Outbreak of the Looper, Perixera illepidaria (Lepidoptera: Geometridae) on Litchi, Litchi chinensis (Sapindales: Sapindaceae) - A New Pest Record from India

Authors: Kumar, Vinod, Reddy, P. Venkata Rami, Anal, Ajit Kumar Dubedi, and Nath, Vishal

Source: Florida Entomologist, 97(1) : 22-29

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.097.0103

OUTBREAK OF THE LOOPER, *PERIXERA ILLEPIDARIA* (LEPIDOPTERA: GEOMETRIDAE) ON LITCHI, *LITCHI CHINENSIS* (SAPINDALES: SAPINDACEAE) - A NEW PEST RECORD FROM INDIA

VINOD KUMAR[1,*], P. VENKATA RAMI REDDY[2], AJIT KUMAR DUBEDI ANAL[1] AND VISHAL NATH[1]
[1]National Research Centre for Litchi, Mushahari, Muzaffarpur, Bihar - 842002, India

[2]Indian Institute of Horticultural Research, Hessaraghatta Lake, P.O., Bangalore- 560089, India

*Corresponding author; E-mail: vinod3kiari@yahoo.co.in

Supplementary material for this article in Florida Entomologist 97(1) (2014) is online at http://purl.fcla.edu/fcla/entomologist/browse .

ABSTRACT

An outbreak of a looper, identified as *Perixera illepidaria* (Lepidoptera: Geometridae) was observed on litchi trees in Bihar state of India during Sep to Nov both in 2011 and 2012. Loopers fed voraciously on young leaves leaving behind only the midribs. During Oct 2011, trees having highly damaged canopies (> 50% top foliage damage) ranged between 0.7 to 29.4%, while partially damaged (< 50% foliage damage) tree were 1.4 to 20.8% at the Experimental Farm of National Research Centre for Litchi, Bihar, India. During Oct 2012, the incidence of looper infested trees in farmers' field varied from 34.1 to 84.5%., and up to 39.4% trees were in the 81-100% damaged foliage category. The mean number of larvae per 10 leaflets varied from 0.6 to 14.7. The developmental period from larvae to adult ranged from 15 to 19 days. The geographical range of this species had been N.E. Himalaya, Hong Kong, Sundaland, Philippines, Sulawesi and Guam. This is the first report on the occurrence of *P. illepidaria* on litchi in India.

Key Words: Bihar, canopy defoliation, development, litchi looper, pest outbreak

RESUMEN

Se observó un brote de la plaga medidor [*Perixera illepidaria* (Lepidoptera: Geometridae)] en árboles de litchi en el estado de Bihar de la India durante septiembre-noviembre, tanto en el 2011 y el 2012. Los medidores se alimentan vorazmente de las hojas jóvenes dejando sólo las nervaduras centrales. Durante el mes de octubre del 2011, las plantas con copas muy dañadas (> 50% de daño de follaje superior) variaron entre el 0.7 a 29.4%, mientras que los árboles que sufrieron daños parciales (< 50% de daño foliar) varían entre el 1.4 a 20.8% en la Granja Experimental del Centro de Investigación Nacional de Litchi, Bihar, India. Durante octubre del 2012, la incidencia de árboles infestados con medidores en el campo de los agricultores varió del 34.1 hasta 84.5%, y un máximo del 39.4% de plantas se encontraban en la categoría de follaje dañado del 81-100%. El promedio del número de medidores por 10 hojas varió de 0.6 a 14.7. Se completó el período de larva al adulto en 15-19 días. La plaga fue identificada como *Perixera illepidaria* Guenée (Geometridae). Se informa sobre la ocurrencia de *P. illepidaria* sobre litchi por primera vez en la India.

Palabras Clave: Bihar, defoliación de la copa, desarrollo, medidor de litchi, brote de plagas

The litchi or lychee (*Litchi chinensis* Sonnen) is an evergreen subtropical fruit tree of the family Sapindaceae. World production of litchi is estimated to be around 2.11 million tonnes, with more than 95% of the world cultivation occurring in Asia. A relatively small amount is produced in the United States, Mexico, and Central and South America (Evans et al. 2004). The top 5 litchi producing countries are China, India, Taiwan, Thailand, and Vietnam (FAO 2002). India and China account for 91% of the world litchi production. The acreage under litchi was 80,400 ha in India with a production of 538,100 tonnes during 2010-11 (Anon. 2012). In the United States, commercial production of litchi takes place in Florida, Hawaii, and California. Florida is ranked first in litchi production and litchi plantings have increased greatly over the last 18 years. Since 1990, litchi acreage in Florida has increased from 200 acres to between 800 and 1,200 acres (Rafie et al.

2007; Evans et al. 2008), but the overall production is considerably less than in India. Litchi contributes significantly to the growers' economy in Bihar, West Bengal, Assam and Jharkhand states of India, and accounts for 78% of the total litchi production in the country. Bihar produces 45% of total litchi production and occupies about 40% of the area. The important litchi growing districts in Bihar are Muzaffarpur, Vaishali, Sitamarhi, West Champaran, East Champaran, Darbhanga and Samastipur.

Insect pests are one of the major constraints affecting production and productivity of litchi. Insect pests infesting litchi in India have been recorded as fruit and seed borers or litchi stem-end borers (*Conopomorpha cramerella* Snellen, *C. sinensis* Bradley, *C. litchiella* Bradley [Gracillariidae]) (Singh 1975, 1978; Butani 1977; Waite & Hwang 2002; Nair & Sahoo 2006), leaf mite (*Aceria litchii* Keifer [Eriophyidae]) (Prasad & Singh 1981; Singh & Raghuraman 2011), leaf roller *Dudua aprobola* Meyrick [Tortricidae] (Singh 1971a) and *Dichocrosis festivalis* Swinh. (Pyralidae) (Singh & Kumar 1992), leaf miner (*Conopomorpha cramerella*) (Singh 1975; Butani 1977; Nair & Sahoo 2006), litchi bug (*Tessarotoma javanica* Thunberg [Tessaratomidae]) (Kumar et al. 2008; Choudhary et al. 2013), bark eating caterpillar (*Indarbela quadrinotata* Walker [Cossidae] and *I. tetraonis* Moore) (Khurana & Gupta 1972), ash weevil or leaf cutting weevil or little leaf notcher weevil (*Myllocerus delicatulus* Boh. *Myllocerus discolar* Boh., *Myllocerus undecimpustulatus* Fst., *M. undatus* Marshall) [Curculionidae] (Singh 1974; Singh 1971b; Kumar et al. 2011) and a shoot borer (*Chlumetia transversa* Walker [Noctuidae]*)* (Butani 1977; Waite & Hwang 2002; Kumar et al. 2011). The borer complex of litchi is most important as they extensively damage the developing and mature fruits, and reduce yields and marketability. In continuous monitoring of insect pests at the National Research Centre for Litchi (NRCL), Muzaffarpur some new pests were observed. Here, we report the occurrence of a defoliator, loopers hitherto not recorded on litchi in India that necessitates continuous surveillance and attention of researchers. Characteristics of the pest and symptoms of damage are described, as well as summaries of studies conducted to assess the occurrence and extent of damage by loopers in litchi. Graphical materials are shown online in color in a supplementary document at http://purl.fcla.edu/fcla/entomologist/browse.

Materials and Methods

Study Site

This study was conducted at Muzaffarpur (N 26° 04' E 85° 27', 47 m asl) and adjoining areas in East Champaran (N 26° 65' E 84° 92›, 62 m asl) District of Bihar State of India.

Incidence and Severity of Damage

Scouting and fixed plot surveys were conducted in litchi orchards and incidence of the pest was recorded both at the NRCL Experimental Farm and in farmers' fields during 2011 and 2012. In the first year (2011), data on damage to trees was recorded only at NRCL Farm whereas in the second year (2012), it was recorded at the NRCL Farm as well as in the farmers' fields. During October 2011, every tree of the orchard blocks (having about 150 trees) were scored visually on the basis of per cent leaf area (the length and diam of the leaf) damaged. They were categorized as partially (< 50% top foliage) and highly (> 50% top foliage) damaged tree categories. Further, to assess more empirically the extent of damage to upper canopy of trees during 2012, fully damaged twigs having only a bare rachis left were considered. A portion of tree each having approximately 40-50 young twigs was observed from all 4 cardinal directions and the percent damaged twigs was calculated. Data were recorded on 5 randomly selected infested trees in each orchard. The symptoms of damage by the pest were described and the percent leaf damage was calculated.

Insect Count

The mean numbers of insect (count) per 10 leaflets were recorded both at farmers' fields and NRCL Experimental Farm during last wk of Oct to first wk of Nov 2012. Observations on 5 infested trees were recorded in each orchard with 3 randomly selected branches per tree having approximately 100 young leaflets. Though this observation was taken on the same set of randomly selected trees of which the extent of damage was recorded, these 2 parameters (count, % twig damage) constituted independent observations.

Rearing of Insects and Morphometric Measurements

The young larvae (1st to 2nd instars) were collected from field and reared in the laboratory on litchi leaves (1-2 wk old) in Petri dishes (18 cm diam). The pupae were transferred to insect rearing jar (8.5 cm × 8.5 cm × 15 cm) for emergence of adults. A filter paper disc with a cotton swab dipped in honey was kept in each rearing jar. Rearing of the pest was done at a temp of 28 ± 1 °C, relative humidity 70 ± 5% and photoperiod 12:12 h L:D conditions. Morphometric measurements of different stages were taken and biology was studied. Insect morphology was studied with the help of a stereo-binocular microscope. To measure the head capsule width, the larvae

were gently placed in a Petri dish. A cotton swab with a drop of chloroform (99.5%) was then placed in Petri dish and as soon as the larvae ceased to move or die, the maximum head capsule width was measured. This was done to the nearest division of a micrometric grid incorporated in a binocular microscope. The insect species was identified by a taxonomist and the voucher specimen was submitted to the Division of Entomology, Indian Agricultural Research Institute, New Delhi. Experimental feeding of larvae on leaves of various plant species commonly growing adjacent to litchi orchards were tried to know the potential host of the pest. These were castor bean (*Ricinus communis* L.; Euphorbiaceae), gamhar or beechwood or white teak (*Gmelina arborea* Roxb.; Lamiaceae), teak or sagun (*Tectona grandis* L. f.; Verbenaceae), bakain (*Melia azedarach* L.; Meliaceae), bhainth or bhant (*Clerodendrum viscosum* L.; Lamiaceae) and mango (*Mangifera indica* L.; Anacardiaceae).

Data Analysis

The data were analyzed using SAS®9.2 statistical computing software and subjected to analysis of variance (ANOVA). Data on looper counts were square root transformed whereas means of percent twig damage were arcsine transformed before analysis. The F value, least significant differences (LSD) between means at 5% significance level (P = 0.05) and the standard error (SE) of means were computed.

Results

An outbreak of the looper, identified as *Perixera illepidaria* Guenée **comb. nov.** (Geometridae) was observed on the September flush of litchi, both in farmers' fields in Muzaffarpur and East Champaran districts of Bihar, and at the NRCL Experimental Farm. The larvae fed voraciously on the lamina of young leaves leaving only the midribs and veins (Fig. 1). Also the larvae sometimes fed on tender shoots. Within a wk only the bare rachises were left on the top canopy of trees. The experimental feeding of larvae on tender leaves of some plant species commonly growing by the sides of litchi orchard indicated that except castor bean and mango, the larvae did not feed on leaves of any other plants. The larval period was extended by 3-5 days on these plants.

Studies on biology of the pest, *P. illepidaria* revealed that there was much variation in the color of larvae of different instars from black to dark brown with bands (Fig. 2). The last instars were approximately 2 mm wide and 1.7-2.2 cm (mean 2.01 ± 0.11) long. The widths of head capsules in last instar larvae were 1.2-1.5 mm (mean 1.32 ± 0.06). The pupae were 0.8-0.9 cm (mean 0.83 ± 0.03) long and the adults with fully spread wings were 2.1-2.3 cm (mean 2.20 ± 0.03) wide. The developmental period from larva to adult was completed in 15-19 days (mean 17.11 ± 0.92), out of which the larval period was 8-9 days (mean 8.44 ± 0.27), the pupal period was 5-7 days (mean 6.11 ± 0.47) and adult period was 2-3 days (mean 2.56 ± 0.33). The adults, however, failed to mate in the laboratory (temp. 28 ± 1 °C, RH 70 ± 5%, and 12:12 h L:D. The larvae made silken threads that descended vertically between tree branches and some larvae were seen hanging from them. Silken threads allowed larval movement from fully defoliated twigs to undamaged twigs with intact leaves. The newly formed pupa was green in color, which subsequently turned brown before adult emergence. Numerous pupae were seen scattered on the upper surfaces of leaves. The adult male was pinkish fawn, while females were rather uniformly pinkish. The wings of the adult had 2 rows of dark brown spots on the dorsal surface, the first row being just near the distal edge of each wing.

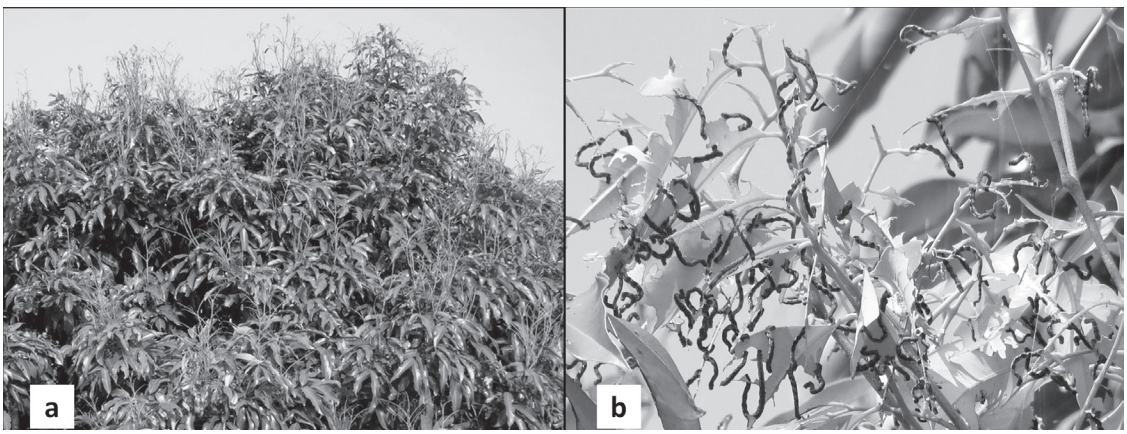

Fig. 1. Symptoms of damage by a heavy infestation of *Perixera illepidaria* loopers on a litchi tree (a and b).

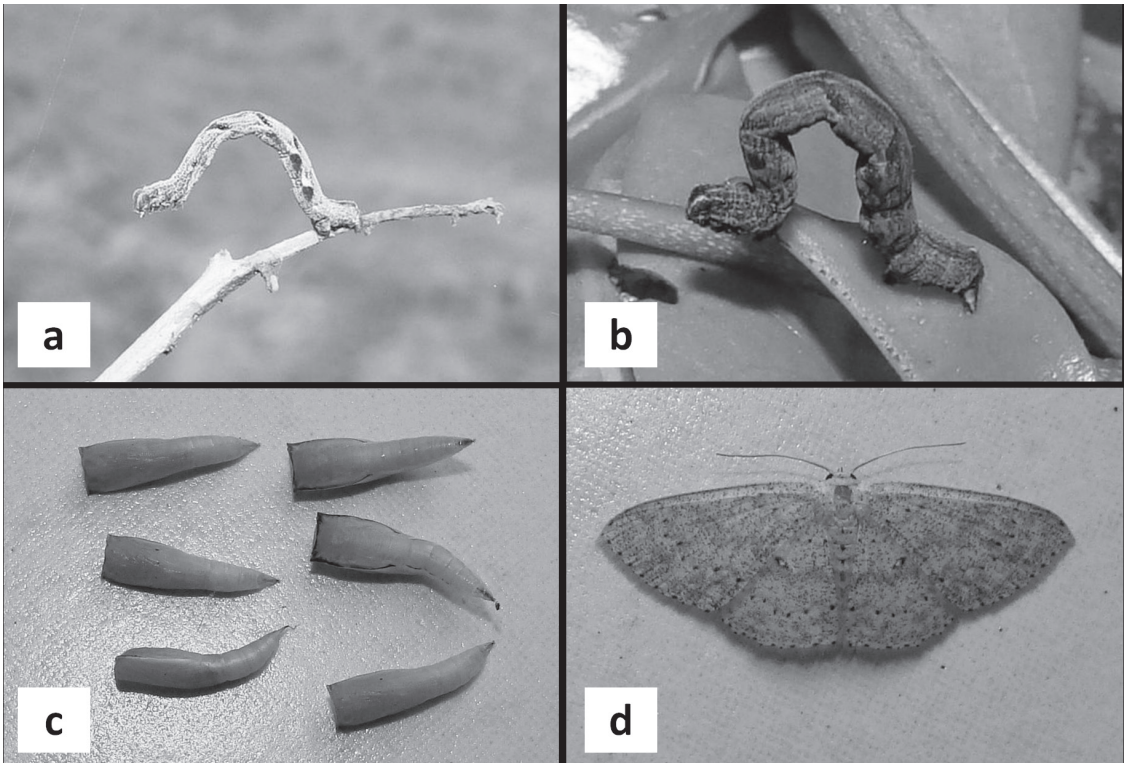

Fig. 2. Characteristics of the *Perixera illepidaria* looper: a. and b. Larvae (close-up view, note the variation in color); c. Pupa; and d. Adult.

The margins of both forewings and hindwings were serrated having tufts of fine hairs.

The observations on incidence and severity of damage recorded at NRCL Experimental Farm during Oct 2011 revealed that the extent of looper infested trees in these blocks was between 2.1 to 40.3%. The trees with highly damaged canopies (> 50% top foliage) varied from 0.7 to 29.4% while those with partially damaged canopies (< 50% top foliage) varied from 1.4 to 20.8% (Fig. 3). Further, the data on 16 randomly selected farmers' fields during Oct 2012 indicated that the incidence of looper infested trees varied between 34.1 to 84.5%. The distribution of trees in 4 different levels of damage by the pest in the 16 orchards is given in the Table 1. In different orchards, trees with up to 30 percent damaged foliage ranged between 16.1-100%, while in the 81-100% damaged foliage category there were up to 39.4% trees. Further, a preference of cultivar by the pest was apparent in the orchards. Between the 2 widely cultivated cultivars, viz., 'Shahi' and 'China', a higher incidence and more damage to foliage was observed in the orchard where only 'Shahi' was present. The incidence of looper infested trees in orchards having 'Shahi', 'China' and both cultivars were 44.2-84.5%, 35.4-67.7% and 34.1-62.4%, respectively. With respect to severity of damage in the low foliage damage (≤ 30%) category, orchards of 'China' had 16.1-100% trees in the low category, compared to 16.7-35.7% in 'Shahi' orchards and 22.7-45.5% in mixed cultivar orchards. Contrary to this, in the high foliage damage (81-100%) category, 'Shahi' orchards had 4.8-39.4% trees compared to only 0.0-36.6% in the 'China' orchards and 0.0-27.3% in the mixed cultivar orchards.

The period of occurrence of loopers in litchi was from Sep to Nov, the peak infestation being in Oct. During Sep, Oct and Nov 2012, the mean temperatures were 25.3-32.2 °C, 21.1-31.6 °C and 11.3-23.5 °C, and the mean relative humidities were 70.6-89.7%, 56.4-84.8% and 47.1-85.5%, respectively. The photoperiod conditions at Muzaffarpur of Bihar state on 15th of Sep, Oct and Nov 2012 was 12.18:11.42 h L:D, 11.33:12.27 h L:D and 10.52:13.08 h L:D, respectively. The data on larval count vis-à-vis percent damaged twigs during last wk of Oct to first wk of Nov 2012 in 19 orchards are given in Table 2. A statistically significant difference in mean larval counts per 10 leaflets (LSD 0.27 ± 0.08, $P = 0.05$) was observed among the orchards at NRCL farm and farmers' fields when tested by one-way ANOVA. It was evident from the data that the mean number of looper larvae per 10 leaflets among the orchards significantly varied from 0.6 to 14.7. The highest

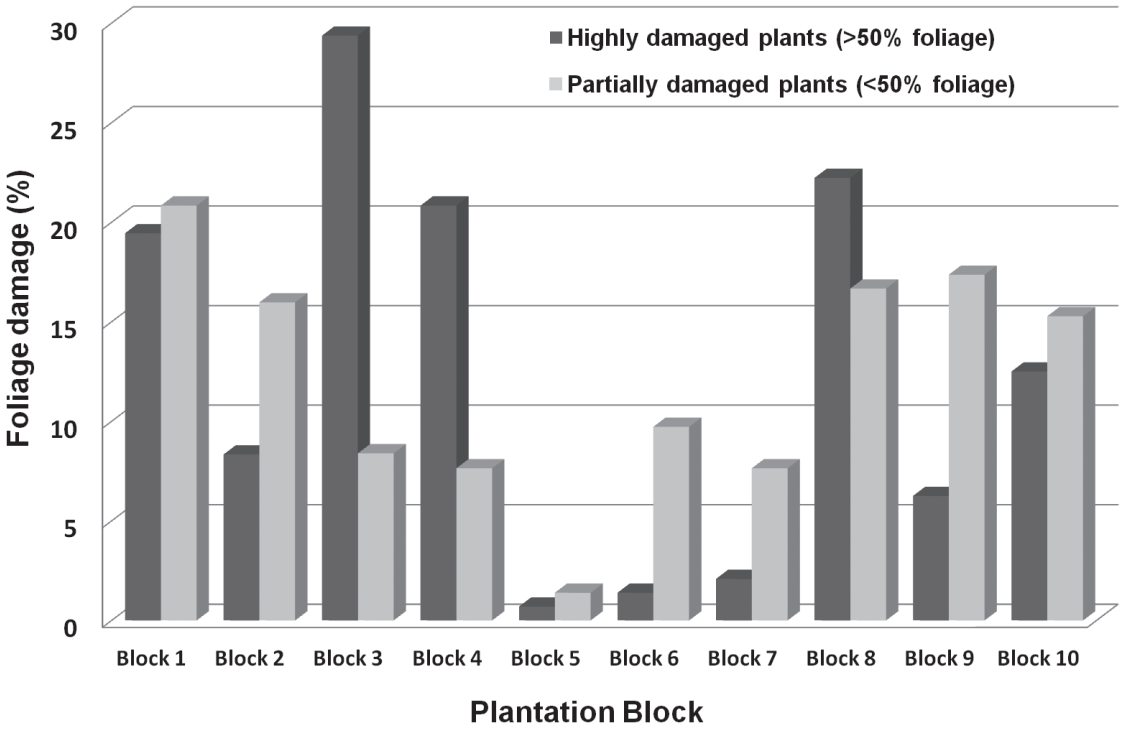

Fig. 3. Mean incidence and severity of damage to litchi trees by the *Perixera illepidaria* pest at the NRCL Experimental Farm during October 2011.

mean count (14.7/10 leaflets) was in litchi orchard block VI at NRCL Farm and in orchard 8 (13.3/10 leaflets) of Mehsi in the East Champaran District of Bihar. The range of numerical values of counts was 0.2-19.8. The mean percent damaged twigs among the orchards also significantly varied (LSD 4.85 ± 1.62, P = 0.05) from 3.8 to 79.0. In the various orchards surveyed, the numerical range of percent damaged twig was 2.0-88.1. The data on damage to top canopies of trees and the looper counts were not correlated because as soon as part of the branches of a tree was damaged, the pest migrated to new branches where enough leaves were present to feed upon.

Discussion

The species, *P. illepidaria* was first described by Guenée (1857) as *Anisodes illepidaria* which is now considered a synonym. The change of scientific name was made in Holloway's Lepidoptera of Borneo series (Holloway 1976), and this name combination was upheld by Scoble et al. (1999). The geographic range of this species had been N. E. Himalaya, Hong Kong, Sundaland, Philippines, Sulawesi and Guam (Holloway 1976). *P. illepidaria* is widely distributed in Thailand (Kuroko & Lewvanich 1993) but not present in Australia (Nielsen et al. 1996) as a pest of litchi, and this is the first report from India.

It is evident from our results that the incidence of *P. illepidaria* in litchi was high and caused severe damage to the foliage. Comparatively higher damage than in farmers' field was observed (Table 2) in litchi orchard blocks of NRCL Farm. This may be because of the presence of a large unattended old litchi orchard with many wild plants opposite the boundary of the NRCL Farm, which were never sprayed with insecticides. For litchi fruit production, the September flush is very important, because it bears the panicle in the ensuing season. *P. illepidaria* preferred developing leaves that emerged during Sep. The population of loopers started building rapidly from Sep to reach its peak in Oct and start to decline in Nov. Thus, the outbreak of this pest has a direct bearing on litchi fruit production; however, losses in terms of fruit yields need to be assessed. Understanding the factors responsible for the outbreak of any insect pest is a complex matter, and outbreaks can be difficult to predict. Outbreaks may be caused by the ever-increasing degree of anthropogenic changes to the environment. Schreiner & Nafus (1992) reported changes in populations of 4 species of Lepidoptera including widespread occurrence of *P. illepidaria* after biological control of

TABLE 1. INCIDENCE AND DISTRIBUTION OF TREES WITH DIFFERENT LEVELS OF DAMAGE BY LOOPERS, *PERIXERA ILLEPIDARIA*, DURING OCT 2012 IN FARMERS' FIELDS OF BIHAR STATE, INDIA.

Orchard No.	Cultivar	% Incidence of infested tree	Trees with different levels (%) of foliage damage			
			≤ 30%	31-60%	61-80%	81-100%
1	Mixed	56.9	26.8	18.3	31.7	23.2
2	Mixed	62.4	22.7	22.7	27.3	27.3
3	'Shahi'	72.0	17.5	21.4	22.3	38.8
4	'Shahi'	56.9	20.7	19.5	22.0	37.8
5	'Shahi'	59.7	23.3	25.6	23.3	27.9
6	'Shahi'	82.5	16.7	18.2	25.8	39.4
7	'Shahi'	84.5	23.3	26.7	28.3	21.7
8	'Shahi'	72.5	17.2	20.7	31.0	31.0
9	'China'	56.3	22.5	22.5	31.3	23.8
10	'China'	65.5	16.1	23.7	23.7	36.6
11	'China'	67.7	19.3	21.6	22.7	36.4
12	'Shahi'	81.3	25.0	28.8	26.9	19.2
13	Mixed	34.1	33.3	66.7	0.0	0.0
14	Mixed	43.1	45.5	36.4	9.1	0.0
15	'Shahi'	44.2	35.7	47.6	11.9	4.8
16	'China'	35.4	100.0	0.0	0.0	0.0

TABLE 2. COUNTS OF LOOPERS AND PERCENT DAMAGED TWIGS IN LITCHI AT THE NRCL FARM AND FARMERS' FIELDS DURING OCT-NOV 2012.

Block #/ orchard†	Location	Larval counts/10 leaflets		% Damaged twig	
		Mean*	Range	Mean**	Range
Block I	NRCL Farm	3.3 (1.80)	0.5 - 5.3	53.4 (46.91)	43.3 - 63.2
Block II	NRCL Farm	5.3 (2.30)	1.0 - 8.2	48.3 (44.04)	37.5 - 60.0
Block III	NRCL Farm	5.8 (2.41)	3.7 - 7.7	79.0 (62.75)	60.0 - 84.2
Block IV	NRCL Farm	7.0 (2.64)	2.3 - 11.3	56.2 (48.57)	47.1 - 66.7
Block V	NRCL Farm	7.3 (2.69)	4.3 - 10.2	46.1 (42.75)	40.0 - 58.3
Block VI	NRCL Farm	14.7 (3.83)	9.1 - 19.8	69.3 (56.38)	60.7 - 77.8
Block VII	NRCL Farm	6.6 (2.57)	4.1 - 10.3	77.8 (61.93)	68.4 - 81.8
Block VIII	NRCL Farm	4.8 (2.19)	2.9 - 10.0	44.6 (41.87)	36.4 - 52.2
Block IX	NRCL Farm	5.0 (2.23)	3.2- 8.3	56.8 (48.94)	53.9 - 66.7
Block X	NRCL Farm	6.3 (2.50)	3.1 - 9.0	62.5 (52.29)	57.9 - 72.7
Block XI	NRCL Farm	6.2 (2.48)	2.5 - 10.4	65.3 (53.92)	50.0 - 76.2
Orchard 1	Sabhapur	2.2 (1.49)	0.9 - 3.5	22.8 (28.50)	14.8 - 26.1
Orchard 2	Chhapra	1.6 (1.22)	0.6 - 1.3	22.8 (28.41)	13.0 - 23.8
Orchard 3	Taraura	4.6 (2.14)	3.5 - 5.8	13.0 (20.57)	7.0 - 22.2
Orchard 4	Raghunathpur	1.3 (1.14)	0.5 - 2.3	7.3 (15.61)	2.2 - 15.5
Orchard 5	Jhapaha	4.6 (2.14)	2.1 - 6.7	20.0 (26.54)	9.1 - 33.3
Orchard 6	Mehsi	0.6 (0.76)	0.2 - 0.9	8.1 (16.44)	4.6 - 13.0
Orchard 7	Mehsi	1.4 (1.16)	0.4 - 0.7	3.8 (11.23)	2.0 - 5.4
Orchard 8	Mehsi	13.3 (3.64)	10.2 - 19.8	75.1 (60.06)	56.7 - 88.1
SE (m) ±		0.08	—	1.62	—
LSD (P = 0.05)		0.27	—	4.85	—

†Orchards 1-5 are at Muzaffarpur and orchards 6-8 are in the East Champaran district of Bihar.
*Data in parentheses are square root transformed values.
**Data in parenthesis are Arcsine transformed value.

dominant pest species in mango, viz., the mango shoot caterpillar, *Penicillaria jocosatrix* Guenée (Noctuidae). *Perixera illepidaria* caterpillars increased 10-fold after suppression of *P. jocosatrix*. Similar pest dynamics might be responsible for the outbreak of *P. illepidaria* in litchi. However, this needs further investigation to derive a definite conclusion. In recent years, several other pests have been reported on litchi in India that was hitherto minor pests.

We found that the general appearance and feeding behavior of this pest was similar to that of the croton caterpillar (*Achaea janata* L.; Noctuidae), but there was dissimilarity in adult moth characteristics, especially the color of the wings. In *A. janata,* the fore wings are grayish brown with wavy lines and the hind wings are gray with a bright spot of black and white near the tips whereas in *P. illepidaria,* both the wings are uniformly pinkish fawn. It was hypothesized that the looper might be surviving on adjacent shrubs and wild timber trees from which it might had migrated to litchi. In experimental feeding in laboratory, larvae were found to feed on castor bean and mango leaves, but this resulted in an extension of the larval period by 3-5 days, indicating these species are not preferred hosts. Moreover, in nature we could not find larvae of *P. illepidaria* feeding on any of these plants. Schreiner & Nafus (1992) reported that the larvae of *P. illepidaria* fed on flowers and foliage of mango in Guam. The common name of *P. illepidaria* is mango shoot looper in Guam, where it is listed as an invasive alien species (Shine et al. 2003). Nafus (1997) had also reported *P. illepidaria* as a pest of mango in the Federated States of Micronesia, and in Palau. In nature, *P. illepidaria* oviposits mostly on spider webs near new foliage, the web being either old, uninhabited, or small, inhabited by juvenile spiders (Nafus & Schreiner 1991). This was shown to be a significant defense against predation, particularly by ants. We found that in the laboratory the adults of *P. illepidaria* failed to mate. Hence, the favorable conditions or stimuli for mating need to be determined.

Considering the recent outbreak and the damage *P. illepidaria* caused to litchi trees, there is a need to keep vigil on the further spread and undertake studies on the eco-biology, behavior and spatial and temporal distribution of *P. illepidaria* particularly during the anticipated period of occurrence, so that effective management strategies can be developed.

Acknowledgments

Authors are grateful to Dr. V. V. Ramamurthy, Principal Scientist and PI, Network Project on Insect Biosystematics (NPIB), Division of Entomology, Indian Agricultural Research Institute, New Delhi for identification of the pest. We are thankful to the reviewers for their thorough review and we highly appreciate their comments and suggestions, which significantly contributed to improving the quality of the publication. We are grateful to Dr. Greg Evans (USDA-APHIS-PPQ) for the Spanish resumen and palabras clave.

References Cited

ANON. 2012. Final area and production estimates for horticulture crops for 2011-2012. National Horticulture Board, Government of India. http://nhb.gov.in/area%20_production.html. Accessed 17 May 2013.

BUTANI, D. K. 1977. Pests of litchi in India and their control. Fruits 32: 269-273.

CHOUDHARY, J. S., PRABHAKAR S. C., MOANARO, DAS, B., AND KUMAR, S. 2013. Litchi stink bug (*Tessaratoma javanica*) outbreak in Jharkhand, India, on litchi. Phytoparasitica 41: 73-77.

EVANS, E., DEGNER, R., CRANE, J., RAFIE, R., AND BALERDI, C. 2004. Is it still profitable to grow lychee in South Florida? EDIS FE496, Dept. Food and Resource Econ., Univ. Fla., Gainesville. http://edis.ifas.ufl.edu/fe496. Accessed 25 Sep 2013.

EVANS, E., DEGNER, R., CRANE, J., RAFIE, R., AND BALERDI, C. 2008. Is it still profitable to grow lychee in Florida? EDIS FE496, Dept. Food and Resource Econ., Univ. Fla., Gainesville. http://edis.ifas.ufl.edu/document_fe496. Accessed 25 Sep 2013.

FAO. 2002. Lychee production in the Asian-Pacific Region. RAP Publ., Bangkok, Thailand. GUENÉE, A. M. 1857. *Anisodes illepidaria.* Histoire naturelle des insects, Spécies général des Lépidoptères 9: 421.

HOLLOWAY, J. D. 1976. Moths of Borneo with special reference to Mt Kinabalu. Malayan Nature Society, Southene Sdn Bhd, Kuala Lumpur, Malaysia. http://www.mothsofborneo.com/part-10/cosymbiini/cosymbiini_6_14.php. Accessed 25 September 2013.

KHURANA, A. D., AND GUPTA, O. P. 1972. Bark eating caterpillars pose a serious threat to fruit trees. Indian Farmers Digest 5: 51-52.

KUMAR, H., MITTAL, V., GUPTA A., AND SINGH, C. P. 2008. Population dynamics and seasonal occurrence of *Tessaratoma javanica* Thunberg in litchi orchards. Ann. Plant Prot. Sci. 16:70-73.

KUMAR, V., KUMAR, A., AND VISHAL NATH. 2011. Emerging pests and diseases of litchi (*Litchi chinensis* Sonn.). Pest Mgt. Hort. Ecosyst. 17: 11-13.

KUROKO, H., AND LEWVANICH, A. 1993. Lepidopterous pests of tropical fruit trees in Thailand (with Thai text). Japanese Intl. Coop. Agency, Tokyo.

NAFUS, D. M. 1997. Insect survey of the Federated States of Micronesia, and Palau. Technical paper No. 210. South Pacific Comm., Noumea, New Caledonia.

NAFUS, D., AND SCHREINER, I. 1991. Oviposition by herbivorous insects on spider webs as an anti-predation defence. Ecol. Entomol. 16: 513-517.

NAIR, N., AND SAHOO, A. K. 2006. Incidence of *Conopomorpha cramerella* Snellen (Gracillariidae: Lepidoptera): a serious pest of litchi and its control in West Bengal. Environ. Ecol. 24: 772-775.

NIELSEN, E. S., EDWARDS, E. D., AND RANGSI, T. V. [EDS.]. 1996. Checklist of the Lepidoptera of Australia. Monographs on Australian Lepidoptera Vol. 4. Melbourne, Australia, CSIRO Australia.

PRASAD, V. G., AND SINGH, R. K. 1981. Prevalence and control of litchi mite, *Aceria litchii* Keifer in Bihar. Indian J. Entomol. 43: 67-75.

RAFIE, R. A., BALERDI, C., AND CRANE, J. 2007. The potential of Florida lychee to cross over to American consumers: An industry perspective. EDIS HS1112, Dept. Horticultural Sci., Univ. Fla., Gainesville. http://edis.ifas.ufl.edu/document_hs369. Accessed 25 Sep 2013.

SCHREINER, I. H., AND NAFUS, D. M. 1992. Changes in a moth community mediated by biological control of the dominant species. Environ. Entomol. 21: 664-668.

SCOBLE, M. J. 1999. Geometrid moths of the world: a catalogue (Lepidoptera, Geometridae). Vol. 2. Apollo Books, Stenstrup, 714-718 pp.

SHINE, C., REASER, J. K., AND GUTIERREZ, A. T. 2003. Invasive alien species in the Austral Pacific Region: National Reports & Directory of Resources. Global Invasive Species Programme, Cape Town, South Africa. http://www.sprep.org/attachments/52.pdf. Accessed 19 May 2013.

SINGH, J., AND RAGHURAMAN, M. 2011. Emerging scenario of important mite pests in North India, Zoosymposiim 6: 170-179 *In* G. J. de Moraes and H. Proctor [eds.]. Zoosymposium 6: 1-304, Acarology XIII, Proc. Intl. Congress.

SINGH, H. 1974. Occurrence of *Myllocerus delicatulus* Boh. (Coleoptera: Curculionidae) on tender leaves of litchi (*Litchi chinensis* Sonn.). Indian J. Entomol. 36: 238.

SINGH, H. 1975. *Acrocercops cramerella* Snell. (Gracillariidae: Lepidoptera) as a pest of litchi in Uttar Pradesh and its control. Indian J. Hort. 36: 238.

SINGH, H. 1978. Pest complex of litchi in Dehradun and Saharanpur district of Uttar Pradesh. Indian J. Entomol. 40(4): 464.

SINGH, M. P. 1971a. Occurrence of *Platypepla aprobola* Meyr. (Tortricidae: Lepidoptera) on litchi (*Litchi chinensis*) in North Bihar. Indian J. Entomol. 33(1): 98.

SINGH, M. P. 1971b. *Myllocerus discolar* Boh. and *Myllocerus* sp. *undecimpustulatus* Fst. (Coleoptera: Curculionidae) as pest of litchi (*Litchi chinensis*). Indian J. Entomol. 33(2): 221.

SINGH, Y. P., AND KUMAR, V. 1992. *Dichocrosis* (*Dichocrocis festivalis* Swinh. Lepidoptera: Pyralidae) - a new pest of litchi (*Litchi chinensis* Sonn). J. Bombay Nat. Hist. Soc. 89.1: 137.

WAITE, G. K., AND HWANG, J. S. 2002. Pests of litchi and longan, pp. 331-359 *In* J. E. Pena, J. L. Sharp and M. Wyoski [eds.], Tropical fruit pests and pollinators: Biology, economic importance, natural enemies and control. CABI Publishing, Wallingford, UK.