Sucking Pests of Mango

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Abstract

Mango, *Mangifera indica* L., is grown throughout the subtropics and tropics and is one of the world's most important fruit crops. Mango is vulnerable to a variety of pests including insects, mites, pathogens and vertebrates. However insect pests often pose serious threat to the profitable cultivation. Insect pests considered economically important to mango are leafhoppers, mealybugs, thrips, fruit flies, stone weevil, stem borer, etc. The changing climate, growing number of

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monovarietal orchards, clean cultivation and chemical intensive plant protection measures have contributed to significant shifts in pest community structures. Those pests considered to be of minor importance sometime back have become major, like thrips, and vice versa. Hence there is a need to constantly update the information on pest status to enhance our preparedness to tackle them effectively. This chapter deals exclusively with the sucking pests, including insects and mites, occurring on mango, their biology, damage potential and management strategies.

13.1 Introduction

Mango, *Mangifera indica* L., widely acclaimed as 'King of Fruits' is a major fruit crop of tropical and subtropical regions. A native of Indo-Burma region, mango is cultivated in India, China, Thailand, Mexico, Pakistan, Philippines, Indonesia, Brazil, Nigeria and Egypt. India contributes about 50% of the world's mango production with 2.5 million hectares with an annual production of 18.0 million tons (Reddy et al. 2018). Like any other cultivated crops, mango is vulnerable to biotic stresses induced by several kinds of pests like insects, mites, pathogens, vertebrates, etc. Among these, insect pests are a major constraint in sustainable cultivation of mangoes. Exhaustive lists of insect pests attacking mango compiled by different workers indicate that about 400 species of insect pests infest mango in different parts of the world (de Laroussilhe 1980; Tandon and Verghese 1985; Veeresh 1989; Pena et al. 1998). They include sap feeders, borers, defoliators and fruit pulp feeders. Of them, sucking pests comprising mainly those from Orders Hemiptera (leafhoppers, mealybugs, scales), Thysanoptera (thrips) and non-insect group, Acarina (mites), form a major chunk. They cause both direct and indirect losses. Sucking insects, characterized by shorter life cycles and ability to produce asexually, pose serious challenge to plant protection experts. They are also more sensitive and responsive to climatic variations (Jayanthi et al. 2014), which leads to frequent outbreaks. This chapter deals with the species diversity, distribution, ecology and management of major sucking pests of mango (Fig. 13.1).

13.2 Leafhoppers (Hemiptera: Cicadellidae)

Species and Distribution

Leafhoppers are the major sucking pests of mango. About 15 species are reported to occur on mango in Asia, of which four species viz. *Amritodus atkinsoni* (Lethier), *Idioscopus nitidulus* (Walker), *I. clypealis* (Lethierry) and *I. nagpurensis* (Pruthi) are of economic importance. They are distributed across mango growing regions of the country (Veeresh 1989; Waite 2002), though the geographical distribution of different species is not uniform across the country. For instance *A. atkinsoni* and *I. clypealis* are more severe in northern states while *I. nitidulus* and *I. nagpurensis* are predominant in the southern part of India (Veeresh 1989).

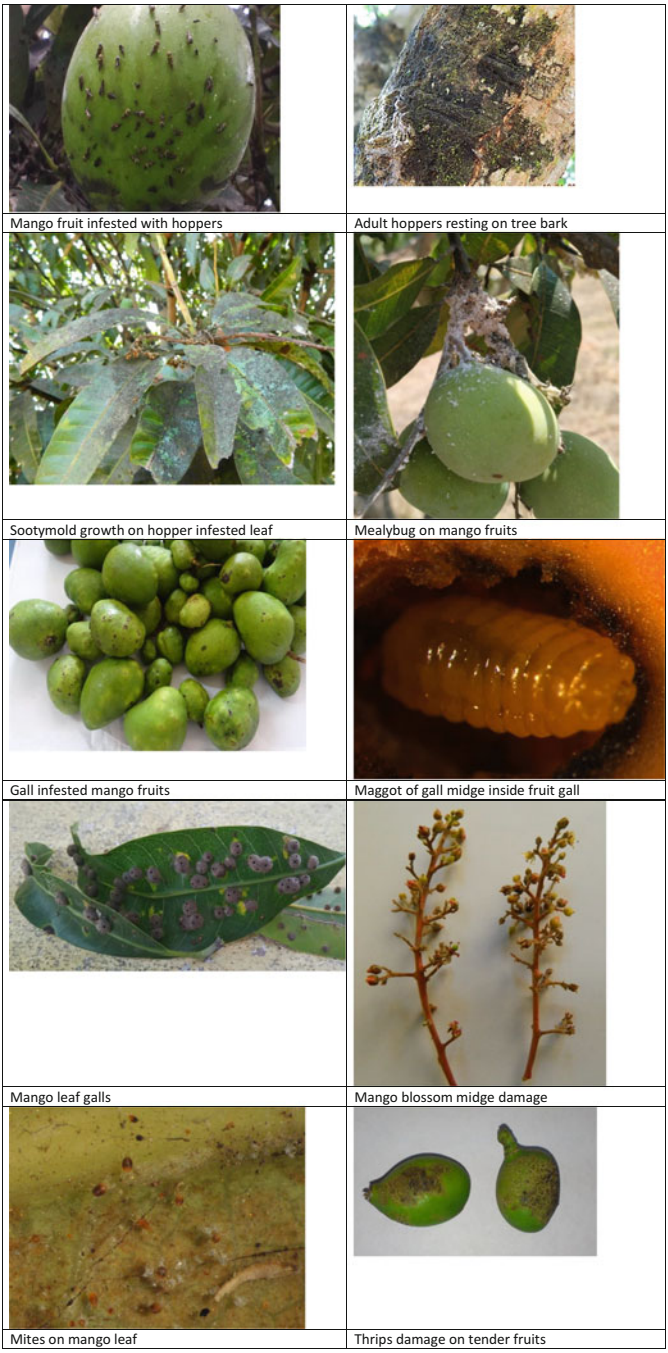

Fig. 13.1 Major sucking pests of mango

Biology

Major hopper species are easily distinguishable with naked eye based on certain morphological characters. *A. atkinsoni* is relatively bigger (4.2–5 mm) of all three species and is dark grey in colour. It has two prominent spots on the abdomen and scutellum. In case of *I. nitidulus* there are three spots on the scutellum with a prominent white band across wings. It is light brown in colour and is slightly smaller than *A. atkinsoni* and bigger than *I. clypealis*, the smallest of three (3.5 mm). It also bears two spots on the scutellum (Butani 1979). Eggs are laid singly by female adults on tender shoots, flower buds and new foliage. One adult female can lay up to 200 eggs. The duration of egg stage ranges from 4 to 7 days. Nymphal period lasts for 8–13 days with three to four instars. It takes 15–19 days to complete one generation and there are 2–3 generations in a year depending on the geographical location. The insect overwinters as adult. Hoppers are reported to rest in the cracks and crevices under the bark of main trunk during hot noon and rainy days (Patel et al. 1973). The population reaches a peak during March–April and maximum and minimum temperature and relative humidity are major abiotic factors contributing to population fluctuations (Tandon et al. 1983). The spacing of mango trees in orchards also plays an important role in breeding of the hoppers. *I. nitidulus* occurs during both vegetative and flowering stage while *I. clypealis* and *I. nagpurensis* survive only on inflorescence (Verghese and Devi Thangam 2011). The hopper incidence is more severe in closely planted orchards and on those varieties with dense inflorescence (Srivastava 1997; Reddy and Dinesh 2005).

Nature of Damage

Nymphs and adults of leafhoppers cause damage by sucking sap from flower buds, flowers, shoots, tender foliage and young fruits. The extent of damage due to leafhoppers, if unchecked, may be as high as 100% (Verghese and Devi Thangam 2011). Besides sucking sap, they excrete honey dew which attracts sooty mould. This makes affected plant parts turn black and adversely affects photosynthetic efficiency of leaves. Severe infestation causes withering and dropping of florets, thus leading to failure of fruit setting (Butani 1979). The affected trees exhibit leaves and fruits shining with honey dew. Another common symptom of hopper damage is congregation of honey bees on leaves to collect honey dew and also one would experience droppings of honey dew drops while walking under affected trees.

Management

1. Full grown trees, especially centre branches, have to be pruned to facilitate adequate light penetrance.
2. Spray the botanical pesticides, like azadirachtin 1% @ 3 mL/L if the hopper population is low (<4/ panicle). If the density is beyond four hoppers/panicle, spray systemic insecticides imidacloprid 17.8SL @ 0.3 mL/L or thiamethoxam @ 0.5 g/L or Lambda-Cyhalothrin @ 0.5 mL/L at panicle initiation stage. Chemical spray during full bloom stage is not advisable to safeguard pollinator activity (Verghese and Devi Thangam 2011).

3. Foliar application of entomopathogen, *Metarhizium anisopliae,* three times at weekly interval, is also reported to be effective, especially for organic orchards (Reddy and Ganga Visalakshy 2018).

13.3 Mealybugs (Hemiptera: Pseudococcidae)

Species and Distribution

About 20 species of mealybugs are reported to infest mango. However, only three species, viz., *Drosicha mangiferae* (Green), *D. stebbingi* (Green), and *Rastrococcus iceryoides* (Green), are considered to be serious pests and are more frequently found. They occur in India, Nepal, Bhutan, China, Pakistan and Bangladesh, while *R. iceryoides* is also reported from Malaysia (Tandon and Verghese 1985). The giant mealybug, *D. mangiferae* is a serious pest in Punjab, Uttar Pradesh and Bihar. Infestation due to this pest leads to significant loss in size and weight of fresh mango and is a growing threat to mango orchards (Karar et al. 2012).

Biology

During March to May, the gravid females of mealybugs crawl down the trees and enter the soil (about 80 to 150 mm deep). They deposit a whitish foam in which 400–500 eggs are deposited and the female dies soon after oviposition. Eggs remain in a state of diapause till the winter sets in. On hatching, nymphs start crawling up the tree trunks and clusters of these may be seen on young shoots and panicles, sucking the cell sap. A few nymphs crawl away to neighbouring trees as well during December–January. Mealybugs are more active on bright sunny days. The population peak is observed during March–April on inflorescence (Butani 1979).

Nature and Symptoms of Damage

Nymphs and female adults feed on the terminal parts of the panicles, shoots and fruits. They remain stationary and adhere to the panicles, shoots and fruit stalks. Presence of white cottony cushioned nymphs and adults is a conspicuous symptom of infestation (Mani 2016). Affected panicles shrivel and get dried resulting in size reduction and premature dropping of fruits (Singh and Mukherjee 1989). Infested plants are covered by the sooty mould. Due to the growth of sooty mould on the leaves, photosynthetic activity is affected.

Management

Ishaq et al. (2004) worked on the integrated management of mango mealybug and reported that this pest is difficult to control by only insecticides. Tandon (1995) found exposure of eggs during summer, removal of weeds, conservation of natural enemies, application of alkathane bands and spray of neem seed extract 4% or garlic oil on trunk below band effective for the control of *Drosicha* spp. and *R. iceryoides*.

Hence following measures can be integrated to effectively manage mango mealybug.

1. Deep ploughing of the orchard in November–December destroys egg stages.
2. Banding of tree trunk with alkathene (400 gauge) of 25 cm wide 30 cm above ground level and apply *Beauveria bassiana* product (2 g/L) or 5% NSKE in second week of December around tree trunk. Apply grease on lower end of alkathene band (Bindra et al. 1970; Srivastava 1980).
3. Release *Cryptolaemus montrouzieri* @ 10 beetles/plant in case of *R. iceryoides*. Entomopathogens were also found effective against mealybug (Mani et al. 1995; Haseeb and Srivastava 2003).
4. Rake up the soil around tree trunk and mixing with chlorpyriphos dust 1.5% @ 250 g /tree during second week of December.
5. Remove weed plants like *Clerodendrumin fortunatum* an alternate host plant of the giant mealybugs (Tandon 1995).

13.4 Thrips (Thysanoptera: Thripidae)

Species and Distribution

In the recent past, thrips are emerging as one of serious pests of mango in India. Several species of thrips are reported to infest mango in India and other countries (Reddy and Sreedevi 2016). However, only a few are of major economic importance. Species which are encountered frequently are *Caliothrips indicus* (Bagnall), *Rhipiphorothrips cruentatus* (Hood), *Scirtothrips dorsalis* (Hood), *Thrips palmi* Karnyand (Butani 1979; Tandon and Verghese 1987). The former two species feed mainly on foliage while the latter two colonize on leaves, buds, inflorescence and fruits. Other species reported on mango elsewhere include *Frankliniella bispinosa* (Morgan) and *F. kelliae* (Sakimura) in Florida, USA, (Pena 1993), *F. occidentalis* (Pergande) in Israel (Wysoki et al. 1993), *T. imaginis* Bagnall in Australia (Waite 2002) and *T. hawaiiensis* (Morgan), *Scirtothrips dorsalis* (Hood), *Frankliniella schultzei* (Trybom) and *Megalurothrips usitatus* (Bagnall) in Malaysia (Aliakbarpour and Che Salmah 2010).

Biology

Females lay up to 200 pale white eggs in leaf tissues. Nymphal stage has two instars and feed in groups, particularly along the leaf midrib and veins. Pre-pupal instar is inactive and does not feed. Duration of egg incubation period is 6–8 days, of larval instars 6–7 days and pre-pupal and pupal stages 2–4 days. Adults are pale yellow or whitish in colour, but with numerous dark setae on the body. A black line, resulting from the juncture of the wings, runs along the back of the body. The slender fringed wings are pale. Adult longevity is 10–30 days for females and seven to 20 days for males. *S. dorsalis,* yellow in colour, completes a life cycle in 14–20 days and is capable of reproducing both sexually and parthenogenetically. It typically has 4–8

generations per year. *R. cruentatus* is dark in colour compared to *S. dorsalis* (Butani 1979).

Nature of Damage

Nymphs and adults of thrips suck the sap from new flush, buds, inflorescence and tender fruits. Their lacerating nature of feeding leaves characteristic marks on leaves and fruits (Pena et al. 2002). Inward curling of tender foliage and bronze rough patches on fruits are typical symptoms of thrips infestation. Apart from weakening the inflorescence and reducing fruit set, thrips cause serious bronzing of the fruit surface due to the presence of air in emptied cell cavities which is more pronounced in mature fruits (Lewis 1973). Damage due to thrips leads to flower and fruit dropping besides affecting market value of fruits. In case of severe infestation, the leaf tips turn brown and get curled (Aliakbarpour and Che Salmah 2010). *T. palmi* showed preference to lower canopy over upper canopy (Verghese et al. 1988b). Populations reach a peak during hot dry weather.

Management

Erecting blue sticky traps helps to monitor as well as control thrips population in the field. Spraying of neem based pesticides is effective against nymphs and reduce the egg-laying ability of adults. Since hoppers and thrips occur simultaneously on inflorescence, control measures adapted against hoppers also help to check thrips. Effective insecticides against thrips are dimethoate (2 ml/L), imidacloprid (0.3 mL/L), spinosad (0.25 mL/L) and thiamethoxam (0.5 g/L). Module comprising first spray of acephate 75 SP (0.04%) at panicle emergence stage followed by spinosad 45 SC (0.004%) after 21 days and a third need based spray was reported to be effective treatment in reducing the thrips population (Bana et al. 2015). Neem oil 2% was reported to be effective to thrips and safer to pollinators (Aliakbarpour and Che Salmah 2010). Conservation of natural enemies, like predatory thrips, predatory mites (e.g. *Amblyseius* spp.), anthocorid bugs or minute pirate bugs (*Orius* spp.), lacewings, hoverflies and spiders helps in keeping thrips population under check. Entomopathogen, *Metarhizium anisopliae,* is also reported to be effective, against thrips (Reddy and Ganga Visalakshy 2018, 2019).

13.5 Shoot Gall Psylla (Hemiptera: Psyllidae)

Species and Distribution

Mango shoot gall psylla, *Apsylla cistellata* Buckton is a monophagous pest of mango. It was first recorded from Dehradun, India and is distributed in plains of northern India, Nepal and Bangladesh (Tandon and Verghese 1985) and in north-Eastern States. It is reported from Uttar Pradesh, Bihar and *Tarai* regions of north India (Singh 1960; Ahsan 1983). In recent years the incidence of shoot gall psylla is on the rise (Gundappa et al. 2014; Reddy et al. 2018).

Biology
Shoot gall psylla is active from August onwards. It is a univoltine pest with one generation per year. Adult females lay eggs into the midrib of leaves in March–April and they hatch in the last week of August. There are five to six nymphal instars and the freshly hatched nymphs are yellowish in colour, but colour changes with the age. Nymphal period lasts for 140 days. Nymphs emerge during August–September and crawl to the adjacent buds to suck the sap. Second instar nymphs migrate to the already formed gall. Adults may live up to 30–72 h (Butani 1979).

Nature of Damage
Psyllid feeding makes the buds develop into hard conical green galls which are usually seen during September–October. Generally terminal shoots are affected. Green conical galls are formed in leaf axis in response to egg-laying by adult insects or feeding by nymphs. In due course of time, infested twigs dry and show die-back symptoms (Singh et al. 1975; Singh and Misra 1978). The physiology of shoot gall formation was studied by Singh (2000).

Management
Galls with nymphs should be collected and destroyed. Spray insecticides with ovicidal properties, like profenophos @ 2 mL/L during the second week of March (Singh 2003).

13.6 Midges (Diptera: Cecidomyiidae)

Species and Distribution
Midges are important sucking pests of mango across the world. Thirteen midge species have been found associated with 16 types of gall makers (Mani 1943). Other reports indicate that 16 species of gall midges attack mango (Harris and Schreiner 1992; Peña 2002). Major species are inflorescence midge, *Dasineura amaramanjarae* Grover, mango blossom gall midge, *Procontarinia mangiferae* Felt (=*Erosomyia mangiferae* Felt) and mango leaf gall midge, *P. matteiana* (Kieffer and Cecconi). Mango midge, *Erosomya indica* Grover has gained much attention in recent past as it has become major pest in all mango growing areas of the world (Abbas et al. 1985; Ahmad et al. 2005). Similarly the leaf gall midge, *P. mattieiana* is a serious pest of mango in India, Indonesia, Kenya, Mauritius, Oman, Reunion, South Africa and United Arab Emirates.

Biology
Each female midge lays up to 150 eggs on tender inflorescence axis, newly set fruits or tender leaves encircling the inflorescence. The eggs hatch within 2–3 days. After hatching maggots penetrate into the infesting parts, viz. leaf, inflorescence or fruits, and form galls due to feeding. They fall to the ground for pupation, though a few of them pupate within the galls. Adult gall midges emerge from soil or galls and induce serious outbreaks during mango flowering (Prasad 1972). The affected floral parts

dry up and drop. The larval period varies from 7 to 10 days while pupal period from 5 to 7 days. There are 3–5 overlapping generations during January to March; thereafter, the weather conditions turn unfavourable. Mature larvae undergo diapause in the soil instead of pupation. The midge has four larval instars. The total life cycle varies from 14 to 25 days (Pezhman and Askari 2004). Spatial distribution was studied and sampling plan was standardized for mango midge by Verghese et al. (1988a).

Nature of Damage

The midges attack mango throughout the year prominently at the floral bud burst stage, young fruiting stage and on foliage. Black spots appear on the inflorescence and the infested buds, shoots and young fruits produce small blister like galls in solitary or gregarious manner. They measure about 2–4 mm long, each containing a maggot. Maggots tunnel into bud and feed on inner content and bore into axis of inflorescence and destroy completely. Infested panicles have characteristic right angled bend, with an exit hole, from which last instar maggots emerge. Larval feeding prevents flower opening and consequently development of the fruit. Finally the inflorescence dries up. Midge infested leaves have multiples of blister like galls which either fall to the ground much earlier than usual or remain on trees infested with anthracnose inoculum (Pezhman and Askari 2004; Rehman et al. 2013).

Management

1. Deep plough the orchard in November to expose pupae and diapausing larvae to sun's heat and natural enemies.
2. Monitor the larval population on white paper in April–May and application of chlorpyriphos (1.5%) dust on soil below the tree canopy for its control.
3. Spray recommended systemic insecticide at bud burst stage. Muhammad et al. (2017) evaluated newer molecules and found bifenthrin treated trees showed least development of galls.
4. Conservation of parasitoids of cecidomyiid pests, like *Platygaster* sp., *Systasis* sp. and *Eupelmus* sp. associated with *Dasineura* sp. and *Tetrastichus* sp. associated with *Erosomya indica*. An external parasitoid, the pteromalid, *Pirens* sp. was found attacking *Procystiphora mangiferae* (Felt.). Certain species of ants like *Formica* sp.; *Oecophila* spp. and *Camponatus* spp. are reported as predators of gall midges (Grover 1986).

13.7 Scales (Hemiptera: Coccidae)

Species and Distribution

There are three types of scales, viz., fluted (Monophlebids), armoured (Diapsids) and soft scales (Lecanids) which are known to infest mango in India. Of about 15 species recorded, the armoured scale, *Aspidiotus destructor* Sign is the most economically important one. Besides India, this insect has been reported from Sri Lanka, China, Taiwan, Fiji Island, Mexico, West Indies, British Guiana, Africa, Mauritius, etc. In

India, it is found throughout the plains and foot of the hills (Butani 1979). In Australia and South Africa, the mango scale, *Aulacaspis tubercularis* (Newstead), is considered a serious pest as its infestation on fruits leaves blemishes resulting in loss of market (Joubert 1997). Swirski et al. (1997) listed 63 species of soft scales of which *Ceroplastes pseudoceriferus* Green is considered a key pest.

Biology

Nymphs and adults of scales suck the sap from leaves and fruits. Though scales are not considered to be major pests, severe infestation may affect the growth and fruit setting capacity of the tree. Female scale is circular, semi-transparent and pale brown and reproduces oviparously. Total life cycle lasts for 32 to 34 days. Nymphs are small (2 mm long), oval, translucent, yellowish-brown crawlers which colonize underside of leaves and tender shoots. They are covered with waxy material and become immobile. They suck the sap and excrete honey dew which attracts black sooty mould. Branches with high density of scales showed more decline symptoms than branches with low scale density. Nevertheless the role of scales in mango decline is yet to be established (Pena 1993).

Management

Specific management measures are not warranted unless the scale incidence is very severe. A number of parasitoids are recorded to exercise natural control of the scales (Sankaran 1955; Wen and Lee 1986). Coccinellid predators are effective against soft scales. Among predators *Cryptolaemus montrouzieri* is very efficient predator besides other coccinellids like *Chilocorus nigritus* and *Scymnus* sp. In case of *Chloropulvinaria polyginata*, the parasites *Anagyrus* sp. and *Anicetus annulatus* are effective.

The scale insects are very difficult to control with pesticides. The presence of waxy coating or shield over the bodies of insects limits the chemical reach to target. Therefore, only crawlers and young nymphs are vulnerable to insecticides. Pruning of the heavily infested plant parts and their immediate destruction helps minimising scale infestation.

13.8 Mites (Acari:Tetranychidae and Eriophyidae)

Species and Distribution

Mites are sporadic pests of mango but have potential to become serious pests due to indiscriminate use of insecticides against other sucking pests. The spider mite, *Oligonychus mangiferus* Rahman and Sapra and the bud mite, *Eriophyes mangiferae* (Sayed) commonly occur in India. The bud mite, *E. mangiferae* is more prevalent in northern states (Singh and Mukherjee 1989). In other countries, like Australia and Central America, the tea red spider mite, *Oligonychus coffeae* (Nietner) and the avocado brown mite, *O. punicae* (Hirst), are reported to be minor pests of mango (Cunningham 1989). Besides these mites, Broad mite, *Polyphagotarsonemus latus*

(Banks) of family Tarsonemidae was reported to occasionally infest the nursery seedlings, causing stunting and crinkling of new leaves and rolling of leaf margins.

Nature of Damage
The infestation starts from April and gradually reaches a peak in June. Spider mite feeds on the upper surface of mango foliage. Nymphs and adults suck the sap from leaves and tender shoots, resulting in leaf bronzing. On closer observation, webbing of mite colonies can be seen on leaves. The mango bud mite attack results in proliferation of shoots on the terminal, giving rise to a witches' broom effect (Ochoa et al. 1994). In Florida, *E. mangiferae* is associated with malformed mango flowers (Pena 1993) and hence there is an impression that it may be vectoring the disease that could be the real cause of the malformation.

Management
Spraying of acaricides, like wettable sulphur @ 2.5 g/L or dicofol @ 1 mL/L or spiromesifen @ 1.5 mL/L will be effective against mites.

13.9 Minor Sucking Pests

Besides the above-mentioned sucking pests, there are other sucking pests rarely and sporadically encountered. They are, mango blackfly, *Aleurocanthus mangiferae* Quaintance and Baker, citrus blackfly, *A. woglumi* Ashby, leafhopper, *Amrasca splendens* Ghauri, aphid, *Toxoptera odinae* van der Goot and cow-bug (membracid), *Otinotus oneratus* (Walker). Painted bug, *Coptoso manazirae* Atkinson also has been reported sucking the sap from tender shoots; *Antesia cruciata (*Fabricius) infests the inflorescence and *Spilostethus pandurus* (Scopoli) attacks the fruits. (Butani 1979).

13.10 Conclusions

Insect pests remain a serious challenge to entomologists and farmers. With the growing concern to food safety and environment, devising pest management strategies that are not only effective but also safe and sustainable is the need of the hour. This is all the more important in case of fruit crops, like mango, where produce is consumed fresh and has wide domestic and international market. Application of broad spectrum insecticides and their indiscriminate usage must be avoided to safeguard the health of orchard ecosystem as well as consumers. Since most of sucking pests have short life cycle with overlapping generations and are also capable of reproducing parthenogenetically, they are hard to manage and can lead to frequent outbreaks. Integrated management strategies involving crop habitat management, natural enemies and safer pesticides should be in place. Besides research interventions, enhancing farmers awareness on safe pest management go a long way in this direction.

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