PESTS OF FRUITS
(Banana, Mango and Pomegranate):
‘E’ Pest Surveillance and Pest Management Advisory

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E-pest surveillance and pest advisory project for some horticultural crops like banana, mango and pomegranate was launched during the year 2011-12 by Commissionerate of Agriculture Maharashtra State. The objectives of the project are pest surveillance, training of field staff about crop pests, crop diseases, data entry and issuing of pest management advisories based on economic threshold level for reducing pest densities by using eco friendly and environmentally compatible strategies. In the current era of globalization, the major concern before the nation is quality of harvested fruits and profitability to farmers as well as the concern of pesticide residues and pest infestation in harvested produce. Policy makers weighed the need for quality of produce and competiveness on international agriculture output market against the negative externalities of pesticides and presence of pest stages in the harvested produce that can damage the sustainability of the fruit production and export potential.

Maharashtra enjoys a prominent position on country’s horticulture map with more than 15 lakh hectare area under fruit crops. At the national level the state ranks 2nd in the fruit production after Tamil Nadu. Despite the production potential, the productivity of many fruit crops in Maharashtra is low as compared with national productivity and also average productivity of other states. Though the productivity of banana and pomegranate in Maharashtra is highest in the country, it has witnessed declining trend in productivity since 2010-11 as compared to 2008-09. Many reasons have been listed for declining trend in productivity of fruit crops. However, pests and diseases had their own share for lower productivity. Prominent among them are sigatoka disease in banana, hoppers and fruit fly in mango and bacterial blight in pomegranate.

Maharashtra is having Agri Export Zones for many horticultural crops like mango, pomegranate, banana etc. The thrust for raising productivity and preventing losses due to pests resulted into high use of pesticide which confounds the aim of integrated pest management and action threshold based application of pesticides.

Department of Agriculture and Marketing, Government of Maharashtra recognized the need to invest in and pioneered implementation of e-pest surveillance programme and to promote farmers’ participatory pest management practices. It’s wider uptake of judicious, timely application of right kind of pesticides in fruit crops to raise the potential for export as well as alleviate the consumer awareness about health hazards arising from high level of pesticide.
residues in the harvested produce. It has also recognized an opportunity to forge a stronger and more substantive partnership with the National Centre for Integrated Pest Management (NCIPM-ICAR), National Research Centre for Pomegranate, Solapur, National Research Centre for Banana, Trichy, Mahatma Phule Agriculture University, Rahuri and Dr. Balasaheb Sawant Agriculture University, Dapoli for surveillance plan and expertise in pest management.

The objective of e-pest surveillance is scientific control of pests and diseases through meticulous field observations by uploading in time for experts’ scientific advice and timely implementation of management interventions based on these advisories so as to ensure ecofriendness, economic, timely pest control measures with minimum pesticide residue levels.

This goal of timely application of pesticides was achieved through three-pronged approaches viz.,

(i) Recording of pest/pest incidence data at weekly intervals in structured sheet through pest scouts at field level in villages,

(ii) Collation of such pest data into one central server for analysis and

(iii) Interpretation of such data to provide guidance and issue pest advisory on the basis of economic threshold levels.

This programme acted as a vehicle to catalyse and facilitate the collaboration among policy makers (Department of Agriculture and Marketing, Government of Maharashtra) on one hand and research institutes (NCIPM, NRC Banana and NRC Pomegranate) and state agriculture universities (MPKV and Dr. BSKKV) on the other side in the planning and implementation of e-pest surveillance project.

The success of implementation of e-pest surveillance project lies in proper identification of pests and diseases, timely collateral entry of such data into the centralized server, its accessibility by the experts, proper maintenance of software and suitable delivery of pest management advisory to the farmers and end users. The meticulous pest data entry, prompt monitoring and approval of such data by field staff of State Department, available expertise of national research institutes and state agricultural universities in the field of pest management and trainings enabled the herculean task of implementation of e-pest surveillance easier, commendable and exemplary.

I appreciate the team work and efforts taken by national research institutes and state agricultural universities as well as implementing officers and staff of Department of Agriculture and Marketing, Government of Maharashtra in the implementation of e-pest surveillance and wish that dedicated efforts made by all has achieved the goals set for the project and shall continue to deliver and provide effective farmer-friendly results in the near future.
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Annexure VI : Pest Monitor Survey Proforma for Pomegranate Diseases and Insect Pests in Maharashtra
Introduction

India is the second largest producer of fruits in the world, just behind China. The area under fruit cultivation in 2011-12 was 6.704 million hectares with a total production of 76.4 million tonnes (Source: Ministry of Agriculture, GOI, and website: www.nhb.gov.in). The major fruits grown in India are mango, banana, citrus, guava, grape, pineapple, pomegranate, and apple. Although fruits are grown throughout the country, the major fruit growing states are Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Bihar, Uttar Pradesh and Gujarat.

India ranks first among banana producing countries in the world with a production of 29.7 million tonnes from an area of 830 thousand ha. In the year 2010-11, Tamil Nadu lead in area (125.4 thousand ha), production (8253.40 thousand tonnes) and productivity (65.8 mt/ha). The other major banana growing states are Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Bihar, Uttar Pradsh, Madhya Pradesh and Assam (www.apeda.gov.in). In Maharashtra, productivity (tonnes/ha) has declined in year 2010-11(52.5) as compared to year 2009-10 (61.17) and 2008-09 (62.0) (NHB 2011-12). Major reason assigned for declined productivity was the severe loss caused by one disease i.e. the sigatoka leaf spot that caused severe decline in productivity.

Mango, referred to as the ‘King of fruits’ is the most important commercially grown fruit in India and ranks first among mango producing countries accounting for 50 percent of the world’s production. India has the richest collection of mango cultivars. Major mango producing states are Uttar Pradesh, Bihar, Andhra Pradesh, Odisha, West Bengal, Maharashtra, Gujarat, Karnataka, Kerala and Tamil Nadu. Uttar Pradesh ranks first in production with 3,841.00 thousand tonnes. Area under mango cultivation in Maharashtra has not changed over the years, however both the production (000MT) and productivity (HA/MT) has declined considerably in year 2010-11(331 and 0.7) as compared to year 2009-2010 (597 and 1.3) and year 2008-09 (712.8 and 1.6). The climatic change in Konkan belt, coupled with erratic winters and damage due to pests and diseases have led to this fall.

Pomegranate was considered as a minor fruit in India till the year 1986, but gained importance due to its economic and nutraceutical values. A steady increase in pomegranate area and production of India was witnessed till 2007-08 when it occupied an area of 123.6 thousand ha and production of 884.1 thousand tonnes. In 2010-11 the area decreased to 107.3 thousand ha and production to 743.1 thousand tonnes. Picture of avarage productivity of Maharashtra was grimmer as compared to all India figures. Average productivity of pomegranate in state is 6.0 tonnes/ha which is very low compared with other states like Tamil Nadu (27.6 tonnes/ha), Karnataka (10.5), Gujarat (10.4 tonnes/ha), Andhra Pradesh (10.0) and national average of 6.9 tonnes/ha (Indian Horticultural Data Base 2012). Moreover the productivity of pomegranate in Maharashtra stated for the last 3 years remained static. This has been attributed to diseases and insect pests that were of little economic importance in the past, but have now emerged as new threats to the growers in some localities. Apart from bacterial blight, wilt, thrips and fruit borer along with new pests like some fungal fruit rots and spots, and fruit sucking moth required immediate attention.
Awareness among growers to identify and manage diseases and insect pests of fruit crops is essential for higher productivity as well as for quality produce. This requires long term strategies to manage risks such as pests and diseases following the principles of integrated pest management. Farmers tend to overuse pesticides which are detrimental to human health as well as to the environment. They have to be advised to apply need based pesticides. Also, the fruit growing areas are widespread in Maharashtra and it is impossible to convey proper warning at the time of pest infestation. By the time management measures are underway, large areas gets devastated. Hence, a comprehensive method has to be devised so that such catastrophe can be avoided. In view of the futuristic requirements as well as strategies to meet unforeseen circumstances and to increase the yield by reducing pest infestation, an “e-Pest Surveillance” programme has been initiated by Maharashtra State Govt along with National Centre for Integrated Pest Management (NCIPM), New Delhi. Other collaborators are, NRC Banana, NRC Pomegranate, MPKV and Dr. BSKKV. It provides field-specific information on pest pressure and crop injury leading to take appropriate decision about selection and application of pest management procedures by constant monitoring and scouting useing e-Pest Surveillance. It is basically a web based Decision Support System (DSS) for timely collection of data with regard to pest population and preparation of reports which greatly facilitates the execution of pest management activity. Besides it helps in creation of data base on pests that may also be used to ascertain the impact of climate change on the incidence of pest in the mandated crops. Present compilation envisage the procedure to be followed for implementation of e-Pest Surveillance, transmission of pest advisory to farmers, nature and symptoms of damage due to the pests for these three important fruit crops grown in Maharashtra and pest management strategies to reduce the pest densities in environmentally compatible way.
**BANANA**

**Major insect pests**

**Thrips (Chaetanaphothrips signipennis)**

**Symptoms**
- Distinctive reddish brown oval stains on the finger, which can extend the entire length.
- In severe cases peel splits and the exposed flesh quickly discolors.

**Pest identification**
- **Egg:** Kidney shaped, invisible to naked eye, laid just below the fruit or pseudostem surface.
- **Larva:** They are wingless creamy white, smaller but have the same shape as the adult.
- **Pupa:** Pupae are white like the larvae, can crawl, 1 mm in length.
- **Adult:** They are slender, creamy yellow to golden brown with delicate feathery wings and 1.5 mm long. Their wings have dark, eye-like spots at the base and are fringed; when the wings are folded, the adult appears to have a black line down its back.

**Biology of the pest**

Adult banana rust thrips reproduce sexually. After mating, females lay eggs in plant tissues where the thrips feed and hatch in 6–9 days. The newly hatched yellow nymphs feed for a few days before molting and after 8–10 days, mature nymphs migrate off the host plant into the soil and undergo pupation with the adult emerging in 6–10 days. The entire life cycle is completed in approximately 28 days.

**Management practices**
- At the time of shooting, cover the bunch firmly (without any space between polythene cover and bunch) with 100 gauge thickness polythene sleeve having 6 to 10% holes.
- Remove the male flower buds after opening of all hands.
- When the bud is in upright position, bud injection with imidachloprid 17.8EC @ 2ml
chemical solution (0.2 ml of chemical dissolved in 500 ml of water) per bud using disposable syringe

- Spray the bunch with chlorpyriphos @ 2.5 ml/litre of water/ acetamiprid 20SP (0.0025 %) i.e. 1.25 g/ 10 liter of water along with sticking agent (@ 0.5ml/litre of water, two times ie one at the time of opening of hands and second spray after all the hands opened.
- *Verticillium lecanii* (2 x 10^8 cfu/g) 3g/ lit + 1ml Milk + 1ml sticker or NSKE 5% + sticker can be taken up as second spray.

### Aphids (*Pentalonia nigronervosa*)

#### Symptoms
- Banana leaves are bunched into a rosette appearance with leaf margins becoming wavy and upward rolling thereby reducing the growth and vigour of plant. Severly infected plants do not produce bunches and act as a vector of bunchy top disease.
- Noticed in colonies on leaf axils and pseudostem

#### Pest Identification
- **Eggs:** Egg stage not present and young ones are born live
- **Nymph:** Oval or slightly elongated, reddish brown with six segmented antennae
- **Adult:** Reddish to dark brown/ almost black, shiny, small to medium sized.

#### Biology of the pest

It is a phloem feeder that uses its long stylet to pierce plant tissues to suck the sap directly from the vessels. Reproduction is entirely parthenogenetic (without mating). Females give birth directly to live young female. The life cycle from nymph to adult is completed in 9 to 16 days.

#### Management practices
- Adopt clean cultivation using healthy and pest free suckers
- Remove the affected plants and do not take up ratoon and inter crops
- Drench the petioles, furled leaves, whorls or young suckers with soapy water or insecticidal soap
- Spray dimethoate (75ml/100lit) or acephate (1.3g/lit) on infested plants and suckers
- Use of braconid wasps, *Lysiphlebius testaceipes* as parasitoid
- Releasing of predators such as lady bird beetles and lace wings
- Application of bio control agent *Beauveria bassiana* in the banana fields

### Corm Weevil (*Cosmopolites sordidus*)

#### Symptoms
- The young grub tunnels into the base of suckers, roots and rhizome/corm.
- Presence of larval tunnels on the entire length of pseudostems.
- Yellowing and withering of leaves, reduced plant vigour, root destruction, reduced fruit production and are easily blown over by the wind.

#### Pest Identification
- **Egg:** White colour, elongate to oval, about 2 to 3 mm long and present on upper part of rhizome
- **Grub:** Legless grubs, creamy white with red head having strong mouthparts, stout and distinctly curved.
- **Pupa:** They are white and found in corm tunnels.
- **Adult:**
  a. Weevils newly emerged are red brown which turns almost black after a few days, hard-shelled having a long curved snout and about 10 to 16 mm long.
  b. They are active at night, may live up to two years but are very sensitive to dehydration and will die within 48 hours if kept in a dry substrate.

#### Biology of the pest

Females lay eggs singly in small cavities at the base of pseudostem, in the upper part of the corm, in roots near the soil surface and at the end of cut stems (stumps). They hatch after 6 to 8 days and pupation takes place in holes bored by the grubs and adults emerge from the pupae 5 to 7 days after pupation.

#### Management practices
- Practice clean cultivation with the suckers pruned periodically and infested clumps are removed and destroyed
- Crop rotation with non host crops like paddy and sugarcane
- Ensure proper fertilization and weed removal
- Use of pheromone trap @ 16 traps /ha
- Disc-on-stump traps can be used for trapping weevils.
- Application of bio control agents, Beauveria bassiana and Metarhizium anisopliae, causes more than 90% mortality of the weevils
- Application of carbofuran 3G @ 40g or rugby 10G @ 10g/plant neem cake @ 500 g/plant at planting and then at three months after planting.
- Sucker dipping in triazophos solution (2.5 ml in 1 lit water) for about 20 minutes kills the eggs and grubs
- Remove the entire plants after harvest and treat the pit with carbaryl (1g/lit) or chlorpyrifshos (2.5ml/lit)

## Stem Weevil / pseudostem borer (Odoiporus longicollis)

### Symptoms
- Presence of small pinhead-sized holes on the stem.
- Jelly exudation on the stem is the initial symptom of damage.
- Due to secondary infection of pathogens, rotting occurs and a foul odour is emitted.
- After flowering, when tunnelling occurs in the true stem and peduncle, the fruits do not develop properly.

### Pest identification
- **Egg:** Creamy, cylindrical with rounded ends.
- **Grub:** They are fleshy, yellowish white dark brown head and apodous.
- **Pupa:** Pupate in fibrous cocoon, pale yellow colour and is exarate.
- **Adult:** Brownish black and measure 23-39 mm.

### Biology of the pest

Gravid females lay eggs at random on cut ends of pseudostem. The incubation period ranges from 3 to 8 days. The larvae pass through five instars with the fifth instar larvae entering a non-feeding pre-pupal stage and after 15 days of pupation, adult emerges. The total life cycle completes about in 55-60 days.

### Management practices
- After harvesting the bunch, remove the Pseudostem from ground level and destroy them in order to avoid it serving as a breeding site for the pest.
Pests of Fruits (Banana, Mango and Pomegranate)

- Uproot and burn infested plants.
- Use Disc-on-stump or longitudinal Pseudostem traps @ 100/ha for trapping weevils.
- Swabbing with chlorpyripos 2.5ml/l + adjuvant 1ml/l on the stem prevents infestation of banana stem weevil.
- When jelly exudation is noticed, inject 2ml triazophos solution (350 ml in 150 ml water). Two injections per plant at 2 and 4 feet above the ground level till flowering. The injection needle should enter only two or three leaf sheaths and should not touch the central core.

Burrowing Nematode *(Radopholus similis)*

**Symptoms**

- Reddish-brown to black, elongated discoloured area seen parallel to the root axis which eventually blacken and die.
- Lack of vigour in infested plants and poor fruiting observed.
- Infested plants are readily toppled and the roots get exposed.

**Biology of the pest**

The nematode is a migratory endoparasite, which completes its life cycle in about 21 days at 25°C in the root corm tissues. Females and juvenile stages both attack and enter host roots, especially near the tip of the roots. Males do not feed, as their stylets are weak. Females lay an average of 4-6 eggs each day.

**Management practices**

- Crop rotation with non host crops
- Adopt soil solarization.
- Remove all the black or discolored spots on the corm and root tissue, leaving only clean white tissues
- Grow marigold as repellent and trap crop in the inter space
- Use of neem cake @ 500g/ plant along with anyone of the bioagents *Trichoderma viride/ Paecilomyces lilacinus/ Pseudomonas fluorescens* @ 20 g/ plant.
- Application of carbofuran @ 50 g/ plant.
- Nematicide rugby 10G applied at 10g/ plant during 3rd and 5th month reduced the nematode population and increased the yield.
Major diseases

Sigatoka Leaf Spot (*Mycosphaerella eumusae*)

**Symptoms**
- Small, pale spots on leaves that turn dark purplish black with grey centres
- Disease more prevalent on shallow, poorly drained soil
- Severity of symptoms depicts burnt appearance of leaves
- Poor filling and quality of bunches
- Fruits don’t mature uniformly

**Pathogen dissemination**
- Wind, rain water and old dried infected leaves carrying conidia help to spread the disease

**Management practices**
- The field must be kept weed free and clean. Follow either hand weeding/harrowing till 5 months after planting or use herbicide- glyphosate 7-10 ml/litre of water + 25 g of urea or ammonium sulphate/tank or by intercropping with cowpea.
- While planting, optimum/recommended spacing (1.6 M X 1.6 M) must be followed
- Provide adequate drainage facility whenever it is required
- Apply only the recommended dose of fertilizer - N, P, K g/plant (200:40:400) as per the schedule + 25g azospirilium + 25 g phosphorussolublizing bacteria. Application of Neem cake @0.5 to 1 kg/plant may also be applied. Potash can be applied 10 to 20% more. Micronutrient mixture 10 g/plant in 3rd month and 5th month after planting must be applied.
- Remove of disease infected leaves or part of leaves & destroy it outside the orchard
- No dried leaves should be hanging around the plant
- The following pesticides may be applied as soon as the symptom appears on the leaves. The interval between two sprays may be 20 to 25 days
  - a) Mineral oil 10 ml + propiconazole 0.1% (1ml per litre of water)
  - b) Mineral oil 10 ml + carbendazim 0.1% (1g per litre of water)
  - c) Mineral oil 10 ml + tridemorph 0.1% (1g per litre of water)
  - d) Mineral oil 10 ml + companion 0.1% (1g per litre of water)
e) Mineral oil 10 ml + propiconazole 0.1% (1ml per litre of water)
f) Mineral oil 10 ml + carbendazim 0.1% (1g per litre of water)
g) Mineral oil 10 ml + tridemorph 0.1% (1ml per litre of water)
h) Mineral oil 10 ml + propiconazole 0.1% (1ml per litre of water)

Note:
1. When oil (Banole – banana spray oil) is used no sticking agent is required
2. Spray must be done in such a way that the spray should cover a) both the side of the leaves, and b) all the leaves including the top most unfurled leaf.
3. Only the recommended dose of chemicals should be applied to avoid development of resistance to fungicides, to reduce the cost of cultivation, to reduce the environmental pollution and also to avoid residue problems in the produce.

Anthracnose (Colletotrichum musae)

Symptoms
- Small, circular, black spots develop on the affected fruits.
- At the initial stage dark brown patches on immature fruits
- Severe infestation leads to shriveled and black coloured rotten fruits covered with pink spore masses, which gradually spreads and affects the whole bunch.

Pathogen dissemination
- Air-borne conidia and numerous insects visiting banana flowers spread the disease.
- High atmospheric temperature, humidity, wounds and bruises caused in the fruit and susceptibility of the variety favours disease development.

Management practices
- Adopt clean cultivation and maintain proper field sanitation.
- Harvest bunches at correct stage of maturity.
- When all the hands are opened, the distal bud should be removed to prevent infection.
- Transported bunches should be stored carefully at 14ºc without causing any bruises.
- Avoid contamination in collecting places, during transport and in ripening rooms.
- Preharvest spray with carbendazim 0.1% two times at monthly interval.
- Postharvest dipping of fruits carbendazim 400 ppm or benomyl 1000 ppm.
Banana Bract Mosaic Virus (BBMV)

Symptoms
- Presence of spindle shaped pinkish to reddish streaks on pseudostem, petiole, midrib and peduncle
- At emergence, suckers exhibit unusual reddish brown streaks and separation of leaf sheath from central axis
- Crowding of leaves at crown which appears like palm leaf frill with elongated peduncle and half filled hands.

Pathogen dissemination
- Aphid vectors such as *Aphis gossypii*, *Pentalonia nigronervosa* and *Rhopalosiphum maidis* transmit the disease.
- Disease spread is also through suckers.

Management practices
- Use disease free planting material.
- Rouging of diseased plants.
- Practice clean cultivation and remove weeds which might harbour virus
- Control of insect vector by spraying dimethoate (75 ml / 100 l) or acephate (1.3 g/l).
- Apply more amount of organic manures especially cakes and 25% more of recommended fertilizers

Banana Bunchy Top Virus (BBTV)

Symptoms
- Yellowing of leaf margin initially and dark green streaks on the leaves.
- New leaves emerge with difficulty, are narrower than normal, are wavy rather than flat, and have yellow (chlorotic) leaf margins.
- Leaves form a bunch at the top.
- Usually fruiting doesn’t occur in severely infected banana plants but if produced, the banana hands and fingers are likely to be distorted and twisted.
Pathogen dissemination
- The virus concentration is more in phloem sap.
- It is transmitted by infected suckers and banana aphid.

Management practices
- Use of virus free planting materials.
- Rouging and removal of infected banana plants.
- Practice clean cultivation.
- Avoid banana cultivation in sugarcane and cucurbitaceous areas as sugarcane mosaic virus or cucurbit mosaic virus can easily spread to banana.
- The diseased trees should be injected with 4 ml of fernoxone solution (50g in 400 ml of water) or insertion of fernoxone capsules (containing 200 to 400 mg of chemical per capsule) into the pseudostem to kill the virus infected plants.

Cigar End Rot (*Verticillium theobromae*)

Symptoms
- Black necrosis from the perianth to the tip of immature fruits causing shrinkage and folding of the tissues.
- Fingers that appear rotten are full of grey conidia, which look like the ash of cigar.

Pathogen dissemination
- Warm and moist conditions favour the disease occurrence and the disease spread is high in old and badly maintained plantations.

Management practices
- Avoid overcrowding of plants ensuring enough aeration in plantations.
- Young bunches should be exposed to light and air and the stray bracts should be removed especially during wet weather.
- Improved sanitation helps in the reduction of the disease.
- Removal of pistil and perianth by hand immediately after the fruits are formed.
- Pistils should be removed 8 to 11 days after bunch emergence.
- Spraying the peduncle with carbendazim at 0.1% after shoot emergence.
Erwinia Rot (*Erwinia carotovora*)

**Symptoms**
- Affected young suckers show rotting and emits foul odour.
- The rot progresses up the Pseudostem causing internal decay often with vascular discoloration.
- If affected plants are pulled, it comes out from the collar region leaving the corm with their roots in the soil.
- Infection at late stage shows splitting of Pseudostem in some cultivars.
- Yellowish to reddish ooze seen when affected plants are cut open at collar region.
- Soft rotting may spread radially towards growing point through the cortical tissues.

**Pathogen dissemination**
- The pathogen being soil borne enters through wounds and also through leaf sheath of suckers.
- Hot and damp weather with plenty of rainfall trigger the disease development.
- Water is required for the bacteria to invade into the plant.

**Management practices**
- Use disease free suckers for planting.
- Removal and destruction of infected plants.
- Rainy season planting should be avoided.
- Grow sunnhemp or cowpea as intercrop to provide shade to the banana plants.
- Give regular irrigation only in either morning or evening hrs.
- Apply the plants with bleaching powder at 8g/m at 10 to 15 days interval for 2-3 times.

Panama Wilt (*Fusarium oxysporum f. sp. cubense*)

**Symptoms**
- Visual observations show yellowing of lower leaves, longitudinal splitting of Pseudostem and wilting of plants.
- Advanced stages of disease shows plants with a spiky appearance due to prominent upright apical leaves.
The xylem (water conducting) vessels turn reddish-brown as the fungus grows through the tissues.

Pathogen dissemination

- It is a soil borne disease and the fungus enters the roots through the fine laterals.
- Infected rhizomes or suckers, farm implements, irrigation water is responsible for the spread of the fungus.

Management practices

- Grow wilt resistant cultivars in endemic areas and avoid susceptible varieties.
- Use pathogen free suckers and dip in 1% carbendazim before planting.
- Use tissue cultured plants.
- Follow proper crop rotation.
- Practice clean cultivation with proper fertilization, irrigation and weed control.
- Provide good drainage especially during rainy season and use organic soil amendments
- Apply neem cake @ 250 Kg/ha
- Application of bioagent *Trichoderma viride* and *Pseudomonas fluorescens* along with farmyard manure and neem cake.
- Drenching of carbendazim 0.2 % solution @ 2-3 liter / plant in the soil around the plants at monthly interval starting from 1st month of planting.
Major insect pests

Mango hopper (*Idioscopus clypealis, I. nitidulus and Amritodus atkinsoni*)

It is most serious of all the mango pests and prevalent all over the country causing heavy damage to mango crop. Though hopper population exists throughout the year in mango orchards but occasionally it advances during January to April on flowering flush. Also noticed during June-August on vegetative flush. Old, neglected and closely planted orchards that are shady and with high humid conditions favour their multiplication.

Symptoms

- Piercing and sap sucking of tender parts by nymphs and adults causing reduction of vigour that leads to shedding of flower buds, flowers and young fruits.
- Development of sooty mould due to honey dew secretion on leaves gives blackish appearance.
- Hoppers hibernate in the crevices of the barks on the tree.
- During higher infestation periods, characteristic clicking sounds of leaf hoppers can be heard.
- Warm, humid and cloudy climate is most congenial.

Pest identification

- **Eggs** - Cigar-shaped, creamy-yellow in colour. Size: 0.9–1 mm in length.
- **Nymph** - Nymphs greenish with black or brown markings, resemble small adults but without wings. They are very active and hide in flower rachis.
- **Adult** – Golden brown or dark brown resembling to bark colour wedge-shaped. Size: 4–5 mm in length.
  1. *Idioscopus niveoparsus*: dark with wavy lines on wings and three spots on scutellum.
  2. *Idioscopus clypealis*: small, light brown with dark spots on the vertex and two spots on scutellum.
  3. *Amirtodus atkinsoni*: large, light brown with two spots on scutellum.
Biology of pest

Leafhoppers will breed all year round if tender flush is available. The female hoppers insert 100-200 eggs on mid rib of tender leaves, buds and inflorescence. Eggs hatch in two to three days and nymphs develop between 12 to 20 days. The nymphs develop faster during the flowering and fruiting period. The total life cycle occupies 2-3 weeks. They complete 2-3 generations in flowering period itself.

Management practices

- Avoid dense planting, maintain clean orchards, prune overlapping branches and infested shoots.
- Neem based sprays can be utilized at initial stage of hopper population (Azadirachtin 3000 ppm@2ml/l).
- Application of bio-agents, *Metarhizium anisopliae* @ 1x 10⁸ cfu/ml or *Beauveria bassiana* @ 10⁸ cfu /ml on tree trunk once during off season and twice at 7 days interval during flowering season.
- Three to five sprays depending on pest intensity, first spray before flowering with 0.007 % cypermethrin, second at panicle intitiation stage with 0.07 % quinalphos or 0.1 % carbaryl, subsequent sprays with imidacloprid (0.0053%), thiomithaxam (0.005%) or dimethoate (0.03%).

Mealybug (*Drosicha mangiferae*)

In India, it is widely distributed along the Indo-gangetic plains and found in Punjab, Uttar Pradesh, Bihar and Delhi caused severe damage to mango crop. It attacks almost all the plant parts.

Symptoms

- Pinkish nymphs and adult mealy bugs are present on leaves, inflorescence, branches, fruits and fruit stalk.
- The nymphs of this pest suck sap from leaves and inflorescence causing dryness leading to flower drop and negligible fruit set.
- They also secrete honey dew which gives rise to sooty mold attack.
Pest identification

- **Nymph** – They are flat in shape and pink to brown in colour.
- **Adult** – The adult male is small and winged while the female is bigger and wingless. The females can be identified by their flat shape, covered with white flocculent wax covering.

Biology of pest

They complete one generation each year. Females mate and crawl down the tree during the month of April-May and lays egg in the soil in large numbers sheathed in an egg sac. The eggs lie in diapause state in the soil till the return of the favourable conditions in the month of November - December. First instars move to the leaves and molt three times to become adults. Just after hatching the nymphs crawl up the tree. They are considered more important because of their activeness and infestation during the flowering season.

Management practices

- Proper orchard maintenance by removal of weeds that harbor mealy bugs.
- Ploughing of the orchard during November-December.
- Flooding of orchard with water and raking of soil around tree trunk exposes the eggs to sun and natural enemies thereby destroying them.
- Banding of tree trunk with polythene sheets (400 gauge) 30 cm above ground level and just below the junction of branching to obstruct the ascent of the nymphs. Banding should be done well in advance before the hatching of eggs, i.e., around November - December.
- Application of *Beauveria bassiana* product (2g/L) or 5% NSKE around the tree trunk.
- Release of predators, *Menochilus sexmaculatus*, *Rodolia fumida*, *Sumnius renardi* and Australian ladybird beetle, *Cryptolaemus montrouzieri* @ 10-15 No./tree are effective in controlling the nymphs of the mealy bug.
- Application of Methyl Parathion dust 2% @ 250 g per tree in the soil around the trunk during 3rd or 4th week of December.
- Early instar nymphs of the mealy bug can be controlled by spraying of 0.05 % carbaryl from January to March.

Leaf webber (*Orthaga euadrusalis*)

It is a pest that is attaining serious proportions mainly in North India especially in old, crowded orchards where there is excessive shade. Pest infestation begins from the month of April and continues up to December. The species *Orthaga exvinacea* is found commonly throughout the plains of South India.
### Symptoms
- Infestations of leaf webber may begin as early as seedling stage and persist even during flowering and fruiting.
- Webbing of terminal leaves and tender shoots with several caterpillars found inside.
- Caterpillars initially scrap and feed on the terminal leaves within the web and give burnt appearance to leaves.

### Pest identification
- **Larva** - Pale greenish with brown head and prothoracic shield.
- **Adult** - Brown moth with wavy lines on fore wings.

### Biology of pest
The life-cycle completes in 3-4 weeks. Eggs are laid in clusters of about ten on buds and young leaves. After hatching the larvae forms a web around the leaflets and feed on the tender leaves. Pupation takes place inside the webs in silken cocoons. The last generation pupates in the soil around December-January.

### Management practices
- Webbed leaves should be removed mechanically along with larva and pupa and destroyed.
- Pruning of overcrowded branches and proper orchard maintenance.
- Encourage the activity of predators, carabid beetle *Panera lacticincta*, reduvid *Oecama sp*
- Spray carbaryl at 50 WP @ 0.1%, or quinalphos @0.05% when initial infestation is observed.

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### Thrips (*Caliothrips indicus, Rhipiphorothrips cruentatus, Scirtothrips dorsalis*)

Thrips are polyphagous in nature and are widely distributed around mango growing regions.

### Symptoms
- Laceration of leaf tissues as a result of sucking of the cell sap by nymphs and adults.
- Silvery sheen on affected leaves bearing small spots of faecal matter.
- *C. indicus* and *R. cruentatus* feed on leaves and causes stippling on leaves.
- *S. dorsalis* mainly feed on inflorescences and fruits which show discoloured tissues that subsequently turn brown.

*C. indicus* – Larvae are tiny, wingless and pale. Adults are blackish brown with brown and white banded forewings. The eggs are oval and duration of egg instar is slightly longer i.e. 7-10 days. Males are shorter than females.

*R. cruentatus* – Dark brown body, antennae, legs and fore wing pale with the veins and all basically being yellow. Head with complex irregular sculpture, with a transverse ridge near posterior and basal reticulate collar; cheeks sharply incut behind eyes and constricted to basal neck.

*S. dorsalis* – Yellow coloured with dark antennae and dark striping on the lower abdomen, small in size (under a millimeter in length). Duration of egg incubation period is 6-8 days, of larval instars 6-7 days and pre-pupal and pupal stages 2-4 days.

**Biology of the pest**

*S. dorsalis* can complete a life cycle in 14 - 20 days and is capable of reproducing both sexually and parthenogenetically. It typically has 4 - 8 generations per year. Female lays eggs within leaves, flowers or fruits. The larva emerges from eggs deposited on the host plant and feeds during its first two larval stages which then enter a pre-pupal stage and later a pupal stage during which it does not feed.

*Thrips hawaiiensis* and *Thrips flavous* have recently become serious in Konkan region of Maharashtra causing discoloration of fruit rind and fruits become brown.

**Management practices**

- Monitor for thrip infestation by placing sticky traps at regular intervals.
- Neem based pesticides control young nymphs effectively, inhibit growth of older nymphs and reduce the egg-laying ability of adults.
- Control thrips by spraying spinosad 0.0112%
- Promoting natural enemies that include predatory thrips, predatory mites (e.g. *Amblyseius* spp.) anthocorid bugs or minute pirate bugs (*Orius* spp.), ground beetles, lacewings, hoverflies, and spiders.
- If the infestation is severe, spray with either dimethoate (0.15%) or spinosad (0.0112%) or thiamithoxam (0.05%) when incidence noticed.
Stem borer (*Batocera rufomaculata*)

This pest is widely distributed in India and attacks not only mango but also other varieties of fruits.

**Symptoms**
- Grubs feed inside the stem boring upward making irregular tunnels which results in interruption of nutrient and water transport in the tissue.
- Drying of terminal shoot in early stages and severe symptoms causes wilting of branches or entire tree.

**Pest identification**
- **Grub** - Full grown grubs are cream coloured, fleshy and apodous with dark brown head and measure 90 x 20 mm in size.
- **Adult** - Beetle is dark with a fine grayish vestiture and 2 kidney-shaped orange yellow spots on pronotum.

**Biology of the pest**
Eggs covered with a viscous fluid are laid in incisions cut in the bark by females. Full grown grubs are cream coloured with dark brown head and 90 x 20 mm in size. Pupation takes place within the stem. Beetle emerges in July-August. There is only one generation of the pest in a year.

**Management practices**
- Maintain healthy orchard by destroying affected branches along with grubs and pupae.
- Exclude alternate hosts around the vicinity of mango orchards.
- Block the tunnel hole by cleaning and inserting cotton wool soaked in emulsion of DDVP (0.05%) or kerosene/petrol and pack them with mud.
- Carbaryl 0.1% can be swabbed at bimonthly intervals.

Shoot borer (*Chlumetia transversa*)

This pest can be found throughout India and is serious in seedlings and young trees.

**Symptoms**
- Tunneling from top-down wards of the tender terminal shoots.
Stunting of seedlings with terminal bunchy appearance.

Larvae of this moth bore into the young shoot resulting in dropping of leaves and wilting.

Similar symptoms also noticed on panicles.

**Pest identification**

- **Caterpillar**- Young caterpillars are yellowish orange with dark brown pro-thoracic shield. Full grown caterpillars (20-24mm) are dark pink with dirty spots.

- **Adult**- Adult moths are stout grayish brown in colour with wings having wavy lines and measure about 17.5 mm at expanded wings. Hind wings are light in colour

**Biology of the pest**

Female moths lay eggs on tender leaves. Young larvae after hatching enter the midrib of leaves and then enter into young shoots through the growing points by tunnelling downwards. Four overlapping generations of the pest are found in a year and it overwinters in pupal stage.

**Management practices**

- Attacked shoots should be clipped off and destroyed.

- Effective control of the pest can be attained by spraying carbaryl (0.2%) or quinalphos (0.05%) at fortnightly intervals from the commencement of new flush.

- Two sprays at three weeks interval commencing from initiation of new flush of leaves may be required.

**Scale insect (Chloropulvinaria polygonata, Aspidiotus destructor)**

In India mango is attacked by several species of scale insects, the predominant ones being *Chloropulvinaria polygonata*, *Aspidiotus destructor*, *Parlatoria pergandii*, *P.cinerea* and *Lepidosaphes gloverii*.

**Symptoms**

- The vigour of the plants is reduced as both nymphs and adult scales suck the sap of the leaves and other tender parts.

- Secretes honeydew which encourages the development of sooty mould on leaves and other tender parts of the mango plant.

- Flower spikes and fruits may also be infested.
Severe scale infestation tends to adversely affect the growth and fruit bearing capacity of the tree.

**Pest identification**

- Two species of scale insect are most serious in India.
  - *Chionaspis vitis* - White elongate hard scale.
  - *Chloropulvinaria psidii* - Females with white ovisac.
- Adult - White, elongate, hard scale. Male smaller than female. Female scale is oval in shape having transparent skin coat.

**Biology of the pest**

Life cycle is completed in 31-35 days with around ten generations in a year. A large number of eggs are produced by the females and some species also directly give birth to crawlers. Eggs hatch into young nymphs, which resemble mealy bugs and disperse over the plant to new feeding sites on leaves or stems where they attach themselves. Once a feeding site has been selected the scale will not move losing their legs and secreting wax like coating under which they hide.

**Management practices**

- Prune heavily infested plant parts and destroy them immediately.
- Spray imidacloprid 17.8SL (.005%) 2 times (0.04%) or dimethoate (0.06%) at 21 days interval.
- Elimination of ants may allow natural enemies to control the insect.

### Termites (*Odontotermes* sp.)


**Symptoms**

- The worker termites feed on roots, shoots and trunks of the mango tree moving upward making the tunnels.
- Mud galleries on tree trunk which when nudged shows the damage caused due to feeding of tissues inside.
Pest Identification

- Termites are white in colour, prefer darkness and remain underground.
- They feed on root or move upward making the tunnels with the construction of mud galleries on tree.

Biology of the pest

The larvae having hatched from the eggs turn into nymphs that then develop into one of three adult phases: reproductive adults, workers or soldiers. The queen of a colony can lay up to 1,000 eggs per day.

Management practices

- Orchards should be kept clean and free of all refuse vegetation all the dead and decaying wood should be regularly removed.
- Knock down the mud galleries on trunk and dust with 2% methyl parathion or spray the trunk with Malathion (1.5 ml/l).
- Application of finely ground mahua cake, followed by irrigation, helps to drive away the termites.
- For the control of termites, dusting with 2% methyl parathion at 22 to 27 kg/ha in soil around the infested plants, and raking it into the soil has proved effective.
- Drench the soil with chlorpyriphos (1ml/l) at the base of the tree.

Shoot gall psylla (*Apsylla cistellata*)

It is a serious pest of North India and particularly reported from Uttar Pradesh, Bihar and Terrai regions of northern India. The pest is active from August onwards with the nymphs emerging from eggs during August-September and crawling to the adjacent buds to suck cell sap. As a result of feeding, the buds develop into hard conical green galls which are usually seen during September-October.

Symptoms

- Terminal shoots affected.
- Formation of green conical galls in leaf axis in response to egg-laying by adult insects or feeding by nymphs.
- Development of the green galls results in no flowering and fruit setting.
Pests of Fruits (Banana, Mango and Pomegranate)

Pest Identification
- **Nymphs**: Freshly hatched nymphs are yellowish in colour, but change in size and colour with time
- **Adults**: 3-4 mm long with black head and thorax and light brown abdomen. Membranous wings.

Biology of the pest
It has a single generation per year. Adult females lay eggs into the midrib of leaves in March-April. Eggs hatch in the last week of August. Five nymphal instars are present and nymphal period is 140 days. Second instar nymph migrates to the already formed gall. Adults may live up to 30-72 h.

Management practices
- Galls with nymphs should be collected and destroyed.
- Spray thiomithoxam (0.05%) or quinalphos (0.05%) at fortnightly interval starting from the middle of August.
- New mango orchard in humid region need to be discouraged.

Midge (*Erosomyia indica, Dasineura amraramanjarae, Procystiphora mangiferae and Procontarinia matteriana*)
There are four species of midges prevalent in India with three species attacking blossoms while one attacks the leaf. The inflorescence midge is becoming serious in some pockets of Uttar Pradesh, as well as Maharashtra.

A] Leaf gall Midge (*Procontarinia matteriana*)

**Symptoms**
- Wart-like galls produced on leaves that reduce photosynthetic activity leading to leaf drop and lowered fruit production.
- Infested plant material and wind currents are responsible for its spread.

B] Inflorescence midge (*Erosomyia indica*)

**Symptoms**
- Attacks at flower bud burst stage and fruit set stage during January and May.
- Appearance of black spots on the inflorescence.
Pest Identification

- **Larva** – A maggot light yellowish in colour and moults three times
- **Adult** – a. *Erosomyia indica*: Yellowish fly
  b. *Procystiphora mangiferae*: Light orange fly
  c. *Dasineura amaramanjarae*: Orange red fly

Biology of the pest

Midge flies are very small 1-2 mm in length. Female laying eggs into the tissue of young leaves leaving a small reddish spot. The leaf tissue under the red spot becomes swollen and soft. Within seven days gall formation begins and reaches a maximum diameter of 3-4 mm. From the underside of the leaf adults usually emerge leaving the pupal skin sticking out from the emergence hole.

Management practices

- Deep ploughing of orchard exposing pupae and diapausing larvae to sun’s heat kills them.
- Monitor of larval population and follow effective control measures based on population.
- Spray thiomithoxam (0.05%) or dimethoate (0.05%) at bud burst stage.

Bark-eating caterpillar (*Indarbela quadrinotata*)

This pest is found damaging varieties of trees all over India. Three species of this pest have been recorded in India, viz., *Indarbela quadrinotata* Wlk., *I.tetraonis* M.o. and *I.dea Swinhoe*. *I.quadrinotata* is found in Uttar Pradesh, Maharashtra and Madhya Pradesh.

Symptoms

- Characteristic presence of long-winding, thick, blackish or brownish ribbon-like masses composed of small chips of wood and excreta.
- Larvae also make shelter tunnels inside where they rest. Continuous devouring of the tissues by caterpillars weakens the stem, resulting in drying of the branches and finally of the tree itself.
Pests of Fruits (Banana, Mango and Pomegranate)

**Pest Identification**

- **Larvae**: The full grown caterpillar is dirty brown in colour and is about 35-45 mm in length.
- **Adult**: The moth is light grey in colour with dark brown dots and measures about 35-40 mm with expanded wings.

**Biology of the pest**

Female lays egg below the bark or in between cracks. Eggs hatch in about 8-10 days and the larvae bore into the tree feeding on the bark for 9 – 11 months. There is only one generation per year.

**Management practices**

- Maintain a healthy orchard.
- Clean hole and put emulsion of monocrotophos (0.05%) in each hole and plug them with mud.

**Fruit fly (Bactrocera dorsalis)**

In India, eight species of genus *Bactrocera* are identified among quarantine pests with the oriental fruit fly *B. dorsalis* Hendel being the most destructive fruit fly of mango, followed by Peach fruit fly *B. zonata* Saunders and Guava fruit fly *B. correcta* Bezzi. The flies attack fruits at different stages of maturity but damage is more obvious at harvest period.

**Symptoms**

- Sting marks and bruising to the fruit skin constitute the external damage that later turn to brownish rotten patches.
- Injury to fruit occurs through oviposition punctures by females and subsequent larval tunneling.
- Ripening fruits are more likely to be attacked.

**Pest Identification**

- **Larva** – creamish yellow apodous maggots with a black tooth-like feeding mouthpart.
- **Pupa** – ranges in color from dull red or brownish yellow.
- **Adult** – Reddish brown with transparent wing and with prominent yellow and dark brown to black markings on the thorax.
Biology of the pest

Females lay clusters of 6–10 eggs just under the skin of the fruit. After 1–2 days larvae hatch from the eggs and take 6–8 days to mature. Larvae feed upon the pulp of fruit. The larvae pupate in soil (5-10 cm) and flies start emerging from April onwards with maximum population during May to July which coincides with fruit maturity. The adults emerge after 10–12 days and may live for a few months.

Management practices

- Affected fruits should be collected and destroyed.
- Rake up the soil below the tree and drench with chlorpyriphos 20 EC@ 2.5 ml/ L.
- Setting up of methyl eugenol traps to lure the males in the orchard @ 10/Ha.
- Spraying malathion@ 2 ml + Jaggery@ 10 g/ L or Carbaryl@ 4 g + Jaggery@ 10 g/ L at ripening stage.

Major Diseases

**Powdery mildew (Oidium mangiferae)**

This mango disease is widespread around the world, and in India it is most destructive in the states of Uttar Pradesh, Maharashtra and Karnataka.

**Symptoms**

- White powdery growth of fungus observed on the leaves, inflorescence and young fruits.
- Severe fungal attack eventually leads to dry leaves, resulting in its shedding.
- Young fruits covered by mildew become misshapened, turn yellow, remain undersized and drop-off pre maturely at pea size stage.

**Pathogen dissemination**

The fungal spores are wind-borne and spread from other affected trees or within the same tree. This fungus attacks only the mango crop.

**Management practices**

- Prune plants regularly so as to improve air circulation in the canopy.
- Remove diseased leaves, severely infected panicles and destroy them.
- After the occurrence of high humidity and low temperature for 4–5 days in disease
prone areas, two sprays with wettable sulphur WP @ 0.2%, tridemorph EC @ 0.1% or penconazole @ 0.05%/ hexaconazole @ 0.05% at 15 days interval, could combat the disease very effectively.

**Anthracnose (Colletotrichum gloeosporioides)**

This disease is reported from all mango growing tracks in India particularly in several districts of Punjab.

**Symptoms**

- Almost all plant parts viz., the young leaves, branches, inflorescence and fruits are affected causing leaf spot/leaf blight, wither tip, blossom blight and fruit rots.
- On leaves, characteristic oval or irregular lesions start as small, angular, brown to black spots that shows ‘shot hole’ symptoms when disease advances.
- Appearance of small black spots on panicles and flowers coalesce progressively leading to the death and shedding of flowers.
- The pathogen also produces black necrotic areas on twigs and tip drying of young branches is observed.
- On fruits it is seen as slightly depressed grey-black areas in the skin on ripening fruit

**Pathogen dissemination**

During the dry season, rain and humidity favours disease development. Conidia get dispersed by splashing rains or irrigation water. Spores landing on infection site penetrate into the tissues. Between seasons, the pathogens survive on the infected branches or older leaves.

**Management practices**

- Wider plant spacing, yearly pruning of trees and proper disposal of diseased leaves, twigs and fruits.
- Foliar infection can be controlled by spraying of copper oxychloride (0.3%)/ bordeaux mixture (1%) / carbendazim (0.1%) / methyl thiophenate (0.1%)
- Spraying of carbendazim (0.1%) at 15 days interval can effectively control blossom infection.
Bacterial leaf blight/ spot/ canker (*Xanthomonas campestris pv. mangiferae-indicae*)

It is prevalent in several mango growing regions including Andhra Pradesh, Maharashtra, Karnataka, Kerala, Tamil Nadu, U.P., Bihar, Delhi, Haryana and Madhya Pradesh.

**Symptoms**
- Emerges as tiny black, irregular and dark raised spots with/ without yellow halo. Also found on petioles, twigs and branches that becomes black and leads to tip-dieback.
- Lesions on fruits are black and star-shaped cracks appears which usually burst open with exudation of gummy ooze containing bacteria.

**Pathogen dissemination**
Unseasonable wet situations favour the disease development and the bacteria are harboured in stem cankers or crack which spread to the fruits later on.

**Management practices**
- Maintain clean orchards and use only certified seedlings
- On visual observation of disease, spraying with Streptocycline (100 ppm) or Agrimycin-100 (100 ppm) thrice at 10 days interval

Sooty mould (*Capnodium mangiferae/ Meliola mangiferae*)

Disease commonly found in India where mango orchards are mismanaged and infested with sucking pests such as hoppers, mealy bug etc.

**Symptoms**
- The honey dew secreted by some insects encourages mould growth on them giving a black velvety sooty look.
- The fungus being saprophytic causes no harm by itself but its presence on the leaf surface adversely affects the photosynthetic activity

**Pathogen dissemination**
Air currents or splashing rains bear and spread the causal fungi. The fungi survive saprophytically as mycelium or spores on plant debris. Cool, moist, humid conditions favor some sooty molds.
Management practices

- Preventing the spread of the disease by pruning of affected branches and their timely destruction.
- Due elimination of sucking pests secreting honeydew.
- Effective control by spraying of 2% starch.
- Spraying of wettable sulphur + methyl parathion + gum Acacia@ 0.2 + 0.1 + 0.3%

Mango malformation (different species of Fusarium)

Mango malformation is a serious disease in tropical and subtropical areas of the world and has been attributed to various Fusarium spp. Mango malformation disease is caused by one or more species of the fungus Fusarium. The disease spreads on a tree very slowly, but if left unchecked, can reduce yields in orchards. Mango is the only known host of the disease. It is a result of hormonal imbalance in the trees, induced by the Fusarium infections and associated with bud mite (Aceria mangiferae) infestations.

Symptoms

- Deformation of vegetative and floral tissues.
- Growing tips produce distorted shoots with short internodes and affected leaves smaller than normal leaves giving a compact and bunchy-top appearance while the flowers are sterile and don’t bear fruits.
- Both normal and malformed growth can be present on the plant at the same time.

Pathogen dissemination

The fungus, Fusarium mangiferae produces both macro and micro spores which are the infective propagules. The main spread of mango malformation disease to new areas is by infected pruning equipment or grafted planting material. The bud mite, Aceria mangiferae is also shown to spread the disease within a tree and not between trees.

Management practices

- Orchards may be kept in good hygienic conditions and disease free planting material be used for planting.
- Regular pruning of malformed panicles and parts along with affected shoots.
- Simple, effective and eco-friendly control can be attained by using leaf extracts of...
neem tree and common weeds namely *Datura stramonium*, *Calotropis gigantea* etc.

- Since this disease is the result of various agencies, an assortment of management practices are followed as – application of pesticides, plant growth regulators, nutrients, phenolics etc along with pruning, de-blossoming.

### Dieback / Gummosis (*Lasiodiplodia theobromae*)

The disease is observed all year round but is most evident during June, July and August and low during cool months from November to February. Disease is accompanied by damage caused by trunk borers Resembling *Batocera reformaculata*. It is a common soil-borne saprophyte or wound parasite, distributed throughout the tropics and subtropics.

**Symptoms**

- Characteristic leaf drooping and drying that leads to defoliation lending a scorched look to the tree.
- Trees exude gummy stuff from the bark of their trunks or branches and vascular tissues are discolored.

**Pathogen dissemination**

Main spread is through diseased plant parts, contaminated equipment and inoculum present in the field.

**Management practices**

- Use of disease free propagating material.
- Pruning and disinfection of infected branches.
- Avoid planting alternate host trees in the vicinity of orchards.
- Application of cowdung or copper oxychloride paste on pruned ends.
- Proper disposal and burning of affected branches
- Two foliar sprays with topsin-M (Thiophanate-methyl) @1 g/ L or foliar spray with carbendazim @ 0.1%, or chlorothalonil @ 0.2% at fortnightly interval

### Phoma blight (*Phoma glomerata*)

This disease is more prevalent in and around Lucknow region.

**Symptoms**

- Mainly older leaves show the symptoms of the disease.
- Small irregular lesions yellow to light brown found scattered over the leaf lamina at initial stage.
- Enlarged lesions are characterized by dark margins and dull grey necrotic centres and under severity defoliation occurs.

**Management practices**
- At initial stage of disease, spray benomyl (0.2%).
- The disease can be effectively controlled by spraying copper oxychloride (0.3%) at fortnightly interval.

### Red rust (*Cephalteuros virescens*)

**Symptoms**
- Disease caused by algae whose attack on leaves cause reduction of photosynthetic activity thereby lowering the vitality of plant.
- Greenish grey spots, velvety in texture found on leaves which later turn reddish brown.
- Disease found commonly in closely planted orchards.

**Pathogen dissemination**
- Poor nutrition, poor growing conditions and other stresses. Dense canopy and wet humid environment are some of the pre-disposing factors of the diseases.

**Management practices**
- Balanced nutrient supply reduces the disease.
- Two to three sprays of copper oxychloride (0.3%) is effective in controlling the disease.
- Use of Bordeaux mixture (1%).
- Cut badly infected branches from the tree.

### Black banded disease (*Rhinocladium corticolum*)

**Symptoms**
- Black velvety fungal growth on midribs, twigs and branches of mango tree forming black bands
Management practices
- Removal of black growth by rubbing.
- Application of Bordeaux paste/ Copper oxychloride paste and spraying of Bordeaux mixture (1%)/ Copper oxychloride (0.3%).

Physiological Disorders

Black tip

Symptoms
- Found in orchards in the vicinity of brick kilns.
- Coal fumes from brick kiln releasing gases like carbon monoxide, sulphur dioxide and ethylene are responsible for black tip.
- Characteristic depressed spots leading to yellowing tissues of the distal end of the fruit that turn black finally.

Management practices
- Planting of mango orchards away from the brick kilns may reduce incidence
- Spray 1% borax at the time of fruit set, followed by two more sprays at 10 days
- Sprays of washing soda (0.5%) and caustic soda (0.8%) are good in minimizing the disorder.

Red nose (cause not known)

Symptoms
- This problem is prominent in late maturing select varieties like Neelam and Mallika when they are harvested late resulting in considerable loss.
- Fruits with red nose are unfit for marketing and steadily become soft and rot.

Management practices
- Harvesting of fruits at appropriate time.
- Provision of proper plant nutrient.
Woody stem gall (cause not known)

Symptoms

- Woody galls sized 10-15 inches found on branches and are more prone in select varieties

Management practices

- Sawing out the galls and applying Bordeaux paste to cut surface

Nutritional Disorders

Potassium deficiency

Symptoms

- Leaf margins have a scorched look which starts from tip downwards lending a burnt look to the foliage and subsequently affecting fruit quality.

Management practices

- Deficiency can be overcome by application of 1Kg muriate of potash along with 2 Kg urea and 6 Kg super phosphate.

Zinc deficiency

Symptoms

- Young leaves are usually the most affected and are small, narrow, chlorotic and often rosetted due to significant shortening of inter-nodal length.
- Typical zinc deficient leaves show pale inferential areas and green veins.
- Bloom spikes are small, distorted and drooping.
- Zinc deficient trees do not grow well and the yield, size and quality of the fruits are affected.
- Alkaline, saline and sandy soils are more prone to be zinc deficiency.
**Management practices**

- By spraying twice a mixture of zinc sulphate (5 g) + urea (10 g) / L water, one at the time of flowering and the other at one month after the first spray, zinc deficiency can be overcome.

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**Iron deficiency**

**Symptoms**

- Leaves look bleached losing their natural colour, luster and with reduced size.
- Leaves have a mesh of green veins contrasting with the yellow of the lamina.
- Leaves dry from tip downwards, in severe cases of iron deficiency.
- The deficiency is widespread in soils with high calcium content.
- Excessive amounts of manganese in poorly drained soils can induce iron deficiency in plants.

**Management practices**

Two sprays of ferrous sulphate (2.5 g/ L) at fortnightly interval.

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**Boron deficiency**

**Symptoms**

- Small leaves of pale green colour on shortened internodes.
- Causes death of the apical bud, resulting in excessive number of lateral buds.
- The floral panicles are smaller and have fewer hermaphroditic flowers.
- Fruit cracking is a characteristic symptom of boron deficiency and develop prominent brown areas in yellow fruit pulp.
Management practices

- Two foliar sprays of borax (1%) at pea stage at 15 days interval or 100 g borax/ boric acid per tree.
- Application of boron @250 g/ tree (10-15 year old) around the tree basin with recommended dose of manures.

Copper deficiency

Symptoms

- Occur frequently on young trees due to heavy nitrogenous fertilization.
- Tip burning of old leaves with grey brown patches is the typical symptom.
- Terminal shoots appear weak followed by defoliation and die back of branches.
- Causes long, tender and ‘S’ shaped branches and leaves with downward curls.
- Boil-like eruptions are caused on the branches.

Management practices

- Spraying of 0.3% copper sulphate checks the disorder effectively.
- Spraying of Fe (0.1 %) and Cu (0.1%) reduced spongy tissue in mango

Salt injury / toxicity

Symptoms

- Due to excess salt in soil or irrigation water the leaves are scorched and turn bronze losing their natural colour.
- Severe cases of salt injury results in tip burning.

Management practices

- Adequate application of FYM and compost every year.
- During tree bearing years intercropping with dhaincha as green manure crop in the orchard during onset of monsoon and their incorporation into the soil after one month growth.
- Gypsum filled gunny bag if kept in flowing irrigation water will reduce salt effect.
Major insect pests

Pomegranate fruit borer (*Deudorix isocrates*)

Pomegranate fruit borer is distributed all over India and Asia. It is the most widespread, polyphagous and destructive pest of pomegranate. The adult female lays egg on buds, flower and young fruits. On hatching, the caterpillar bores into the fruit and feeds on the pulp. The fruits then rot and drop off on the soil. The adult males are glossy bluish and brownish violet and in case of females a conspicuous orange patch on the forewings is seen. The damage of fruit borer is seen throughout the year irrespective of the *bahar*.

**Symptoms**

- The female butterfly lays eggs on flowers, buds and the calyx of developing fruits, after hatching, caterpillars enter the fruit and feed on the pulp.
- The striking symptom is the odious smell and excreta of caterpillars coming out of the entry holes ultimately leading to fruit rot.

**Pest identification**

- **Egg**: They are laid singly on tender leaves, stalks and flower buds.
- **Larva**: Full-grown larvae are dark brown with short hair and white patches all over the body and measures about 16 to 20mm long
- **Pupa**: Pupation occurs either inside the damaged fruits or on the stalk holding it
- **Adult**: Adults are glossy bluish in the case of male and brownish violet in the case of female with a conspicuous orange patch on the forewings.
Biology of the pest

Adults lay eggs on the stalks or flower buds with incubation period lasting 7-10 days. The larva hatches and bores into the fruit with the larval period lasting for 18-47 days. Pupation lasts for 7-34 days and the life cycle is completed in 1-2 months.

Management practices

- Remove and destroy the affected fruits.
- Clip off calyx cup immediately after pollination followed by two applications of neem oil @ 3 %.
- Before maturity, bag the fruits with butter paper.
- At flowering stage, spray NSKE 5% or neem formulations 2 ml/l.
- Spray deltamethrin 2.8 EC (1.5 ml/litre of water) at fortnightly interval from the stage of flowering to fruit development.
- Spray malathion 50 EC 0.1% or methomyl 40 SP @ 1.0 ml/l or azadirachtin 1500 ppm @ 3.0 ml/l at 15 days intervals commencing from initiation of flowering up to the harvesting subjected to the presence of fruit borer.

Thrips (Scirtothrips dorsalis and Rhipiphorothrips cruentatus)

Thrips, *S. dorsalis*, always prefer feeding on new growth of plants. This species is pale yellowish in colour and seen with two black stripes on the body. *S. dorsalis*, remain associated during all the three bahars of the pomegranate. Nymphs and adults lacerate and suck the contents of buds, flowers, leaves and fruits.

Symptoms

- Leaf tips turn brown and get curled due to the feeding of thrips on the underside of the leaves by rasping the surface and sucking the oozing cell-sap leading to drying and shedding of flowers.
- Scrapping on fruits leads to scab formation, reducing market value.
Pest identification

- **Egg**: Dirty white bean-shaped  
- **Nymphs**: Newly hatched nymphs are reddish and turn yellowish brown as they grow  
- **Adults**:  
  - *Rhipiphorothrips cruentatus* - Minute, slender, soft bodied insects with heavily fringed wings, blackish brown with yellowish wings and measure 1.4 mm long.  
  - *Scirtothrips dorsalis* - Straw yellow in color.

Biology of the pest

Female lays on an average 50 eggs on the under surface of leaves. The incubation period is 3-8 days. Pupal period lasts for 2-5 days.

Management practices

- Do not intercultivate crops like chilli and onion.  
- Remove and destroy affected plant parts  
- Use of blue sticky traps @ 1trap / 10 plants  
- Spray with acetamiprid 20 sp @ 0.005% to 0.01% i.e. 25 to 50 g /100 L or spinosad 45 SC @ 0.25 ml/L i.e. 25 ml/100 L or NSKE 5% or *Verticillium lecani* (2x10⁸ cfu/g) @ 200 g / 100 L starting from prior to flowering at the interval of 10 days.  
- Spray chloropyriphos @ 0.02% or imidacloprid @ 0.04% or deltamethrin @ 0.15 or dichlorovos @ 0.05% as prophylactic or on observing the symptoms.  
- Spray dimethoate 0.06% prior to flowering. In severe conditions, spray methyl oxydemeton 0.05% and repeat after fruit set.

**Stem borer (Coelosterna spinator and Zeuzera sp.)**

It is a polyphagous pest of minor importance boring the stems and trunk of pomegranate trees. It prefers breeding in dead wood but also attacks the living branches. The grubs of stem borer bore into the cambium then girdle the stem or branch causing death of the tree.

**Symptoms**

- Holes made by grubs are seen on bark of main stems. Grubs feed internally on sapwood while adult beetles are active by the day and feed by gnawing the green bark of shoots.  
- Usually, excreta and dry powdered material is seen near the base of plants.

**Pest identification**

- **Adult**: Beetles *C. spinator*, have pale yellowish-brown body with light grey elytra and are 30 to 35 mm long.
Biology of the pest

Egg period is 12 to 15 days, grub 9 to 10 months and pupal period is 16 to 18 days. There is only one generation per year and longevity of beetles is 45 to 60 days.

Management practices

- Treat the holes by injecting with fenvalerate 5ml/L or dichlorvos 10 ml/L and seal holes with clay.
- Spray quinalphos (0.05%) or chlorpyrifos (0.05%).

Bark-eating Caterpillar (Indarbela sp.)

Peak activity period of bark eating caterpillar is September to October. Indarbela sp. is a polyphagous insect that feeds on a range of trees. The caterpillar bores the stem and feeds the bark of the tree at night. Several holes can be seen on the trunk at the joints of the branches. Neglected and ill-managed orchards witness the heavy infestation of this pest. The tunnelling causes weak points on the trees where breakage occurs affecting the vitality of the trees badly.

Symptoms

- Holes or zigzag tunnels are bored by the caterpillar on the tree trunk and it feeds inside the bark.
- Around the affected portion wood dust and excreta pellets can be found hanging in the form of a web.
- Beneath fresh webbing, brownish larvae can be seen.
- Severe infestation may damage the whole stem/plant and lessen production.
Pest identification

- **Egg**: They are oval, reddish in colour and larva: caterpillars are pinkish white with brown spots and are about 40 mm long.
- **Pupa**: Pupae are chestnut-brown in colour and 22 to 28 mm long.
- **Adult**: Moths are white with pairs of small black dots on thorax, numerous small black spots and streaks on fore wings and few black spots on posterior edges of hind wings.

Biology of the pest

Eggs are laid in clusters of 15-25 under loose bark or in cracks and crevices from April to June. They hatch in 8-11 days with the larval duration of 9-10 months. Pupal period extends to 3 to 4 weeks. Total life cycle lasts 4-5 months in south India and more than a year in north India. It completes one generation per year.

Management practices

- Maintain clean orchards by avoiding overcrowding of trees
- Clean the webs around the affected portion and inject kerosene oil into the holes and seal with mud.
- Inject larval holes with quinalphos @ 0.01% or fenvalerate @ 0.05%.
- Spray with carbaryl @ 0.04% or dichlorovos @ 0.08% on the stem or on affected part.

Major Diseases

### Bacterial blight (*Xanthomonas axonopodis pv. punicae*)

Bacterial blight has been of wide occurrence in India, resulting in economic losses in all major pomegranate growing areas of Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, Himachal Pradesh and Rajasthan. Outside India it is reported from Pakistan and South Africa.

Disease build up is rapid during rainy season. High disease severity is observed from July to October. Temperatures between 25 to 35°C coupled with humidity above 50%, rains and wind favour rapid disease development. The disease affects all plant parts, but is most destructive on fruits.

**Symptoms**

- On leaf the disease appears in the form of regular to irregular dark brown to brown-black necrotic spots, surrounded by a yellow hallo or a water soaked margin. The infected leaves turn yellow and drop on the ground.
On twigs and branches, brown to black water soaked lesions start around the nodes. These lesions develop into large cankers and may break on a slight pressure.

On fruits disease starts with water soaked lesions on the skin surface, which turn dark brown to black. Spots enlarge and merge with each other to cover large area; however, infection is restricted to the rind. Small cracks appear on the spots and in severe cases entire fruit splits open along the lesions. The spots may be covered with thin shining white encrustation consisting of bacteria.

Survival and Dissemination

- This bacterium can survive on infected plant debris lying in and around the orchards for more than 8 months.
- It can also survive for several years on stem cankers on plants in orchard or in dormant buds; these are major sources of primary inoculum for next crop season.
- It cannot survive in soil for more than 25-30 days without its host.
- Planting material prepared from a blight affected orchard or air borne inoculum from neighbouring infected orchard during rainy season is a primary source of inoculum in new area.
- The secondary spread of bacteria is mainly through rain and spray splashes, irrigation water, pruning tools, man and insect vectors.

Management practices

- Plant new orchard with disease free planting material
- Adopt orchard sanitation, proper plant nutrition and irrigation, cultural practices and chemical spray schedules to check diseases and insect pests.
- Spray Bordeaux mixture (0.5% except 1% just after pruning and rest period), altered with spray of streptocycline (5g/10l) or 2-bromo, 2-nitro propane-1, 3-diol (5g/10l) mixed with copper based formulations like copper oxychloride or copper hydroxide (20-25g/10l) and spreader sticker (0.5ml/l) at 10-15 days interval depending on weather conditions. Depending on fungal problems present in the orchard copper based formulations may be replaced with appropriate fungicides.
Pomegranate wilt: (Ceratocystis fimbriata, Xyleborus fornicates and X. perforans Fusarium oxysporum, Rhizoctonia solani and Meloidogyne incognita)

Wilt is the second most important disease of pomegranate, adversely affecting pomegranate cultivation in India. The disease has been reported from Maharashtra, Karnataka, Andhra Pradesh and Himachal Pradesh. Pomegranate vascular wilt is mainly caused due to a fungus *Ceratocystis fimbriata* occasionally by other agents like *Fusarium solani and F. oxysporum*. Root rot organisms *viz. Macrophomina phaseolina, Phytophthora nicotianae, Rhizoctonia bataticola*; root-knot nematode *Meloidogyne incognita* and shot hole borer -*Xyleborus fornicates and X. perforans* - are the other agents which, alone or in association with *C. fimbriata* result in drying and wilting of plants.

**Symptoms**

- Initially yellowing of leaves is observed in some twigs or branches, followed by drooping and drying of leaves, finally the entire tree dies.
- Longitudinally or cross-section of root or lower part of affected stem shows dark bluish-black/grey/brown discolouration of the wood is seen if the pathogen is *Ceratocystis, in Fusarium* browning of only xylem is observed.
- Pin holes are observed in the bark and wood when shoot hole borers are associated with wilt.
- *Macrophomina* sp. destroy the feeder roots and result in root rots or *Rhizoctonia* sp. cause girdling of stems in nursery or young plants-resulting in wilting
- In nematode infestations infected plants form knots on the roots.

**Survival and dissemination**

- Thick walled Aleurioconidia of *C. fimbriata*, in soil, host and plant debris are the most common survival structures and primary source of inoculum. The fungus can survive in infected wood for several years.
- Infected Planting material or the soil used for raising the nursery planting material generally are the primary source of infection for wilt organisms
- Pruning wounds are common entry points for *C. fimbriata*, and the fungus can also be carried on pruning tools and through air.
- Spread to adjacent trees can take place via root grafts generally in plantation at close spacing.
- Flood irrigation/rain water also spread the pathogens from the infected plant/s to healthy plants.
- Wounds in the roots made by insects, nematodes and rodents also predispose the plant to wilt pathogens.

**Management practices**
- The planting material (sapling as well as soil in which it is planted) should be free from all wilt organisms.
- Before planting solarize the soil or sterilization with formalin (50 ml/l).
- Avoid water stagnation and create proper drainage.
- Follow recommended spacing of 4.5 m × 3.0 m in the orchard.
- On observing first symptoms of wilt due to fungal pathogens in the orchard immediately drench soil with chlorpyriphos 20EC (2.5-4ml/l) + carbendazim 50WP (2g/l) or propiconazole 25EC (2g/l) use 5-8 l solution/tree. Also drench at least 2-3 healthy plants on all the four sides around the infected plant/s, repeat the drenching 3-4 times at 20 days interval.
- For root knot nematodes apply carbofuran 3G @40g/plant or phorate 10G @ 25g/plant in wet soil. Drenching with azadirachtin 1% @ 2ml/l. Plant *Tagetes erecta* (African marigold) between plants in a row, or in a ring, on the border of plant basin, for more than 4-5 month.
- For shot hole borer (*Xyleborus* spp.), 10 litres preparation containing red soil (4kg) + Methyl parathion 4% dust (25g) + Chlorpyriphos 20EC (20ml) + Copper oxychloride (25 g) needs to be applied on plant base up to 1-2 ft. from second year onwards.

**Physiological disorder**

The three common disorders – fruit cracking, sun scald and aril browning are common problem in dry seasons and regions of India.

**Fruit cracking**

**Symptoms and causes**
- The fruits can split/crack open and arils are exposed without any biotic cause.
- Rains or irrigation after a long dry spell result in cracking of fruits.
Boron deficiency, calcium and potash deficiency indirectly contribute in cracking, however, improper irrigation is the major cause.

Maximum cracking is in *Ambe bahar* followed by *Hasta* and lowest in *Mrig bahar*.

**Management practices**

- Cultivate tolerant varieties
- Irrigate the plants from fruit setting to maturity, with adequate quantity of water at regular intervals.
- Give two sprays of boron @ (2 g/litre) at fruit enlargement stage and before fruit harvest.
- Apply calcium and potash as per soil test values. This helps to reduce cracking during water stress.

**Sun scald**

**Symptoms and causes**

- Surface skin of fruits facing afternoon sun turns brown or bronze colour and may also become dark brown due to scorching, underneath skin is normal.
- High temperature along with excessive light, drought, and low relative humidity is usually responsible for sun scald injuries.
- The damage is more in open canopies

**Management practices**

- Protect the fruits from direct sunlight by bagging/ covering.
- Avoid very heavy pruning and develop good canopy by proper pruning and plant nutrition to provide shade to fruits.
- Spray kaolin thrice at 15 days interval during hot summer months. First spray of 5% and next two of 2.5%. If heavy rain or winds occur spray interval can be reduced.

**Internal Breakdown / Aril dicolouration**

**Symptoms and causes**

- It is a serious problem of some cultivars.
The apparently healthy looking fruits when cut open reveal discoloured mushy arils.

The arils become soft, light creamy-brown to dark blackish-brown and unfit for consumption.

The problem is seen mostly after 90 days of fruit set and severely increases if left on tree for more than 140 days.

It is more common in dry hot season.

**Management practices**

- Give proper irrigation to maintain proper humidity
- The fruits should be harvested as soon as they mature.
- Management strategies used for other disorders may also help in reducing the problem.
Implementation of electronic -pest (e-pest) surveillance

Surveillance Plan

Cultivation of mango, pomegranate and banana is adversely affected due to damage by one or more of the above documented pests but a few pests such as Sigatoka leaf spot and thrips in banana, hoppers, thrips, powdery mildew and anthracnose in mango and bacterial blight, wilt, fruit borer and thrips in pomegranate were considered most important leading to economic losses and force the farmers to make repetitive sprays. To change from the situation of repetitive sprays to Economic Threshold Level (ETL) based application of pesticides, constant watch is required on pest activity. It was made possible with the help of information technology that helped to develop an e- pest vigilance/ surveillance programme by recording pest activity data with the help of scouts and pest monitor employed by Department of Horticulture, Govt. of Maharashtra. The pest data recorded is fed in to the system and subsequently transferred to centralized server located at NCIPM, New Delhi. Consultative meeting of all the identified partners under CROPSAP (Horticulture) finalized the structure of pest surveillance plan, ETL’s and guidelines for pest scout/monitor were also framed. Observations were recorded on weekly basis as per plan (Table 1). Pest surveillance programme was implemented in nine districts of Maharashtra i.e. Sindhurg, Raigarh, Ratnagiri, Thane for mango; Solapur, Nashik, Sangli and Ahmednagar for pomegranate and Jalgaon for banana covering 184643 ha (Table 2). These data are archived, reviewed and approved by district horticultural officer and based on the extent of damage, pest advisories are issued by respective crop experts of MPKV, Rahuri and Dr. BSKKV, Dapoli and disseminated to the farmers through SMS for timely action on part of the farmers by state department of Horticulture on the basis of Economic threshold levels (Table 3) available for the important pests as mentioned above.

Table 1: Surveillance plan (observations on weekly basis)

<table>
<thead>
<tr>
<th>Day</th>
<th>Surveillance schedule of pest scouts &amp; data entry operators (DEO)</th>
<th>No. of orchards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>Two fixed orchards and two random orchards /village in two villages by one scout. Scouts would look for presence of pests and outbreaks for general reporting under pest alerts.</td>
<td>8</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Two fixed orchards and two random orchards /village in two villages by one scout.</td>
<td>8</td>
</tr>
<tr>
<td>Wednesday</td>
<td>Data entry operator (DEO) to enter data collected on previous two days + documentation of data (Geographical, Cropping System and Agronomic details ).</td>
<td>16</td>
</tr>
<tr>
<td>Thursday</td>
<td>Two fixed orchards and two random orchards /village in two villages by one scout.</td>
<td>8</td>
</tr>
<tr>
<td>Friday</td>
<td>Two fixed orchards and two random orchards /village in two villages by one scout.</td>
<td>8</td>
</tr>
<tr>
<td>Saturday</td>
<td>Data entry operator (DEO) to enter data collected on previous two days + documentation of data (Geographical, Cropping System and Agronomic details ). Issuing of timely advisories.</td>
<td>16</td>
</tr>
</tbody>
</table>
In this programme, NRC Pomegranate, Solapur, NRC Banana, Trichi, Dr. BSKKV, Dapoli and MPKV, Rahuri are co partners responsible for development of surveillance plan and issue of advisory. NCIPM, New Delhi is facilitating the development of software, GIS maps, data entry and overall coordination of the project activity.

**Table 2 : Area of operation under e-pest surveillance of Banana , Mango and Pomegranate crops (pest scout and pest monitor)**

<table>
<thead>
<tr>
<th>Crops</th>
<th>Number of districts covered</th>
<th>Number of talukas covered</th>
<th>Number of villages covered</th>
<th>Number of days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>1</td>
<td>15</td>
<td>432</td>
<td>48</td>
</tr>
<tr>
<td>Mango</td>
<td>4</td>
<td>45</td>
<td>1659</td>
<td>73</td>
</tr>
<tr>
<td>Pomegranate</td>
<td>4</td>
<td>40</td>
<td>382</td>
<td>76</td>
</tr>
</tbody>
</table>

**Table 3 : Economic threshold levels (ETL) for various pests in banana, mango and pomegranate as per recommendation of universities/NRC**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Pest</th>
<th>Recommended stage of the Spray</th>
<th>Proposed ETL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banana</td>
<td>Sigatoka leaf spot</td>
<td>After appearance of yellow spots on lower leaves</td>
<td>0.1(10 spots/leaf)</td>
</tr>
<tr>
<td></td>
<td>Thrips</td>
<td>At flag leaf stage</td>
<td>Score 2.1 or 1.1% fruit infestation</td>
</tr>
<tr>
<td>Mango</td>
<td>Hoppers</td>
<td>10 Hopper/panicle/vegetative flush</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Thrips</td>
<td>Immediately after appearance of thrips on inflorescences &gt;10/panicle and appearance of scrapping symptoms on fruits.</td>
<td>Score 1.25 on fruits</td>
</tr>
<tr>
<td></td>
<td>Powdery Mildew</td>
<td>After appearance of incidence on panicles</td>
<td>1 Score</td>
</tr>
<tr>
<td></td>
<td>Anthracnose</td>
<td>After appearance of incidence on foliage/fruit/panicles</td>
<td>1 Score</td>
</tr>
<tr>
<td>Pomegranate</td>
<td>Bacterial blight</td>
<td>Appearance on any plant part</td>
<td>(Grade 1 or more) Appearance on any plant part</td>
</tr>
<tr>
<td></td>
<td>Wilt</td>
<td>Appearance of single partial/completely wilted plant</td>
<td>Appearance of single partial/completely wilted plant</td>
</tr>
<tr>
<td></td>
<td>Thrips</td>
<td>Wait and watch Curative sprays</td>
<td>If fruit infestation is &lt; 0 %, If fruit infestation is &gt; 1%</td>
</tr>
<tr>
<td></td>
<td>Fruit Borer</td>
<td>Wait and watch Curative sprays</td>
<td>If fruit infestation is &lt; 0 %, If fruit infestation is &gt; 1%</td>
</tr>
</tbody>
</table>

The manual presents the procedure to be followed towards selection of orchards at village level besides methods to be adopted for recording of observation on pest using the data recording formats finalized. The details guide lines are presented cropwise as follows.
Structure and maintenance of the e-pest surveillance software

Keeping in view the size of data and internet connectivity in remote areas of state, three tier architecture based system was designed comprising three major functional components viz. a database, data entry & transfer module and pest reporting & advisory module. The inter-connection and arrangement of these modules is shown in the adjacent depicted figure.

Information flow chart of the system is mentioned below:

Data collection → Data entry → Data verification → Data transfer to centralized database → Pest reporting & advisory issue → Pest advisory dissemination

The software is maintained at NCIPM server and data can be accessed using user Id and login password provided to selected and identified users.

GUIDELINES TO PEST SCOUT

Banana

Selection of Orchards & Trees

Two fixed orchards and two random orchards /village are selected by one scout who cover two villages per day. From each selected orchard, randomly 20 plants are selected, and on each selected plant, 15 leaves are observed randomly for recording observation for insect pests and diseases. Scout looks for presence of pests and outbreaks for general reporting under pest alerts. Observations on different pests is recorded in structured sheet prepared for scout (Annexure i) as per procedure laid out below:

Method of recording observation

Banana Thrips- Select 20 plants during shooting stage and observe for rust thrips damage on the developing fingers. In each bunch, observations may be taken in 3 hands one each at top, middle and lower hands. In each hand, scoring may be carried out for 10 fingers at random. The thrips damage may be measured on 1-5 scale on the basis of extent of damage as described below:
Thrips Score scale

1 – Healthy
2 – 1-25% of fruits damaged
3 – 26-50% of fruits damaged
4 – 51-75% of fruits damaged
5 – 76 and above of fruits damaged

Means score is calculated (Total No. of values / 20) and on this basis advisory is issued.

Sigtoka leaf spot disease - The disease is scored in the scale given below on 15 leaves per plant.

Sigtoka Disease Score

0 – Nil
1- 1% of the leaf having spots or less than 10 spots
2- 2 to 5% of the leaf area affected
3- 6 to 15% of the leaf area affected
4- 16 to 33% of the leaf area affected
5 – 34 to 50% of the leaf area affected
6- > 50% of the leaf area affected

Means score (Total No. of values/20x15) is calculated for issuing of advisory.

Severity average score (Infection index) for sigatoka disease may also be calculated as below:

\[
\text{Infection index} = \frac{Onb \times 100}{(N-1)T}
\]

Where, \(n\) = number of leaves in each grade, \(b\) = grade or \(nb\) = total grades of each plant
\(N\) = number of grades used in the scale (7), \(T\) = total number of leaves scored

It may be noted that missing leaf or dead leaf hanging down the pseudo stem i.e. when a leaf is missing or dead and hanging down the pseudo stem, it should not be included in the infection index calculations. Calculate the infection index for each plant at each growth stage i.e. vegetative, flowering/shooting and harvest stage.

**Crop conditions:** It may be rated **good** (Number of hands/plant is 10-12 or number of leaf/plant is 15-20), **medium** (Number of hand/plant is 8-10 or number of leaves/plant is 10-15) and **poor** (Number of hands /plant is 6-8 or number of leaves/plant is 5-10)

**Mango**

**Selection of orchards and trees**

The orchards are selected one each on hill slope/top and on plane for fixed and random survey. From each selected orchard, randomly 4 trees are selected, and on each selected trees,
5 shoots/panicle are observed randomly for recording observation on pests and diseases. Two fixed orchards and two random orchards/village are selected by one scout who cover two villages per day.

**Method of recording observation**

Observations for different pests are recorded in structured sheet (Annexure ii) which is prepared for the pest scout. Five shoots/panicles are selected per tree, one from each direction and centre of selected tree. Number of hoppers per panicle shall be counted. Observations on thrips population are recorded by tapping the shoots/panicles on white paper and total number of thrips are counted. For assessing the potential damage caused by a pest, criteria for hoppers is based on number/panicle/shoots whereas for thrips before fruit formation is also on the basis of number as for hoppers but after fruit formation, it is recorded on 0-4 scale. Total number of fruits from pea nut stage onwards are recorded per shoot/panicle selected.

**Mango Hoppers:** Weekly observation on number of both nymphs and adults are recorded on selected shoots or panicles. Mean hoppers per shoot/panicle is calculated (Total No. of values / 20).

**Mango Thrips:** Total number of fruits from pea nut stage onwards are recorded per shoot/panicle selected. Observations on thrips population are recorded by tapping the panicles on white paper. As the fruiting starts, damage due to thrips on fruits is assessed. On the basis of surface area of fruits damaged by thrips, the observed fruits is placed in 0-4 scale as details below. Mean thrips per shoot/panicle per plant (Total No. of values / 20).

**Thrip Scoring Scale**

0 – healthy fruits
1- 1 to 25% fruit area damaged
2- 26 to 50% fruit area damaged
3- 51 to 75% fruit area damaged
4- 76% and above fruit area damaged

\[
\text{Sum of all numerical rating} \div \text{No. of fruit observed} \times \text{Maximum rating} \times 100
\]

% Per cent thrip damage = \[\text{Sum of all numerical rating} \div \text{No. of fruit observed} \times \text{Maximum rating} \times 100\]

**Powdery mildew and anthracnose**

The same shoots/panicles is observed for disease intensity. The disease intensity is score in zero to five scale
Pests of Fruits (Banana, Mango and Pomegranate)

Rating Scale

<table>
<thead>
<tr>
<th>Rating</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No. intensity</td>
</tr>
<tr>
<td>1</td>
<td>1 - 20% intensity</td>
</tr>
<tr>
<td>2</td>
<td>21 - 40% intensity</td>
</tr>
<tr>
<td>3</td>
<td>41 - 60% intensity</td>
</tr>
<tr>
<td>4</td>
<td>61 - 80% intensity</td>
</tr>
<tr>
<td>5</td>
<td>81-100% intensity</td>
</tr>
</tbody>
</table>

\[
PDI = \frac{\text{Sum of all numerical rating}}{\text{No. of shoot/panicles observed} \times \text{Maximum rating}} \times 100
\]

Mean PDI of Powdery mildew and anthracnose = Total No. of values/20

Fruit fly: Four traps per ha are installed in the selected orchards and weekly count of the fruit fly trapped in each trap is taken. The trap is charged with methyl eugenol (3ml) every month.

Crop condition: It may be recorded visually and rated as good if more than 50% of the tree is in flowering, average if 25-50% of the tree is in flowering and poor if less than 25% of the tree is in flowering.

Fruit bearing: Observed the tree visually and if most of the panicles bear fruit means heavy, if 50 per cent of the panicle bears fruit it is optimum and if less than 50% of the panicle bears fruit means average.

Other pests: Record the name of other pests only

Pomegranate

Selection of orchards and trees

Two fixed orchards and two random orchards /village are selected by one scout who cover two villages per day. In each orchard, 50 trees are observed by selecting 5 trees at ten sites. Select orchard having at least one acre area and assigned fixed 1/2 and random 1/2. Prefer villages at 10 Km distance, however, adjoining village is also considered if it has at least 50 ha area. Write the name of village as mentioned in office records. Name and contact number of Grower to be noted for fixed plots only.

Methods of observations: Observations on bacterial blight, wilt, thrips and fruit borer are recorded in structured sheet (Annexure iii). Pick a zigzag route across the orchard so as to represent the entire orchard area, and inspect 5 plants each at 10 sites in an orchard for all diseases except wilt and 1 plant at each site for insect pests, leaving border rows and plants.
**Bacterial Blight:** Bacterial blight symptoms should be observed on all the units of a tree -such as leaves/stems/fruits -available at the time of survey. Note on leaves (L) symptoms should be observed only if fruits (F) are not available or fruits are disease free. Strike off L/F in the table, depending on the unit on which data is not recorded. On stems (S) symptoms should be observed always. A tree will be considered affected if blight is found on any unit on a tree. Write total affected trees out of 5 at each site in Column A.

**Severity Grade:** For severity on leaves, stems and fruits observe 5 trees at each site. Move around the tree and observe leaves and fruits all over the tree. Write the grade as per guidelines in the table on severity grades based on observation method in Column B for each unit and plant and average of all 5 in Column C. Mean score (L/F) = Total No. of values/10 x 5.

For assessing bacterial blight cankers on stems & twigs, observe symptoms on main stems, branch and twigs and write the grade in Column B as per guidelines in table on severity grade. Mean score (Total No. of values/10 x 5).

**Wilt:** Do not consider plants wilted due to water logging/water stress/breaking of stems. Count total no of plants in the orchard and total wilted (partial/complete) plants and write in Columns D and E, respectively. Also observe the roots and split stems (lower region just above ground) in few plants randomly and write the abbreviation depending upon the cause observed, more than one cause can be seen for same plant/site. Enter the abbreviation/s as given in the box in Column F. Percent Incidence : wilted plants in the orchard x 100/plants in the orchard.

If grey / blue / brown discolouration of wood in split stem is observed write Cf, if the blackening of roots with rotting of tertiary or secondary roots is observed with/without white fungal growth write RRF, if small pin holes are observed on the surface of roots or split stems

---

### Guidelines for Severity Grade Bacterial Blight

<table>
<thead>
<tr>
<th>Severity Grade to be allotted</th>
<th>% severity</th>
<th>Observation Method on different units</th>
<th>Leaves and fruits</th>
<th>Stems (No. of cankers/tree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Disease not seen</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1-10</td>
<td>Disease not easily visible, very few units/plant found diseased after careful search,</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>11-25</td>
<td>Disease visible easily in each direction, but most (75%) of the units look healthy</td>
<td>2-3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>26-50</td>
<td>Both disease and healthy units are equally observed</td>
<td>4 - 6</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>51-75</td>
<td>Disease seen very easily, with only some healthy units</td>
<td>7-10</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>76-100</td>
<td>All most all units are diseased with few healthy units seen on careful search</td>
<td>≥11</td>
<td></td>
</tr>
</tbody>
</table>

### Abbreviations for cause of wilt

<table>
<thead>
<tr>
<th>Abbr.</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cf</td>
<td>Ceratocystis fimbriata</td>
</tr>
<tr>
<td>RRF</td>
<td>Root Rot Fungi</td>
</tr>
<tr>
<td>SHB</td>
<td>Shot hole borer</td>
</tr>
<tr>
<td>N</td>
<td>Root Knot Nematode</td>
</tr>
<tr>
<td>O</td>
<td>Others</td>
</tr>
</tbody>
</table>

---
write SHB, if knots are observed on the roots generally fine roots, write N and if some other cause like some other insect/fungal damage is observed write O.

**Thrips:** Twigs and fruits should be observed on top, middle and bottom portion of the plant. Note number of affected tips (AT) out of 40 young twig tips observed/site, 8 from each plant in four directions. Calculate % affected twigs (AT/40*100) and enter in **Columns G.** Count number of fruits showing thrip symptoms out of 100 fruits observed per site (20/plant) and enter in **Columns H.** Percent Twig or fruit affected = Total No. of values /10.

**Fruit borer:** Enter in **Column I** total numbers of bored fruits/100 fruits from 5 plants at each site, **Note same 100 fruits observed for thrips can be observed.** Percent fruit affected = Total No. of values / 100.

**Other Diseases/Insect Pests and their Incidence:** While following zigzag route across the orchard for recording major diseases and insect pests also observe other diseases and insect pests mentioned in the proforma in **Column J** and check in **Column K** as:

- **Nil** for absence of disease and/or insect pest,
- **Low** for presence at a level which causes insignificant loss in quality/quantity (i.e. you may come across only 1 or 2 out of 20 sites and that too up to 1-4% incidence/infestation on each infected plant).
- **Moderate** for the presence at a level which may cause economic losses (quality/quantity) if not monitored constantly and managed through IDPM strategies to reduce its population (i.e. you may come across the presence at 5-6 out of 20 sites with 5-10% incidence/infestation on each infected plant).
- **Severe** for presence at a level where it has crossed economic threshold and is causing qualitative/quantitative losses and warrants immediate attention and implementation of IDPM strategy (i.e. you may come across the presence at more than 10 out of 20 sites with 11-25% incidence/infestation on each infected plant).
- **Any Other:** If any other diseases or pests, apart from those mentioned above, are seen, they should be mentioned. If unable to identify samples may be sent to the nearest SAU/NRCP for identification and Pest monitor be alerted for confirming and taking further action.

**Av. No. of trees/ha:** Observe the approximate plant to plant and row to row distance in meters (m) and write the number of trees against the distance in the table/Enquire the farmer.

**Stage of crop on the day of survey:** Pomegranate production is taken throughout the year in Maharashtra, hence the crop can be at rest/stress/defoliation/flowering/fruiting/ready for harvest at the time of survey, disease/insect pest situation also varies with crop stage, hence should check the crop stage and note.

**Orchard Sanitation:** Check **Poor** if full of weeds and fallen plant debris, **Good** if the basin and rows are almost free from weeds and plant debris, however some weeds may be seen along the bunds and plant debris dumped near the orchard, **Excellent** if the orchard has no weeds and fallen debris in and around the orchard.

**Crop condition:** Note the plant growth and foliage depending on age of crop.
**Foliage:** Check **Good** if sufficient healthy green foliage with normal expanded leaves is observed with proper plant canopy, **Average** if in general foliage is green but some foliage is yellow/distorted or bunched leaves/affected with diseases and pests and **Poor** if heavy incidence of diseases and insects observed or foliage is not green and showing poor nutrition status.

**Fruit bearing:** Observe fruit bearing depending on age and canopy of plant. The optimum bearing for a good canopy is given in the table. For trees bearing fruits more than this check **Heavy**, for trees with optimum bearing check **Optimum** and for lower than optimum check **Poor**

**Fruit stage:** If fruits have developed colour/on tapping the fruit you get metallic sound/arils are red and sweet to taste check **ready for harvest** otherwise check **not ready for harvest**

**Fruit Size:** Write the size depending on size of 70% fruits, if ≥70% fruits are above 400g check **King size**, if 350-400g check **Large**, if 250-300g check **Medium** and below 250g write check **Small**

**Fruit colour:** Note fruit colour only if fruits are almost ready for harvest. The varieties Bhagawa/Arakta/Mridula/Ruby have red fruits and Ganesh has yellowish pink colour fruits. If the fruits have the normal varietal colour uniformly without any spots/scars check **Excellent**, if fruit colour deviates slightly from normal or has some scars/spots check **Medium**, if fruits have not developed normal varietal colour or have many spots or scars check **Poor**.

**Other Activities:** Note down various activities of pruning, training, irrigation schedule, fertilizers and most common insecticides, fungicides, bactericides, bioformulations, botanicals etc used by the farmer in the schedule. Any other information relevant to the orchard performance (Good/bad) may be noted.

### GUIDE LINE TO PEST MONITOR

Guide lines for selecting village/orchards/tree/plants and methods of observation are same as laid out for pest scout except pest monitor shall also make roving survey for all the three crops, select five orchards per day randomly and record observations in the structured sheet for Banana (Annexure iv), Mango (Annexure v) and pomegranate (Annexure vi). Digitization of such data on a centralized server enable the pest managers to view the pest activity without loss of time and pass on the pest advisory. In order to facilitate the pest monitor about the rating and extent of pest damage caused due to various pests in each crop, guidelines are issued which are given in Table 4-6. He also visits the orchards, wherever he comes to know about the sudden outbreak of pest activity and immediately report the incidence to pest approval officer. He is also responsible for supervising the work of pest scout to establish the truthfulness and accuracy of data.
### Table 4: Guidelines for Pest Monitors for rating the intensity of pest damage (Banana)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Pest/Disease</th>
<th>Crop stage</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Banana leaf spot disease</td>
<td>Vegetative stage</td>
<td>0.1 to 5% leaf area infected</td>
<td>6 to 10 % leaf area infected</td>
<td>&gt; 10% leaf area infected</td>
</tr>
<tr>
<td>2.</td>
<td>Banana thrips</td>
<td>Flag leaf or just shooting stage</td>
<td>10 to15 thrips/bract</td>
<td>16 to 20 thrips/bract</td>
<td>&gt; 21 thrips/bract</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.1% fruit infestation</td>
<td>1.1% to 10 % fruit infestation</td>
<td>&gt; 10% fruit infestation</td>
</tr>
</tbody>
</table>

### Table 5: Guidelines for Pest Monitors for rating the intensity of pest damage (Mango)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Pest/Disease</th>
<th>Crop stage</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mango hopper</td>
<td>Flowering flush</td>
<td>1 to 5 hopper/panicle</td>
<td>6 to 10 hopper/panicle</td>
<td>&gt; 10 hoppers/ panicle</td>
</tr>
<tr>
<td>2.</td>
<td>Mango thrips</td>
<td>Flowering flush</td>
<td>1 to 5 thrips/panicle</td>
<td>6 to 10 thrips/panicle</td>
<td>&gt; 10 thrips/ panicle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peanut marble stage fruits</td>
<td>1.25% incidence</td>
<td>1.25% to 10% incidence</td>
<td>&gt; 10% incidence</td>
</tr>
<tr>
<td>3.</td>
<td>Powdery mildew</td>
<td>Flowering flush</td>
<td>1 to 25% incidence</td>
<td>26 to 50% incidence</td>
<td>&gt; 50% incidence</td>
</tr>
<tr>
<td>4.</td>
<td>Anthracnose</td>
<td>Flowering/vegetative flush</td>
<td>1 to 5% incidence</td>
<td>6 to 10% incidence</td>
<td>&gt; 10% incidence</td>
</tr>
</tbody>
</table>

### Table 6: Guidelines for Pest Monitors for rating the intensity of pest damage (Pomegranate)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Pest/Disease</th>
<th>Crop stage</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Pomegranate Bacterial Blight</td>
<td>Vegetative/flowering</td>
<td>Up to 10 % incidence on any part with average severity grade up to 1</td>
<td>11 to 20% incidence on any part with average severity grade &gt;1 to 2</td>
<td>More than 20% incidence on any part with average severity grade &gt;2 to 5</td>
</tr>
<tr>
<td>2.</td>
<td>Pomegranate Wilt</td>
<td>Any stage</td>
<td>Up to 5% incidence</td>
<td>6 - 10% incidence</td>
<td>&gt; 10% incidence</td>
</tr>
<tr>
<td>3.</td>
<td>Pomegranate Thrips</td>
<td>New flush / tender twigs / fruits</td>
<td>1 to 5% infestation</td>
<td>6 to 10% infestation</td>
<td>More than 10% infestation</td>
</tr>
<tr>
<td>4.</td>
<td>Pomegranate Fruit borer</td>
<td>Fruits</td>
<td>1 to 5% infestation</td>
<td>6 to 10% infestation</td>
<td>More than 10% infestation</td>
</tr>
</tbody>
</table>
PEST MANAGEMENT ADVISORY

Based on the recommendation of NRC and University, the two types of pest advisory were issued for all the three crops. The details of advisory is given cropwise in the pages to follow.

Detailed form of advisory is available on NCIPM website and is disseminated to villages through field staff of state agriculture department and also popularized through radio / bulletin. The short form of advisory is disseminated through SMS to progressive farmers.

1. Banana

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Situation</th>
<th>Short Advisory</th>
<th>Detailed Advisory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Initiation of yellow spots</td>
<td>Spray Carbendazim 50 WP at 0.1%</td>
<td>As soon as the yellow small spots observed on the lower leaves of the plant spraying with Carbendazim 50 WP at 0.1% i.e. 1g/l + 1ml sticker may be initiated</td>
</tr>
<tr>
<td>2.</td>
<td>Spots turns brown colour</td>
<td>Spray with Propiconazole 0.05%</td>
<td>The colour of the spot changed yellow to brown spray with Propiconazole 0.05% 1ml/l+ sticker 1ml/l of water.</td>
</tr>
<tr>
<td>3.</td>
<td>The spots further increase in size, intermingled with each other forming large dry leaves(gray spots)</td>
<td>Carbendazim 0.5% (0.5 g/l) + Mineral oil 1%</td>
<td>The spots further increase in size, intermingled with each other forming large gray spots spray with Carbendazim 0.5% (0.5 g/l) + Mineral oil 1% (10ml/l)</td>
</tr>
<tr>
<td>4.</td>
<td>More than 4-5 no of leaves infected</td>
<td>Remove infected part of the leaves and spray with Propiconazole 0.05% (0.5 ml/l) + Mineral oil 1%</td>
<td>As large area of leaves were infected the photosynthesis will be affected, to keep maximum no of functional leaves remove only infected part of the leaves and spray with Propiconazole 0.05% (0.5 ml/l) + Mineral oil 1% (10ml/l)</td>
</tr>
<tr>
<td>5.</td>
<td>As disease intensity increases</td>
<td>Remove infected part of the leaves and repeat the spray with above mention fungicides alternatively</td>
<td>Remove infected part of the leaves and repeat the spray with above mention fungicides alternatively</td>
</tr>
<tr>
<td>6.</td>
<td>Flag leaf stage or just shooting stage (observe for thrips)</td>
<td>Spray with acetamiprid 20sp at 0.0025% or Verticillium lecanii (2x10^8 CFU/g) 3g/l+ Sticker 1ml/l or NSKE 5%</td>
<td>Observe the fruit infestation by egg laying on immature fruits feeling pimple like structure at oviposition site. Record percent fruit infestation 10% with 10-15 thrips/bract. Spray with acetamiprid 20sp at 0.0025% or Verticillium lecanii (2x10^8 CFU/g) 3g/l+ Sticker 1ml/l or NSKE 5%</td>
</tr>
<tr>
<td>7.</td>
<td>Opening of all hands (observe for thrips)</td>
<td>Spray with acetamiprid 20sp at 0.0025% or Verticillium lecanii (2x10^8 CFU/g) 3g/l+ Sticker 1ml/l or NSKE 5%</td>
<td>Observe the fruit infestation by egg laying on immature fruits feeling pimple like structure at oviposition site. Record percent fruit infestation 10% with 10-15 thrips/bract Spray with acetamiprid 20sp at 0.0025% or Verticillium lecanii (2x10^8 CFU/g) 3g/l+ Sticker 1ml/l or NSKE 5%</td>
</tr>
</tbody>
</table>
## 2. Mango

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Situation</th>
<th>Short Advisory</th>
<th>Detailed Advisory</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Egg laying site and curling of leaves. Nymphs of hopper on panicles at early stage.</td>
<td>Spray Quinalphos (25 EC) 20 ml/10 lit water or Phozalone (35 EC) 15 ml/10 lit water</td>
<td>Observe the egg laying site on veins of leaves and also on panicles. Record the nymphs population, if it is 1 to 5, spray Quinalphos (25 EC) 20 ml/10 lit water or Phozalone (35 EC) 15 ml/10 lit water.</td>
</tr>
<tr>
<td>2.</td>
<td>Honey dew excretion due to hopper observed on panicles and foliage.</td>
<td>Spray Imidachloprid (17.8 SL) 3 ml/10 lit water or Thiamethoxam (25 WG) 1g/10 lit. water</td>
<td>Honey dew excretion is noticed on foliage, panicles and various stages of hoppers in the range of 5 to 10/panicles is observed spray Imidachloprid (17.8 SL) 3 ml/10 lit water or Thiamethoxam (25 WG) 1 gm/10 lit. water</td>
</tr>
<tr>
<td>3.</td>
<td>Honey dew excretion due to hopper and growth of sooty mould</td>
<td>Spray Chlothianidin (50 WDG) 1.2g/10 lit. water</td>
<td>Honey dew excretion on foliage, panicles and fruits, blacking due to black sooty mould and number of hopper more than 10/panicles spray Chlothianidin (50 WDG) at 0.006 % i.e. 1.2gm/10 lit. water</td>
</tr>
<tr>
<td>4.</td>
<td>Brown streaks on panicle rachis due to thrips</td>
<td>Spray Phozalone (35 EC) 15 ml/10 lit or Diamethoate (30 EC) 10 ml/10 lit. water</td>
<td>Observe the thrips population by tapping panicles on white papers. Thrips population exceed more than 10/panicles spray Phozalone 35 EC at 0.05 % i.e. 15ml/10 lit or Diamethoate 30 EC at 0.03 % i.e. 10 ml/10 lit.</td>
</tr>
<tr>
<td>5.</td>
<td>Scrapping injury on fruits rind result in development of brown spot</td>
<td>Spray Spinosad (45 SL) 2.5 ml/ 10 lit. water or Thiamethoxam (25 WG) 2 g/10 lit. water</td>
<td>Observed the thrips on fruit at pea nut stage onwards. The rind surface is rough brown due to scrapping injury. Sprays Spinosad 45 SL at 0.0112% i.e. 2.5 ml/10 lit or Thiamethoxam at 0.005 % i.e. 2 gm/10 lit.</td>
</tr>
<tr>
<td>6.</td>
<td>Powdery growth of powdery mildew on panicles</td>
<td>Spray Sulphur (80 WP) at 0.2 %, 20 g/10 lit. water</td>
<td>Powdery growth noticed on panicles. Spray Sulphur (80 WP) at 0.2%,20 g/10 lit. water concentration along with insecticidal sprays.</td>
</tr>
<tr>
<td>7.</td>
<td>Powdery growth of powdery mildew on panicles rachis and fruit stalk</td>
<td>Spray Carbendazim (50 WP) at 0.1 %, 10 g/10 lit water</td>
<td>Powdery growth noticed on panicle rachis and fruit stalk. Spray Carbendazim (50 WP) at 0.1%, 10 g/10 lit water along with insecticidal sprays.</td>
</tr>
<tr>
<td>8.</td>
<td>Powdery growth of powdery mildew on all the panicle parts.</td>
<td>Spray Hexaconazole (5 EC) at 0.05 %, 5 ml/10 lit water</td>
<td>Powdery growth covered all the parts of panicles, flowers and fruits drops is noticed spray Hexaconazole (5 EC) at 0.05 %, 5 ml/10 lit. water</td>
</tr>
<tr>
<td>9.</td>
<td>Black/Brown spot on panicles rachis and fruit of all stages due to Anthracnose.</td>
<td>Spray Carbendazim (50 WP) at 0.1%, 10 g/10 lit. water or Thiophenate methyl (70 WP) at 0.1%, 10 g/10 lit water or Propineb (70 WP) at 0.2%, 20 g/10 lit. water</td>
<td>Brown to black spot or blightening symptoms on rachis and fruits due to unseasonal rainfall or heavy dew deposition, spray Carbendazim (50 WP) at 0.1%, 10g/10 lit water or Thiophenate methyl (70 WP) at 0.1%, 10 g/10 lit water or Propineb (70 WP) at 0.2 %,20g/10 lit water</td>
</tr>
<tr>
<td>10.</td>
<td>Puncture injury due to fruit fly, maggots in ripped fallen fruits, fruit fly population in traps</td>
<td>Install fruit fly trap at 4 trap/ha.</td>
<td>Puncture injury observed on infested fruits at maturity stage, maggots observed in ripped fallen fruits, fruit fly population noticed in traps. Install fruit fly trap at 4 trap/ha.</td>
</tr>
</tbody>
</table>
3. Pomegranate

<table>
<thead>
<tr>
<th>Disease</th>
<th>Situation</th>
<th>Short Advisory</th>
<th>Detailed Advisory</th>
</tr>
</thead>
</table>
| Bacterial Blight      | Blackish brown spots due to bacterial blight infection seen in traces on any plant part | Spray Streptocycline (5g/10 l) /2-bromo, 2-nitro propane-1, 3-diol (Bronopol) @ 5g/10 l mixed with copper based formulations like copper oxychloride or copper hydroxide (20-25g/ 10 l) altered with Bordeaux mixture (0.5- 1%) | During crop season spray Bordeaux mixture (0.5% except 1% just after pruning), altered with streptocycline (5g/10 l) /2-bromo, 2-nitro propane-1, 3-diol (Bronopol) @ 5g/10 l mixed with copper based formulations like copper oxychloride or copper hydroxide (20-25g/ 10 l). Depending on fungal problems present in the orchard Copper based formulations may be replaced with appropriate fungicides. During rest period after harvest take prophylactic sprays of Bordeaux mixture (1%) altered with streptocycline (2.5 g/10 litres)/Bronopol @ 5g/10 litres mixed with copper based formulations like copper oxychloride or copper hydroxide (20-25g/ 10 l) at 15-20 days intervals  

**Follow all sanitation measures:**  
◆ Remove fallen plant debris and burn them- do not dump them in or near orchards nor throw them in irrigation channels  
◆ Drench bleaching powder (a.i. 33% Cl) every 3 months @ 25 Kg/1000 litre water/ha on ground below the canopy  
◆ Disinfect pruning tools – secateurs etc after handling each plant with sodium hypochlorite (2.5%) and keep orchard free from weeds.  

| - Blackish brown spots on fruits with or without splitting due to bacterial blight infection and stem infections around the nodes | Remove and burn all infected fruits/stems followed by sprays of Streptocycline (5g/10 l) /Bronopol @ 5g/10 l mixed with copper based formulations like copper oxychloride or copper hydroxide (20-25g/ 10 l) altered with Bordeaux mixture (0.5- 1%) | 1. Change crop season; Avoid *mrig bahar* (rainy season) crop and shift to *hasta bahar* crop for at least 4-5 few years  
2. Follow all sanitation measures as given above  
3. Practice proper pruning and training  
  ◆ If stem infections are severe practice heavy pruning immediately after harvest and remove all stems with blight infection.  
  ◆ Prune about 2-3" below the infected area.  
  ◆ Cankers, should be preferably removed by pruning; if not removed should be scooped out, till normal wood appears and then pasted/painted. Apply Bordeaux paste (10%) to the cut ends after pruning and to scooped cankers. Oil based pastes [COC paint made by mixing 500g COC + 1 l linseed oil or Chaubatia paste prepared by mixing 1kg red lead(non setting grade) + 1kg copper carbonate + 1.25 l linseed oil] are preferred for pasting during rainy seasons.  
  ◆ Severely infected plant must be uprooted burnt and replaced with new disease free plant or cut from base 2-3 inches above ground level. New well }
Pests of Fruits (Banana, Mango and Pomegranate)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Situation</th>
<th>Short Advisory</th>
<th>Detailed Advisory</th>
</tr>
</thead>
</table>
| Wilt    | Yellowing/drooping/drying of 1 or more branches in a plant(s) or entire plant(s) due to wilt | First Ascertain the cause/s.  
- If fungal pathogens and shot hole borer, immediately drench soil with chlorpyriphos 20EC (2.5ml/l to 4.0ml/l) + carbendazim 50WP (2.0g/l) or propiconazole 25EC (2ml/l).  
- If root knot nematodes are associated apply phorate 10G @10-20g/plant or carbofuran 3G @ 20-40g/plant in the plant basin. | growing sprouts should be trained for new disease free plant.  
4. Follow spray schedule during crop season and rest period as above  
5. **Observe all precautions:**  
   - Take only need based sprays at recommended doses, too many sprays increase the disease.  
   - Before starting any spray remove and burn all affected fruits.  
   - Insecticides, fungicides or micronutrient sprays required should be combined with bactericidal sprays depending on compatibility to reduce number of sprays.  
   - During crop period soon after the rains -when plant surfaces dry up- additional spray with a bactericide should be taken without fail.  
   - Always (rains or no rains) mix good quality non-ionic spreader sticker with sprays except with Bordeaux mixture.  
   - Bordeaux mixture should always be prepared fresh and used on the same day  
   - Provide balanced nutrition to plants, follow rest period of 3-4 months and take only 1 crop in a year to improve plant vigour and resistance.  
1. On observing first symptoms of wilt first ascertain the cause/s. If wilt is due to fungal pathogens in the orchard immediately drench soil with chlorpyriphos 20EC (2.5ml/l to 4.0ml/l) + carbendazim 50WP (2.0g/l) or propiconazole 25EC (2ml/l) use 5-8 l solution/plant. Also drench at least 2-3 healthy plants on all the four sides around the infected plant/s, repeat the drenching 3-4 times at 20 days interval.  
2. For controlling shot hole borer (*Xyleborus* spp.) which is associated with wilt disease, 10 litres preparation containing red soil (4kg) + Lindane (25g) + Chlorpyriphos 20EC (20ml) + Copper oxychloride (25g) needs to be applied on plant base up to 2 ft. from second year onwards. To control stem borer, inject in the holes on the trunk with DDVP 2-3 ml and plug the holes with mud.  
3. Wilt due to root knot nematodes can be managed with soil application of phorate 10G @10-20g/plant or carbofuran 3G @ 20-40g/plant in the plant basin, in a ring near root zone and cover it with soil. Drenching with azadirachtin (1%) @ 2ml/l is also recommended. Plant *Tagetes erecta* (African marigold) between plant
<table>
<thead>
<tr>
<th>Disease</th>
<th>Situation</th>
<th>Short Advisory</th>
<th>Detailed Advisory</th>
</tr>
</thead>
</table>
| Thrips  | Leaf curling; tender tip drying; scrapping marks on buds, flowers and fruits due to thrips. | Spray thiamethoxam 25 WG @ 3 gm/ 10 lit. or acetamiprid 20 SP @ 3 gm/ 10 lit. or Acephate 75 SP 10 gm/10 lit. from new leaf initiation to final harvest subjected to the presence of thrips. | • Do not plant the seedlings which tips are dried or leaves are curled and deformed.  
• Do not intercultivate alternate host crops like chilly, onion, garlic, brinjal and tomato in Pomegranate.  
• Pluck the tender shoots as and when it appears on plant from leaf shedding to final harvest. |
| Fruit Borer | Bored holes on buds, flowers and fruits due to fruit borer. | Spray deltamethrin 2.8 EC @ 1.5 ml/l or methomyl 40 SP @ 1.0 g/l or azadirachtin 1500 ppm @ 3.0 ml/l at 15 days intervals from initiation of flowering up to harvesting subjected to the presence of fruit borer. | • If the pomegranate acreage is 1 to 2 ha, fruits can be wrapped with butter paper for hindering the egg laying by butterflies as well as boring by larva.  
• Do not plant alternate host crops like guava, sapota, aonla and tamarind in the pomegranate orchard.  
• The affected fruits should be collected and destroyed continuously up to final harvest. |
Annexure
PEST SCOUT SURVEY PROFORMA FOR BANANA DISEASES AND INSECT PEST IN MAHARASHTRA

Name of Grower: .................. Contact Number: .................. Village Name: .................. Taluka Name: ..................
District Name: .................. Variety Name: .................. Spacing followed: .................. Crop Condition: ..................
Good/Medium/Poor Crop Stage: Vegetative/Flowering/Bunch Maturing/Harvest Stage: .................. Spray undertaken: ..................
a) Fungicide Name: .................. b) Dosage followed: .................. c) No. of sprays: .................. d) Interval followed: ..................
Intercultural operations followed including removal of dried leaf

### DATA SHEET

<table>
<thead>
<tr>
<th>Pest</th>
<th>Thrips (Score scale) at the time of flowering / fruiting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant No.</td>
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**PEST SCOUT SURVEY PROFORMA FOR MANGO DISEASES AND INSECT PEST IN MAHARASHTRA**

**Date of Survey** ...............................  **Orchard Type**: Fixed1/Fixed2/Random1/Random2 .................................  **Orchard area** .................................  
**Name of Grower** ...............................  **Contact Number** ...............................  **No. of trees/ha.** ...............................  **Village Name** .................................  
**Taluka Name** .................................  **District Name** ...............................  **Mango Variety**: Alphonso/Kesar/Ratna/Pairi/Goa Mankur/Local  
**Crop Condition**: Flowering: Good/Average/Poor  **Crop Stage** ...............................  **Fruit Bearing**: Heavy/Optimum/Poor

### DATA SHEET

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<th>No.</th>
<th>Pest</th>
<th>Diseases</th>
<th>Other information</th>
<th>Plant 1</th>
<th>Plant 2</th>
<th>Plant 3</th>
<th>Plant 4</th>
<th>Plant 5</th>
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<tbody>
<tr>
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<td>Shoot/Panicle</td>
<td>Hopper Population</td>
<td>No. of thrips/panicle</td>
<td>Thrips damage on fruits</td>
<td>Powdery Mildew intensity</td>
<td>Anthracnose intensity</td>
<td>Other pest/disease</td>
<td>No. of flies trapped</td>
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<td>No. of fruits counted</td>
<td>No. of Fruits placed in Score</td>
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<td>0 1 2 3 4 5</td>
<td>0 1 2 3 4</td>
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<td>Total No./% incidence</td>
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**No. of flies trapped**

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<th>Plant 4</th>
<th>Plant 5</th>
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<tr>
<td>Total No./% incidence</td>
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<thead>
<tr>
<th>Plant 2</th>
<th>Plant 3</th>
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<tr>
<td>Total No./% incidence</td>
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Pests of Fruits (Banana, Mango and Pomegranate)
## Annexure III

### PEST SCOUT SURVEY PROFORMA FOR POMEGRANATE DISEASES AND INSECT PESTS IN MAHARASHTRA

<table>
<thead>
<tr>
<th>Village Name:</th>
<th>Taluka Name:</th>
<th>District Name:</th>
<th>Pomegranate Variety: Bhagaw/gansh/Arakha/Mirula/any other</th>
<th>Orchard Sanitation: (Poor/Good/Excellent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage of crop on the day of survey: Rest/Stress/Defoliation/Flowering/Fruiting/Ready for harvest</td>
<td>Crop condition: Foliage (Good/Average/Poor)</td>
<td>Fruit bearing (Heavy/Opimum/Poor)</td>
<td>Fruit stage Ready/Not Ready for harvest</td>
<td>Fruit Size (King Size/Large/Medium/small)</td>
</tr>
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</table>

#### Bacterial Blight

<table>
<thead>
<tr>
<th>Site No</th>
<th>Total no. of trees affected out of 5</th>
<th>Severity Grade (0-5) on leaf (L), Stem (S), Fruit (F)</th>
<th>Plant Number</th>
<th>Average Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B.</td>
<td>C.</td>
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</tr>
<tr>
<td>1</td>
<td>L/F</td>
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<tr>
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<td>S</td>
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<td>L/F</td>
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<tr>
<td>10</td>
<td>S</td>
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#### Thrips

<table>
<thead>
<tr>
<th>Plant No.</th>
<th>% Affected Twigs</th>
<th>% Affected fruits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>G</td>
<td>H</td>
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#### Fruit Borer

<table>
<thead>
<tr>
<th>Plant No.</th>
<th>No. of Bored Fruits out of 100</th>
</tr>
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<tbody>
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<tr>
<td>10</td>
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</table>

#### Other Diseases/Insect Pests Incidence

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Diseases/Insect Pests</th>
<th>Severity Rating</th>
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<tbody>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>Ceratospore Fruit spot</td>
<td>Nil/Low/Moderate/Severe</td>
</tr>
<tr>
<td>2</td>
<td>Fruit Scab</td>
<td>Nil/Low/Moderate/Severe</td>
</tr>
<tr>
<td>3</td>
<td>Colletotrichum Fruit rot</td>
<td>Nil/Low/Moderate/Severe</td>
</tr>
<tr>
<td>4</td>
<td>Mixes</td>
<td>Nil/Low/Moderate/Severe</td>
</tr>
<tr>
<td>5</td>
<td>Fruit sucking moth</td>
<td>Nil/Low/Moderate/Severe</td>
</tr>
<tr>
<td>6</td>
<td>Stem/Shot hole borer</td>
<td>Nil/Low/Moderate/Severe</td>
</tr>
<tr>
<td>7</td>
<td>Any other</td>
<td>Nil/Low/Moderate/Severe</td>
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#### Wilt

<table>
<thead>
<tr>
<th>Total Plants</th>
<th>Total wilted plants</th>
<th># Tick( ) the Major causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>RBF</td>
</tr>
</tbody>
</table>

#### Other Activities

- **Pruning**: After harvesting/Before flower regulation
- **Training** (No. of main stems): 1/2/3/4/5/6
- **Irrigation** (quantity of water/plant): 1/2/3/4
- **Fertilizers Used** (Dose/plant and sources):
  
<table>
<thead>
<tr>
<th>FYM</th>
<th>N</th>
<th>P</th>
<th>K</th>
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</table>

#### Other Activities

- **Spray schedule**: Daily/after 2-3 days/after 5-7 days/after 10-15 days
- **Major Pesticides used with dose**

#### Any other essential information

---

**Collected by**
Name and Signature of Scout with date

**Data Verified by**
Name and Signature of Pest Monitor with date

**Data Uploaded by**
Name and Signature of Data Entry Operator with Date and Time

**Counter Signed by**
Name and Signature with Date and Time
# PEST MONITOR SURVEY PROFORMA FOR BANANA DISEASES AND INSECT PESTS IN MAHARASHTRA

Date of Survey: 
Orchard Type: Random 1,2,3,4,5
Plantation Area: 
Name of Grower: 
Contact Number: 
Village Name: 
Taluka Name: 
District Name: 
Variety Name: 
Spacing followed: 
Crop Condition: Good/Medium/Poor
Crop Stage: 
Vegetative/Flowering/Bunch Maturing/Harvest Stage: 
Spray undertaken: 
a) Fungicide Name: 
b) Dosage followed: 
c) No. of sprays: 
d) Interval followed: 
Intercultural operations followed: 
including removal of dried leaf

## DATA SHEET

<table>
<thead>
<tr>
<th>Plant No.</th>
<th>Thrips (Score scale) at the time of flowering / fruiting</th>
</tr>
</thead>
<tbody>
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**PEST MONITOR SURVEY PROFORMA FOR MANGO DISEASES AND INSECT PEST IN MAHARASHTRA**

**Date of Survey** .......................................................... **Orchard Type**: Random 1, 2, 3 .......................... **Orchard area** ..........................................................

**Name of Grower** ......................................................... **Contact Number** ................................. **No. of trees/ha.** ............. **Village Name** ..........................

**Taluka Name** ............................................................. **District Name** .............................. **Mango Variety**: Alphonso/Kesar/Ratna/Pairi/Goa Mankur/Local

**Crop Condition**: Flowering: Good/Average/Poor  **Crop Stage** ............................... **Fruit Bearing**: Heavy/Optimum/Poor

### DATA SHEET

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# Annexure VI

## PEST MONITOR SURVEY PROFORMA FOR POMEGRANATE DISEASES AND INSECT PESTS IN MAHARASHTRA

### Bacterial Blight

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### Fruit Borer

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### Any Other Information

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**Collected by:**

Name and Signature of Pest Monitor with date

---

**Data Uploaded by:**

Name and Signature of Data Entry Operator with Date and Time

---

**Counter signed by:**

Name and Signature of Officer Incharge-State Agriculture Department