Chapter 2
Review of Literature

1. Salvi et al. (2013) had reported effect of hike in maximum temperature by 2.3°C and decrease in relative humidity by 7-9% on fruit drop in Vengurla. They had further reported that those climatic changes were responsible for premature fruit drop and incidence of spongy tissue in Alphonso mangoes. Fruits of all stages including marble size, areca-nut size, egg size and full mature fruits were dropped. All fallen fruits were affected by spongy tissue. That was finally found to affect the crop yield. They had recommended some control measures like intercropping with various vegetables, supplementary irrigation, mulching and to insure the Crop Insurance Scheme. They had also suggested the use of dropped mango fruits for the preparation of by-products.

2. Munj et al. (2013) had reported that Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli have developed Rakshak methyl eugenol trap. It is an ideal tool to reduce the incidence of mango fruit fly occurrence on mango crop Bactrocera dorsalis (Hendel). Use of Rakshak methyl eugenol trap has proved very effective in controlling the fruit fly population during unseasonal rains. Fruit fly population is favoured by the unseasonal rains during its growing period. Rakshak methyl eugenol trap can be used to cope with this problem. They have suggested planting the traps at the rate of 4 traps per hectare. That is expected to decrease the fruit fly population and minimize the incidence of pest on mango crop.

3. Salvi et al. (2013) had reported various factors influencing flowering phenology and mango productivity in Vengurla. Delayed rainfall up to November has been found to push the winter season further. Winter season is essential to initiate the flowering stage. Similarly the delayed rainfall was found to shorten the October heat. This led to the absence of October heat and lack of abiotic stress, finally resulting in the failure in first flowering flush and finally losing the March harvest. Further they had also mentioned that prolonged winter increases the percentage of hermaphrodite flowers while severe cold decreases it. Environmental stress causes flowering failure, alteration in the male/hermaphrodite flowers and dropping in fruit setting. They suggested using paclobutrazol (flowering induction chemical). The application of paclobutrazol induce flowering phase, hermaphrodite flowers, bud breaking and improve fruit setting under climate change uncertainties. Paul et al. (2001) mentions in his work about the mango farmer’s knowledge, perception and pest management practices in Vietnam. Almost all farmers apply the insecticides and pesticides to control the pest infestation. Farmers have very less
knowledge of the mango diseases overall. Similarly the farmers are also unaware about the natural enemies of pest, predators and entomopathogens. Farmers have been found to use a similar pattern of pesticide application for rice and mango. They mostly use the pesticides to control the pest as they lack in information regarding pest, fear of low yield and commercial advertisements of pesticide companies. Thus the chemical companies have good market there. Consistent use of pesticides has been found to develop resistance within the pest and decrease the population of predators. Farmers imitated their neighbors in spraying pesticides on their crops, even though it is not essential for the crop. It was essential to make farmers aware about the adverse effects of the chemical pesticides and encourage them to use sustainable means to control the pest.

4. Pitan et al. (2000) had reported that there was reductions in the population levels of mango mealybug (*Rastrococcus invadens* Williams) after the introduction of parasitoid *Gyranusoidea tebygi* Noyes (*Hymenoptera: Encyrtidae*) in Nigeria. Along with the mango, mango mealy bug was also found to infest plants such as citrus, banana, guava, fig, frangipani, breadfruit, grasses, tomatoes, peppers etc. When mealy bug infestation was lowered, mango trees later started flowering and fruiting. In the regions of high infestation, the condition started improving slowly and fruit production was increased. Similar reporting has been done by Agricola et al. (1989); Matokot et al. (1992); Agounke and Fischer (1993); Bokonon-Ganta and Neuenschwander (1995) in their work. Mealy bug population was found to decrease drastically after introduction of parasitoid *Gyranusoidea tebygi* reduce but mango has become its vital host plant.

5. Chowdhury (2015) had reported 16 different pests infesting all mango varieties in Kaliachak II Block of Malda district in West Bengal during March 2013-February 2014. The nature of damage of each pest is specific. Pests are restricted to particular plant parts for their mode of action. Pest infestation is almost common to all mango varieties irrespective of its genotype. Pest infestation is a major reason to decrease the crop production. Pest damages the flowers, shoots, leaves, shoots, stem and fruits. They also interrupt the photosynthesis and metabolism of plant. Pest damages each stage of fruit right from flowering to mature fruit. Maximum damage was observed during March end to the beginning of April. But as the May approaches, the infestation was found to be lowered. During the study period among the varieties observed Himsagar was highly susceptible to pest followed by Fazli, Lakshmandhog, Asiana and Nargra.

6. Gopalkrishnan (2013) mentioned in his work that Maharashtra, Karnatak, Tamil Nadu, Bihar, Gujarat, West Bengal, Andhra Pradesh, Uttarakhand, Kerala and Orissa are states
of India that are leading in mango production. In India, Mango varieties like Alphonso, Neelum, Bangalora, Rumani, Bangangpali, Kaepad, Peter, Sendhura, Jahangir, Mulgoa, Himayuddin, Mallika, Amrapali, Salem, Sindhu, Dashehari, Langra, Fajil and Totapuri are grown on commercially basis. Highest production of mango in world is done in India. India is the top most mango producing country in the world. The average mango yield of whole world is 25t/ha. While that of India is as low as 6t/ha. The national productivity of India is 5.5 t/ha. Uttar Pradesh tops the list in India with maximum productivity of 12 t/ha. Further he reported that mango farmers are not directly involved in marketing. They do not have sufficient knowledge of marketing. Thus a long chain of middle men is involved marketing channel. As mango is highly perishable and seasonally available fruit farmers do not take any risk of marketing. He suggested to emphasizing on the processing of mango and making it available also during off season. Mango products pickle, jam, pulp, candy, squash etc. also have good market.

7. Akoto et al. (2011) revealed that infestation of fruit fly larvae alters some quality parameters of mango in Ghana (Greater- Accra, Eastern and Volta) during December 2001 to May 2009. The incidence of fruit fly larvae causes changes in some quality parameters like Total Soluble Solids, Percentage Titratable Acidity (% T. A) and pH. Fruit fly larvae also cause internal damage to mango. TSS and pH values decreased while % T. A. increased with storage time. The tunnels made by the larvae provide entry routes for the fungus and bacteria which later cause fruit rot. Further they mentioned that punctured fruits without larval incidence have no change in their pH and % T. A. Thus they suggested harvesting these fruit at the earliest and processing them. Incidence of fruit fly on mango degrades internal quality. Such fruits were rejected from market.

8. Bhattacharyya (2014) mentioned about the impacts of ecological factors influencing attack of mango red banded caterpillar during 2008-2009 and 2008-2009 fruiting season. He revealed that mango fruit borer is also known as red banded caterpillar. He reported that fruits in between the pea to marble size are more susceptible to fruit borer. Pest infestation was observed during March to April. Peak infestation was reported at the end of March and April. Lowest infestation was reported during mid of May due to unavailability of fruits. Further he had also reported that mango fruit borer is emerging as a major pest and the pest is infesting the fruiting stages of mango at an alarming rate. Availability of the fruits is the most important factor for the incidence of pest. The pest cannot reproduce in the absence of fruits. Mango varieties like Gopalbhog and Rakhabhog were least susceptible to the pest. On other hand, Langra, Fazil and Phunia
like varieties were highly susceptible. It was observed that infestation was low in the area where the plants were exposed to sunlight and better aeration was available.

9. Nboyine et al. (2013) studies out population dynamics of fruit fly (Diptera: Tephritidae) species associated with mango in the Guinea Savanna Agro- Ecological zone of Ghana during March 2011 to February 2012. They reported that fruit fly species like *Ceratitis cosyra*, *Bactocera invadens*, *Ceratitis ceratitis* and *Ceratitis capitata* were significantly attacking mango crop. Fruit fly oviposits beneath the mango skin. This results in rot and fruit drop. They had also mentioned that worldwide fruit fly alone pose 20-30% loss of mango crop. Population of *Ceratitis cosyra* was higher during the mango fruiting period that is between January to April. On the other hand, population of *Bactocera invadens* was at peak during off mango fruiting period from May to November as compared to *Ceratitis cosyra* and *Ceratitis capitata*. *Ceratitis ceratitis* was maximum recorded in June, July and November. Further they had also reported that *Bactocera invadens* and *Ceratitis cosyra* were negatively correlated with each other. *Bactocera invadens* was correlated with relative humidity but negatively correlated with temperature. For late maturing varieties appropriate management of *Bactocera invadens* and *Ceratitis cosyra* is essential.

10. Sathe et al. (2014) had mentioned in their work about the pests at storage and their management practices in western Maharashtra during the years 2012-2014. They had reported ten species of pests damaging mango at storage. From insect category fruit fly, stone weevil and mealy bug were prominent pests. While in rodents, *Rattus rattus* and *Bandicota indica* were found feeding on fruits at storage. They suggested disposing of the damaged fruits from storage place and nearby area. After consuming fruits, stones should be collected and burned. To avoid fruit damage, fruits should be harvested at appropriate time. Further they have suggested hot water treatment and ethylene di-bromide emulsion to get rid of stone weevil. To control rodents, they have suggested the application of poison baits that can be placed near the nests.

11. Fowomola (2010) had revealed vital nutrients and antinutrients contents of mango seeds. Mango fruit is a good source of essential nutrients like potassium, copper, and seventeen different kinds of amino acids have been found to be present sufficient quantity. Pigments, antioxidants, carotenoids, polyphenols, omega-3 and six polyunsaturated fatty acids are present in mango skin and pulp. Further he had mentioned that mango seed contains carbohydrates too. The carbohydrate content is thirteen times that of cassava. Seed also encompasses glutamate, methionine, essential amino acids, leucine and
arginine. Mango seed has promising nutrients content. It can be implemented as an alternative source of vitamins mentioned. He had suggested using mango seed as an alternate ingredient in manufacturing animal food.

12. Fita (2014) studied the distribution and severity of mango scale in Western Ethiopia. Farmers produce mango for multiple reasons like source income, consumption, animal feed, firewood and fencing material. Some farmers have planted mango trees of unknown varieties in traditional way. Mango is well adapted to temperature extremes. Mango tree is also referred as a shade plant because of its large canopy and ever greenness. Incidence of white mango scale was reported for very first time in locality and country as well. Just within one year, pest infestation covered miles of distance. Thus pest was found to be getting dispersed at an alarming rate. During the studies, it was observed that application of pesticides was done throughout the day. The spraying failed to cover completely infested plant. Such sprays were found to create a resistance in the pest. Scale infestation causes premature leaf drop, dieback of leaves and twigs, fruiting disorders and premature fruit drop. Pest infestation had seriously hampered the fruit quality and quantity. Some biological methods need to be implemented to control the pest attack.

13. Badii et al. (2015) had mentioned in their work about the status, economic impact and management of fruit infesting flies in Africa. Incidence of fruit fly had been detected to affect adversely on fruit production and quality. Due to the infestation, the market value of fruit decreases. The female oviposits beneath the fruit skin by puncturing it. It is followed by the infection caused by the bacteria introduced by the fly. Thus the harvestable fruits get damaged. In Africa, fruit producing farmers have to bear heavy losses due to fruit fly. Further they had mentioned that before invasion of fruit fly (Bactrocera invadens) in Africa, Ceratitis species was the major pest. Infestation of fruit fly (Bactrocera invadens) had hampered the trade of fruits and vegetables from Africa. US had banned the import of African fruits and vegetables. Bactrocera invadens was highly damaging and pathogenic pest. It was found to be infesting almost 40 different types of fruits. Parapheromone traps were used to control the fruit fly infestation. It proved very effective in controlling the male fruit fly population. Accordingly, food baits were also used to reduce the fruit fly incidences. But they were less effective as compared to parapheromones traps. A new of soil treatment was also implemented to control fruit fly attack. The soil was inoculated with naturally occurring fungus Metarhizium anisolie which is lethal to maggots and pupa of fruit fly. After harvesting, the fruits should be exposed to heat treatment or coal treatment to get completely rid of the pest.
14. Ganniron Jr. (2014) had mentioned in research work regarding determination of size properties of mango using Image Analysis. An image analysis, algorithm was applied to analyze the size, roundness and defect in mango fruit. Euclidean distance technique was implemented in determining the quality of mango since the data point cannot be easily separated. The isodata algorithm was applied to determine the threshold converged for each image. By using the final segmented image, the object’s pixels were classified either healthy or defective. This method was found capable of identifying the defective areas in mango correctly. The algorithm perfectly separated the mango at different position. The healthy region was displayed as green stem pixels and brown stem pixels showed the defective part.

15. Sareker et al. (2012) studied the effects of doses and splits of fertilization application on harvesting time, yield and quality of mango in Bangladesh in fruiting season of 2005-06. They reported that plants were applied with fertilizer doses of 50%, 100% and 150% in three splits. Mangoes were harvested initially from the control plants followed by the plants treated with the 150% of fertilizer dose. The studies revealed that fertilizer application in installment had significant impact on fruit production. Similarly plants applied with the 150% of fertilizer dose produced maximum fruits as compared to others plants. Highest yield was reported from the plant combined treated with the 150% fertilizer amount and three installments of applications. Trailed by the plant that was treated with the 100% fertilizer dose and two installments of applications. Least yield was recorded from the control plants. They also mentioned that treatment of fertilizer doses based on appropriated installments had significant impact on fruit quality. Fruit size, breath, pulp and durability were significantly improved. Similarly variations were found in the vitamin C, moisture content, dry weight, etc. However, pH and titratable acidity was unaffected.

16. Mali et al. (2016) studied production and export of mango in India during 1991-92 to 2013-14. They reported that quantity of mango exported from India depended on the area under cultivation, production and crop yield. The coefficient of area under mango cultivation was 0.859, whereas coefficient of production was negative at -0.086. As one unit increased in mango production, it decreased the export of mango. Concerning about the net profit of whole sale business of mango traders authors reported that the amount spent on purchasing and selling mangoes significantly affected the net profit level. They mentioned that India is a leading country in mango production. Numbers of mango varieties are cultivated here and exported to number of countries. They further mentioned
that about 1.23 million hectares area in India is under mango cultivation. Horticultural crops productivity in 2004-05 was 8.4 tons per hectare which was increased to 11.4 in 2010-11. Even after growth in productivity, it was low than other counties. Thus it is essential for India to focus on increasing crop productivity. They also mentioned Andhra Pradesh, Maharashtra, Tamil Nadu, Karnataka, West Bengal and Gujarat were some of the leading states in mango production. However, marketing of the produce was mainly done by the intermediaries such wholesalers commission agent. Farmers were not directly involved in the marketing chain.

17. Acema et al. (2016) reported mango pest, disease and orchard management practices in West Nile Zone of Uganda from June to August. Studies revealed that most of the farmers didn’t know the name of the pests and disease. They define them on the basis of damage caused and infested plant part. Infestation of fruit fly was general pest causing loss to mango crop on large scale. *Bactrocera invadens* was commonly observed fruit fly species in all orchards. Mango seed weevil was second most reported pest. They observed incidence of fruit fly was observed in all districts. Termites were also reported by the farmers, but they were easily identified by farmers. Other mango pest like mango scales and mealy bug were also mentioned by farmers. Farmers had very less knowledge regarding diseases as compared to pest. However the yield loss caused by the diseases was low as compared to pest attack. Among the diseases mentioned by farmer’s anthracnose was most damaging mango disease. This was due to close plantation and wet humid conditions, which favors the infection of diseases. Bacterial black spot was other recorded as prominent diseases prevalent. Besides this other disease cited by farmers was powdery mildew. It affected fruits, inflorescences and pre-mature fruits, ultimately reducing fruit yield. Further they mentioned that most of the diseases mentioned by the farmers were fungal in nature. Other diseases like algal spot and sooty mould were also stated by farmers. Farmers failed to exercise the appropriate plant protection measures such as regular pruning of mango trees, weeding and application of manure. Cultivation of exotic mango varieties in zones of Uganda can improve the mango production and productivity. However, attack of pests and diseases hampers the production potential of exotic mango cultivation. Hence it was essential to create awareness among farmers regarding pest and diseases on mango crop to improve exotic mango production.

18. Upadhyay et al. (2013) studied integrated management practices for stem borer (*Bactocea rufomaculata*) in Eastern Terai Region (ETR) of Nepal during 2010-11. They reported that to study the life cycle of pest, standing crops were covered with cloth net
and no pesticides were applied on these plants. Stem borer adult start laying eggs on the bark and dead shoots between July to August. Eggs got hatched within 10-15 days. Newly hatched larvae bore the shoot and start to feed within. Infested plant dry up and do not flower or fruit. Stem borer was reported as a major pest in Saptari district. Incidence of stem borer was reported in almost all orchards. On an average 30% damage was reported but in some severe cases about 60% damage was also reported. Infestation of stem borer was also increasing in Udaipur district where 20% damage was reported. However infestation of fruit fly was also high in Udaipur district. Further they reported that farmers had less knowledge regarding orchard sanitation, fertilization and pesticide application. Studies reveal that Imidacloprid 17.8 SL was most effective in controlling the stem borer followed by Thiomethoxame 25% WG and Trizophos 40% EC. They further mention that infestation of stem borer can be suppressed by orchard sanitation and destruction of dry shoots. They also mentioned that orchard sanitation along with pruning of unwanted branches and dry shoots were some of the important steps to control stem borer infestation.

19. Rosalin et al. (2014) mentioned in their work about growth analysis of mangoes in India. Study was carried out in Salem District of Tamil Nadu for period of three years that is from 2012-2014. They reported that during 2010 mango covered 4946 thousand ha land in world and production was about 37.12 million tons. India is leading country in mango production and contributes about 40.48% of total world mango production. While China stood second and Thailand bagged third place in race of mango production. Some of the major mangoes producing countries mentioned by authors were Thailand, Pakistan, Mexico and Indonesia. From India mangoes are exported to more than 33 countries. Mango is cultivated in tropical and subtropical regions of India. Mango varieties such as Alphonso, Neelum, Totapuri, Mulgova, Mallika, Amrapalli, Pusa Surya, Arka aruna, Arka Anmol, Pusa Arinima are cultivated in Tamil Nadu. Andhra Pradesh was the highest cultivator of mango and Jharkhand was the least producer. However they observed that mango productivity was more in Jharkhand as compared to other mango producing states. Second largest grower of mango was Maharashtra contributing nearly 482 ha land. But productivity is very low that is 1.3 tons per hectare. Marketing of the produce was mainly done by the middlemen. They noted that marketing infrastructure was poorly developed which lead to incompatibility between demand and supply. Further they reported that it was essential to educate the farmers to exercise appropriate orchard management practices like pest control, diseases, irrigation, marketing and government policies.
Farmers should be trained to adopt new technologies in order to improve mango productivity. One of the major problems concerning mango plant was alternate bearing of mango trees. It can be solved by appropriate application of hormones. Farmers should be educated with correct harvesting methods. However Government should take necessary steps to start up cold storages throughout country as mango is a perishable fruit that spoils readily. This can make mango available in off season and gain good market price.

20. Jose et al. (2013) mentioned about the fruit fly infestation and related damage in Cabo Delgado Province from January to March 2012. Four species of fruit *Ceratitis cosyra*, *Bactocera invadens*, *Ceratitis rosa* and *Ceratitis capitata* were considered for proposed study. *Bactocera invadens* fruit fly species was well established with higher population density as compared to other species. In Mahipa and Cabo Delgado maximum infestation of *B. invadens* was observed due to availability of abundant host plants like mango and cashew. They termed *B. invadens* as polyphagous, as its emergence was observed on all five studied host samples. The highest percent of damage was recorded from guava followed by tropical almond and least on mango. During peak infestation it was noted that emergence of *B. invadens* was maximum and dominating one. Studied revealed that *B. invadens* had better competitive ability than other species. *B. invadens* was considered as a major insect pest for great economic interest due to its destructive potential. Further they mentioned that *B. invadens* fruit fly infestation was dominant in study area. Its presence dominated occurrence of other fruit flies. *C. cosyra* was displaced by *B. invadens* and emerged as dominant pest on mango crop. Among the trapped fruit flies from mango orchards, 98% of flies were *B. invadens*. Consequently incidence of fruit fly resulted in yield loss, influencing livelihood, income and food security in country.

21. Thakur et al. (2016) had evaluated the adoption of plant protection measures for control of mangoes pests and diseases in Kolhapur district of Maharashtra. They mentioned that 66.67% respondents had medium level of adoption regarding plant protection while 21.90% had low level of adoption. However only 11.43% respondents had high level of adoption regarding plant protection measures. The adoptions of the farmers were crossed checked against the plant protection measures suggested by Taluka Agriculture Officers. They noted that no significant adoption measures were recorded from first spray to sixth spray. Similarly the recommendations to control the thrips were neglected by farmers. In the same way the farmers ignored to use the pheromone traps to control the incidence of fruit fly. Further they reported that majority of farmers to failed implemented the mechanical methods to control the stem borer. With respect to shoot borer and mealy bug
maximum farmers failed to adopt the protection measures. For controlling attack of termites maximum farmer preferred destruction of whole termitearium but fail to practice the further treatment to suppress pest population. Similar reading were recorded with respect to diseases such die-back, anthracnose, powdery mildew and fruit rot, majority of the farmers had no adoptions. Overall it was observed that, farmers had medium level adoption for pest control measures. They suggested that awareness programs and trainings should be conducted for farmers to improve pest management practices. Also some demonstrations should be imparted to increase the level of adoption.

22. Nordin et al. (1995) had studied the biology of mango hopper in Perlis and Malaysia. They reported that hopper pose serious threat to mango industry due to their feeding activity on flowers and fruits. Females deposits eggs on the inflorescence in clusters. These eggs were partially embedded in the plant tissues. The eggs were translucent, smooth shining and about 0.95±0.05 mm in size. The incubation period of the eggs was between 3.85±1.00 days. Newly emerged nymphs were initially stable and then started looking for feeding sights. Male and female nymphs were differentiated on the basis of shape and size of their sheath. The newly emerged nymphs were pale cream in colour with weak venation. Later on after 30 min they turned brown and veins changes to black. They observed that body length of male hopper was between 4.75±0.59 and females ranged between 5.07±0.26 mm long. The leaf hoppers begin to mate 4.75±1.67 days after their emergence. They also mentioned that oviposition took place soon after the mating process. The life span of the males feeding on the shoots was 60.5±8.5 days and in case of female it was found to be 69.8±9.8 days. But difference between them was not significance. Further they mentioned that mated females lived longer than the males of same age.

23. Kumar (2015) had studied the population dynamics of mango hopper *Amritodus atkinsoni*(Leth), and its relationship with temperature in Jhansi during March 08-February 09. He mentioned that hopper was one of the serious monophagous insect pests on mango crop. Hopper caused heavy damage to inflorescence, leaves and young fruits. He marked migratory behavior of the hopper from main trunk to inflorescence. In case of mango hopper two population peaks were observed throughout the year. Further he mentioned that population of mango hopper varied from 2.33 to 6.00 hoppers per square cm on branches at 6 am while at 2 pm the population of hopper was 9.33 to 14.66 per square cm. This revealed that hoppers shelter under the barks to protect themselves from high temperature. As the temperature increases hoppers migrate towards the cold and
shady place. But their presence on the twigs was noted only during the availability of young plant parts. Hoppers were influenced by the specific volatiles emitting from the inflorescence which attracted hopper towards it. The movement of hoppers from the stem to inflorescence indicates need for appropriate hopper management practices. The residual population on stem should be managed during the off season so as to decrease its pest emergence in cropping period.

24. Sathe et al. (2014) studied destructive mealy bugs of agriculture and medical crops from Kolhapur district. They reported that there were fifteen different species of mealy bugs in Kolhapur district infesting economically important crops. Among these *Maconellicoccus hirsutus* and *Drosicha mangiferae* were dominant over other species in the region. They also mentioned that mealy bugs’ incidence also causes dropping of flowers and fruits. Mealy bug secreted sticky substance on the leaves which facilitated the growth of sooty mould. Development of this mould arrested the photosynthetic mechanism of plants. *Drosicha mangiferae* and *Drosicho contrahens* were found to be infesting mango crop between December – March. Apart from this, they also infest other economically important fruit crops like citrus, papaya, guava, sugarcane, etc. Mealy bug was a serious threat to several agricultural crops in Kolhapur district. Hence it became essential to carry out their survey focusing on occurrence, life cycle, host plants and control measures. Both chemical and biological pest management practices should be implemented to suppress pest population.

25. Bemph et al. (2011) had reported the pesticide residue in fruits and vegetables and related health risk assessment in Kumasi Metropolis, Ghana during August 2009 to June 2010. They assessed the concentration of pesticide residues in fruits and vegetables sold in markets. Maximum farmers apply pesticide to suppress attack of pest and diseases on food crops. Continuous use of pesticides leads to residue problem. Food intake is the main exposure route to toxins as compared to other exposures like air and drinking water. They evaluated about 350 different samples of various fruits and vegetables from different markets. Residue of pesticides like Gamma-HCH, Methoxychlor, Permethrin, Cypermethrin, Fenvalerate and DDT was found in mango above maximum permissible limit. The pesticide residues not only lower the nutritive value of mango but also have adverse effect on the health of consumers. Consumers in Kumasi were exposed to high concentration of pesticides. Such intake of pesticides can lead to chronic diseases.

26. Yadav et al. (2016) had reported about geographical perspectives of mango production in India. They mentioned that in India largest share of land is under mango cultivation,
followed by China. Even though India is leading the world in terms of both area under mango cultivation and production, it lacks far behind in terms of mango productivity. Other major mango producing countries has considerable high productivity than India. Traditional management practices, old orchards, lack of techniques, irrigation facilities, fertilizers and manures application arrest the mango production. Mango has the privilege to grow throughout India. Farmers in India can replace traditional crops with mango to gain good returns. They mentioned that due to agro-climatic conditions in country, India is home for more than 1500 mango varieties, but only few are cultivated on commercial bases. Each variety has its distinctive characters such as colour, shape, size, texture and flavor. Further they mentioned that on basis of maturity period commercially important varieties are classified as early, mid and late season. Andhra Pradesh was a leading state in both area and production of mango, whereas Uttar Pradesh and Maharashtra holds second position. However, Uttar Pradesh has highest productivity in country. They further mentioned that there were several problems in mango gardening, production, processing and marketing in India. The key constraints are irregular bearing, low productivity and disease prone varieties. Apart from this low level application of tools and techniques was recorded. Mango production in India was mainly limited to traditional means, poor harvesting and crop management methods coupled by lack of processing units, transportation, storage and marketing facilities. Besides these, old orchards, small scale and marginal farmers deprived from adequate governmental support were main hurdles in mango industry. All these factors were negatively affected mango production in India, thus mango farming is not economical. Thus it was essential to eradicate all the problems to insure mango marketing profitable. If the mango productivity in India increases, mango production will be accelerated in many folds. It can be achieved by implementation of disease resistant varieties, regular bearing varieties, proper manuring, irrigation and integrated pest management practices. Further they mentioned that availability of easy accessible transportation, marketing facilities, good returns for produce, abolishment of intermediaries, poor supply chain management and technical advances in mango plantation and production was need of the situation.

27. Sharma et al. (2014) had studied biology of mango hopper *Idiscopus clypealis* (Leth) in Jammu region. The mango hopper *Idiscopus clypealis* (Leth) was most serious pest in Jammu and cause serious damage to crop. They studied complete biology of the mango hopper *Idiscopus clypealis* (Leth). They revealed that adult male and female immediately started mating when they were placed in raring jars. Soon after copulation, female started
ovipositing on the flowering shoots and leaves of mango. Single eggs were laid on each flower bud and were well deposited into the tissues with help of ovipositor. They mentioned that blunt end of eggs were noticeable superficially as the pointed once were embedded deep with the tissue. Region around the site of oviposition turned blackish brown in colour. Freshly laid eggs were smooth and creamy in colour. Eggs were about 0.85mm to 1.00mm in length and 0.25 to 0.30mm in width. Further they reported that there were five nymphal instars stages in *Idiscopus clypealis* with in period of 12-17 days. The newly hatched nymphs were voracious feeder. Simultaneously they excrete sticky secretion called as honey dew. Hopper nymphs moult five times to become adult. They mentioned that newly hatched nymphs were very delicate and white in colour which later on turned yellowish green. Head of hoppers was much bigger in size as compared to body and bulged compound eyes were present. First nymphal stage lasted for 2-3 days. In second nymphal stage nymphs were initially yellow in colour, and then turned grayish yellow. The thoracic segments were observed during this stage. Second nymphal stage extended from 2-3 days. During third instar nymph were yellow in beginning, further they turn darker in colour on lateral sides. Two black spots were marked on the vertex as well as pronotum overlaps the head region. Third nymphal instar varied from 3-4 days. At the time of fourth nymphal instar nymphs were pale yellow along with red compound eyes. Wing pads of nymphs were more enlarged and clearly differentiable. The period of this stage ranged from 3-4 days. Soon after moulting fifth instar were pale yellow in colour but changed to grey colour subsequently. Distinct dark patches were marked on the pronotum, vertex and face. This stage lasted for 2-3 days. Adult hoppers were creamy at emergence later on turned greyish brown dorsally and pale yellow ventrally after an hour. Female hoppers were slightly bigger than the male. *Idiscopus clypealis* hopper oviposits once in a year from February to March on the floral parts of the mango tree during the flowering period. Incubation period was 5-7 days and nymphal period ranged from 12-17 days. The total life cycle varied from 18-22 days.

28. Karthick *et al.* (2013) had reported about the mango pulp processing industry in Tamil Nadu and its economics. Study was carried out in Krishnagiri and Dharmapuri district of Tamil Nadu during year 2010-2011. They mentioned that mango occupies an important place among fruit crops that are grown in India particularly due to its utility. Mango is accredited as the king of tropical fruits. It is also popular in processed form. Mango is perishable fruit, therefore unavailability of adequate storage and transportation facilities significant share of mangoes were wasted every year. They mentioned that number of
mango processing firms in Tamil Nadu generated employment in the region. Krishnagiri and Dharmapuri districts in Tamil Nadu contributed largest share of mango processing in the state. Even though mango processing gains good returns it has some problems associated with it. Some of the major constrains mentioned by the entrepreneurs were frequent power cuts and fluctuation in mango prices. The processing sector was particularly labour demanding one. Hike in the wages of the labours had increased production cost. Thus maximum female labours were engaged to cut the production coast. However unavailability of labour force was another prominent hurdle faced by the processing units. Along with this inadequately supply of raw material was other constraint. Throughout the year mango fruits were available for processing only 130-150 days, rest of the period processing of other fruits and vegetables like papaya, guava and tomato was carried out. Besides this declining export and competition from the other countries were some of the other problems faced by the processors. The enhancement in the mango pulp industries would be beneficial to people in Tamil Nadu. It will generate both income and employment for people in the region. Adequate and timely supply of raw material to processing unit was essential. Government should accelerate cultivation of mango and other horticultural commodities that will provide raw material to industries.

29. Lathankumar et al. (2016) had mentioned about the intravarietal diversity of Western Ghat Mangifera indica L. ‘Kottoorkonam’ using ISSR markers from different altitudes of Thiruananthapuram district of Kerala state. They reported that portion of Kerala state coming under the Western Ghat is rich in wild varieties of mango. However these varieties are exploited from wild for various reasons. The invasion of popular horticultural varieties had marginalized the local unpopular mango varieties. Apart from this local varieties were commercially exploited for preparation of pickles and fruits. Monoculture plantation and anthropogenic activities were some of the major threats to natural varieties. The samples of M. indica L. variety Kottoorkonam were divided into two clusters. Cluster I encompassed two groups of accessions from southern part of the Thiruananthapuram which was the originating location of this variety, Kottoor. Cluster II included accessions from northern part of Thiruananthapuram. The relationship between various Kottoorkonam accessions was resolved by the ISSR marker. The findings revealed that the relation between the genetic markers and Kottoorkonam accessions. Relatively low dissimilar values revealed that there was less gene diversity in Kottoorkonam accession samples. The less polymorphism was due to unavailability of productive and uniform planting material. Although homogenous and well documented
scion was recommended for mango grafting, still some farmers use scion from their own blocks while other used scion of unknown genetic diversity. However the intracultivar heterogeneity in Kottoorkonam was vital for breeding purpose. Intracultivar polymorphism would offer opportunities for breeding and improvement within cultivars. There were very few accessions which had distinct genotype. Further they mentioned that genome of mango was allotetraploid and large. But ISSR markers were capable of individualizing accessions at Kottoorkanam. Thus ISSR markers have proved a beneficial tool in identifying heterogeneity in mango. The traditional were particularly accountable low level intravarietal polymorphism in the Kottoorkanam variety of *M. indica*.

30. Kumar *et al.* (2014) studied influence of season affecting flowering and physiological parameters of mango in Periyakulam, Tamil Nadu during year 2010 to 2012. They reported that environmental factors played important role in inducing flowering and fruiting stages in mango. Highest hermaphrodite flowers and fruit set as well as lowest male flower percentage were observed in Neelum variety. This was result of high leaf nitrogen level at flowering stage which has positive correlation with percentage of hermaphrodite flower. This in turn increases the fruit set percentage. They mentioned that vegetative growth was suppressed during the flowering and fruit setting. Perfect flowers need additional nutrients as then male flowers. Temperature during the flowering phase determines the sex of flowers, it was observed that higher temperature produced more perfect flowers. Physiological changes are essential to inhibit the vegetative growth, this in turn accelerate the flowering stage. After prevention of the vegetative growth it was observed that there was increase in the content of chlorophyll, carbohydrates and carbohydrate-nitrogen ratio.

31. Pujari *et al.* (2016) had reported about the effect of swell (CPPU) on fruit retention, fruit quality and over all yield of Alphonso mango in Dapoli for two years from 2012-13 to 2013-14. Application of swell to test mango plant was done between the ranges of 1ppm to 4 ppm whereas control was kept untreated. They reported that application of swell to Alphonso mango help in retaining the fruits at marble stage. As compared to control significant fruit retention was noted in case of treated plants. Use of swell had suppressed the ABA content and accelerated the fruit setting process. Similarly fruit dropping at harvesting stage was arrested. They mentioned that these positive effects on fruit retention may be due to improvement in nutrition status of the tree. Foliar application of CPPU, one at peanut stage and other at marble stage reduced fruit drop. They estimated that beneficial effect on fruit retention, fruit setting and decreased fruit drop may be due
to upgraded nutrition level. They revealed that prominent rise in yield was observed, application of CPPU at 3 and 4ppm proved more beneficial. Fruit chemical properties were also significantly influenced by treatment CPPU. Further they mentioned the effect of CPPU on physiological loss in weight of the fruit with increase in storage period. It may be due to decrease in moisture content of fruit or utilization of water in senescence process. The quality of fruits harvested from both treated and control plants were somewhat similar. Studies revealed that application of CPPU can increase the profit margin of the farmers.

32. Sarwar el al. (2014) had studied surveillance on population dynamics and fruits infestation of Tephritid fruit flies in mango orchards of Faisalabad during two experimental seasons that is in 2011 and 2012. They observed that Bactrocera zonata was frequently fruit fly. Infestation level of this pest was severe and reported as a dominant pest. In month of February lowest number of fruit fly were captured in trap. Peak emergence of fruit fly on mango was recorded during July than June followed by August. During April, May and in September emergence B. zonata on mango was less. However from October to March infestation was zero due to unavailability of fruits. Studies revealed that B. zonata was the prominent pest on mango cultivations. It was only fruit fly species observed on all studied fruit plants. Dominating nature of B. zonata showed that it had better polyphagy and competitive abilities than other species. B. zonata suppressed the population of other fruit fly species in competition of larvae for food in the same fruit. Furthermore it did not permitted other females to oviposit on same fruit. B. zonata was noted as a dominant and abundant pest. Peak population of fruit flies was observed in the period without fruits, vegetative flush and flowers, reflected that the flies exploited the orchards for food and shelter. Fruit fly incidence was a major concern in exporting fruits there by hampering the trade of fruits from country. Pakistan mangoes are traded to various countries but it is mandatory to fulfill the sanitary requirements proposed by respective developed countries. Fruit fly population infesting mango cultivations can be controlled by implementing appropriate biological pest management measures. Apart from this regular observation timely it is necessary to record the period and site of their appearance. Collection of this data will help in implementing the control measures to manage the pest. Peak population of pest was observed during availability of fruits on host plant causing heavy economic loss. Robert el al. (2013) had mentioned about the fruit flies population dynamics in mangoes production zone of Cote-d'Ivoire. Initially study was carried out in Yamoussoukro and afterwards in Central and Northern Cote-
d’Ivoire from June 2005 to September 2006. For the study they used four dry traps with attractants and 36 other traps with attractants and insecticide to capture the fruit flies. These traps were hung at height of 1.60 to 1.80 m in orchards using wire. The branch carrying the traps was covered with solid layer of grease to avoid the interference of ants. Several fruit fly species were recorded by them during survey. They mentioned that introduction of this pest in Cote-d’Ivoire was due to trade of fresh plants around the world. Population of Ceratitis cosyra was low due to inter specific competition between these flies and other indigenous species. B. invadens gradually adapted to the host plant as well as the climatic conditions with ecological niches. Mango crop was the favourable and preferable host of the invasive species because it was suitable for the development of the pest offspring. B. invadens became dominant and gained the title super candidate as compared to other species. Total sixteen species of fruit fly were reported from in mango cultivations of Central and Northern Cote-d’Ivoire. The invasive fruit fly species B. invadens was abundantly caught in traps. Other minor species were C. cosyra and C. bremii. The occurrence of invasive species B. invadens was noted throughout the year. It was found that it pullulates in rainy season from March to August and peak population was seen after May. But in dry season that is from September to February population level was low. February to the season of mango availability. But it was displaced by invasive B. invadens. 

33. Raju et al. (2011) determined multiclass pesticide residues in mango by liquid chromatography– tandem spectrometry in Tirupati. They reported that wide ranges of pesticides were used on mango crop to minimize the economic loss caused by pest, fungi and weeds. But when these pesticides were applied inappropriately, residue of some pesticides can remain in fruit and can cause significant threats to human health. Thus Indian exportable mangoes are regularly monitored to access the residue of 54 pesticides. Liquid chromatography – mass spectrometry was used to detect pesticide residues in mangoes. LC-MS method fulfills the criteria prescribed by legislation for sensitivity, selectivity and confident identification of pesticide residues at low level. The MRM ratio provided a key parameter during qualitative evaluation especially when matrix interference was present during multi residue analysis. The proposed method was beneficial in accessing the occurrence of pesticides residue of different chemical classes in mangoes.

34. Sathe el al. (2014) had reported that vermiwash was a good biofertilizer and tonic for mango crop, which helped to increased fruit production in many folds. Vermiwash
application accelerated the flowering percentage from 62% to 95% in indigenous mango varieties and 70% to 100% in Alphonso mango. There was notable enhancement in size, test and luster of fruit. During study period no pesticides were applied on the test plants during their flowering and fruiting stages. But no insect pest, fungus or bacteria was recorded from the test plants during study period. This raveled that vermiwash has potential to control diseases and pest infestation. Vermiwash acted as a plant tonic as it was composed of several microorganisms, actinomycetes, enzymes, hormones and multi nutrients. These characters boosted 15% vegetative and reproductive growth in fruiting trees and flowering plants subsequently increased the final crop yield from 40% to 80%. They mentioned that vermiwash also increased the diseases resistance capacity in agriculture crops. Similarly vermiwash was superior foliar spray, it prevented detachment of flower from plant and promote fruit setting. *Mangifera indica* showed improved productivity, fruit size and better test than control. Application of organic fertilizer and vermiwash is need of the day as it is a sustainable agriculture practice. Vermiwash, a liquid biofertilizer was obtained from worm’s activity like coelomic fluid and vermicasting filtrate that has greater economic value. Further they mentioned that plant growth and development was prominently governed by the favourable environment, adequate sunlight, water and availability of essential nutrients. Vermiwash provided all essential inputs to mango crop necessary for its metabolism and growth which resulted in development of size, flavor and luster. Apart from this there was growth in fruit production in both terms qualitatively as well as quantitatively.

35. Jaggaiah (2015) had studied returns on mango orchards and economic feasibility tests of mango orchard in Chittoor district of Andhra Pradesh. He reported that good returns were obtained from mango orchards from 7th year onwards. Flowering flush was initiated after rainy season in October and November. Subsequently fruit setting begin. Yields were obtained from mango orchards on commercial scale from 15th year and may last up to 40th year. During 5th year yield of mango orchard was about 1.82 tons per hectare. As the age of orchards increased, mango yield also increased up to 7.24 tons per hectare by 10th year. Study revealed that fruit production from 11th year to 20th year was improved from 7.73 tons to 15.31 tons per hectare. It was observed that per hectare mango production of orchard from 21st year reached 14.36 tons, while in 30th year production was improved to 20.16 tons. But by 40th year, mango yield declined to 15.14 tons. It was marked that gross and net returns were on increasing trend up to 30th year, but thereafter showed gradual decrease in yield after 30th year. However it was observed that, there was substantial
growth in yield from 5th year to 30th year as age of mango plants increased, but then stabilized and declined subsequently. He cited that cost and returns analysis are not the appropriate measures to evaluate the profitability from the investment from the mango orchards. In case of annual crops, returns can be obtained within a year, being a perennial crop it was not possible to evaluate the mango crop in similar manner. Studies revealed that investment on mango cultivations was overall profitable. He further mentioned that most of the farmers were large scale mango producers but their involvement in farm operations was comparatively low. Farmers failed to adopt essential farm operations like orchard and pest management. He quoted that as farmers were unaware of the significance of applying recommended doses of manure and fertilizers. Therefore external agencies should take initiative in educating farmers. Farmers should exercise the recommended package practices. Besides this government should establish cold storage units to minimize the post-harvest losses.

36. Gundappa el al. (2016) had studied prediction of mango thrips using thermal indices during two seasons in 2013 and 2014 in Lucknow, Uttar Pradesh. They mentioned that, in recent years thrips emerged as a serious insect pest on mango cultivations and pose considerable yield loss. Peak infestation of thrips was reported during flowering and fruit developmental stages. Due to increase in temperature, emergence of thrips was delayed by one week during 2014 as compared to 2013. But later, hike in temperature accelerated the growth and development of pest. They also mentioned that vegetative and reproductive growth of mango tree was influenced by high temperature variations. The peak population of thrips was well synchronized with the availability of flowers, fruits and tender plant parts. Studies revealed that thrips infestation was found to be negatively correlated with maximum and minimum relative humidity in 2013. Similarly pest population had negatively correlated with low temperature, minimum and maximum relative humidity as well as evaporation. Positive correlation was marked between thrips population and mango thermal indices. Thermal indices was an important factor in prediction of thrips population. Thrips population was adversely affected by the weather variables like rainfall, temperature, relative humidity and wind. The thermal indices varied throughout the mango season and thereby influencing the pest population. For effective use of pesticide to control pest attack prediction model was developed with help of thermal indices. Studies revealed that application of thermal indices in study will proved effective in predicting the thrips population. This model will help famers for better preparedness to arrest thrips infestation in advance.
37. Joshi et al. (2012) had studied effect of some meteorological factors on seasonal abundance of *Idioscopus nitidulus* (Walker) in mango orchards of Haridwar. They reported that no infestation of hopper was noted in January on mango trees. At that period average temperature was about 14.5°C. Similarly relative humidity and rainfall was also very low. In month of February hopper population gradually started to appear on the mango tree. Rise in hopper population was coordinated with the flowering flush, because breeding of hoppers takes place on flowers of mango tree. Hopper population was highest in month of May and June. But July onwards hopper population started declining. Studies revealed that temperature and hopper population was positively correlated.

38. Sarode et al. (2016) had reported the seasonal incidence and biorational management of mango hopper, *Amritodus atkinsoni* (Leth), in Kolhapur from September 2014 to January 2015. They stated that hopper infestation was a major limiting factor in mango production. Hoppers adversely affected the productivity and fruit quality. Farmers mostly rely on insecticides to arrest hopper population. Mango hopper was a ponderable menace for mango cultivation and pose irreversible damage to crop. They mentioned that incidence of hopper was noticed from 36 meteorological week which gradually increased from 37 to 39 meteorological week. The peak incidence of hopper had been found to on 44th meteorological week. Temperature was positively correlated with incidence of hopper while, relative humidity was negatively correlated. They also mentioned that pesticides such as imidacloprid 17.8SL @ 0.004%, lambda cyhalothrin 5 EC @ 0.004%, quinolphos 25@ EC 0.05% and spinosad 45 SC@ 0.02% were helpful in suppressing hopper infestation. While pesticides like monocrotophos, thiamethoxam, difenthiuron and acephate were moderately effective in suppressing hopper population. Further they mentioned that biopesticides like *Metarhizium* anisoplae, *Beauveria bassiana* and *Verticillium lecanii* were also equally operative in controlling the hopper incidence. They cited that two sprays of thiamethoxam 25WG, one before blooming stage and other at blooming stage drastically reduced the hopper population.

39. Kumar et al. (2009) studied the population dynamics of mealy bug, *Dorsicha mangiferae* Green in Jhansi, Uttar Pradesh during year 2007-08. They reported that adult stage of mealy bug was found in the midsummer period from April to June. During this period mature females were wingless and large in size, whereas males were found to be winged with single pair of wings and delicate with reddish coloured body. Male adults flew actively to fertilize the females. Males have shorter life span nearly about a month which
is less than that of females. The fertilized females crawl down along tree trunk and laid eggs at depth of about 2-6 inches in ground. They also mentioned that oviposition was noted generally around the base of trunk. After mating, male mealy bugs die, whereas death of females takes place after oviposition. The hatchings were significantly influenced by the abiotic factors like temperature and moisture content in soil. It was observed that hatchings start to emerge from November to May. They reported that late monsoon and winter rains delayed the hatchings. Immediately after emergence, nymphs start crawling in search of food. They start moving upward on trees trunks. After reaching the plant, nymphs congregate and start to suck plant sap. Nymphs mould three times to become adult and last for about three months or more than that.

40. Solangi *et al.* (2014) had mentioned the population trend and varietal preference of mango mealy bug, *D. mangifera* (Green) in Kamaro of Sindhu province during December 2011 to March 2012. They selected Sindhri, Sorali, Sonaro, Chaunsa, Fajri, Began pali and Langra mango varieties for study. They reported that *Dorsicha mangifera* was is a serious pest on mango crop. *D. mangifera* has wide range of host plant; it includes 62 host plants under 51 genera belonging to 28 families. It infests fruit crop, forest trees, ornamental plants and weeds. Nymphs and adults of mealy bug damage the mango crop by sucking the sap from inflorescence, tender plant parts and fruits. Subsequently the infested inflorescences wrinkle and dried up. Mealy bugs also secreted honey dew on leaves, fruits and shoots; consequently arresting the photosynthetic activity of plant. They also mentioned that in case of severe infestation, fruit setting was adversely affected. They reported that first instar population of mealy bug nymphs emerged from soil in first week of December and then started crawling on the tree trunk in upward direction. The maximum upward movement of mealy bug was recorded in later weeks of December and continued up to first week of January. After crawling on trunk mealy bug population was observed on the mango plant shoots. Their movement was scattered and were noticed on various positions of shoots like bottom, mid and tops shoots. They further cited that top branches had significantly larger share of population as compared to middle branches. However, the bottom branches had low population concentrated on them. They revealed that mealy bug infested all selected mango varieties. They quoted that though mealy bug was mainly found infesting mango crop, it was also found attacking other fruit trees like papaya, citrus, plum and peach. Not a single mango variety from selected varieties was marked as completely free from mango mealy bug infestation. Mango varieties like Saroli, Sindhri and Chaunsia were found to be severely infested.
41. Debnath et al. (2015) had studied non-linear and parametric model for the incidence of mango hopper *Amritodus atkinsoni* Leth. in Madhya Pradesh from December 2009 to April 2010. They used seven non-linear distribution models such as logistic, gamma, exponential, normal, beta, Weibull and uniform for estimating mango hopper population. The goodness of fit test helped to identify the best distribution models which fit into test of study on mango hopper population. Six different parametric models were subjected to study the incidence of mango hopper. They revealed that cubic parametric model was best fitted to study the incidence of hopper on sites like tree trunk, secondary branch, tertiary branch, leaves and inflorescence. On other hand compound, growth and exponential models were suited for primary branches. They mentioned that selection of appropriate model for handling data is essential to ensure efficient statistical inference. Interpretation of pest incidence data can prove beneficial for farmers to plan their pest management practices accordingly. They also mentioned that among the seven nonlinear fitted models uniform distribution was found to be best suited for the study of hopper incidence followed by Weibull distribution. Whereas, in case of parametric models, cubic fitting model were found to be best in all cases except in primary branches.

42. Padhi et al. (2015) had studied supply chain management of mango in South Odisha. They mentioned that farmers do not have sufficient knowledge of mango marketing. Also, mango fruits are highly perishable and seasonally available thus farmers avoid marketing and related risk of price fluctuation. Different types of marketing system such as online marketing, farmer owned producer company; corporate farming and cooperative marketing system are prevailing in market. They further mentioned that few steps were taken by Government to improve business of mango. Mahamango co-operative society, Mangrow and Pradhan institution were few initiatives taken by Government to accelerate the mango industry. They also gave some suggestions to improve the present situation of mango business. Appropriate steps should be taken to trade mangoes online from the mango growing states. Proper care should be taken in post-harvest handling so as to avoid the loss of mango fruit and increase the quality of produce in market. Fruits should be graded on the basis of quality, weight, size and defective one should be discarded. Packing centers should be started for proving mango packing facility for farmers every year. Local youth should be motivated to be engaged themselves in professions related to mango industry like preparing mango products like mango pulp, pickle and other items. Similarly linkages between the farmers and processors should be strength to increase the trade of mango fruits. Farmers should be provided with basic facilities like pre-cooling,
cold storage, package house, grading packing lines etc. Government should specially focus on the enhancement of supply chain management. Like Tamil Nadu, Odisha farmers should have associations to provide them with technical, economic and social support.

43. Bhattacharyya (2014) had reviewed biology and symptoms of attack of Mango red banded caterpillar *Autocharis albizonalis* (Hampson) in West Bengal. He reported that previously red banded caterpillar (fruit borer) was a minor pest on mango cultivation but recently it has gained a status of a major pest. He also cited that pest was predominant on mango crop and emerged as a serious pest. The pest infestation caused about 10%-25% fruit damaged right from pin head stage to maturity. Period from April- May was congenial for fruit borer infestation as the fruits of medium size were available for pest to attack. Peak infestation was recorded during second fortnight of April. However the damage reduced later on as the mature larvae pupated. The most important factor for the emergence of fruit borer was availability of fruits. He further quoted that in absence of fruits, pest failed to reproduce. Female moths of fruit borer lay eggs on fruit or at the fruit apex. The larvae of *Autocharis albizonalis* (Hampson) completed five larval instars stages and then pupated inside fruit or in soil. The larvae were distinct in appearance with alternate white and brown colour bands along with a black collar on the first segment. The head was brown or black in colour. During pre-pupal stage the larvae shows minimum mobility and turned blue to green. The adult male moth was tubular blunt with black brown hair. The females were smaller than the males. He further stated that fecund female preferred to oviposit on fruit which were devoid from complete exposure to sunlight. Female oviposit at the base of the peduncle covered with dried leaves. Eggs were oval, waxy white and were laid in cluster on the fruit apex. The incubation period ranged from 2-3 days. Generally hatching occurred after 3 days and soon after hatching larvae bore into tender fruits through distal end. Borer fed on the mango in all developmental stages. First and second instar larvae fed just below the skin surface boring towards the seed. Subsequent instar fed on the inner content of the fruits including the seed. This leads to formation of minute holes at typical small hole at the distal end of the fruit. Progressively the hole enlarges and fecal matter gets accumulated. Larvae preferred seed as a source of food than inner content. Then after, secondary infestation was noted due to incidence of bacteria and fungus causing fruit rotting, consequently fruit feel from tree prematurely. He cited that fully grown larva pupates either inside fruits or outside in soil or cracks, crevices or even sometimes in the branches. He also mentioned that fruits
of all size were preferably attacked by the fruit borer but the marble size fruits were most preferred site for oviposition. He quoted that attack of fruit borer occurred as early as 45 to 55 days after flowering flush and continued up to fruit maturity. However maximum damaged was recorded when fruits were of medium size that is from 75 to 85 days after flower induction.

44. Istianto el al. (2015) had reported the effect of Citronelle essential oil on controlling the attack mango red banded caterpillar, *Noorda albizonalis* Hampson in Pasurum from July to December 2011. They reported that presence of pest and disease was the main reason behind low yield and fruit borer was a serious pest limiting mango production. They mentioned that citronella essential oil is a natural ingredients in lemongrass can be used against the fruit borer. Citronella essential oil is bactericidal, fungicidal and pest repellent. For controlling fruit borer population four different concentration of citronella oil viz. 2cc/l, 4cc/l, 6cc/l and 0cc/l were applied. Spraying began when fruits were of pea size up and continued up to harvesting stage. They revealed that application citronella essential oil was successful in protecting mango crop against pest attack. Fruit borer attacked mango fruit from young phase to ripen stage. Sever attack was observed at beginning of young fruits and continued up to development phase until fruits get mature. Citronella essential oil was highly effective in arresting attack of mango fruit borer. Treatment of 6cc/l was more effective in controlling pest population, whereas treatments of 2cc/ l and 4cc/ l were ineffective to suppress the pest attack. They further mentioned that citronella essential oil has some negative properties against pest that help in controlling pest population. Spray citronella oil has insect repellent effect that makes them undesirable to access the crop. The distinct aroma of citronella essential oil causes unwillingness in pest to attack fruits. Even though citronella essential oil is not as strong as synthetic chemical effect but has considerable detrimental effects on some insect pest. Apart from these, inhibitory properties (Antifeedant) makes pest unwilling to infest plant. Consequently pest remains away from plant without making any harm. Along with this it also possesses ovicidal properties that reduce the rate of hatched eggs. Among these four properties it was found that repellent activity was dominant in suppressing the pest population.

45. Durrani et al. (2012) had reported influence of storage temperature on physicochemical sensory and nutritional properties of chemically preserved mango pulp. They studied inhibitory effect of potassium- metabisulphate, sodium benzoate and potassium sorbate at room temperature as well as at refrigerated conditions. They mentioned that instead of
using only potassium-metabisulphate; combination of potassium sorbate and potassium-metabisulphate can be used in mango pulp. Potassium-metabisulphate, when used in recommended level it acts as good antibacterial and antioxidant that help to increasing shelf life of mango pulp at ambient room temperature and refrigerated conditions. They also mentioned that sodium bisulphate had highest effective diffusivity in mango slices which was followed by sodium chloride and potassium sorbate. However stabilization stage of mango was achieved due to potassium sorbate. They further mentioned that refrigeration proved beneficial in stabilization the mango pulp with application of recommended doses chemical preservatives.

46. Makhmale et al. (2015) had studied flowering physiology of mango. They reported that mango trees are polygamous, bearing both perfect and hermaphrodite flowers. Both types of flowers were reported on same inflorescence. The mango tree bears terminal inflorescence. Number of flowers per panicle ranged from 1000 to 6000 depending on the mango variety. The size of flower ranged from 5-10 mm. Irrespective to its genotype flowering is significantly influenced by the ecological factors. Initially there is emergence of vegetative flush on mango. After maturity of vegetative flush, flower initiation takes place. After rainy season there is dry period and then winter season begins. These climatic conditions trigger flowering stage in mango. Generally three flowering flushes happen in a season. They cited that flowering flush in mango is an important physiological event that initiate fruit production. Temperature is one of the vital environmental factors influencing flowering in mango. Very high and low temperature is harmful for pollen grains. In extreme climatic conditions trees fail to flower. Further they mentioned that information regarding floral bud differentiation is necessary so that farmers can plan further crop management practices accordingly.

47. Anonymous (2015) had studied population dynamics of leaf webber in mango. Seasonal incidence of leaf webber on mango variety Banganpalli was studied at Sangareddy, Telangana during 2006-2011. It was reported that previously mango leaf webber (Orthaga eudrusalis) Walker was a minor pest on mango crop. But since last five years it had become a serious limiting factor in Telangana and Andhra Pradesh. The extent of damage caused by pest was about 35%. Pest activity initiated in the month of June, remained active up to December, and then sudden decline in pest population was observed. This pest completed several over lapping generations from June to December and old leaves were mainly preferred by pest as breeding site. The most active period of infestation was noted from September to December. Correlation coefficient indicated that
maximum temperature, forenoon relative humidity and afternoon relativity humidity had no direct influence on pest population. But, maximum temperature, forenoon relative humidity and afternoon relativity humidity had significant correlation with pest. Apart from these, remaining factors may include mango variety, tree canopy, natural enemy, leaf age and sunlight. It is also mentioned that abiotic factors alone were not sufficient to predict the incidence of leaf webber on mango crop. It is also essential to understanding leaf webber population across the varieties for better management of pest.

48. Gundappa et al. (2016) had studied seasonal incidence and weather based forecasting model for mango leaf webber *Orthaga eudrusalis* Walker under subtropical conditions in Lucknow for two consecutive years 2013 and 2014. They reported that mango leaf webber had become a major limiting factor in mango production in North India. Wide variations in incidence pattern of mango leaf webber were observed during the study period. The variation in incidence pattern was mainly attributed due to microclimatic conditions existing within orchards. Peak population was noted during 37th meteorological week (MW) that is in 2013 where as in consecutive year it was notes in 38th MW. Pest infestation was higher in 2013 as compared to 2014. This variation was attributed due to higher rainfall received during peak incidence of leaf webber during 2013 as compared to 2014. This revealed that humid and wet conditions accelerated pest population. While higher evaporation coupled by wind speed, low rainfall and maximum temperature resulting in dry conditions arrested the pest population. Mango leaf webber was negatively correlated with minimum temperature, wind speed and positively correlated with minimum relative humidity. Minimum temperature and wind speed played crucial role in population build up and survival of leaf webber population. They further mentioned that these data can be beneficial for farmers to predict incidence of pest and accordingly plan their management practices.

49. Affandi *et al.* (2013) had studied age structure and sex ratio of thrips *Scirtothrips dorsalis* Hood association with mango agroecosystem in East Java, Indonesia from May to June 2013. They reported that *S. dorsalis* attacked on meristem and other young plant parts. They observed that most of the weeds associated with mango orchards possessed soft meristem tissues. Adult stage of *S. dorsalis* was found to be associated with weeds instead of mango leaves. The presence of weeds with soft tissue and flower in all season supply essential nutrients to pest. Pollen grains were a prominent source of protein for thrips to produce eggs. As adult thrips females require protein source to mature their ovaries and eggs, thus protein was an important component of insect diet. They cited that thrips can
consume pollens grains of wide range host plants including grasses that grow in orchard. Adult also consumed cell sap if pollen grains availability was limited. Second instar of *S. dorsalis* was found infesting on all available host plants such weeds and mango. It revealed that, this stage had no special nutrient requirement for its nourishment and adaption capacity of pest was relatively high. They also quoted that flowers and leaves were preferred by all stages and sexes of *S. dorsalis*. It indicated that *S. dorsalis* was capable of adapting to all growth stages and utilized available resources such as food, refuge and breeding habitat for prolong sustainability. They further mentioned that *S. dorsalis* had no selective host plants it fed no number of plants available in region. Population dynamics, age structure and sex ratio of insect were governed by availability of food, refuge and breeding habitat, along with abiotic factors like temperature, relative humidity and rainfall. They also stated that continuous sea wind during day coupled with land wind during night, favoured pest dispersion. Sex ratio of *S. dorsalis* was almost equal at all life stages. However, sex ratio was highly influenced by internal and external environmental factors. They cited that draughty weather affected sex ratio of thrips, which resulted in more male population. The association of *S. dorsalis* with weeds must be considered in order to control the pest population. Hence weed management became an essential operation to arrest pest population. Twenty seven weeds were found to be associated with thrips and mango crop and border. The most preferred weed by *S. dorsalis* was *Arachus hypogaea* L.

50. Gundappa *et al.* (2016) studied seasonal dynamics of mango hoppers and their management under subtropics in Lucknow. They reported emergence of hopper population coincided with emergence of inflorescence on mango tree and hoppers migrated from trunk to upper canopy region. They observed that hoppers hide on trunk during off seasons. The emergence of panicle was critical period where hopper severely attacked the mango crop. However hopper population hide in fissure on plants and appeared when tender leaves and inflorescence were available for feeding. Hoppers had two broods in a year, initially in the February to April and then in June to August. Population of *Amritodus atkinsoni* accelerated with flowering flush in month of January to June and adults’ population was seen from March onwards. Later, July onwards population gradually decreased. Hopper population was significantly positively correlated with temperature and sunshine hours, whereas significantly negatively correlated with minimum and maximum temperature. Farmers unmethodically used insecticides for suppressing pest population. That subsequently led to problems of like insecticide.
residue, resurgence and residue. In order gain to more profit; sustainable and need based interventions were necessary to control pest. They also mentioned that to manage hopper population below economic injury level farmers should spray imidacloprid @ 3 ml per liter when hopper population was more than 5 per panicle during emergence of inflorescence. Second spray should be taken after fruit setting with insecticide thiamethoxam @ 3 g per liter. They suggested farmers, not to take any spray when crop was in full bloom stage as it may affect the pollinator population.

51. Chakraborty et al. (2015) studied incidence of mango mealy bug, *Droschia mangiferae* in the agro-climatic conditions of the upper gangetic plain of West Bengal during four consecutive summer months of 2011-2014. They reported that *D. mangiferae* was one of the notorious and destructive pest on mango crop. The pest incidences begins in December, gradually gained momentum and attain peak population by middle of April. Minimum temperature and temperature gradient had significantly positive relation with incidence of pest. However, heavy rainfall for short period had significant negative effect on pest population. They mention that temperature fluctuation severely affected abundance and mortality of mealy bug. The active period of *D. mangiferae* was from December to May. *D. mangiferae* lays eggs in soil in month of April. Incubation period of eggs is up to December- January. First instar nymphs was noticed from December to February and second instar during February to mid of March. Third instar was noted from March to April and then they became adult. They cited that occurrence of mealy bug on mango plant started from December and continued up to May. Peak infestation was noted during first week of April and lowest was observed at end of March. They revealed that pest starts to gain momentum from March to April and then subsides by May.

52. Singh *et al.* (2013) studied factors influencing the incidence of mango leaf webber, *Orthaga euadrusalis* on mango and their management in Entkhedi, Bhopal. They reported that mango leaf webber attack wide range of varieties that causes considerable damage before mango cropping season. Management of mango leaf webber was complicated due to large size of mango tree and micro-ecosystem of mango orchard in which the pest breed in active period and shelter in same orchard during off season. The activity of pest was initiated in month of June and remains active up to December. Beyond that, sudden decline in population was observed and no further infestation was noted on mango crop. Mango leaf webber completed several lapping generation from June to December. Pest was found to be most active from September to December. They mentioned that weather factors like temperature, rainfall and related humidity had no significant impact on pest
activities. They further mentioned that mango varieties namely Chinnarsam, Bombay Green, Malda, Piddarasm, Sindhri and Alpfamjo were least susceptible to pest attack. On other hand varieties like Totapuri, Safeda, Hathijhool, Karela, Local collection, Bombay Yellow, Mallika and Lalpari were also less infested. While, Gulab khas, Swarn Rekha, Malgoba, Dasher, Hapus and Fajali were moderately infested. However Langrah, Temuria, Dahiyar and Mango Glass were varieties were severely infested. They also mentioned that most susceptible cultivars were Dasher, Fajali and Temuria. They observed that tree canopy was an important factor in determining pest infestation level rather than the mango variety. All chemical treatments were significantly efficient in controlling the pest population. The most effective treatments for pest management were Diflubenzuron 0.01%, Trizophos 0.006%, Chorpyriphos 0.04% and Indoxacarb 0.01%. Besides these, mechanical removal and spot treatment with Imidacloprid was also effective in suppressing pest population.

53. Shirin et al. (2013) studied fruit characteristics of some locally important mango cultivars at Chapai Nawadganj District, Bangladesh from 2008 to 2011 fruiting seasons. They selected seven locally cultivated important mango varieties namely Alam shai, Champa, Danadar, Hayati, Lygnee, Mirabhog and Shantu. They studied quantitative and qualitative characters to evaluate the variation in these mango cultivars. They reported that large fruit size was found in Alam shai and Hayanti whereas Champa registered small size fruit. However cultivars like Danadar, Lygnee, Mirabhog and Shantu produced medium size mangoes. They cited that fruits of Alam shai were oblong, Champa had oblong elliptic shape, Danadar and Mirabhog exhibited oblong oblique shape, Hayati fruits were roundish, Lygnee were ovate and Shantu were oblong oval. They observed oblong fruit shape in most of the cultivars. They found that glossy skin in Alma shahi and Lugnee whereas other five cultivars had non glossy skin. The skin colour of fruit was marked as an important factor as it attracted consumers. Alam shai, Champa, Hayati, Lygnee and Mirabhog had green yellow skin while Danadar and Shantu had green skin. It was observed that these varieties exhibited variety in pulp colour like other traits. Light yellow pulp colour was recorded in Champa and Lugnee. Yellow pulp colour was marked in Shantu whereas Mirabhag registered light orange pulp. Cultivars like Alam shai, Danadar and Hayati registered deep yellow pulp colour. Variations were also noted in fruit texture from firm, moderate to soft. Firm texture fruits were marked in Alam shai, Lygnee while soft texture was noticed in Champa, Danadar and Hayati. Whereas moderate texture was recorded by Mirabhog and Shantu. They also mentioned that taste of fruit was found to be
excellent in Alam shai, Champa, Danadar, Lygnee, Mirabhog, good in case of Shantu and fair in Hayati. Mature fruits of Alam shai, Champa, Mirabhog possessed low fiber content while Danadar, Hayati, Lygnee and Shantu had medium fiber content. They further cited that among the seven studied varieties Shantu and Alam shai were late season varieties. They recorded maximum fruit productivity in Champa, Danadar, Hayati and Shantu whereas medium in Lygnee and low in Mirabhog and Alam shai. The longest fruit was obtained from Alam shai and shortest was recorded from Champa. Considering overall quantitative and qualitative characteristics Alam shai, Danadar Mirabhog and Shantu were superior over other varieties with respect to fruit weight, skin type, pulp colour, flavor, texture and fiber, taste and shelf life. Champa and Lygnee had low fruit weight but can be considered for their fruit taste.

54. Razig (2014) carried out survey for identification and incidence evaluation of dominant pests on mangoes in some parts of Southern Sinnar State in Sudan during October to December 2009. He reported that changing climatic and environmental conditions led to spread of insect and plant disease. Poor cultural pest management practices led to low yield and productivity in many potential states of Sudan. Mango crop in Sudan was susceptible to numerous insect pests including mango scales. Pest feed on plant sap that causes loss of tree vigor and develop spots on foliage due to toxins present in saliva of scale. Pest infestation also led to deformation of infested plant parts, loss of leaves and even death of plant. He mentioned that spread of Cockerelli scale was mainly due to introduction of infested plant material. Pest generally spread through potted plants, cut flowers and leaves. Mainly leaves were damaged by the pest by desaping them and finally turning them yellow. In case of severe infestation leaves die. He also mentioned about attack of termites on plants. Termites usually attack the dry plant parts above soil surface then gradually go up along the stem. Infestation slowly interfere the water and food transmission and weaken the stem. Pest completely destructed the young plants. He further mentioned that all surveyed trees were free from termite infestation. Mango scale infestation was not a major constrain in Southern Sinnar State. But there are possibilities to increase infestation level as the plantations get mature pest can cause considerable loss to mango crop. Regular and acute monitoring of leaves and twigs should be done to trace the pest infestation level on crop. To check a living scales use a pin to remove the cover and prick the scale. If body fluid is released, the pest is alive. In case of sever infestation appropriate pest control measures should be implemented.
55. Patel *et al.* (2013) studied fluctuation of fruit fly oriented damage in mango in relation to major abiotic factor in Navsari (Gujarat) during 2009-2011. They reported that besides mango hopper, mango crop was severely damaged by fruit flies. The incidence of fruit fly not only reduces yield and quality of fruit but is also responsible for considerable economic loss. The highest rate of incidence was observed on mid-May to June which coincided with ripening cum harvesting period of mango crop. This indicated selective performance of pest to appropriate crop stage. When fruits were physiologically mature female oviposit on fruit by pricking fruit surface. Subsequently emerging maggots entered inside fruit pulp and deteriorated fruit quality making fruits unfit for consumption. Fruit fly avoided oviposition prior to fruit ripening stage as fruit surface was too hard to oviposit. They reported that population of fruit fly in south Gujarat remained considerable higher from March to July that was coinciding with mango fruiting season. Population of fruit fly started gaining momentum from March and was highest in April. Further in June population was maximum. They further reported that maximum activity of fruit fly was synchronized with the fruiting and harvesting period of mango. Fruit fly adults were trapped throughout the year but their high population was observed during March to June then after reached peak in May and subsequently gradually declined. Fruit fly infestation showed positive correlation with maximum temperature, relative humidity, wind velocity and evaporation.

56. Kumar *et al.* (2016) studied role of insects in pollination of mango tree. They reported that role insect was to maintain nutrient cycles, soil regeneration and protection, pollination of phanerogamic plants as well as natural regulation of pests. Mango is largely anemophilous plant but morphologically or physiologically it does not show any adoptions for wind pollination. Mango flowers produces nectar to attract insect, this indicated entomophilous pollination of mango trees. They observed that mango flowers were visited by numerous insects of orders namely Diptera, Hymenoptera, Lepidoptera and Coleoptera. Pollen grains had been observed adhering to bodies of many insect species visiting flowers. Studies revealed that insects belonging to order Diptera and Hymenoptera play major role in pollinating mango trees. They also mentioned that honey bee were chief pollinators for mango. Dipteran species were good pollinators for more than 550 species of flowering plants. Fruit trees including mango were dependent on insects to carry out their pollination. The major pollinating insects recorded on mango from order Diptera were *Meliopona species*, *Syrphus species* and *Musca domestica*. They also cited that house fly was not a good pollinating agent. Insects belonging to families
Syrphidae, Bombyliidae, Tachinidae also visited flowers frequently. Flowers flies were responsible for pollinating about 80% of total plant species. The species like *Eristali stenax* or *Helophilus* were some insect species that were responsible for pollinating pollen grains at considerable long distance. Honey bee was one of the major pollinator in mango orchard. *Chrysomya megacephala, Chrysomya pinguis* and *Musca domestica* were considered dominant species due to their frequent appearance. A special study was made in orchard to record insect pest on mango orchards and study revealed that 39 species from 23 families and 5 orders were reported. Most of observed pollinators belonged to Diptera and hymenoptera orders.

57. Ugese *et al.* (2012) studied mango production and production constrains in Gboko Local Government Area of Benue State. They reported that majority of farmers involved in mango production fell within age range of 41-50 years followed by age group of 51-60 years. The age groups with minimum participation were between 21-30 years and those over 60 years old. In agriculture production age was considered as an important factor especially where manual labors were involved. It was observed that only 2% of age class 21-30 was involved in fruit production which means that this age group was least involved in agriculture and busy in pursuing formal education. They observed that there was strong gender disparity in mango production. Majority of farmers, near about 90% were male while only 10% were female. Among these females majority of females were widow who were actually involved in mango production after death of their husband. They mentioned that most of the females were engaged in retail marketing of mangoes. However women were more engaged in practices like vegetable production. It depicted that women played a significant role as an enterprise in economic life of families. They also mentioned that majority of trees in study area were between 21-30 year while few trees where above 50 years. It revealed that mango production in study area was on small scale. It was found that farmers did not paid significant attention in spacing of mango trees. However tree spacing is one of the major considerations in mango production. They further mentioned that Julie, Peter and Hindi were most preferred mango varieties by farmers. They also evaluated mango fruit production practices of farmers. They observed that majority of farmers (61.9%) did not applied fertilizers to their farms, 36% of farmers applied irregular fertilizer while only 6% applied regular fertilizers to their farm. Among farmers who applied fertilizer majority of farmers used inorganic fertilizers and rest preferred organic fertilizer. Most of the famer applied fertilizers in ring form within drip margin, followed by farmers who applied at margin. Rest of the farmers applied the
fertilizers outside the margin. Yearly application of fertilizers was essential to compensate uptake of nutrients by tree. At least every year N, P, K should be progressively added from 6th year of tree. They further mentioned that organic matter and compost particularly released nutrient slowly over a period of time and improved soil moisture retention capacity. They recorded that no farmer watered mango trees even in dry period. Most of the farmers about 86% prune their trees as per need while remaining 14% farmers did it regularly. Pruning tree was essential as it increases the aeration, simplifies farm operations and increases the production. They also mentioned that majority of the farmers stated that they harvested their fruits in such a way that it did not fell on ground. Few the farmers were not concerned whether fruit fell on the ground, while remaining did not take any efforts to prevent fruits falling on the ground. Most of the farmers harvested fruits when they were partially ripe or unripe fruits as per their strategy to prevent fruit spoilage. Generally mango fruits were harvested at unripe or partially ripe form as this stage was better for transportation and safeguarded from quick spoilage. Their studied revealed that mango production was profitable. Farmers received greater source of information for improving their yield from extension agents and radio. Whereas newspaper and bulletin did not play any significant role in adding to their knowledge. The major limiting factor in mango production was pest incidence and high perishability of mango. Other constrains were inadequate farm labors, low price and poor yield. They observed that most of the famers failed to apply pesticides to control pest attack while some used pesticides to control the pest population.

58. Mouly et al. (2017) evaluated weather based forecasting models for prediction of leafhopper population *Idioscopus nitidulus* Walker in mango orchard of Hesaraghatta, Bangalore during 3rd week of July 2013 to 4th week of March 2015. They reported that in organic mango orchard the population of *I. nitidulus* had significant positive correlation with maximum temperature and significant negative correlation with relative humidity. While relative humidity had negative effect on hopper population. They developed prediction model for both temperature and humidity to forecast the occurrence of leafhopper on vegetative and flowering phases. They mentioned that maximum temperature as an independent variable that can be used to predict hopper accurately. It was found that there was no significant difference between observed value and predicted value. They also mentioned that linear model for maximum temperature can be considered as an optimum model to predict hopper population. They further mentioned that higher temperature seemed to promote hopper population and increasing relative
humidity indicated decline in pest population. Therefore it was observed that hoppers were well adapted to drier weather which was the situation at flowering and fruiting phase of mango during summer. Among two variables temperature and relative humidity, temperature was a critical factor. They reported that even though relative humidity was high and temperature goes up hopper population showed increasing trend, which was usually observed on coastal belts. Relative humidity was another important factor which was valid in the plains and non-coastal areas. They further stated that *I. nitidulus* was a major limiting factor in mango flower survival and fruit setting. Pest has two breeding phases, one during flowering and other in vegetative phase. If hopper occurrence can be predicted at vegetative stage and if managed in same period will prevent pest establishment in flowering period. Thus temperature and humidity monitoring can help in keeping watch on hopper population. In case of organic orchards sprays of azadirachtin was only means to check hopper attack which work only at low to medium population level. Therefore such studies were essential in generating timely organic interventions for management of *I. nitidulus* population. These data will form base line for the integrated pest management strategies for timely interference and management of mango hopper.

59. Kumar *et al.* (2014) studied population dynamics of mango hopper *Amritodus atkinsoni* (Leth) in Jhansi, Uttar Pradesh from March 2008 to February 2009. They reported that population of hopper was higher in early morning but gradually decreased at day time. Then again population increased at the time of sunset. This raveled that higher temperature of mid-day directs hopper to shelter under barks or under bushes. They also cited that hopper preferred to house under old leaves than the younger once. They mentioned that hopper population was abundant throughout the year. They recorded that hopper incidence was more in old orchards as compared to new orchards.

60. Varshney (2013) studied species composition and relative abundance of *Idioscopus clypealis* and *Amritodus atkinsoni* in Western Uttar Pradesh from April 2004 to March 2006. He reported that Uttar Pradesh is the largest mango producing state in India, where about 5,38,383 acres of land is under mango cultivation. In proportion to area under cultivation; productivity of mango was very low. He mentioned that one of the key factors limiting productivity was insect pest infestation. Among the mango insect pest, mango hopper were noted as most serious and widespread pest throughout the country. During study period he noted two species of mango hopper in Western Uttar Pradesh namely *Idioscopus clypealis* and *Amritodus atkinsoni*. He stated that in all study areas, population of *Idioscopus clypealis* showed increasing trend from February. The peak
population of the mango leafhopper coincided with pea size of fruit. He observed that adults of *Idioscopus clypealis* occurred in large number during month of May but their number declined from July to October. On other hand *Amritodus atkinsoni* population increased from March and was highest in May. After May *Amritodus atkinsoni* population started declining and second peak was marked in the August. After that population showed declined by the end of December, then after hoppers disappeared gradually. The relative abundance of two hopper species revealed that *Idioscopus clypealis* was abundant in all four selected study area for six months from February to July and population of *Amritodus atkinsoni* was rich in next five months from August to December. In January no mango leafhopper was noticed on mango tree.

61. Palanivel *et al.* (20015) studied cultivation and marketing of mangoes in Krishnagiri District of Tamil Nadu during 2003-2004 to 2013-14. They reported that Andhra Pradesh, Uttar Pradesh, Karnataka, Bihar, Gujarat and Tamil Nadu were mango producing states in India. In Tamil Nadu, Krishnagiri was major mango producing district and majority of mango variety produced there was Totapuri (Bangolara). Along with this other mango varieties like Alphonso, Banganapalli, Senthura, Malgova and Neelum were also cultivated and consumed in the district. Many people in Krishnagiri district were engaged in mango cultivation and related operations. Farmers sell their mangoes to local trader, commission agents, juice factory and direct consumers. The price of mango was based on market situation and demand. Majority of the mangoes were consumed by mango pulp industry. They also mentioned that Totapuri (Bangolara) mangoes were maximum produced and sold from Krishnagiri district as compared to other mango varieties. Government took some vital steps for marketing of mangoes worldwide through on line spot trading therefore farmers gained good returns. Farmers got fair price for their produce rather than selling their produce locally. They concluded that farmers in Krishnagiri district were facing many constraints in both production as well as marketing of mangoes. The major limiting factors were lack of proper irrigation system and pest management practices. Apart from these farmers have to face post-harvest losses due to inadequate storage facilities within region. Thus due to lack of marketing avenues and channels farmers avoid individual marketing and sell their produce to middle man. They further mentioned that farmers needed appropriate guidance to tackle their problems. They suggested proper storage facilities should be provided to store their perishable produce. Similarly farmers should take initiative to find new market avenues so that they get fair price for their products.
Abbasi et al. (2011) had reported effect of coatings and packing material on quality of mangoes stored at low temperature. They mentioned that mango of cultivar Chaunsa were harvested from Multan (Punjab) orchards at mature stage. These fruits were immediately given hot water treatment at 48 to 52°C for 3 minutes to get rid of fungal attack and then dried. Then after mangoes were coated with different concentrations of Carboxy Methyl Cellulose (CMC) and CaCl₂ along with bee wax and polythene sheet packing. All products were applied with KMnO₄. They observed that treatment with different levels of Carboxy Methyl Cellulose (CMC) along with KMnO₄ had showed maximum storage life as compared to other applications with remarkable conservation of physic-chemical and sensory parameters. All treatments like CMC1%, CMC 2% and CMC3% delayed fruit ripening and improved keeping quality of mangoes. However CMC 2% showed supremacy over rest treatments with extension in storage life up to 77 days at refrigerated temperature. Different levels of CaCl₂ (1%, 2% and 3%) along with ethylene absorbent extended storage life of mangoes up to 56 days and equal period was registered by bee wax. They also mentioned that no significant difference was recorded in quality parameters between control and wrapping in polythene sheet with storage life of 49 days at refrigerated conditions. They concluded that CMC coating at 2% level significantly increased storage of mangoes and hindered alterations of physical, chemical and sensory parameters. The coating applied on produce actually acted as physical barrier for gaseous exchange between fruits and environment which subsequently suppressed the rate of respiration.