Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(3): 838-843

Received: 28-03-2017
Accepted: 29-04-2017

**BR Soumya**
Ph.D Scholar, Department of Life Science (Zoology), Centre for Post Graduate Studies in Sciences, Jain University, Bengaluru, Karnataka, India

**Abraham Verghese**
GPS Institute of Agricultural Management, Peenya, Bengaluru, Karnataka, India

**PD Kamala Jayanthi**
Division of Entomology and Nematology, Indian Institute of Horticultural Research, Bengaluru, Karnataka, India

**Correspondence**
**BR Soumya**
Ph. D Scholar, Department of Life Science (Zoology), Centre for Post Graduate Studies in Sciences, Jain University, Bengaluru, Karnataka, India

# Diversity and economic status of Lepidopteran insect-pest on two major varieties of mango

**BR Soumya, Abraham Verghese and PD Kamala Jayanthi**

**Abstract**
The present research was undertaken to study the diversity and economic status of Lepidopteran insect-pest on two major varieties of mango *viz.,* Totapuri and Alphonso during 2014-15 in mango orchards of the Indian Institute of Horticultural Research (IIHR). In this study biodiversity of lepidopterans on mango ecosystem, there were a total of 13 lepidopteran species recorded. In both the varieties, *Orthaga exvinacea, Chlumetia transversa, Dudua aprobola, Anarsia* sp. and *Nanguna* sp., were the serious Lepidopterans both on vegetative and reproductive parts of the tree. However, on the basis of the level of infestation, *D. aprobola*, which damage both tender leaves and new panicles proved to be the most serious Lepidopteran pest of mango.

**Keywords:** *Mangifera indica*, Alphonso, Totapuri, economic status

## 1. Introduction
Mango is a fleshy stone fruit belonging to the family Anacardiaceae, genus *Mangifera* (Mukherji, 1958) [1]. Although India is the world's leading producer of mango, the country's productivity is lower than that of China (Ahuja *et al*., 2011) [2]. One of the causes for low productivity in India may be insect pests. About 400 species of insects, 17 species of mites and 26 species of nematodes are known to infest mango worldwide, of which more than 250 species are recorded as pest and 188 species have been reported from India (Tandon and Verghese 1985: Pena *et al*., 1998) [3, 4]. The distribution of key pests varies from region to region within India. Most of the insect pest belongs to the orders Diptera, Hemiptera and Lepidoptera and several secondary pests and a large number of occasional pests pose serious threat to mango production (Verghese, 1998) [5].
Among the major mango producing states, Karnataka records a productivity of 9.7 t/ha, which is higher than the national average (7.3 t/ha) (Anonymous, 2014) [6]. The state is potential to increase mango productivity however the lepidopterans are one among the several obstructers for its growth. These pests were less significant in the past but their diversity and abundance have increased in recent years owing to rapid change in the agro-ecosystem and the climate (Pena *et al*., 1998) [4].
Damage to mango inflorescence by a complex of Lepidopteran pests was reported from Karnataka (Verghese and Jayanthi, 1999) [7]. Such infestation affects flowering-related variables that eventually determine yield, extent of flowering, flower retention and fruit set. Many inflorescence caterpillars are reported from mango are *Eucrostus* sp., *Argyroploce aprobola* Meyrick and *Euproctis fraterna* (Moore) (Kannan *et. al.* 2002) [8]. The caterpillars create webs of leaves, cut the stalks of flowers, gathering the flowers into a ball and continue feeding within the webbed leaves, completing their lifecycle within the inflorescence (Chowdhury, 2015) [9]. As a result, yields are lowered by 20-40% (Verghese and Jayanthi, 1999) [7]. These caterpillars have mostly shifted from leaves to the inflorescence (Abdullah and Shamsulaman, 2008) [10].
An invasive Lepidopteran is the mango fruit borer *Citripestis eutraphera* (Meyrick) mainly infest the immature fruit by scrapping its surface and then bores into the fruit and to continue feeding, arresting its growth (Anonymous, 2015) [11].
Mango being a seasonal crop, the pest scenario also changes with the season. Most of the Lepidopterans tend to flourish in mango orchards. To devise effective ways to control the pests and to safeguard the health of the agricultural environment at the same time, the present investigation sought to study the diversity of Lepidopteran on mango and to assess their economic status.

## 2. Materials and Methods

The diversity of mango Lepidopterans and their mode of damage were observed in the mango orchards of the Indian Institute of Horticultural Research (IIHR), Hessaraghatta, Bangalore, India, from July 2014 to June 2015 to record the distribution of mango lepidopteran insects associated with the Alphonso and Totapuri varieties of mango along with their mode of damage. The orchards were sampled once a week and damage by Lepidopterans on ten randomly selected tree of each variety was assessed visually and recorded on the ten randomly selected trees/variety for the study period. Infestation by Lepiodpterans on different parts of the tree was recorded by recording the number of infested shoots or inflorescence or fruits in each direction (north, east, south and west). To understand the Lepidopteran complex, immature stages (larvae) of the insects were collected and reared upto the adult stage. These specimens were labelled and sent for identification to the Division of Entomology, Indian Agricultural Research Institute (IARI) New Delhi and the corresponding specimens were dry-preserved as voucher specimens at IIHR.

Each Lepidopteran population was tabulated direction-wise and from this the mean population per tree was calculated. According to level of infestation by the mango lepidopteran on particular mango parts in each months were analysed and scored as maximum observed population (++), lowest population observed (+) and no population observed (-). To calculate economic status of each Lepidopterans in both vegetative and reproductive stage on mango ecosystem, mean population of each Lepidopterans were calculated individually. The data were ranged from major (>10) to miner (<10) and classified their status.

## 3. Results

A total of 13 species of Lepidopteran were recorded, the details of which are given below along with the effect of each species on the mango plants.

### 3.1. 1 Leaf webber (*Orthaga exvinacea*)

The leaf webber is one of the causes of low productivity in mango, and its infestation is common in the more intensively cropped areas. Under favourable conditions the damage can be as high as 35%. On hatching; the caterpillars scraped the tips of leaves and fed on the tissue within. The mature larvae were found feeding voraciously and webbing the shoots and leaves together. The leaves loosened from their stalk and often fully detached remained entangled in the form of webs on the tree. More than 80% of the completely defoliated shoots (new growth), which failed to set fruit even in next season. The upper and lower canopies of the tree also played a role in infestation of mango leaf webber. Fig. 1 showing webbing of mango leaves by *O. exvinacea*.

### 3.1.2 Leaf roller (*Dudua aprobola*)

The leaf roller is reported to be a major pest of litchi (*Lichi chinensis*) but in recent past has spread to mango as well. It mainly damaged tender leaves and the inflorescence. Eggs were laid in axils of leaves or on flowering stalks. The young larvae tunnelled into the axil or stalks and damaged new leaves and inflorescence. In later stages the larvae rolled the leaves inward from their edges and fed inside. The infestation thus lowered the rate of photosynthesis. The infestation mainly from October to May and peaked in November and December, when new vegetative flush appeared and panicle initiation began. Fig. 5 and 6 showing folding of mango leaves due to *D. aprobola* and larva of the same respectively.

### 3.1.3 Shoot borer (*Chlumetia transversa*)

A major pest in mango nurseries is the shoot borer; nearly 40% of the damage to tender shoots (new flushes during September and October) is due to this pest. The caterpillars bored into the shoot bud and the axis of the inflorescence, developed within, exited through the midrib to bore into the growing region of shoots, and tunnels downwards through them. A clear sign of infestation was seen with presence of excreta in and around the holes and if the infestation was severe, wilted shoots can be seen. Fig. 3 showing larva of *C. transversa* and their infestation.

### 3.1.4 Leaf miner (*Acrocercops syngramma*)

Another Lepidopteran pest in mango nurseries is the leaf miner. The tiny caterpillars of which formed tunnels within the epidermis of leaves and later formed blister-like patches on them. As the leaves matured, the patches dry up and formed large holes in the leaves. On average one leaf houses three to four larvae could be seen. The infestation was from October to December and Totapuri was more susceptible than Alphonso. Fig. 2 showing mines on tender mango leaves by *A. syngramma*

### 3.1.5 Leaf feeder (*Penicillaria jocosatrix)*

The infestation of *Penicillaria jocosatrix* peaked mostly in May. The caterpillar fed on tender leaves, which looked as though they have been grazed upon. Fig. 7 showing mango leaves damaged by *P. jocosatrix.*

### 3.1.6 Leaf and flower feeder *(Porthesia scintillans)*

*Porthesia scintillans* damaged both tender leaves and the inflorescence. Fig. 4 showing larva of *P. scintillans*

### 3.1.7 Leaf feeder *(Thalassodes quadraria* and *Perixera illepidaria)*

*Thalassodes quadraria* and *Perixera illepidaria* are commonly referred to as loopers and mainly infested the growing parts of mango trees.

*Thalassodes quadraria* damaged vegetative flushes as they appeared during May-June and in October to December by feeding on tender leaves. Fig. 10 is adult of *T. quadraria.*

*Perixera illepidaria* found on mango during its reproductive stage of mango, the infestation was being clearly visible when flowering was at its peak. The larvae preferred Alphonso to Totapuri. Fig 9 is adult of *P. illipidaria.*

### 3.1.9 Flower feeder (*Nanaguna* sp.)

The caterpillar causes the inflorescences to be webbed, thereby hindering normal development of the flower and lowered the fruit production. The pest persisted throughout the reproductive phase of the mango. In both the varieties, *Nanguna* sp. was seen from December to March. Fig 11 is the larva of *Nanaguna* sp.

### 3.1.10 *Anarsia* sp.

The tiny caterpillar infested the inflorescence by making a web with its silken thread. Within the web, the pest fed on flowers, pupated, and laid its eggs. The infestation on varieties was seen from December to March.

**3.1.11 *Orgyia australis***

Light brown larvae of *Orgyia australis* nibbled at the inflorescence and damaged growing points, thereby impaired normal development. The later instars fed on the inflorescence. Although the species was reported as a potential pest of mango in Uttar Pradesh, in Karnataka it was only an occasional pest. Its infestation mostly occurred during January and February when flowering was at its peak.

**3.1.12 *Hypotima* sp.**

Although *Hypotima* sp. was reported mainly on cashew, was now being reported on mango as well. The tiny reddish caterpillars damage both vegetative and reproductive parts during the summer months (March-May). Like *Dudua aprobola, Hypotima* sp., also rolled the tender leaves inwards, formed a web of leaves or inflorescence and fed within it. The infestation on Alphonso was greater than that on Totapuri. Fig. 12 showing larva of *Hypotima* sp.

**3. 1.13 Fruit borer *(Citripestis eutraphera)***

The fruit borer laid its eggs on rough areas of the fruit and pedicels during its lifespan of about a week. The larvae scraped the skin of the fruit and later instars bored into the fruit and fed on the pulp. The infestation was seen in April and May mostly when the fruits were the size of a marble or that of a lime. The fruit borer caused heavier loss compared to other insect pests of mango because as fruits were directly affected. Fig. 8 showing mango fruit infestation by *C. eutraphera*

**3.2 Varietal differences and economic status**

In Totapuri, infestation of lepidopterans on vegetative phase ranged between 0.23 to 14.46 and economic status from major to minor in the descending order was *D. aprobola*> *A. syngramma*>*O. exvinacea*> *P. jocosatrix*> *T. falsaria*> *C. transversa*>*Hypotima* sp. >*P. scintillans* (Table 1). In Alphonso, infestation on vegetative phase ranged between 0.12 to 25.17 and economic status from major to minor in the descending order was *D. aprobola*>*P. jocosatrix*> *A. syngramma*> *O. exvinacea*> *T. falsaria*> *C. transversa*>*Hypotima* sp. >*P. scintillans* (Table 1).

In Totapuri, infestation of Lepidopterans on flower phase ranged between 1.50 to 15.75 and economic status from major to minor in the descending order was *D. aprobola*>*Anarsia* sp.>*Nanaguna* sp. >*P. Scintillans* >*C. transversa*> *Hypotima* sp. > *O. Australis postica*> *P. Illepidaria* (Table 1). In Alphonso, infestation of lepidopterans on flower phase ranged between 7.14 to 21.79 and economic status from major to minor in the descending order was *D. aprobola*> *C. transversa*>*P. scintillans*>*Nanaguna* sp.>*Anarsia* sp. >*O. australis* > *P. illepidaria*>*Hypotima* sp.(Table 1 ).

In the present study, *O. exvinacea, A. syngramma*, *P. jacosatrix*, and *T. Falsaria* were seen on vegetative phase of mango. *Nanaguna* sp., *Anarsia* sp., *P. illepidaria* and *O. australis* were documented on flowering phase of mango and *C. eutraphera* documented on mango fruits whereas, *D. aprobola, C. transversa,, P. scintillans* and *Hypotima* sp., were documented both on vegetative and reproductive phase of mango, of which, *Hypotima* sp., *Nanaguna* sp., *Anarsia* sp., *P. illepidaria* and *O. australis* are perhaps recorded here for the first time on mango crop.

## 4. Discussion

It is pertinent to mention that Lepidopterans recorded on mango differ with the geographical region, whether in India or the world over (Dyer *et al.,* 2007) [12]. The species richness and biodiversity also change with stage of the crop, ecology of the geographical regions, altitude but not vary with varieties (Zahoor *et al.,* 2003) [13]. In the current study 15 lepidopterans were documented in both Totapuri and Alphonso. This is far in excess of those which have been documented from one place. In Tamil Nadu Kannan and Rao (2007) [14] recorded five species only from one study area. Most workers have only single species study Lakshmi *et al.,* 2011 [15]; Bhole *et al.,* 1987 [16]; Verghese and Sudhadevi, 1998 [17]. Lepidopterous insects attacking flowers are very crucial as they directly affect fruit set and hence yield (Kannan and Rao, 2006 [18]: Peňa, 2002 [19]. These occurring on flowers are a recent phenomenon seen in the last 20 years. Verghese and Jayanthi (1999) [7] recorded six Lepidopterans on mango, whereas a much higher number of Lepidopterans were recorded in this study.

*Dudua aprobola* is a pest mainly recorded northern India on litchi (*Litchi chinensis*) (Singh 1971, Chakraborti and Samanta, 2005). It has shown off-seasonal breeding (March-April) on jamun (*Syzygium jambolona*) (Lall and Mallik, 1976). However, in Bangalore, it was found on mango, almost throughout as it can feed both on flowers and new leaves.

## 5. Conclusion

Lepidopterans constitute an important group of insect on mango, attacking almost all parts (Tandon and Srivatsava, 1982) [20]. It is important to remember that it is the young larval stages, as caterpillars that damage the tree. Not all Lepidopterans that were recorded affect the crop. By computing the mean infestation levels, the status of the Lepidopterans were classified as major to minor. In both the varieties, *O. exvinacea,* and *D. aprobola* were the only serious Lepidopterans that could possible make an impact on vegetative phase of mango whereas, *D. aprobola, Anarsia* sp. and *Nanguna* sp., were recorded from reproductive phase.

The vegetative Lepidopterans were recorded mainly during the months between July and December, after the new flush and shoots were produced. The months between October and December had high Lepidopteran population. After January till about April there were no Lepidopterans that occurred on the leaves. This trend was common in both varieties. So from a management point of view, the uncertainty in the late vegetative phase (October - December) demands appropriate predator models to take up specific interventions. The high diversity, with low certainty implies that management should be from that one or two species which dominate. Again from April to June, a few summer rains induced vegetative growth which led to moderate species richness of *O. exvinacea, D. aprobola, C. transversa, P. jocosatrix, T. falsaria* and *Hypotima* sp. High diversity was recorded during peak flowering which varied with both varieties. The diversity in December was moderate. From the management point of view, preventing this diversity and hence saving the flowers is crucial for good yield.

**Table 1:** Economic status of Lepidopterans on vegetative and flowering phase in Totapuri and Alphonso during 2014-15

| Lepidopterans of vegetative phase | Mean infestation | | Lepidopterans of flowering phase | Mean infestation | |
|---|---|---|---|---|---|
| | Totapuri | Alphonso | | Totapuri | Alphonso |
| *D. aprobola* | 12.65 | 19.87 | *D. aprobola* | 15.75 | 21.79 |
| *P. jocosatrix* | 7.69 | 5.25 | *Anarsia* sp. | 11.13 | 14.86 |
| *A. syngramma* | 8.33 | 4.52 | *Nanaguna* sp. | 6.81 | 15.79 |
| *C. transversa* | 1.94 | 1.50 | *Hypotima* sp. | 3.88 | 7.14 |
| *O.exvinacea* | 10.63 | 2.73 | *O. australis* | 2.88 | 7.00 |
| *T. falsaria* | 3 | 1.79 | *C. transversa* | 4 | 16.64 |
| *P. scintillans* | 0.85 | 0.27 | *P. illepidaria* | 1.50 | 4.64 |
| *Hypotima* sp. | 1.5 | 1.08 | *P. scintillans* | 4.31 | 2.86 |

**Table 2:** List of Lepidopteran and their period of damage during 2014-15 in Alphonso variety of mango

| Name of the pest | Affected parts | Period of damage (Alphonso) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan. | Feb. | March | Apri. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
| *O. exvinacea* | Shoots | - | - | - | - | - | - | - | - | + | + | ++ | + |
| *D. aprobola* | Leaves, inflorescccence | + | + | + | - | + | - | - | - | - | + | ++ | ++ |
| *C. transversa* | Leaves, inflorescccence | ++ | + | - | - | - | - | - | - | - | + | + | + |
| *A. syngramma* | Leaves | - | - | - | + | - | - | - | - | - | + | + | + |
| *P. jocosatrix* | Leaves | - | - | + | + | ++ | + | - | - | - | - | + | + |
| *P. scintillans* | Leaves, inflorescccence | + | + | - | - | - | - | - | - | - | - | - | + |
| *T. quadraria* | Leaves, inflorescccence | + | - | - | - | + | - | - | - | - | - | - | + |
| *Nanaguna* sp. | inflorescccence | + | + | + | - | - | - | - | - | - | - | - | + |
| *Anarsia* sp. | inflorescccence | + | + | + | - | - | - | - | - | - | - | - | + |
| *O. postica* | inflorescccence | + | + | - | - | - | - | - | - | - | - | - | - |
| *P. illepeddaria* | inflorescccence | + | + | + | - | - | - | - | - | - | - | - | - |
| *Hypotima* sp. | Leaves, inflorescccence | + | + | + | + | + | - | - | - | - | - | - | + |
| *C. eutraphera* | Fruit | - | - | - | ++ | + | - | - | - | - | - | - | - |

**Table 3:** List of Lepidopteran and their period of damage during 2014-15 in Totapuri variety of mango

| Name of the pest | Affected parts | Period of damage (Totapuri) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | March | April | May | June | July | Aug | Sep | Oct | Nov | Dec |
| *O. exvinacea* | Shoots | + | - | - | - | + | - | + | + | + | + | ++ | ++ |
| *D. aprobola* | Leaves, inflorescccence | + | + | + | - | - | - | - | - | + | + | ++ | ++ |
| *C. transversa* | Leaves, inflorescccence | + | - | - | - | - | - | - | - | ++ | ++ | + | ++ |
| *A. syngramma* | Leaves | - | - | - | + | - | - | + | - | + | - | ++ | ++ |
| *P. jocosatrix* | Leaves | - | - | - | + | ++ | - | - | - | - | - | ++ | + |
| *P. scintillans* | Leaves, inflorescccence | + | + | - | - | - | - | - | - | + | - | + | - |
| *T. quadraria* | Leaf, inflorescccence | - | - | - | - | + | + | - | - | - | + | + | + |
| *Nanaguna* sp. | inflorescccence | + | + | + | - | - | - | - | - | - | - | - | + |
| *Anarsia* sp. | inflorescccence | + | + | + | - | - | - | - | - | - | - | - | + |
| *O. postica* | inflorescccence | + | - | - | - | - | - | - | - | - | - | - | - |
| *P. illepedaria* | inflorescccence | + | - | - | - | - | - | - | - | - | - | - | + |
| *Hypotima* sp. | Leaves, inflorescccence | + | - | + | - | + | + | - | - | - | - | - | + |
| *C. eutraphera* | Fruit | - | - | - | + | + | - | - | - | - | - | - | - |

**Fig 1:** Webbing of mango leaves by *O. exvinacea*

**Fig 2:** Mines on tender mango leaves by *A. syngramma*

**Fig 3:** Larva of *C. transversa*

**Fig 4:** Larva of *P. scintillans*

**Fig 5:** Folding of mango leaves due to *D. aprobola*

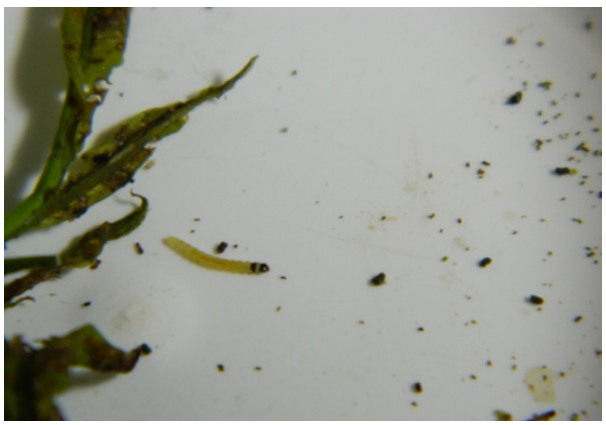

**Fig 6:** Larva of *D. aprobola*

**Fig 7:** Mango leaves damaged by *P. jocosatrix*

**Fig 8:** Mango fruit infestation by *C.*

**Fig 9:** Adult of *P. illipidaria*

**Fig 10:** Adult of *T. quadraria*

**Fig 11:** Larva of *Nanaguna* sp.

**Fig 12:** Larva of *H. haligramma*

**6. Acknowledgments**

Authors sincerely thank Indian Institute of Horticultural Research (IIHR) for providing research facility and Biosystematics unit, Indian Agricultural Research Institute (IARI) for identifying the insect. The financial support from ICAR for first author is acknowledged. This is part of the doctoral thesis of the first author under Jain University, Bangalore.

**7. Reference**

1. Mukherjee SK. The origin of mango. Indian Journal of Horticulture. 1958; 15:129-134.
2. Ahuja DB, Vannila S, Kalra B, Bambawale OM. Pest inflicting damage to mango and their management. In abstract book on Global conference on augmenting production and utilization of mango: biotic and abiotic stresses-21-24 June, Lucknow. 2011, 122.
3. Tandon, PL, Verghese A. World list of insects, mites and other pests of mango. Tech. Doc. 5, IIHR, Bangalore-89, 1985, 22.
4. Pena JE, Mohyuddin AI, Wysoki M. A Review of the Pest Management Situation in Mango Agroecosystems. Phytoparasitica. 1998; 26(2):129-148
5. Verghese A. Fallen fruit sampling helps timing of first spray for control of mango stone weevil *Sternochetus mangiferae* (Fab.) (Coleoptera: Curculionidae). Insect Environment. 1998; 3(4):91-92.
6. Anonymous. 2014, http://www.nhb.gov.in 14 February 2017.
7. Verghese A, Jayanthi KPD. Lepidopteran Pest Complex on mango inflorescence. Insect Environment. 1999; 5(2):51-52.
8. Kannan M, Umamaheshwari T, Rao V. Incidence of flower pests on mango. Insect environment. 2002; 7(4):151.
9. Chowdhury SK. Diversity and nature of damage of mango insect pests at Kaliachak-II Block of Malda, West Bengal, India. Journal of Entomology and Zoology Studies. 2015; 3(4):307-311.
10. Abdullah F, Shamsulaman K. Insect pests of *Mangifera indica* plantation in chuping, Perlis, Malaysia. Journal Entomology. 2008; 5(4):239-251.
11. Anonymous, 2015. http://www.planthealthaustralia.com.au/wp, 10 February 2017
12. Dyer LA, Singer MS, Lill JT, Stireman JO, Gentry GL, Marquis RJ *et al*. Host specificity of Lepidoptera in tropical and temperate forests. Nature, 2007, 696-699.
13. Zahoor M, Kashif S, Anjum I, Javaid Z, Zeeshan, Anwar M. Biodiversity of Noctuidae (Lepidoptera) in Agro-Forest Area of Faisalabad. International Journal of Agriculture and Biology. 2003; 5(4):560-563.
14. Kannan M, Venugopala RN. Seasonal incidence of Lepidopteran pests in relation to weather parameter in mango (*Mangifera indica*). Crop Research. 2007; 33(2):198-203
15. Lakshmi, Vijaya K, Reddy, Raji D, Varma, NRG. Seasonal Incidence of Mango Leaf Webber, *Orthaga euadrusalis* as Influenced by Weather Parameters in Andhra Pradesh. Indian Journal of Plant Protection. 2011; 39(3):180-182.
16. Bhole SD, Jadhav VS, Dumbre RB, Dalvi CS. Seasonal incidence and chemical control of mango nursery pests in Konkan region. Journal of Maharashtra Agriculture University. 1987; 12(3):387-388.
17. Verghese A, Sudhadhevi K. Seasonality and sampling of the mango shoot borer, *Chlumetia transversa* Walker (Lepidoptera: Noctuidae) Pest Management in Horticultural Ecosystems. 1998; 4(1):16-20.
18. Kannan M, Venugopala RN. Ecological studies on mango leaf webber (*Orthaga exvinacea* Hamp.) in Andhra Pradesh as a basis for IPM. International Journal of Agricultural Science. 2006; 2(2):308-311.
19. Pena JE, Sharp JL, Wysoki M. 'Tropical Fruit Pests and Pollinators'. In: Waite, G. K. (ed.) Pests and Pollinators of Mango. CAB International, Wallingford, UK, 2002, 103-130.
20. Tandon PL, Srivastava RP. Notes on new pests of mango in India. Science and Culture. 1982; 48:78-80.