Survey Based Diversity of Mango Insect Pests at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India

Abstract

The only purpose of conducting this research is to know the diversity of insects. This research is completely field based, which was selected at different twelve locations of Jawaharlal Nehru Agricultural University, Jabalpur, Madhya Pradesh campus. In this research, 38 insect pests with different species were recorded whose nature of causing harm has been told. The principle insect pests of mango are hopper, mealy bug, midge, fruit fly, bark eating caterpillar, shoot borer, leaf webber and stone weevil.

Key words: Mealy bug, fruit fly, shoot borer, 38 insect pests and diversity.

1. Introduction

Mango (*Mangifera indica* L.) is one of the most popular tropical and subtropical fruit crops worldwide. The fact that it is commonly referred to as the "King of Fruits" throughout the tropical world reflects its popularity and importance. India is the world's greatest mango producer, accounting for 40.48 % of global mango production (Anonymous, 2013). Mango has been cultivated in India for over 4000 years, with over 1200 varieties said to exist (Chowdhury, 2015). On a global scale, more than 300 insect pest species have attacked the vegetative and reproductive phases of the mango crop (Pena *et al.,* 1998). India has 188 species of which 188 have been documented (Tandon and Verghese, 1985). Hoppers species such as *Amritodus atkinsoni* Lethierry, *Idioscopus clypealis* Lethierry, and *Idioscopus nitidulus* Walker stay active and inflict up to 100% losses in mango crops from the emergence of new flush through flowering cum fruit setting stages (Bana *et al.,* 2016; Kumar *et al.,* 2014). Both nymph and adult hoppers have been seen sucking cell sap from young leaves, fragile shoots, inflorescences or panicles, and the rachis of young fruits, preventing flowers from blooming and immature fruits from falling. Hoppers also excrete large amounts of honey dew, which causes the production of sooty mould, which interferes with the plants photosynthesis. Fruit flies, *Bactrocera dorsalis* Hendel, *Bactrocera zonata* Saunders and *Bactrocera correcta* Bezzi, are a serious bottleneck in mango production (Bana *et al.,* 2017; Verghese *et al.,* 2006). Thrips nymphs and adults feed on mango tender leaves, shoots, inflorescence and fruits, causing a silvery sheen with leaf edges curling upwards, stunted growth, discoloration of buds and panicles, malformed, premature drops, and fruit bronzing with feeding scars, lowering marketable produce quality. It is critical as a

quarantine pest. During the ripening stage, a female fruit fly uses an ovipositor to lay eggs in the mango skin and after hatching, the maggots begin feeding inside the fruit pulp, causing internal discoloration, off flavours, pulp rotting and fruit drop, before pupating soil. It reduces mango yields by up to 80% (Verghese and Jayanthi, 2001) resulting in annual losses of Rs 29, 460 million in mango, guava, citrus, and sapota (Mumford John, 2001). The current study contributes to a better understanding of the variety of insect pests found in mango plants in JNKVV, Jabalpur, Madhya Pradesh.

2. Materials and methods

From two years field investigations were undertaken at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, to record the distribution of mango and insect pests connected with the plant, as well as their mode of harm. Twelve spot/location were selected mango plants on the tagged leaves, shoots, fruits, and inflorescence of mango plants, data was collected every seven days. The attack of different parts of the mango was documented by counting the number of injured pieces in each direction at random. Hand picking and hand net were used to gather the insects in their immature and mature stages. Adults and nymphs were collected and kept in vials with 75% alcohol for eventual identification in the lab.

3. Results and Discussion

3.1. Mango hoppers/mango leaf hopper

The hopper population peaks during the flowering flush, which lasts from January to April. During the vegetative flush in June-August, this was also noted. Their multiplication is aided by old, neglected and densely planted orchards that are gloomy and have high humidity levels. Nymphs and adults weaken the vigour of the plant by piercing and sucking the sap from sensitive areas, resulting in the shedding of flower buds, flowers and early fruits. As a result of honey dew discharge, sooty mould forms on leaves, giving them a blackish appearance. Hoppers sleep in the cracks between the bark of trees. During instances of heavy infestation, the clicking sounds of leaf hoppers can be heard. When the weather is warm, humid, and cloudy, it is most comfortable.

3.2. Thrips

Thrips can be found throughout the year, with the exception of November and December. Thrips nature polyphagous and can be found in abundance in JNKVV. Laceration of leaf tissues

caused by nymphs and adults draining the cell sap. A silvery sheen appears on damaged leaves with tiny faecal matter specks. *C. indicus* and *R. cruentatus* stipple leaves by feeding on them. *S. dorsalis* feeds mostly on inflorescences and fruits that have discoloured tissues that eventually turn brown.

3.3. Shoot borer

This pest can be found all over India and is particularly harmful to seedlings and young trees. Tunneling from the tender terminal shoots top down. Seedlings that are stunted and have a terminal bunchy look. The larvae of this moth drill into the young shoot, causing the leaves to drop and the plant to wilt. On panicles, similar symptoms have been observed.

3.4. Midge

The midge infests and destroys the crop during the floral bud burst stage, juvenile fruiting stage and on leaves. The eggs are positioned on the inflorescence in the creases of the sepals and petals. The larvae tunnel through the axis and completely destroy the inflorescence. Larval feeding inhibits floral opening and so fruit development. Infested buds develop into long, pointed galls, which are where pupation occurs. Panicle infestations have a distinct right-angled bend with an exit hole through which the last instar maggots emerge to pupate in the soil. The second generation then infests extremely young fruits, which eventually drop before reaching the marble stage. The majority of highly galled leaves fall to the ground much sooner than is common in most mango orchards, while the majority of galled leaves stay on anthracnose affected trees. Mango tree branches that have been severely damaged have almost no inflorescence, resulting in very little mango fruit output.

3.5. Fruit fly

The oriental fruit fly is one of the country most troublesome mango pests, posing a threat to fresh fruit export. The female punctures the outer wall of mature fruits with its pointed ovipositor and places eggs in small clusters into the mesocarp of ripe fruits. After hatching, the larva feeds on fruit pulp, which appears normal on the outside but soon sinks. The mature maggots pupate on the ground. Fruit fly emergence begins in April and peaks in May-July, coinciding with fruit ripening. The population gradually declines from August to September until becoming non-existent until March.

3.6. Mango ash grey beetle

The adult weevil has a ferruginous brown coloration. On the elytra, there is a white patch and black mottling. It has a rostrum that is slightly wider at the apex. The striae on the elytra are coarsely punctate. There is a central pale grey stripe and a small basal band laterally on the pronotum. The eggs are bright yellow and oval in shape. Grub is a tiny, apodous and bent creature. Grub is a pale white creature. Chitinized and testaceous head. Mandibles are strongly developed and toothed obtusely. Mandibles that are close to the labium. Abdominal segments are less developed than thoracic segments. Exarate, elongate and symmetrically symmetrical pupa. The white body wall of the pupal develops into a light brown colour throughout time.

3.7. Leaf webber

The season of pest infestation begins in April and lasts until December. It is a pest that has reached epidemic proportions in campus of JNKVV, particularly in old, packed orchards with considerable shadow. Leaf Webber infestations can start as early as the seedling stage and last all the way through flowering and fruiting. Several caterpillars were discovered inside a webbing of terminal leaves and fragile shoots. Caterpillars scrape and eat on the web terminal leaves at first, giving them a charred appearance.

3.8. Leaf miner

The appearance of fresh mango plant flushes causes slight leaf damage to fluctuate. The dorsal epidermis of fragile leaves is mined and fed by light brown caterpillars. Blisters of a greyish-white colour appear on the leaves as a result of mining. The mango leaf miner adult was a silvery grey coloured moth with silvery streaks on the forewings.

3.9. Stem borer

Grubs feed on the inside of the stem, burrowing upward and creating irregular tunnels that disrupt nutrient and water flow in the tissue. The drying of the terminal shoot in its early stages and severe symptoms cause the withering of branches or the entire tree.

3.10. Scale insect

The plant vitality is reduced by both nymphs and adult scales sucking sap from the leaves and other sensitive sections. Honeydew is secreted, allowing sooty mould to form on mango leaves and other sensitive regions. Flower spikes and fruits can also be infested. A severe scale infestation has a negative impact on the tree's growth and fruit bearing potential.

3.11. Giant Mealy bugs

The female adult descends the tree in April and May to lay her eggs in the cracks in the earth. On leaves, inflorescence, branches, fruits and fruits speak, pinkish nymphs and adult mealy bugs can be found. This pests nymphs drain sap from leaves and inflorescence, causing dryness and flower loss, as well as a lack of fruit set. They also create honey dew, which promotes the growth of sooty mould.

3.12. Mango mite/spider

The infection begins in April and develops steadily until it reaches its climax in June. The mango bud mite assault generates a profusion of shoots on the terminal, giving the plant a witches broom appearance. Mite infection causes floral and foliar galls that resemble witches broom when the fungus *Fusarium* sp. is present (Ochoa *et al.*, 1994). A widespread pest in India, *Oligonychus mangiferae* Rahman & Sapra, feeds on the upper surface of mango leaf. Leaf bronzing is generated by sucking sap from leaves and susceptible stems by nymphs and adults. Closer inspection reveals the webbing of mite colonies on the leaves. Jumping spiders are energetic hunters who hunt during the day. It climbs back up the silk tether if it falls, such as if the victim shakes it off. Although most jumping spiders are carnivorous, nectar has been observed in the diets of some species.

3.13. Red ant or weaver ants

Red ants, often known as weaver ants, live in trees and are known for their extraordinary nest-building activities, in which workers weave leaves together with larval silk to make nests. Colonies can be massive, with over a hundred nests covering numerous trees and containing over 500,000 workers. Weaver ants, like many other ant species, forage on tiny insects and supplement their diet with carbohydrate-rich honeydew (Hemiptera).

3.14. Hairy caterpillar

Defoliation is the first sign of an attack. Consuming the leaf and scraping it hairy and reddish brown larvae. White hairs on a reddish-brown head.

3.15. Bark eating caterpillar

It is possible that young trees will succumb to the attack. Caterpillars eat their way through the trunk or branch junctions. Caterpillars hide in the tunnel during the day and emerge at night to eat the bark. There is a silk gallery present. Larvae are a stout, muddy brown colour. Adults have big yellowish-brown forewings with brown wavy markings. White is the colour of the hind wings. Males are often smaller than females.

3.16. Semilooper

Caterpillars eat the leaves and shoots, causing defoliation and a loss in photosynthesis.

3.17. Fruit borers

When the larvae hatch, they bore holes in the apex or narrow tip of the fruit, tunnelling through the flesh and skin before feeding on the seed. The infection causes fruit degeneration and early fruit drop. Fruit is fragile at all stages. The first sign of infection is the presence of a sap stain spreading from the caterpillar entry hole and accumulating on the drip point at the fruit apex.

3.18. Termites

Termites wrap their stems and roots with earth to protect them from the sun. Termites are white in colour, prefer to be in the dark, and live underground. They eat the roots or travel upward, creating tunnels by building mud galleries on the tree.

3.19. Shoot gall psylla

The pest becomes active in August, with nymphs hatching from eggs and travelling to neighbouring buds to drain cell sap in August and September. Feeding causes the buds to transform into hard conical green galls, which occur in September and October. Terminal shoots are affected. As a result of adult insects depositing eggs or nymphs feeding, green conical galls grow in the leaf axis. As a result of the green galls, there is no flowering or fruit set.

Nymphs feed inside the leaf's midrib, secreting chemicals (presumably phenyl amino acids) that cause conical galls to form instead of apical and axillary buds. They enter galls to complete their development. Gall formation directly interferes with inflorescence production, decreasing output. Infested twigs gradually dry out and show signs of die-back (Singh *et al.*, 1975; Singh and Misra 1978).

3.20. Mango nut weevil

Oviposition injuries on fruits the size of marbles. The weevil's tunnels for emerging cause the ripe mango fruits to be destroyed. *Cryptorrychus mangiferae* grubs harm both the pulp and the cotyledons of the stone, but *Cryptorrychus gravis* grubs develop in the pulp and devour solely the stone fibre. The eggs are placed in fruits that are just partially formed. The grubs pass through the pulp and into the seeds, where the pupates and adults emerge after penetrating the stone and pulp.

3.21. Lady bird beetle

Many species prey on herbivorous hemipterans such as aphids and scale insects, which are agricultural pests; nonetheless, the majority of coccinellid species are beneficial insects. Many coccinellids lay their eggs in aphid and scale insect colonies so that their larvae have immediate access to food.

3.22. Parasitoids (*Chrysocharis pentheus*)

Phyllocnistis citrella is attacked by a broad group of hymenopterous parasitoids, predominantly eulophids, but also encyrtids, elasmids, eurytomids, eupelmids, and peteromalids (Pena *et al.,* 1996; Schauff *et al.,* 1998; Ishii, 1953; Ujiye *et al.,* 1996). In Japan, Taiwan, and Thailand, more than 32 species of chalcidoids were discovered, including *Chrysocharis pentheus* (Walker) (Hymenoptera: Eulophidae), which was the dominating species in Wakayama prefecture (Ujiye and Adachi, 1995). Seven species of eulophidae, the most abundant of which was *C. pentheus*, were responsible for high levels of parasitism (70%) in the Matsuyama area (Mafi and Ohbayashi, 2004). *Chrysocharis pentheus* is a polyphagous endoparasite that can be found in North America, Europe and several Asian nations.

3.23. Long legged fly

It eats plant-harming bugs, this makes it a beneficial insect. Larvae (maggots) have been discovered in rotting plant materials, as well as feeding on small aquatic organisms. This may be feasible because the larvae of this fly prefer to live near water, which provides a more diversified growth and eating environment. There is not much else known about this fly entire life cycle.

3.24. Green bottle fly

Green bottle fly is similar to that of other flies in the calliphoridae family. The fly maggots are employed in maggot therapy, forensic entomology and can cause myiasis in animals and pets. In the spring, the common green bottle fly emerges to mate. The larvae eat decomposing organic matter.

3.25. Ant like weevil

The sugary exudates of other insects, such as hoppers, may be consumed by the adult.

3.26. Damsel fly

Damselflies trap prey using their legs as adults, and the hairs on their legs aid ensnare the victim. The damselfly will then break them apart with its serrated mandibles, either during flight or after landing.

3.27. Bruchids

Brownish grey beetle with high ivory-like dots on the dorsal side around the middle. It has long prominent serrate antenna and is tiny, short and energetic. Pygidium refers to the fact that the elytra do not completely cover the abdomen. Adults live for a brief time, are harmless, and do not feed on stored produce. During study time, twenty seven observed fauna at campus JNKVV, Jabalpur, Madhya Pradesh mango ecosystem.

Mango hoppers were observed throughout the year in the mango ecosystem, except during the rainy season, when the population on twigs and trunks was very low or non-existent. Mango hoppers were mostly connected with the plants new flush and flowering stages, reaching a peak of activity during the crop flowering and fruit setting stages before gradually diminishing.

During the study period peak periods were recorded mango hopper highly associate with month Feb.-July, thrips, ash grey beetle and midge highly recorded at month Feb.-April, shoot borer highly associated with month Feb.-Sept., peak period in fruit flies May-July, leaf webber highly recorded in month Jan.-Feb. & Oct.-Dec., leaf miner in March., stem borer in month Jan.-Dec., scale insects were highly recorded in month March-April & Oct.-Dec., giant mealy bug in month June-July & Dec., mites/spider March-April, red ants Jan.-July, Bark eating caterpillar Jan.-April & Sep.-Nov., fruit borers were highly recorded in month April-July, termites highly recorded in month Jan. & Sep.-Dec., shoot gall psylla Feb.-May, mango seed weevil or mango nut weevil or mango stone weevil Mar.-June, lady bird beetle April, parasitoids (*Chrysocharis pentheus*) April-May, green bottle fly Mar.-May, damsel fly April-May, respectively. Thrips have also been identified as a significant pest and yield limiting factor in south Gujarat and elsewhere (Bana *et al.*, 2015).

Rhipiphorothrips cruentatus Hood, *Exothrips hemavarna* Ramakrishna & Margabandhu, *Haplothrips ganglbaueri* (Schmutz) and *Scirtothrips dorsalis* are the four species of thrips. During the vegetative (new flush) and flowering cum fruit setting stages (February-March), Hood remained more active. Fruit flies were noted as a prominent nuisance and documented throughout the investigation period, with the highest catches occurring between April and July

with the help of fruit fly trap filled with methyl eugenol that matched with crop fruiting and harvesting stages (Bana *et al.,* 2017). In southern Gujarat, three species were discovered: *Deanolis* spp., *Conogethes punctiferalis* (Guenee) and *Citripestis eutraphera* (Meyrick). *C. eutraphera* is a newly discovered indigenous confined mango fruit borer that causes considerable damage to immature mangoes (Anonymous, 2016). This pest was found in the mainland's coastal region of TN and mango-growing districts of KT (Jayanthi *et al.,* 2014). Mango fruits nearby were frequently observed charred around the area where the infected fruits had drilled holes loaded with frass. The most typical injury occurs when two or more fruits come into contact. *Procontarinia matteiana* is a leaf gall midge. Kieffer and Cecconi observed gall formation in new flushes throughout the year (Table 3.1), which resulted in defoliation of the leaf biomass and a reduction in photosynthetic activity (Patel *et al.,* 2011). *Orthaga* spp., the mango leaf webber, continued to be a minor pest and was in charge of decreased yield because of webbed and desiccated leaves. Its active phase was seen in south Gujarat during June-December and February-April (Kannan and Rao, 2006). Support the current data and state that the first two weeks of November saw the highest

The newly emerged flushes were harmed by the mango leaf miner, *Acrocercops syngramma,* Meyrick, when tiny caterpillars dug beneath the top leaves dorsal sides and displayed symptoms of grayish-white epidermis. *Chlumetia transversa*, a shoot borer Walker attacked fresh mango shoots from October to February (Verghese and Devi, 1998) reported that peak infestation in Sept-Nov under KT conditions. The mealy bug nymphs and females drew sap from inflorescence, tender leaves, shoots, fruit and sooty mould disease-produced fruit. Fruit drop was induced by a severe infestation that interfered with fruit set. The threat posed by the mango stem borer, *Batocera rufomaculata* De Geer, was spreading to more places. Due to branch drying and die-back, affected trees ceased to produce fruit. The stem borer grub persisted inside the stem, where it fed on tissues and created galleries. This survey will aid in the timely dissemination of pertinent information to the scientific community and mango producers in order to develop effective management strategies at the appropriate time.

Table no. 3.1: Enlist insects/pests on mango during the session, 2019-20 & 2020-21.

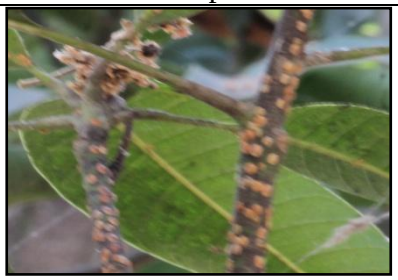
Sl.No.	Insects/pests	Systematic name	Effect	Damaging phase of insects/pests
1.	Mango hoppers			
1.1.		*Amritodus atkinsoni*	New flush and flowering stage	Nymphs &Adults
1.2.		*Idioscopus clypealis*		
1.3.		*Idioscopus nitidulus*		
1.4.		*Amrasca splendens*		
2.	Thrips			
2.1.		*Exothrips hemavarna*	New flush and flowering stage	Nymphs &Adults
2.2.		*Haplthrips ganglbaueri*		
2.3.		*Scirtothrips dorsalis*		
2.4.		*Rhipiphorothrips cruentatus*		
3.	Shoot borer	*Chlumetia transversa*	Newly shoot	Larvae
4.	Midges			
4.1.	Leaf gall midge	*Protocontarinia matteiana*	Leaf/vegetative stage	Adults
4.2.	Blossom midge	*Erosimya indica*	Panicle	
5.	Fruit flies			
5.1.	Oriental fruit fly	*Bactrocera dorsalis*	Fruits	Maggots
5.2.	Guava fruit fly	*Bactrocera correcta*		
5.3.	Peach fruit fly	*Bactrocera zonata*		
5.4.	Spp. of *B. dorsalis*	*Bactrocera caryeae*		
6.	Ash grey beetle	*Myllocerus spp.*	Leaf and nursery	Grub
7.	Leaf webber	*Orthaga spp.*	Leaf	Larvae
8.	Leaf miner	*Acrocercops syngramma*	Leaf damage	Larvae
9.	Stem borer	*Batocera rufomaculata*	Tree trunk	Grubs
10.	Scale insects	*Aspidiotus destructor*	Leaf	Nymphs &Adults
11.	Giant Mealy bug	*Drosicha mangiferae*	Twig and fruit	Nymphs &Adults
12.	Mites			
12.1.	Red spider mite	*Oligonychus mangiferae*	Bud and flush	Nymphs & Adults
12.2.	Bud mite	*Aceria mangiferae*		
12.3.	Two striped jumping spider	*Telamonia dimidiata*	Predatory nature	
12.4.	Daring Jumping Spider	*Phidippus audax*		
13.	Red ant	*Oecophylla smaragdina*	Twig and fruit	Nymphs & Adults
14.	Hairy caterpillar			
14.1.		*Euproctis fraternal*	Defoliation	Caterpillar/Larvae
14.2.		*Prothesia scintillans*		
15.	Bark eating caterpillar	*Inderbela tetraonis*	Larva makes webs and making zigzag galleries	Caterpillar/Larvae
16.	Semilooper	*Achaea janata*	Inflorescence	Larvae

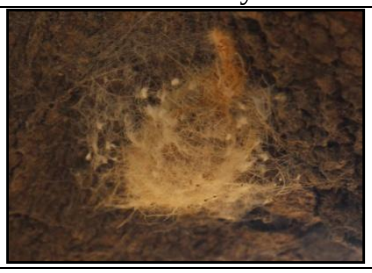
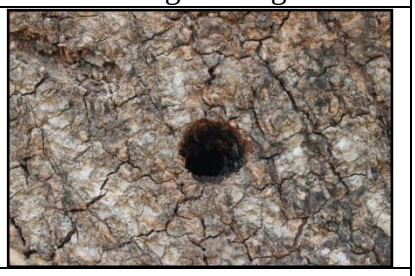
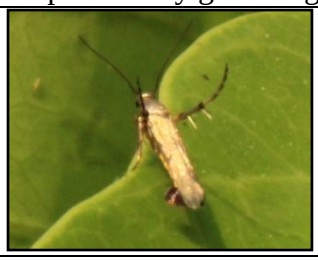
17.	Fruit borers			
17.1.		*Deanolis spp.*	Fruit	Larvae
17.2.		*Citripestis eutraphera*		
17.3.		*Conogethes punctiferalis*		
18.	Termites	*Odontotermis obesus*	Root, Stem	Nymphs & Adults
19.	Shoot gall psylla	*Apsylla cistellata* Buckton	Shoot	Adults
20.	Mango seed weevil or mango nut weevil or mango stone weevil	*Sternochetus mangiferae*		Grub
21.	Carrot rust fly	(Unidentified)		-
22.	Needle stone-fly	(Unidentified)		-
23.	Lady bird beetle	*Coccinella septumpunctata*		Grub & Adults
24.	Parasitoids	*Chrysocharis pentheus*		-
25.	Long legged fly	*Chrysosoma* spp.		-
26.	Green bottle fly	*Lucilia sericata*		-
27.	Ant like weevil	*Cylus formacarius*		Grub & Adults
28.	Damsel fly	*Ischnura heterosticta*		
29.	Bruchids	----		Grub & Adults

Table no. 3.2: List of insect species considered minor pests on mango.

Sl. No.	Insects/pests	Systematic name	Nature of damage
1.	Blossom feeders and webbers	*Asura ruptofascia* Hampson, *Celama analis* Will and Westwood, *C. fasciatus* Walker, *Cosmostola laesaria* Walker, *Gymnoscelis imparatalis* Walker, *Eublemma* spp.	Webbing and feeding on the inflorescence
2.	White grub beetles	*Holotrichia consanguinea* (Blanchard)	Voracious feeding on leaves during night times
		Anomala sp.	
3.	Slug caterpillar	*Latoia lepida* (Cramer)	Feeding on leaves
4.	Leaf-cutting weevil	*Deporaus marginatus* (Pascal)	Cutting and feeding on leaves
5.	Leaf-mining weevil	*Rhynchaenus mangiferae* Marshall	Skeletonization of leaves
6.	Mango blackfly	*Aleurocanthus mangiferae*	Quaintance Suck sap from leaves
7.	Painted bug	*Coptosoma nazirae* Atkinson	Suck sap from leaves, flowers
8.	Fruit-sucking moths	*Eudocima maternal* (Linn.)	Suck sap from fruits
		E. fullonica (Clerck)	
9.	Castor capsule borer	*Conogethes punctiferalis* (Guenee)	Larvae bore the fruits

Plate 3.1: List of insect/pests

		
Mango leaf hopper	Ladybird beetle	Bruchids
		
Shoot borer	Mango leaf minor	Two striped jumping spider
		
House fly	Mango mealy bug	Marble size fruits infested by thrips
		
Bark eating caterpillar	Ash grey beetle	Scale insects
		

Red ants	Damsel fly	Leaf gall midge
		
Green bottle fly	Hairy caterpillar eggs emerged	Stem borer symptoms
		
Gall produce by gall midge	Affected shoot by thrips	Carrot rust fly (Unidentified)
		
Needle stone-fly(Unidentified)	Fruit flies	Thrips on leaf
		
Shooty mould on leaves by mango hopper	Shooty mould on stem by mango hopper	*Chrysocharis pentheus*
		
Long legged fly	Ant like weevil	Blossom midge

Daring Jumping Spider

Leaf webber

Webbing by leaf webber

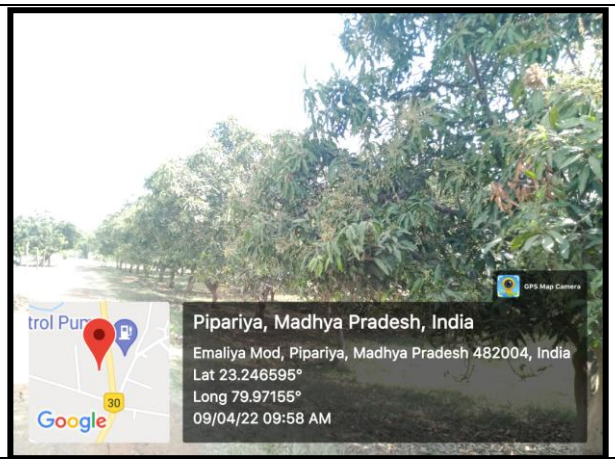
Termite

Infested plants by stem borer

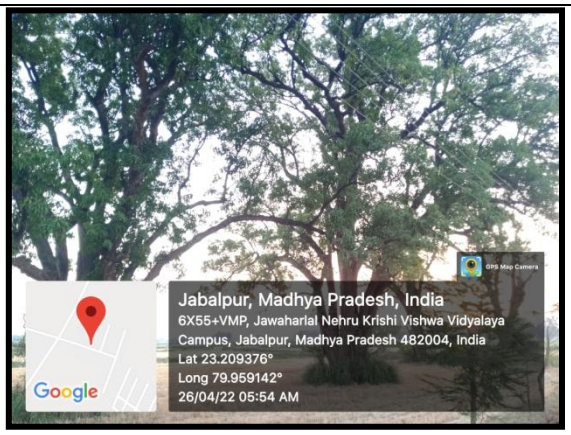
Semilooper

Plate 3.2: Different location

Location- 1



Location- 2



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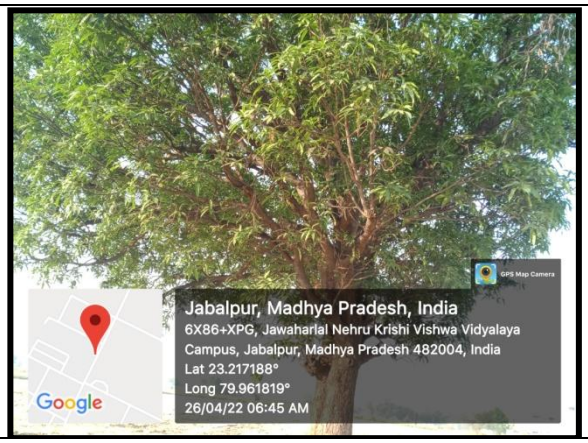
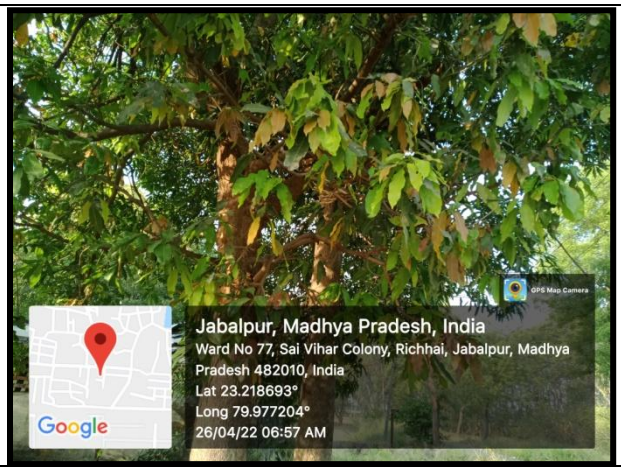


Location-4

Location- 5

Location- 6



Location- 7

Location- 8

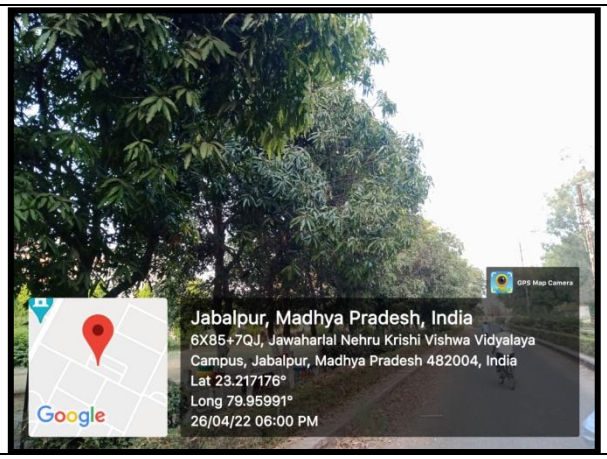
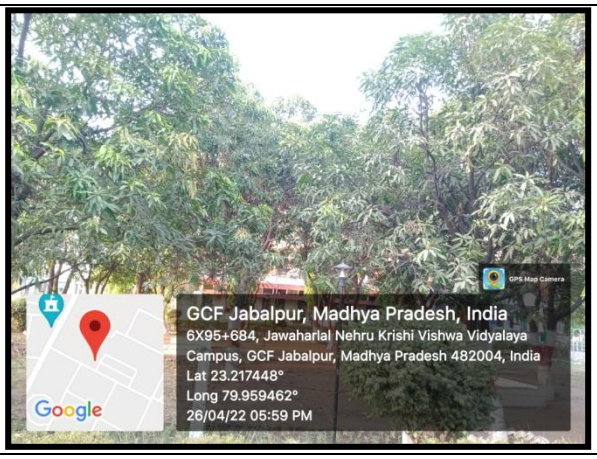
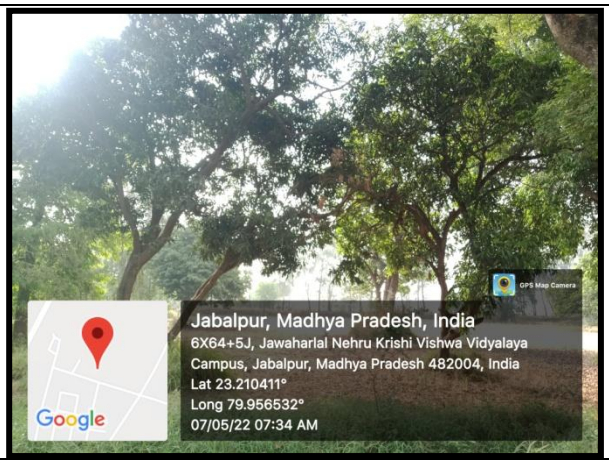
	
Location- 9	**Location-10**
	
Location- 11	**Location- 12**

Table no. 3.3: Insect/pests status during session, 2019-20 & 2020-21.

Sl.No.	Insect/pests	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.	Mango hoppers	+++	++++	++++	++++	++++	++++	++++	+++	+++	++	++	++
2.	Thrips	+	++++	++++	++++	++	+	+	+	+	+	++	+++
3.	Shoot borer	+	++++	++++	++++	++++	++++	++++	++++	++++	+	+	+++
4.	Midges	+	++++	++++	++++	++	++	+	+	++	++	++	+++
5.	Fruit flies	+	+	+	+	++++	++++	++++	++	+	+	+	+
6.	Ash grey beetle	+	++++	++++	++++	++	++	+	+	+	+++	+++	+++
7.	Leaf webber	++++	++++	+++	++	+	+	+	+	+++	++++	++++	++++
8.	Leaf miner	--	++	++++	+++	+	+	+	+	+	+	+	+
9.	Stem borer	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++
10.	Scale insects	+	+++	++++	++++	+	+	+	+	+	++++	++++	++++
11.	Giant Mealy bug	+	+	+	+	++	++++	++++	++	++	+	+	++++
12.	Mites/Spider	+++	+++	++++	++++	+++	+++	++	++	++	++	+++	+++
13.	Red ant	++++	++++	++++	++++	++++	++++	++++	+	+	+	++	++
14.	Hairy caterpillar	+++	+++	++	++	+	+	++	++	++	+	++	+++
15.	Bark eating caterpillar	++++	++++	++++	++++	+	+	+	+++	++++	++++	++++	+++
16.	Semilooper	++	++	++	++	+++	++	++	++	++	+++	++	++
17.	Fruit borers	+	+	+	++++	++++	++++	++++	+	+	+	+	+
18.	Termites	++++	+	+	++	++	+	+	++	++++	++++	++++	++++
19.	Shoot gall psylla	+	++++	++++	++++	++++	+	+	+	+	+	+	+
20.	Mango seed weevil or mango nut weevil or mango stone weevil	+	++	++++	++++	++++	++++	+++	+	+	+	+	+
21.	Carrot rust fly	+	++	+++	+++	++	++	+	+	+	+	+	+
22.	Needle stone-fly	+	+	+	+	++	+	+	+	+	+	+	+
23.	Lady bird beetle	+	+	+	++++	++	++	+	+	+	+	+	+
24.	Parasitoids (*Chrysocharis pentheus*)	+	+	+++	++++	++++	+	+	+	+	+	+	+
25.	Long legged fly	+	+	++	++	++	+	++	+	+	+	+	+
26.	Green bottle fly	+++	+++	++++	++++	++++	+++	+++	+++	++	+	+	++
27.	Ant like weevil	+	+	+	++	+	+	+	+	+	+	+	+
28.	Damsel fly	++	++	++	++++	++++	+++	+++	++	+	+	+	++
29.	Bruchids	+	+	+	++	+	+	+	+	+	+	+	+

(+: Low population; ++: Meadium population; +++; High population; ++++: Very high population)

4. Conclusion

During the years 2019-20 and 2020-2021, researchers looked into the prevalence of mango insect pests. Another aspect that added to the complexity of insect problems in mango was a shift in crop phenology caused by climate change. The study described here would be extremely useful for managing mango pests during various seasons in order to increase mango quality and quantity.

5. Competing interests

Authors have declared that no competing interests exist.

Conference disclaimer:

Some part of this manuscript was previously presented in the conference: 6th International Conference on Strategies and Challenges in Agricultural and Life Science for Food Security and Sustainable Environment (SCALFE-2023) on April 28-30, 2023 in Himachal Pradesh University, Summer Hill, Shimla, HP, India. Web Link of the proceeding: https://www.shobhituniversity.ac.in/pdf/Souvenir-Abstract%20Book-Shimla-HPU-SCALFE-2023.pdf

6. References

Anonymous. Retrieved04.10.13 http://agriexchange.apeda. Gov.in/Market%20Profile/one/MANGO.aspx. 2013.

Anonymous. National Innovations in Climate Resilient Agriculture (NICRA). Research Highlights. 2016; 51.

Bana JK, Ghoghari PD, Kalaria GB, Saxena SP and Shah NI. Efficacy of IPM Modules against Mango Hopper Complex. Indian Journal of Entomology. 2015;77(4):320-322.

Bana JK, Sharma H, Kumar Sushil and Singh P. Impact of weather parameters on population dynamics of oriental fruit fly, *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) under south Gujarat mango ecosystem. Journal of Agrometeorology. 2017;19(1)**:**78-80.

Bana JK, Singh P and Makwana Amit. Influence of abiotic factors and crop stages on population dynamics of hoppers, *Idioscopu*s spp. in Mango ecosystem. Annals of Plant Protection Sciences. 2016; 24:286-289.

Chowdhury SK. Diversity and nature of damage of mango insect pests at Kaliachak-II Block of Malda, West Bengal, India. Journal of Entomology and Zoology Studies. 2015; 3(4): 307-311.

Ishii T. A report of the studies of the parasite wasps of injurious insects. Bull. Fac. Agric. Tokyo Univ. Agric. Tech., 1953; 1(2): 1- 10.

Jayanthi PDK, Verghese A, Shashank PR and Kempraj V. Spread of indigenous restricted fruit borer, *Citripestis eutraphera* (Meyrick) (Lepidoptera: Pyralidae) in mango: Time for domestic quarantine regulatory reforms. Pest Management in Horticultural Ecosystems. 2014; 20(2):227-230.

Kannan M and Rao NV. Ecological studies on mango leaf webber (*Orthaga exvinacea* Hamp.) in Andhra Pradesh as a basis for IPM. International Journal of Agricultural Sciences. 2006; 2(2):308-311.

Kumar S, Desai HR, Patel ZP and Bhatt BK. Impact of climatic variability and crop phenology in abundance of mango hopper. International conference: Changing scenario of pest problems in Agri-Horti ecosystem and their management held at MPUAT, Udaipur. 2014; 114-128.

Mafi SA and Ohbayashi N. Seasonal Prevalence of the Citrus Leafminer, *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) and its Parasitoids in Controlled and Uncontrolled Citrus iyo Grooves in Ehime Prefecture, Japan. Appl. Entomolo. Zool., 2004; 39(4): 597−601.

Mumford John D. Management of fruit flies in India (Diptera: Tephritidae) Funding application and project memorandum. Department of International development (DFID), UK. 2001; 1-95.

Ochoa R, Aguilar H and Vargas C. Phytophagous mites of Central America: an illustrated guide. Centro Agronómico Tropical de Investigación y Enseñanza, Technical series 6. 1994; Turrialba, Costa Rica.

Patel AT, Kumar Sushil and Chavan SM. Screening of mango cultivars against leaf gall midge. Crop Improvement. 2011; 38(1):99-101.

Pena JE, Duncan R and Browning H. Seasonal Abundance of the Citrus Leafminer and its Parasitoids in South Florida Citrus. Environ. Entomol., 1996; 25(1): 698−702.

Pena JE, Mohyuddin AI and Wysoki M. A review of the pest management situation in mango agro ecosystem. Phytoparasitica. 1998; 26(2):1-20.

Schauff ME, LaSalle J and Wijesekara GA. The Genera of Chalcid Parasitoids (Hymenoptera: Chalcidoidea) of Citrus Leafminer *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae). J. Natu. Hist., 1998; 32(7): 1001-1056.

Singh G and Misra PN. The mango shoot gall psyllid Apsylla cistellata Buckton and its control. Pesticides. 1978; 12(9):15–16.

Singh G, Kumar A and Everrett TR. Biological observations and control of *Apsylla cistellata* Buckton (Psyllidae: Homoptera). Ind J Entomol. 1975; 37(1):46–50.

Tandon PL and Verghese A. World list of insect, mite and other pests of mango, IIHR, Bangalore. 1985; 5-22.

Ujiye T and Adachi I. Parasitoids of the Citrus Leafminer, *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) in Japan and Taiwan. Bull. Fruit Tree Res. Stn., 1995; 27: 79−102.

Ujiye T, Kamijo K and Morakote R. Species Composition of Parasitoids and Rate of Parasitism of the Citrus Leafminer (CLM), *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) in Central and Northern Thailand, with Key to Parasitoids of CLM Collected from Japan, Taiwan and Thailand. Bull. Fruit Tree Res. Stn., 1996; 29: 79−106.

Verghese A and Jayanthi PDK. Integrated pest management in fruits. In: Pest Management in Horticultural Ecosystems, (Parvatha Reddy, P., Verghese, A., Krishna Kumar, N.K. Eds.), Capital Publishing Company, New Delhi. 2001; 1-23.

Verghese A, Nagaraju DK, Madhura HS, Jayanthi PDK and Devi KS. Wind speed as an independent variables to forecast the trap catch of the fruit fly (*Bactrocera dorsalis*). Indian Journal of Agricultural Sciences. 2006; 76(3):172-175.

Verghese A and Devi KS. Seasonality and sampling of the mango shoot borer, *Chlumetia transversa* Walker (Lepidoptera: Noctuidae). Pest Management in Horticultural Ecosystems. 1998; 4(1):16-20.