

Diversity of some lepidopteran insect pest associated with *litchi chinensis* from Jammu district, J&K, India

¹Preetika Gupta and ²J.S Tara

¹Research Scholar and ²Professor

^{1,2} Department of Zoology, University of Jammu, Jammu (Tawi) – 180006, J&K, India

Abstract

Lepidopteran pests are a major threat to the horticulturists especially in cases where these pests are the tissue borers. In the Jammu district of J&K state, a survey was conducted during 2013- 14 on *Litchi chinensis* reveals the presence of Lepidopteran pests *Conopomorpha sinensis* Bradley *Deudorix Isocrates* Fabricius as fruit borer and *Lymantria mathura* Moore, *Metanastria hytraca* Walker, *Sylepta* sp., *Amata* sp., *Digama hearseyana* Moore, *Pieris brassicae*, *Asota caricae* Fabricius and *Spodoptera litura* Fabricius as defoliator. It was observed that healthy, young as well as old litchi trees are under severe attack of the lepidopteran insect pest. Catterpillars voraciously feed on fruit pulp, leaves and fruit of litchi and decreases its market value.

Key words: Litchi, lepidopterans, pests, borer, defoliator

Introduction

The litchi (*Litchi chinensis*) is the sole member of the genus *Litchi* in the soapberryfamily, Sapindaceae. It is a tropical and subtropical fruit tree native to Southern China, Taiwan and Southeast Asia, and now cultivated in many parts of the world. The fresh fruit has a "delicate, whitish pulp" with a floral smell and a fragrant, sweet flavour. Litchi crop suffers heavy damage due to large number of insect pests in the present area under investigation. It is nutritionally rich in vitamin B complex, oligonol and minerals. Insects are known to cause significant damage to litchi and affect agricultural productivity. Of the various insect pests recorded, bugs belonging to order Lepidoptera causing serious damage to the litchi plantations. A total of 8 insect species belonging to different families of order Lepidoptera were recorded to infest litchi plantations in investigated areas of Jammu district. The present paper records the taxonomic status, geographic distribution, host plants, diagnostic features and their mode and extent of the damage caused to the host plant.

Material and Methods

The field investigations were carried out during December 2012 to November 2013 in district Jammu of J&K state where litchi plantations were grown. The insects along with their immature stages were collected from the various methods such as handpicking, stem beating and also with the help of entomological nets. Later, collected specimens, eggs, larvae, pupae and adults were preserved by traditional methods for further studies. General morphological studies were made under different magnifications of the stereoscope microscope. Photographs have been taken with Canon Power shot, Digital Still Camera with 8x optical zoom having 16.0 effective mega pixels with inbuilt macro function for extreme close up.

Results and Discussions

During the period of observation, a total of 08 insect pests belonging to Order lepidoptera were recorded by the investigator from the Jammu district of J& K state. These insects were found to be fruit borers and defoliators. A general description of each insect species along with their damage pattern is discussed below:

1. *Amata* sp. (fig.1, 1a)

Taxonomic Status:

Order	–	Lepidoptera
Family	–	Amatidae
Genus	–	<i>Amata</i>

Distribution:

Amata sp. is by far the dominant genus in Australia, widely distributed in the Oriental and Australian regions, especially in tropical areas. Distribution range extends from northern South America through Central America into Mexico and from many Caribbean Islands into Florida. (Sharma, 2009).

In the area under investigation:

Present author found this pest from Udheywala area of Jammu district on *Litchi chinensis*(Litchi).

Host plants:

Vine, Cowpea, *Nerium oleander*, *Echites* sp., *Ageratum* sp., *Ipomoea* (Sharma, 2009)

Diagnostic features:

Adult small, black moth, covered with rows of yellow and black hairs. Wings bluish- black with prominent white spots. Abdomen bluish – black with prominent yellow patches near the basal region. A ring of yellow hair demarcates it from the thorax. Antennae long, filiform and lies above the head. Eyes prominent black, bulging out roundly. Forewings with many overlapping black scales and some scattered white spots. Abdomen slender and covered into thickly populated hairs. Legs white with light brown ends.

Damage:

Larva of *Amata* sp. feeds on leaves and fruiting bodies of leaves. Adult suck the nectar of flower of *Litchi chinensis* in the study field of the present author.

2. *Asota caricae* (Fabricius, 1775) (Fig.2,2a)**Taxonomic Status:**

Order – Lepidoptera
 Family – Noctuidae
 Genus – *Asota*
 Species – *caricae*

Common name:

Tiger moth

Distribution:

It is widely distributed in the Oriental region and in Papuan sub-region. (Common, 1990).

In the area under investigation:

Present author found this pest from Flora Nagbani area of Jammu district on *Litchi chinensis* (Litchi).

Host plants:

Sunhemp, *Ficus* sp., *Broussonetia* sp., *Mesua* sp., *Shorea robusta*, (Browne, 1968) tea, *Tectona* (Mathuret al, 1958).

Diagnostic features:

Wingspan 48.0 mm. Eyes pulpilled. Antennae filiform and brown. Fore wings yellow, each with a pale spot near the centre, and some black dots near the base. The hind wings deeper yellow, and have a number of black spots. Body yellow with a black mark on the top of each abdominal segment. In the upper side of the forewing at the lower end of the discal cell vague white spot. The underside of the forewing and the hindwing yellowish / ochreous colour, with the exception of the apex of the forewing, dark over one third of the area of the wing. Each wing has a dark spot in the middle of the underside near the costa. The spot on the forewing is larger than the spot of the of the hindwing. The thorax and the abdomen have the same yellowish / ochreous colour, the thorax a little bit darker than the abdomen. On the metathorax is a gland opening. On the anterior part of the patagia is a small black spot on the anterior part of patagia. The first joint of the palps has a yellowish / ochreous colour, with a black spot at the end. The last two joints of the palps are black on the upper side and the sides are whitish. The legs are whitish and have a dark stripe on the femur. They bear four spurs, two long ones and two short ones.

Damage:

Larvae feed on leaves and young fruits of litchi. (fig.2a)

3. *Spodoptera litura* (Fabricius, 1775) (Fig.3, 3a)**Taxonomic Status:**

Order – Lepidoptera
 Family – Noctuidae
 Genus – *Spodoptera*
 Species – *litura*

Distribution:

Spodoptera litura is found throughout the tropical and Subtropical parts of the world. It is widespread in India (Atwal and Dhaliwal, 1997).

In the area under investigation:

Present author has reported this pest from Flora Nagbani area of Jammu district on *Litchi chinensis*.

Host plants:

Cabbage, cauliflower, Okra, Peas, Tomato. Besides vegetables, it also feeds on Tobacco, castor, Groundnut, (Atwal and Dhaliwal, 1997) Sunflower, Maize, Millets, Mulberry, Rice, Sorghum and banana.

Diagnostic features:

Medium sized stout moth, 22m long with 32-38mm wingspan. Antennaebipectinate. Brown body covered with hairs and numerous black spots. Forewing dark brown with a network of wavy white marking; hind wings light in colour and their edges tinged with brown patch along the margins. Abdomen 6 segmented, covered by means of brown hairs. There is a prominent black spot just behind the hind legs.

Damage:

Larva feed on the leaves of the plants with voracity and completely defoliates the plants. Hence the young fruits do not ripe properly and fall down.(fig.3a)

4. *Digama hearseyana* Moore, 1859 (Fig.4, 4a)**Taxonomic Status:**

Order	–	Lepidoptera
Family	–	Noctuidae
Genus	–	<i>Digama</i>
Species	–	<i>hearseyana</i>

Distribution:

It is common throughout the hill and forest areas. (c.f Internet).

In the area under investigation:

Present author found this pest in Udheywala area of Jammu district on *Litchi chinensis*

Host plants:

Lichens, *Carissa carandus*.(c.f Internet)

Diagnostic features:

Adults small moth, forewing pale greyish-brown, with darker blotches and having several black basal dots; hind wings orange with a small brown mark on middle of exterior margin; antennae brown, filiform; palpi yellow, first and second joint with a black spot, third joint tipped with black; head and thorax pale greyish – brown, with some black dots; abdomen testaceous, with a dorsal row of black dots; legs yellowish with dark bands and covered with minute scales.

Damage:

Larva feed on the leaves of the litchi.(fig.4a)

5. *Metanastria hyrtaca* Cramer, 1779(Fig.5, 5a)**Taxonomic Status:**

Order	–	Lepidoptera
Family	–	Lasiocampidae
Genus	–	<i>Metanastria</i>
Species	–	<i>hyrtaca</i>

Distribution:

India, Srilanka(Sharma and Tara, 2009),Nepal,Myanmar, Thailand, Malaysia, Indonesia, Vietnam, China, Taiwan.

In the area under investigation:

Present author found this pest from Udheywala area of Jammu district on *Litchi chinensis*(Litchi).

Host plants:

Santol, *Syzygiumcumini*, Cashew, *Nyctanthesarbor- tristis*,*Gmelinaarborea*, *Madhucalatifolia*(Sharma and Tara, 2009)

Diagnostic features:

Adult moth 25mm in length, thick light in colour with markings on the wings, cryptic in design. Antennae short and bipectinate, the palpi small and porrect Adults have a black patch with a small white spot in the centre of fore- wing and two angulated transverse lines on either side of the patch, short wavy lines running across the forewing.The legs are hairy with minute spurs.

Damage:

The caterpillars feed on leaves and stem of litchi voraciously.

6. *Sylepta* sp. (Fig.6, 6a)**Taxonomic Status:**

Order	–	Lepidoptera
Family	–	Pyralidae
Genus	–	<i>Sylepta</i>

Distribution:

It is widely distributed in Orient region and Africa (Atwal and Dhaliwal, 1997).

In the area under investigation:

Present author found this pest on Udheywala area of Jammu district on *Litchi chinensis*.

Host plants:

Cotton, China rose (*Hibiscus rosasinensis*), Marshmallow (*Malvaparviflorus*), Tobacco (*Nicotianatabacum*), Bridal Couch Tree (*Hymenodictyon*), (Atwal and Dhaliwal, 1997).

Diagnostic features:

Yellowish white wing expanse 25.4mm. Wings with brown or black dots and with black border and greyish fringe. Head with two large spots on each side of vertex near the eyes, the face below the front ocellus; antennae brown with pale scape. Thorax with a transversal stripe along hind margin of mesonotum, lateral and posterior margins of scutellum and post- scutellum yellowish-white. Fore wings and hind wings have brown wavy lines transversed. Abdomen yellowish below except at tip, black above with transverse, more or less broad brown stripes, on the 3rd, 5th and hind margin of 6th segments. Legs entirely pale yellow, only upper part of hind coxae and lines above and below the middle and hind femora black.

Damage:

The young larvae feed on the lower side of leaves but they roll up the edges of the leaf towards the mid-rib as they become mature. Sometimes there are 3 rolls in a leaf. Leaves are rolled in the form of trumpets fastened by silken threads. Marginal portion of leaves are eaten away. Attached leaves are shed and in severe infestation even leads to plant defoliation.

7. *Pieris brassicae* (Linnaeus, 1758) (Fig.7,7a)**Taxonomic Status:**

Order	–	Lepidoptera
Family	–	Pieridae
Genus	–	<i>Pieris</i>
Species	–	<i>brassicae</i>

Distribution:

India, Bhutan (Atwal and Dhaliwal, 1997)

In the area under investigation:

This pest has been observed from Udheywala area of Jammu district on *Litchi chinensis*.

Host plants:

Cabbage, cauliflower, radish, turnip as also mustard and rape. (Atwal and Dhaliwal, 1997).

Diagnostic features:

Adult 40-50mm in length. Head black and the dorsum marked with black spots. Body is decorated with short hairs. Adults are pale white and have a smoky shade on the dorsal side of the body. Wings are pale white, with a black patch on the apical angle of each forewing and a black spot on the coastal margin of each hind wing.

Damage:

On hatching, the young caterpillars feed gregariously on leaves for a couple of days, then disperse, spreading infestation to the adjacent plants and fields. As a result of feeding the leaves become skeletonized. (fig.7a)

8. *Lymantria mathura* Moore, 1879 (Fig.8,8 a)**Taxonomic Status:**

Order	–	Lepidoptera
Family	–	Lymantridae
Genus	–	<i>Lymantria</i>
Species	–	<i>mathura</i>

Distribution:

India (Hill, 2007), Nepal, Japan (Hokkaido, Honshu, Kyushu), Republic of Korea, Democratic People's Republic of Korea, Russia (Kozhanchikov, 1950; Pavlovskii & Shtakelberg, 1995; Munson *et al.*, 1995; Lee & Lee, 1996; Dey & Tiwari, 1997).

Host plants:

Mangifera indica, *Litchi chinensis* (Singh 1954a), Jamun and various forest trees (Butani, 1979).

In the area under investigation:

Pest under study has been found from Udheywala area of Jammu district on *Litchi chinensis*.

Diagnostic features:

Adults of *Lymantria mathura* are clearly sexually dimorphic. Antennae strongly pectinate, yellow –grey with black segments; head and thorax yellow-grey with grey strokes; abdomen yellow with bundles of grey hairs on tergites; ventral side of abdomen and thorax yellow; fore wings yellow- grey with many grey and white transversal stripes, yellow veins and yellow- grey

fringe; hind wings dull, grey- yellow, with light yellow fringe; upper side yellow, uncoloured, sometimes slightly pinkish. Wingspan 40-50mm.

Damage:

Lymantria mathura are gregarious defoliators. The larvae are able to consume whole leaves and sometimes avoid tough veins in older foliage growth. Larvae also feed on flowers and tender young shoots of *Litchi chinensis*.(fig.8a)

9. *Deudorix isocrates* (Fabricius, 1793) (Fig.9, 9a)

Taxonomic Status:

Order	–	Lepidoptera
Family	–	Lycaenidae
Genus	–	<i>Deudorix</i>
Species	–	<i>isocrates</i>

Distribution:

India, Srilanka, Nepal, Thailand, Laos, Myanmar. (Chander2003), J&K.(Chetry, 2009;Tara and Sharma,2006).

In the area under investigation:

Present author found this pest from Flora Nagbani area of Jammu district on *Litchi chinensis*(Litchi).

Host plants:

Citru (Chetry, 2009), *Punica granatum*, litchi, mulberry, tamarind, peach, pear, sapota, apple, plum and ber(Chander, 2003), *Embllica officinalis*(Singh and Singh, 2001), *Psidium guajava*(Tara and Sharma, 2006).

Diagnostic features:

Females are larger in size than the males in wing expanse. Adult moth with greyish brown wings; one black dot on the costa of each forewing, antennae with basal pecten, hind wings broad. Antennae ringed with white and a rim of white scales surrounds each eye. Antennae slender and club shaped. Each eye surrounded by a rim of white scales. Hind wings provided with delicate tail like prolongations. Abdomen greyish brown and slender. Legs normal and bear claws. Average body length of adult male was 14±0.7mm which varied between 14-15mm and female was 17±0.56mm which ranged from 16- 18mm. Average width including wing span of adult male was 24±0.60mm and ranges between 23-27mm and of female butterfly 38.0±0.3 mm varies from 36-39 mm. Karuppuchamyet *al.*, (1998) recorded the wing expanse of 38 to 42mm in males and 43 to 47 mm in females.

Damage:

The larval forms of the pest under investigation in the area rolls the leaves of new growth, severely damaging and even destroying new growth flushes(9a). Larvae makes holes into the young fruit and feeds on the flesh of the fruit thereby makes it unedible.

10. *Conopomorpha sinensis* Bradley, 1986 (Fig.10,10a)

Taxonomic Status:

Order	–	Lepidoptera
Family	–	Gracillaridae
Genus	–	<i>Conopomorpha</i>
Species	–	<i>sinensis</i>

Common name:

Litchi fruit borer

Distribution:

The results of the present study revealed the distribution of Jammu and Kashmir. Presently the litchi stem-borer is reported from South China, Taiwan, Malaysia, Thailand, Nepal, and India (Hu *et al.*; 1995).

In area under investigation:

The present author has recorded *Conopomorpha sinensis* as a pest of litchi (*Litchi chinensis*) from Udheywala and Flora Nagbani.

Host(s):

Dimocarpus longan (longan), *Litchi chinensis* (litchi). (He and He, 2001; Huang *et al.*, 1994; Waite and Hwang, 2002).

Adult

The fruit borer moth is a small moth with an average width of 1.90 ± 0.20 mm and 5.50 ± 0.50 mm. in length. Head grey to greyish brown, frons greyish white. Antennae filamentous. Compound eyes dark brown. Labial palpus white, second segment with outer surface and distal tuft of ventral surface fuscous, third segment porrect or obliquely upward. Maxillary palpus greyish brown to dark brown. Antenna with scape greyish brown, flagellum brown to dark brown ringed with greyish white basally. Thorax and tegula dark brown. Forewing narrow, costal and dorsal margins nearly parallel; ground colour greyish brown to dark brown; costal and dorsal margins with three oblique greyish white stripes respectively, first costal stripe from near middle extending obliquely to end of cell; dorsal margin with black speck at basal 1/3; bluish grey fascia with metallic reflection extending from near costal 5/6 to dorsum and along termen, respectively, a large black spot between dorsum and termen; cilia pale greyish brown except fuscous apically. Hind wing and cilia greyish brown. Fore and mid legs brown; hind leg greyish white, distal half of tibia dark fuscous on outer surface. Abdomen grey, with first two segments shining white; ventral surface with five pairs of dark brown stripes along lateral sides. Wing expanse 8.0-15.5mm.

Damage

Larvae penetrate and feed on longan and litchi fruit (Waite and Hwang, 2002) (fig.10a). Adults feed externally on the fruit (He and He, 2001; Waite and Hwang, 2002). Damaged fruit often falls from the tree (Waite and Hwang, 2002).

Table1. Showing the check list of Insect pests recorded on Litchi from Jammu District.

S. No.	Family	Scientific name	Pest type
1.	Amatidae	<i>Amata</i> sp.	Defoliator
2.	Noctuidae	<i>Asota caricae</i>	Defoliator
3.	Noctuidae	<i>Spodoptera litura</i>	Defoliator
4.	Noctuidae	<i>Digama hearseyana</i>	Defoliator
5.	Lasiocampidae	<i>Metanastria hytraca</i>	Defoliator
6.	Pyalidae	<i>Sylepta</i> sp.	Defoliator
7.	Pieridae	<i>Pieris brassicae</i>	Defoliator
8.	Lymantridae	<i>Lymantria mathura</i>	Defoliator
9.	Lycaenidae	<i>Deudorix isocrates</i>	Fruit borer
10.	Gracillaridae	<i>Conopomorpha sinensis</i>	Fruit borer

Conclusion

Amongst the recorded lepidopterans, *Deudorix isocrates* (Fruit borer) and *Conopomorpha sinensis* cause major damage. *Spodoptera litura*, *Metanastria hytraca*, *Sylepta* sp., *Pieris brassicae*, *Digama hearseyana*, *Asota caricae*, *Amata* sp., *Lymantria mathura* cause minor damage to the litchi plantations. *Deudorix isocrates* Fabricius, the major pest of litchi inflicts great loss to the fruit by boring into it. Adults appear in field in the middle of March and remain in the field till July. Female laid eggs on the tender young fruits. After hatching larva feeds on the fruit. As larva grows consumption of fruits increases and it completely destroys the edible part of the fruit. The mature larva undergoes prepupal stage followed by the pupal stage. The harmful stage of this butterfly is the caterpillar. Adults feed on the nectar of flowers and do not cause much damage to plants.

Biological observations regarding *Conopomorpha sinensis* Bradley show that larva of the moth bore into the fruit and eaten up the flesh of the fruit thus causing damage to the fruit.

Acknowledgements

The authors are highly thankful to Head, Dept. of Zoology, University of Jammu and my lab mates for necessary help.

References

- Atwal, A.S. and Dhaliwal, G.S. (1997). Agricultural pests of south Asia and their management. Kalyani Publishers: 322-323.
- Atwal, A. S. and Dhaliwal, G. S. (2009). Agriculture Pests of South India and their management. Kalyani Publishers: 1-616.
- Avhad, S.B. and Hiware, C.J. (2013). Mulberry defoliators: distribution and occurrence from Aurangabad (M.S.), India. *Journal of Entomology and Zoological Studies.*, 1(4) : 1-6.
- Boontham and Lecksawad (1993). Final report on the project of a study of pheromone efficiency for the damage reduction caused by *Conopomorpha sinensis* in organic Longan Plots. German Technical Cooperation (GTZ) and Institute of Product and Standardization (IQS) Maejo University: 1-41.
- Butani, D.K. (1973). Insect pests of fruit crops-4 Citrus. *Pesticides.*, 7(12) : 23-2.
- Butani, D.K. (1979). Insects and Fruits. *International Book Distributors.* : 183- 195.
- Butcher, F.G. (1954). Insect problems in litchi production. In: Florida Litchi Growers' Association yearbook and proceedings. *Second Annual Meeting, Winter Haven, Florida.*, 15-16.
- Chen, B. X., Dong, Y. Z. and Lu, H. (2010). Development of KeluTM 15% alphacypermethrinchlorpyrifos EC and its field trial to *Conopomorpha sinensis*. *Guangdong Agricultural Sciences.*, 7 : 97-99. (In Chinese).

- Chen, B.X., Zhang, Y.J., Dong, Y.Z. and Xu, S. (2011).**Advances in research on biological control of *Conopomorpha sinensis*.*Journal Fruit Science*.,**28(3)** : 493- 497.
- Chhetry, M. (2009).**Diversity, distribution, biology and management of some subtropical fruit plants in Jammu region.Ph. D. Thesis Submitted to University of Jammu, Jammu.
- De Villiers, E.A. (1983).** The litchi moth.Litchis H. Farming in South Africa.
- De Villiers, E.A. (1990).** Die beheer van vrugtevlies by lietsjies. Yearbook of the South African Litchi Growers' Association 3, 29-30.
- Dekle, G.W. (1954).**Some Litchi insects of Florida.Florida State Horticultural Society. State Bulletin., 546 : 226-228.
- Dolsopon, S., Suphakammud, N. and Dasanoda, M. (1997).** Crop loss assessment caused by litchi fruit borer, *Conopomorpha sinensis* (Lepidoptera: Gracillariidae) and its parasitoids. Chiangrai Horticultural Research Centre Annual Report. Horticultural Research Institute, Department of Agriculture, Thailand: 76-91.
- Dong, X.J, Wen, L.G. and Fei, P.X. (2002).** The construction and analysis of natural population life table of *Conopomorpha sinensis* Bradley. *Wuyi Science Journal*., 00.
- Dong, X.J., Fei, P. X., Wen, L.G., Jun, Z.H. and Wu, F. (2002).** The Effects of Secondary Substance of Non-Preferable Plant on *Conopomorpha sinensis* Bradley. *Journal of South China Agricultural University*., 04.
- Dong, X.J., Guangwen, L., Ling, Z., Zhengi, W. and Weigi, C. (2004).**Forecast of the emergence period of *Conopomorpha sinensis* in litchi. *Journal of South China Agricultural University*.,**25(3)** : 67-69.
- Hu, B., Wang S., Zhang, J. and Li, H. (2011).**Taxonomy and biology of two seed-parasitic gracillariid moths (Lepidoptera, Gracillariidae),with description of a new species. *Zoo Keys*.,**83**: 43-56.
- Huang,C-C., Chang , K.-S. and Chu, Y.-I. (1994).** Damage and population fluctuation of the litchi fruit borer *Conopomorpha sinensis* Bradley, in Chia-Nan district, Taiwan.*Plant Protection Bulletin Taipei*, 36, 85-95.
- Karuppuchamy, P., Balasubramanian,G. and Babu ,P.C.S.(1998).** The biology of pomegranate fruit borer, *Deudorix isocrates*.*The Madras Agricultural Journal*., 5/6: 252-256.
- Kaul, V. and Kesar, Y.K. (2003).** Incidence and management of lepidopteran fruit borers of guava (*Psidium guajava* L.) in Jammu, India. *Journal of Asia Pacific Entomology*.,**6(2)** : 201-205.
- Lee, J. H. and Lee, H.P. (1996).** Parasites and phenology of *Lymantria mathura*Moore (Lymantriidae: Lepidoptera) in Kyonggi Province, Korea. *Korean Journal of Entomology* .,**26** : 393-401.
- Lefroy, H.M. (1923).** Manual of Entomology, 203-206.
- Murugan, M. and Thirumurugan, A. (2001).**Ecobehaviour of pomegranate fruit borer, *Deudorix isocrates* (Fab.)[Lycaenidae : Lepidoptera] under orchard ecosystem. *Indian Journal of Plant Protection*.,**29 (1/2)** :121- 126.
- Ren, S.andTian, M. (2000).** Litchi pests and their natural enemies. In: Huang, H.B and Huang, X.M (eds) Research Centre Annual Report. Horticultural Research Institute, Department of Agriculture, Thailand: 76-91.
- Rogers, D.J. and Blair, A.D. (1981).**Assessment of insect damage to litchi fruit in northern Queensland.*Queensland Journal of Agricultural and Animal Sciences*.,**38** : 191-194.
- Schulte, M.J., Martin, K. and Sauerborn, J. (2007).**Biology and control of the fruit borer,*Conopomorpha sinensis* Bradley on litchi (*Litchi chinensis*Sonn.)in northern Thailand. *The Authors Insect Science*.,**14**: 525-529.
- Sharma, D.D. (1975).** Chemical control of anar butterfly, *Virachola isocrates*(F.) (Lepidoptera :Lycaenidae) and studies on its biological and chemical behaviour under mid hill conditions. M.Sc. Dissertation, Dr. Y .S. Parmar University of Horticulture and Forestry.Palampur, H.P., p.71.
- Shevale, B.S. and Khaire, V.M. (1999).** Seasonal abundance of pomegranate butterfly, *Deudorix isocrates*Fabricius. *Entomon*.,**24 (1)** :27-31.
- Shevale, B.S. (2003).** Studies on life fecundity Table of Pomegranate Butterfly, *Deudorix isocrates*Fabricius. *Annals of Plant Protection Sciences*.,**11(2)** : 255-257.
- Singh, A.K. (1991).**Studies on pomegranate butterfly, *Virachola isocrates*Fabricius in relation to guava. M.Sc. (Ag.) Dissertation, N.D.U.A.T. Kumarganj, Faizabad (U.P).
- Singh, S. M. (1954).** A note on serious damage to mango crop by *Lymantria mathura*Moore, in Doon Valley. *The Indian Journal of Horticulture* .,**11**: 150.
- Singh A, Singh, S.K. and Pandey, S.D. (2011).**Vision 2030.National Research Centre for Litchi.
- Singh, S.B and Singh, H.M. (2001).** Biology of *Deudorix isocrates* on its potential host- Aonla (*Embllica officinalis*). *Indian Journal of Entomology*.,**63(1)** : 19-25.
- Storey, R.I. and Rogers, D.J. (1980).**Lepidopterous pests of the litchi in North Queensland.*Queensland Journal of Agricultural and Animal Science*.,**37 (2)** : 207- 212.
- Tara, J. S. and Sharma, R. (2006).** Comparative biology and infestations caused by *Bactrocera dorsalis*, Hendel (Diptera: Tephritidae) and *Deudorix isocrates*Fabricius (Lepidoptera: Lycaenidae) to guava plantations in Jammu plains. *Himalayan journal of Environmental Zoology*., **20 (2)** : 195-199.

Tara, J. S., Sharma, B. and Sharma, R. (2006a). *Deudorix isocrates* Fabricius, a pest of winter crop of Guava (*Psidium guajava* L.) in the plains of Jammu. *Trends in Life Sciences*, **2(1)** : 17- 21.

Tara, J.S. and Sharma, R. (2009). Studies on some Lepidopteran pests of Guava, *Psidium guajava* L. in Jammu Region of J&K State. *Biodiversity & Environment Management*, 101-106.

Tiwari, A.K., Pratibha, M. and Tiwari, S.C.(2007). Biology of *Deudorix isocrates* Fabr. on/onla, *Emblicia officinalis*. *Annals of Plant Protection Sciences*, 15(2): 335-337.

Yadav, L.B. and Pandey, V. (1995). Guava fruit infestations by pomegranate butterfly *Virachola isocrates* in relation to weather factors. *Bulletin of Entomology New Delhi*, **36(1/2)**:113-116.

Yao, Z.W. and Liu, X.Q. (1990). Two gracillarid insects attacking litchi and longan. *Acta Entomologica sinica*, **33** : 207-212.

Zhang, Y. J., Chen, Y., Chen, B. X., Huang, S .S. and Xu, S. (2011). The species selecting preliminary study of *Trichogramma* hosted in the eggs of *Conpomorpha sinensis*Bradley. *Guangdong Agricultural Sciences*, **17** : 59-61. (In Chinese).

Zhao, Z. T., Li, P. Y., Chen, B. X., Zeng, X. N. and Zhang, X. W. (2012). Ultra-structure observation of antennal sensilla of *Conopomorpha sinensis*Bradley. *Guangdong Agricultural Sciences*, **12**: 85-87. (In Chinese).

