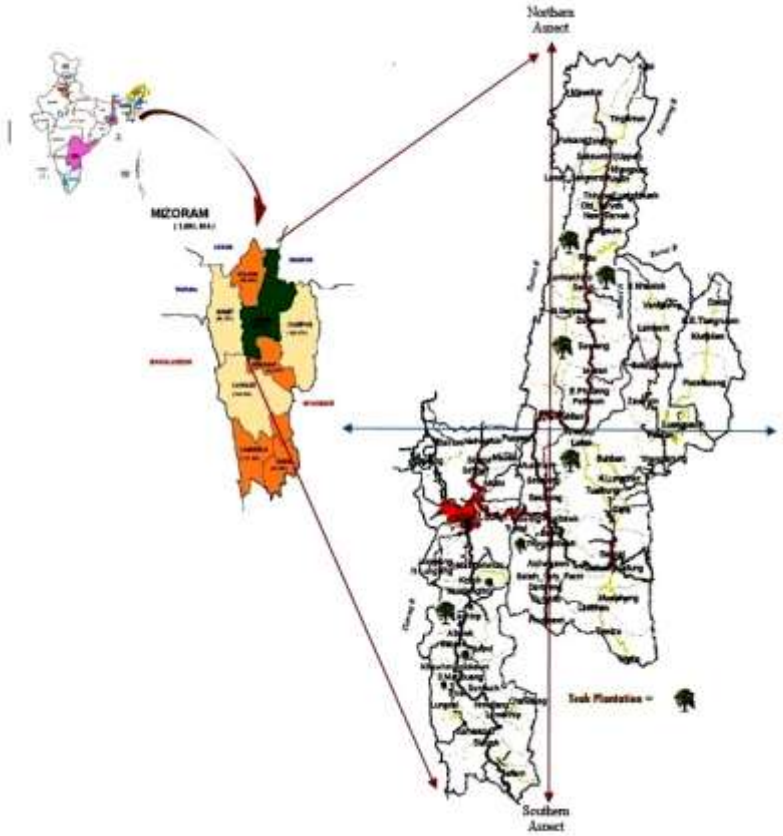

Fig. Study area of teak plantation in two aspects of Aizawl district, Mizoram

Quadrat	Baseline State Highway Aizawl to Tuirini , Sihhmui, Sairang Corridor		Plantation age (Average)	Geographical Bearing	Altitude
	Start From Aizawl (0 km)	Plantation Sites			
Q1	16.9km	Tuirial Teak Plantation	25<	N 23º 44.447 E 092º47.420	851 m
Q2	18.1Km			N 23º 43.898 E 092º47.351	474 m
Q3	18.7km			N 23º 43.448 E 092º47.351	221 m
Q4	24km			N 23º 43.317 E 092º47.869	189 m
Q5	27.1km			N 23º 44.922 E 092º47.869	277 m
Q1	31.2km	Seling Teak Plantation	10<	N 23º 44.506 E 092º47.420	471 m
Q2	36.2 km			N 23º 43.116 E 092º50.880	627 m
Q3	40.5 km			N 23º 45.619 E 092º51.341	627 m
Q4	43.5 km			N 23º 45.619 E 092º51.993	786 m
Q5	44.3 km			N 23º 45.693 E 092º41.003	770 m
Q1	60kms	Tuirini Teak Plantation	10<	N 23º 50.139 E 092º49.916	274 m
Q2	64.3 km			N 23º 51.247 E 092º50.123	195 m
Q3	65.5 km			N 23º 51.761 E 092º49.048	232 m
Q4	66.2			N 23º 51.249 E 092º49.916	235 m
Q5	70.2 km			N 23º 53.049 E 092º50.516	423 m
Q1	16.5 km	Sairang Teak Plantation	20<	23°48'29.5"N 92°39'28.4"E	255 m
Q2	16.5 km			23°48'29.5"N 92°39'28.4"E	235
Q3	16.5 km			23°48'29.5"N 92°39'28.4"E	220 m
Q4	16.5 km			23°48'29.5"N 92°39'28.4"E	225m
Q5	16.5 km			23°48'29.5"N 92°39'28.4"E	218 m
Q1	23.2 km	Sihhmui Teak Plantation	20<	23°48'06.8"N 92°38'25.7"E	212
Q2	24.8 km			23°48'06.8"N 92°38'25.7"E	212
Q3	25.2 km			23°48'06.8"N 92°38'25.7"E	212

Q4	25.9 km			23°48'06.8"N 92°38'25.7"E	212
Q5	26.7 km			23°48'06.8"N 92°38'25.7"E	212

Table 1. List of Teak Plantation Sites and Geographical bearing of Aizawl District

There was also a smaller significant (negative) correlation between defoliator incidence and wind speed, but no significant correlations were found between outbreak occurrence and other climatic factors (wind velocity, relative humidity, and temperature). Rainfall appeared to have no effect in sustaining the epidemic infestation.

Data represented Table 1 List of Teak Plantation Sites and Geographical bearing of study areaAizawl District. The investigations were carried out in teak plantations at Eastern site - Tuirial, Seling, Tuirini and Western site – Sairang, Sihhmui Area, from January to December 2018. The area for survey was selected in 5 quadrats in each Locations. The number of larvae present on leaves of each twig was counted for each sample. The data collected from various samples were pooled. The incidence of defoliator damage was categorized into high, moderate, light and nil classes through visual estimation as suggested by Khan et al. (1988). During the field observation, if one third leaves of a sampled twig were found defoliated, the incidence was considered 'light' (up to 25%); when half leaves of the sampled twig were found defoliated it was assessed as 'moderate' (up to 50 %); if more than two third part of leaves in sampled twig were damaged it was considered as 'high' (> 50%).

Table 1. List of insects pests associated with recorded on Teak, Tectona grandis Aizawl District Mizoram

S.N	Insect species	Scientific name	Status of the pest	Order	Family
1	Gundhi Bug	*Leptocorisa sp.*	minor	Hemiptera	Alydidae
2	Teak Defoliator	*Hyblaea puera Cramer*	Major	Lepidoptera	Hyblaeidae
3	Aphid	*Aphis tectonae v.d.G*	Minor	Homoptera	Aphididae
4	Carpenter ant	*Camponotus sp*	Minor	Homoptera	Aphididae
5	Bagworms				
	(i) stick case moth	*Clania lewiniii*	Minor	Lepidoptera	Psychidae
	(ii) cone case worm	*Lepidoscia sp.*	Minor	Lepidoptera	Psychidae
6	Butterflies	*Euchromia polymena*	Minor	Lepidoptera	Ctenuchidae
	(ii) monarch butterfly	*Danaus plexippus*	Minor	Lepidoptera	Nymphalidae
7	White grubs	*Holotrchia sp.*	Major	Coleoptera	Melolonthidae
8	Sucking Bug	*(unidentified)*	Minor	Hemiptera	Pyrrhocoridae
9	Mealy bugs	*Maconellicoccus*	Minor	Hemiptera	Coccidae
10	Termite infestation on tree trunk	*Odentotermes sp*	Minor	Isoptera	Termitidae
11	Scutellerid bug	*Chrysocoris purpureus*	Minor	Hemiptera	Scutelleridae
12	Placosternum sp.	*Placosternum sp*	Minor	Hemiptera	Pentatonidae
13	Praying mantis	*Mantis religiosa*	Minor	Mantodea	Mantodea
14	Hymenopteran wasp	*Polistes sp.*	Minor	Hymeoptera	Vespidae

Table 2. List of insect pest associated with *Tectona gandis* L

Common Name	Scientific Name	Family	Order
Sap Feeder			
Cicadellid	*Tettigonella ferrugenia*	Cicadellidae	Hemiptera
Pentatomid bug	*Aspongopus janus* F.	Pentatomidae	Hemiptera
Cow Bug	*Penecoccus insolitus*	Coccidae	Hemiptera
Defoliators			
Grasshopper	*Chrotogynous* sp.	Acridae	Orthoptera
Teak Defoliator	*Hyblaea puera Cramer*	Hyblaeidae	Lepidoptera
Other Insect			
Hadda Beetle			
Red Cotton bug	*Dysdercus koenigii* Fab.	Pyrrhoconidae	Hemiptera
Black ant	*Compatonus* sp.	Formicidae	Hymenoptera

Infestation characteristics

Hyblaea puera Cramer population incidence on some trees at study areas of the Tuirial Range was noticed at an early month of June. The initial population of nearly 2-day2 old larvae was confined to 50 -60 trees. At this time, the trees had a full flush of new leaves, but there were differences in leaf maturity. The attacked trees had comparatively tender leaves with larval population distributed throughout the canopy, although the concentration was greater on the most tender terminal leaves. The infestation was limited to a patch, and similar trees in adjacent areas were unaffected. In other areas similar or larger patches of infestation were found at the same time. In each case the larval populations were of similar age-structure. Where the initial population was small and confined to tender leaves at the upper canopy, the larvae after consuming the tender leaves descended to the older leaves of the same tree and continued feeding. In many trees, all the older leaves were eaten by larvae which migrated either from the upper canopy or from adjacent trees. Thus many trees were completely flush of leaves within a short period time . After a few days the moths began appearing, and large numbers were attracted to dlight traps. Since a large population of moths was present in the observation area, a much bigger second infestation in June to July was anticipated. However, no significant infestation occurred in spite of the presence, in the same area, of trees possessing tender foliage-including those partially reflushed after the first insect attack.

No larvae were seen in the area after the end of May. However, generally in June there was heavy pest population causing complete defoliation of the teak trees. The population then declined until late September. Small, new and uneven aged populations were also found during the leafless period of teak (November-February) causing minor but visible defoliation of saplings, which mostly retained their leaves during the deciduous period of teak.

During the transect line sampling, 43 insect species recorded from western aspect and 32 species were collected from eastern aspects. Visual observations revealed some species outside transect line areas. Total number of 65 species were recorded from this area during January to December 2018.

Bioecology of teak defoliator, *Hyblaea puera* Cramer

Damage of teak defoliator started appearing in the month of June i.e. at the time of emergences of new leaves. The damage found with increasing trend till August. It was maximum > 30 per cent in the month of July and August during which fully grown leaves in abundance was available on the teak tree. The damage of defoliator was found increased with availability of ample food on host crop. Thus, the crop stage played significant role to aggravate the pest like defoliator which ultimately turned out in more damage. While, Baksha and Crawley (1998) from Bangalore reported that, teak defoliator appeared during second fortnight of April to July and was seen for the last time during first fortnight of the October. However, Javaregowda and Naik (2007) from Karnataka reported incidence of *Hyblaea puera* Cramer from second fortnight of May onwards in all the divisions except in Sirsi Forest Division, where the incidence was observed from first fortnight of September. Similarly, Pandey et al. (2009) from Faizabad reported that, teak defoliator appeared during second fortnight of June and was seen for the last time during first fortnight of the October. Whereas in Aizawl district, Mizoram *Hyblaea puera* Cramer incidence started at early month of June to late September every year.

The incidence of *Hyblaea puera* Cramer recorded by quadrat method and data on number of quadrats having Teak defoliator *Hyblaea puera* infestation and average number of infested plants is presented in Tables 2 infestation started appearing on the month of june . Peak infestation at Tuirial Teak plantation was recorded during june to July standard month with 5 infested quadrats out of 5 quadrats and number of infested plants per quadrat ranged between 2.4 - 3.0 during this duration.

Table 4 Incidence of *Hyblaea puera* Cramer on study area Aizawl district

Period of observations	LOCATION									
	Tuirial		Seling		Tuirini		Sairang		Sihhmui	
JANUARY TO DECEMBER, 2018	No of quadrat having infestation	Average number of infested plants/ quadrat #	No of quadrat having infestation	Average number of infested plants/ quadrat #	No of quadrat having infestation	Average number of infested plants/ quadrat #	No of quadrat having infestation	Average number of infested plants/ quadrat #	No of quadrat having infestation	Average number of infested plants/ quadrat #
January	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0	0	0	0
June	3	6	3	8	3	9	5	7	4	5
July	4	9	4	6	4	4	5	4	5	7
August	2	1	2	3	2	2	1	2	2	1
September	1	1	1	3	1	1	1	1	1	1
October	0	0	0	0	0	0	0	0	0	0
November	0	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0	0

= out of 5 quadrats, * = no infestation

Hyblaea puera Cramer indicated female oriented egg laying singly on ventral side of leaf lamina. The freshly laid eggs were oblong and pale white in colour. The length and breadth of eggs ranged from 0.92 to 1.0 mm and 0.40 to 0.51 mm, respectively. The incubation period ranged from 2 to 3 days, whereas, egg hatchability varied from 45 to 65 percent

The length of first, second, third, fourth and fifth instars varied from 1.91 to 2.0, 1.0 to 4.50, 11.90 to 15.0, 17.90 to 20.0 and 28.0 to 32.0 mm, respectively while, breadth varied from 0.22 to 0.26, 0.53 to 0.65, 1.50 to 1.70, 1.80 to 2.50 and 3.0 to 3.50 mm, respectively. The duration of first, second, third, fourth and fifth instar larvae varied from 2 to 4,2 to 3,2 to 3,2 to 3 and 3 to 5 days, respectively. The total larval period was completed in 12 to 16 days The pupation took place in the silken cocoon underneath the leaves. The length and breadth of pre-pupa ranged from 18.0 to 26.0 and 16.0 to 24.0 mm respectively. The pre-pupal period varied from 1.10 to 3.0 days The length of male and female pupae varied from 14.50 to 16.0 and 17.0 to 19.0 mm while, its breadth ranged from 3.50 to 4.50 and 4.50 to 5.50 mm, respectively. The male and female pupal period ranged from 3.0 to 5.0 and 6.0 to 8.0 days, respectively.

Length of adult male and female moths was 16.0 to 19.0 and 20 to 22.0 mm, respectively. The wing expansion of adult male and female moth ranged from 24.0 to 28.0 and 32.0 to 36.0 mm, respectively.

Results and Discussion

The defoliation trends caused by *Hyblaea puera* Cramer in the four experimental plots are shown in fig. 1. No other insect caused measurable defoliation during the period when *Hyblaea puera* Cramer is prevalent. Thus the defoliation curve could be represented as the population curve of *Hyblaea puera* Cramer larvae, excepting that when the trees are totally defoliated any increase in the larval population would not be reflected.

Discussion : The present experiment knowing the that the occurrence of Insect pest associated with *Tectona grandis* Linn.F and the main insect pest of teak and it is required to take appropriate management strategies at proper time for these pests. It appears that there are diverse ecological impacts on to the system during this pest outbreak. The outbreak usually result in complete defoliation of Teak trees, and cause a break in the increment growth rate and development of the Teak trees, however this is not fatal for the trees.

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