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# MANUAL FOR MANGO PEST SURVEILLANCE

National Initiative on Climate Resilient Agriculture



National Centre for Integrated Pest Management, New Delhi  
ICAR Research Complex for Eastern Region, Research Centre, Ranchi  
Central Research Institute for Dryland Agriculture, Hyderabad  
Central Institute for Subtropical Horticulture, Lucknow

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National Initiative on Climate Resilient Agriculture



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## Foreword

National Initiative on Climate Resilient Agriculture (NICRA) was launched during 2010-11 by Indian Council of Agricultural Research (ICAR). The mega project has three major objectives of strategic research, technology demonstrations and capacity building. Assessment of the impact of climate change simultaneous with formulation of adaptive strategies is the prime approach under strategic research across all sectors of agriculture, dairying and fisheries. Evolving climate resilient agricultural technologies that would increase farm production and productivity *vis-à-vis* continuous management of natural and manmade resources constitute an integral part of sustaining agriculture in the era of climate change.

Plant protection deserves prime importance in crop production because of the fact that potential yield of crops are limited by pest groups of various categories *viz.*, insects, diseases, weeds, nematodes and rodents. Since pests are biotic natural resources of the Earth, their interdependent interactions amongst system variables are equally influenced by the factors of climate change. Climate effects on pests could be direct as well as crop mediated. NICRA recognized the importance of pest risks associated with climate change and provided a research platform across crops of rice, pigeon pea, groundnut, tomato and **mango** during its first phase of implementation under eleventh plan. Assessment of the changing pest scenarios, mapping of vulnerable regions of pest risks, and to evolve curative and preventive pest management strategies towards climatic stress have been emphasized among many approaches to study the impact of climate change on pests. The long term trend analysis of their association with climate is important. Most often the available historical data lack continuity and their holistic retrieval is cumbersome. Availability of information technological tools has made it possible to create centralized database of desired resources and associated activities with ease, in turn making scientific analyses and inferences more meaningful.

In case of studies relating to pest dynamics, it is essential to streamline methods of surveillance through carefully designed data recording formats relating to crops, pests, and production and protection practices in addition to weather. Implementation of pest surveillance across six different mango growing agro ecologies under NICRA offers *per se* heterogeneity of climate and would help to draw the underlying mechanism of the observed pest status. Analyses with weather would further aid in delineating climate effects on pests. Making pest surveillance operational through provision of pest scouts and data entry operators make it possible to capture quality data at field level guided by scientific staff.

“*Manual for Mango Pest Surveillance*” has been updated to give specific skills to the users to undertake sampling related to mango pests. I appreciate the team work of the mango plant protection specialists of the Nation, and wish that the research outcome would be useful for the present and future of mango pest management.

**(Dr. A. K. Singh)**

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Natural Resource Management, ICAR, New Delhi)





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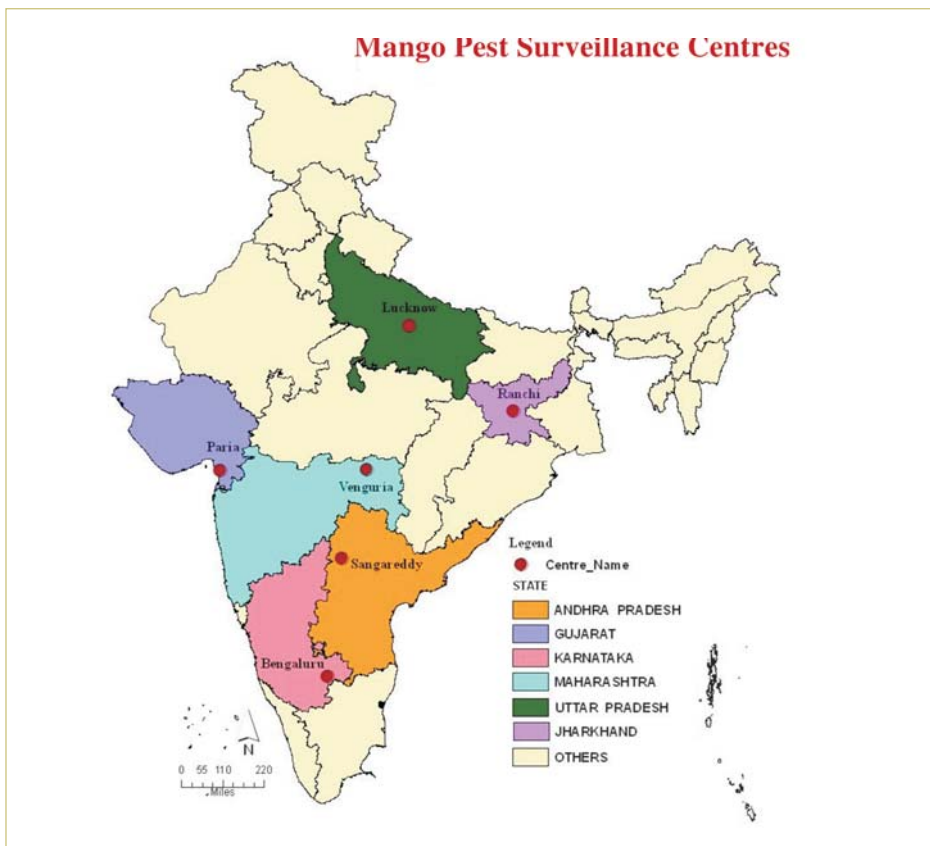
## 1. Introduction

Mango described as the “king of fruits”, known for its strong aroma, delicious taste, and high nutritive value is a prominent horticultural crop of India. Mango is a tropical and subtropical fruit crop grown in India over an area of 2.31 million hectares with production of 15.03 million tonnes (2009-10). The perennial crop grown in diverse agroclimatic conditions face differential biotic and abiotic stress limiting the production and productivity of mango. Climate change is expected to trigger the changes in diversity and abundance of arthropods, geographical and temporal distribution of insect pests, insect biotypes, herbivore plant interactions, activity and abundance of natural enemies, species extinction, and efficacy of crop protection technologies which in turn will have a major bearing on food and nutritional security.

Severity of mango pests is influenced both by crop growth and prevailing weather. In the context of climate change, we expect both the crop in terms of phenology and physiology and the pests in their occurrence and abundance likely to change. Study of impact of climate change on mango crop-pest interactions requires carefully collected data on long term basis. While already available historical data could form an approach for partial study of climate change impacts, formulation and implementation of a robust research strategy combining the present scenario of cropping patterns, cultivars, and production and protection practices across heterogeneous locations over time would yield improved and holistic understanding. “National Initiative on Climate Resilient Agriculture (NICRA)” has given emphasis to study the pest dynamics in relation to climate change. A plan to study of mango pest dynamics in multiple locations over seasons along with other system components including weather was formulated to be implemented through surveillance integrating geographical, field, crop, agronomical and pest management practices. During the XI<sup>th</sup> plan, six mango centres (refer map), that represent dominant mango growing climatic zones have been included under NICRA for pest surveillance Pre requisite for such surveillance is to devise a plan followed by design of data recording formats suiting to the purpose.

The consultative group meeting of identified mango workers under NICRA finalized the structure of pest surveillance to be carried out in orchards located at the research/experimental station of the identified mango growing regions, and at villages in the orchards of farmers.





This manual presents the procedures to be followed towards selection of orchards at the experimental/research stations and at villages besides the methods to be adopted for recording the observation of pests using the data recording formats finalised. The modifications made in the sampling methodology during the second group discussion are included in the manual.

## 2. Surveillance plan and procedures

Two orchards each at the experimental station and in ten selected villages of the region are to be fixed for mango pest surveillance. Fixed orchards are those fields with mango trees, that once selected would be continuously monitored year round on weekly basis for pests and diseases using the specified data sheet formats. In addition, a random survey covering eight orchards @ one per village among villages other than the ten selected villages for fixed surveillance has to be done once a week. The schedule of surveillance is given as **Annexure I**.

### 2.1. Orchard surveillance – selection of orchards

#### 2.1.1. Experimental/Research station

Two orchards -one **unprotected** without any plant protection measures (designated as **Fixed 1**) and the other **protected** with need based plant protection



practices (designated as **Fixed 2**) are to be used for weekly observations. Area of each orchard should be near to one acre.

### 2.1.2. Orchards of farmers

Ten orchards @ two orchards per village at ten villages representative of the agro ecology of the identified region in the same and neighbouring district, distributed randomly should be selected. In each village, two selected orchards of near to one acre each are to be fixed (designated as Fixed 1 and Fixed 2) for weekly observations. Assigning fields of farmers as **Fixed 1** and **Fixed 2** should be made at the time of village selection and same should be maintained all through the project period. In case of orchard destruction due to any reason, almost similar orchard nearby in the same village has to be used for pest surveillance. Care should be taken to select farmers growing common mango variety (ies) of the region.

## 2.2. General information for fixed orchards

The geographical, cropping system and agronomical details relating to each of the fixed orchards (**Proforma 1; Annexure II**) which are *self-explanatory* should be collected once in the beginning of the season from orchards designated as Fixed 1 and Fixed 2 (both at experimental station and farmers' fields).

## 2.3. Specific guidelines for observations in fixed orchards

- The recording of observations on insect pests and diseases in the selected orchards should be initiated with the implementation of the project and continued till the end of project period.
- Fill in the details State, district, taluka, village or location name of orchard being sampled along with the designated field type (protected or unprotected in case of experimental station) and appropriate orchard number as Fixed 1 and Fixed 2 in the **Page 1 of Proforma 2 (Annexure II)**.
- For crop stage, tick mark appropriate terms relating to stage of the tree at the time of surveillance viz., vegetative or emergence of inflorescence or full bloom or fruit set or fruit stages (pin head sized or pea sized or marble sized or fully grown) or harvesting.
- For crop health, tick mark appropriate term as to excellent or good or poor based on the status of orchard relating to tree growth and development.
- In each selected orchard, select five trees such that four are from four corners and one from the centre of the orchard. Two rows of trees alongside of boundary of orchard in all directions should not be selected for observations.
- The tree selection for pest observations during each weekly visit should be random and it is not the fixed trees in an orchard that would be sampled continuously.
- In each of the selected trees, the observations are to be made from four directions viz., East, South, West and North. (Make it a habit to start at East direction of a tree, and follow anticlockwise direction).

### 2.3.1. Insect pests

#### Mango (leaf) hoppers

**Scientific name** : *Amirtodus atkinsoni*,  
*Idioscopus niveosparsus*,  
*I. clypealis*

**Family** : Cicadellidae

**Order** : Hemiptera



#### Description

- Three different species of hoppers are common.
- Nymphs and adults are seen on younger leaves and inflorescence.
- Nymphs are pale yellow and adults vary in size from small to large depending on the species. Adults may be dark with wavy lines on wings and three spots on scutellum, or light brown with dark spots on the vertex and two spots on scutellum or light brown with two spots on scutellum.
- Presence of honeydew secretion on leaves, inflorescence and on fruits with sooty mould development is common.
- Characteristic clicking sound could be heard during higher infestation periods of hoppers produced by the movement of hoppers amidst leaves.
- Hoppers shelter in the cracks and crevices of the bark or underside the leaves of the trees during the off season.

#### Procedure for observation

- Number of nymphs and adults in a single panicle/inflorescence from each direction of selected tree should be visually counted during season.
- During off season, standard sweep nets ( 4 sweeps /tree @ one sweep per direction) should be used to sample the hoppers resting on tree trunks after disturbance using net. Make sweeps across the zone of flight of hoppers. Empty the net after each counting.



Honey dew deposition



Leaf hoppers on trunk



## Mealybugs

**Scientific name** : *Drosicha mangiferae*,  
*Rastrococcus iceryoides*

**Family** : Coccidae

**Order** : Hemiptera



### Description

- Presence of pinkish nymphs and adult mealybugs covered with white waxy filaments are seen on leaves, inflorescence, branches and fruits

### Procedure for observation

- Number of mealybug infested panicles or shoots from each direction of the selected tree should be visually counted during season and off season.

#### Mealybug infestation



On leaf



On twig



On inflorescence



On fruit

## Leaf webber

**Scientific name** : *Orthaga exvinacea*,  
*O. euadrusalis*, *O. thyrisalis*

**Family** : Pyralidae

**Order** : Lepidoptera



### Description

- Webbing of terminal leaves is seen with presence of pale grey larva(e) with brown head and body having white lines and few brown spots.

### Procedure for observation

- Count the number of webs formed in each direction, thus covering the whole tree.



Webbing of terminal leaves due to leaf webber



Larvae of leaf webber



## Thrips

**Scientific name** : *Scirtothrips dorsalis*

**Family** : Thripidae

**Order** : Thysanoptera



### Description

- Nymphs and adults of thrips are creamy yellow to brown insects with fringed wings, largely seen ventral surface of the tender leaves although present on inflorescence and fruits. Thrips infested leaves show silvery shine with the leaf edges curled upwards.

### Procedure for observation

- Count and record the number of adults and nymphs of thrips fallen on to white paper. One of the randomly selected terminal shoot/panicle of any one branch from each direction should be used. Single tap of shoot or panicle on to a white paper should be the sampling criteria.



Thrips on leaf



Damage symptoms due to thrips

## Stem borer

**Scientific name** : *Batocera rufomaculata*

**Family** : Cerambycidae

**Order** : Coleoptera



### Description

- Irregular galleries/tunnels are seen on the stems and grub(s) of the borer are found feeding inside. Chewed food matter along with excreta is seen at the infestation site. Sometimes sap oozes out of the feeding holes on the stem. Wilting of branches or death of tree in severe cases can also happen.

### Procedure for observation

- A total of five spots (all four corners and at centre) should be examined for stem borer infestation per orchard. Number of trees with symptoms of stem borer out of five trees in each spot should be noted.



Stem borer infested trunk



Grubs of stem borer



## Shoot borer

**Scientific name** : *Chlumetia transversa*

**Family** : Noctuidae

**Order** : Lepidoptera



### Description

- Downward tunnelling in terminal shoots caused by dark pink caterpillar with dirty spots is seen. Abnormal stunting with bunched appearance of terminal branch is seen under high severity of attack by shoot borer.

### Procedure for observation

- Number of infested shoots per five tender shoots from each of the four directions of the selected tree should be counted.



Terminal stunting



Larva of shoot borer



## Scale insect

**Scientific name** : *Chionaspis* spp.,  
*Aspidiotus destructor*

**Family** : Diaspididae

**Order** : Hemiptera



### Description

- White elongate hard scales with pinkish active crawlers are seen on leaves, twigs and panicles

### Procedure for observation

- Number of scale infested shoots per five tender shoots from each of the four directions of the selected tree should be counted



Scale infestation on leaves



Closeup view of eggs, crawlers and male



## Red ant

**Scientific name** : *Oecophylla smaragdina*

**Family** : Formicidae

**Order** : Hymenoptera



### Description

- Reddish ants with their nests formed through webbing of leaves are seen mostly on terminal shoots.

### Procedure for observation

- Number of nests of red ants from each of the four directions of the selected tree (covering whole tree) should be counted and noted.

## Leaf miner

**Scientific name** : *Acrocercops syngamma*

**Family** : Gracillariidae

**Order** : Lepidoptera



### Description

- Light brown caterpillars mine the dorsal epidermis of tender leaves and feed within. Mining results in greyish- white blisters on leaves.

### Procedure for observation

- Number of infested leaves per 10 leaves of a shoot from each of the four directions of the selected tree should be counted



Blisters on leaves



Larva of leaf miner

## Termites

**Order** : Isoptera



### Description

- Presence of brown muddy layers as earthen galleries on tree trunk is seen.
- Fresh muddy layers when examined by removal of mud would have live termites that are white and active. In termites the head is highly sclerotized and mandibles of soldier termites are well developed.

### Procedure for observation

- Presence of termite symptoms (old and new) on trunk portions of five trees per spot of the selected five spots (from four corners and at centre) should be examined per orchard.



**Tree trunk and branches infested with termites**



## Shoot gall psylla

**Scientific name** : *Apsylla cistellata*

**Family** : Psyllidae

**Order** : Hemiptera



### Description

- Terminal shoots are affected by nymphs and adults of psyllids. The affected terminal buds develop into hard conical green galls. Adult psyllids with black head and thorax and light brown abdomen are seen.

### Procedure for observation

- Number of infested terminal shoots out of five shoots from each of the four directions of the selected tree should be counted. If psylla infested shoots are found, number of galls in any one of the infested shoot in each direction should also be counted and recorded.

## Midge

**Scientific name** : *Dasineura amaramanjarae*,  
*Erosomyia indica*,  
*Procystiphora mangiferae*

**Family** : Cecidomyiidae

**Order** : Diptera



### Description

- Maggots of midge attack the twigs/shoots, inflorescence stalks, flowers and small developing fruits. They bore into the buds and feed on inner contents, and the infested buds fail to open and drop down. Maggots are light yellowish and the adult flies are orange red, or yellowish or light orange.

### Procedure for observation

- Number of infested new shoots out of five new shoots and number of infested panicles (during flowering season) out of five panicles in each direction is to be counted from the selected tree.

### 2.3.2. Beneficials

#### Coccinellids (Lady bird beetles)

**Family** : Coccinellidae  
**Order** : Coleoptera



#### Description

- Adults are bright (red/orange/cream/black) coloured convex shaped beetles. Grubs are elongated, black to greyish with white spotting. Pupae are fixed to plant substratum and are inverted 'C' shaped. Commonly found feeding on hopper nymphs, aphids, mealybugs and scale insects occurring on panicles, leaves and shoots.

#### Procedure for observation

- The number of grubs, pupae and adults of ladybird beetles per square meter in each direction of the selected tree should be counted and recorded.

#### Hover flies or syrphids

**Family** : Syrphidae  
**Order** : Diptera



#### Description

- Hoverfly or syrphid maggots are soft bodied, greenish to brownish in colour. Mouth part of maggot is tapering, and feed through piercing on soft bodied hopper nymphs, aphids and mealybugs etc., found on panicles and leaves. Pupae are hardened puparia (mostly brown) found attached to plant substratum.

#### Procedure for observation

- The number of maggots and pupae of hoverflies per square meter in each direction of the selected tree should be counted and recorded.



## Chrysopids or Green lace wings

**Family** : Chrysopidae

**Order** : Neuroptera



### Description

- Chrysopid grubs are brown with mandibles highly developed (sickle shaped), and feed on insects such as aphids, eggs of lepidopterans and other soft bodied insects. Pupae are whitish round cocoons found amidst plant parts.

### Procedure for observation

- The number of grubs, pupae and adults of chrysopids together per square meter in each direction of the selected tree should be counted and recorded.

## Spiders

**Family** : Araneidae/Tetragnathidae/  
Theridiidae

**Order** : Araneae



### Description

- Spiders are eight legged arthropods and the body is divided into head (cephalothorax) and abdomen. Spiders vary in size, shape and color. Some are free living and some are web spinners.

### Procedure for observation

- The number of nymphs and adults of spiders per square meter in each direction of the selected tree should be counted and recorded.

### 2.3.3. Diseases

#### Powdery mildew of mango

**Causal organism :** *Oidium mangiferae*



#### Symptoms

- White superficial powdery appearance of the fungal mycelium is seen on leaves, inflorescence and fruits.
- These superficial mycelia produce a large number of conidia on conidiophores. Symptoms are quite severe at the time of flowering and fruiting

#### Procedure for observation

- The ratings to be used for assessment of powdery mildew disease are furnished here under and also in the data sheet. The number of inflorescence(s) affected under each of the ratings out of 10 inflorescences examined should be entered.

#### Disease scoring scale for powdery mildew is as given below.

- 0 : Inflorescence free from infection.
- 1 : Less than 25% of the inflorescence covered by powdery mildew
- 2 : 26-50 % of the inflorescence covered by powdery mildew
- 3 : 51-75% of the Inflorescence covered by powdery mildew
- 4 : More than 75 % of the inflorescence covered by powdery mildew



Closeup view of powdery mildew infestation



## Anthracnose

**Causal organism:** *Glomerella cingulata*  
(*Colletotrichum gloeosporioides*)



### Symptoms

- Disease produces leaf spots, withered tips and twig blight.
- Small dark brown or black spots appear on newly emerged leaves.
- Panicles turn black in colour and dry off. When entire inflorescence is damaged during severe infection no setting of fruits takes place.

### Procedure for observation

- Recording of anthracnose on rachi is based on per cent leaves on rachi infected following the severity grades of no infection, mild, high and severe infections.

### Disease scoring scale for anthracnose on rachi:

0% affected leaves	:	No infection
1-5% affected leaves per rachi	:	Mild
6-10% affected leaves per rachi	:	High
>11% affected leaves per rachi	:	Severe

- Number of infected rachi in respect of the severity scale out of 10 rachi of the selected tree should be recorded.



Severe infection of anthracnose



## Bacterial leaf blight (BLB)

**Causal organism:** *Xanthomonas campestris* pv. *mangiferaeindicae*



### Symptoms

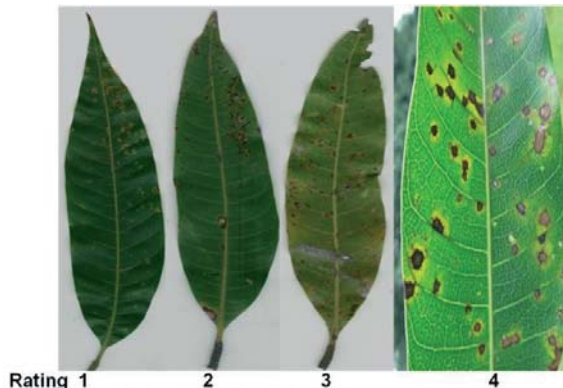
- Lesions on leaves are angular to irregular, dark brown to black, cankerous on lower side but occasionally on both the sides and surrounded by chlorotic halo.
- Cankers on petioles are raised and dark brown to black in color, while on twigs and branches are raised with longitudinal fissures.

### Procedure for observation

- The rating to be used for bacterial blight is based on percentage leaf area affected on the selected shoot for sampling.

### Disease scoring scale for BLB:

- 0 : No infection on leaves
  - 1 : 1 to 10 % of leaf area covered
  - 2 : 11 to 25 % of leaf area covered
  - 3 : 26 to 50 % of leaf area covered
  - 4 : > 50 % of leaf area covered
- No. of infected shoots in respect of the severity scale out of 10 shoots of the selected tree should be recorded.



Bacterial canker infected mango leaf



## Sooty mould

**Causal organism:** *Capnodium mangiferae*



### Symptoms

- Black velvety thin covering on the surface of the leaves, stem and fruits are seen
- Mycelia are superficial and do not penetrate in the host tissues
- Tree appears black from a distance

### Procedure for observation

- The rating to be used for sooty mould is based on percentage leaf area affected on the selected shoot for sampling.

### Disease scoring scale for sooty mould:

- 0 : No infection on leaves
  - 1 : 1 to 10 % of leaf area covered
  - 2 : 11 to 25 % of leaf area covered
  - 3 : 26 to 50 % of leaf area covered
  - 4 : > 50 % of leaf area covered
- Number of sooty mould infected shoots in respect of the severity scale out of 10 shoots of the selected tree should be recorded.



Sooty mould on leaves

## Mango malformation

**Causal organism:** *Fusarium subglutinans*



### Symptoms

Two types of malformations are common *viz.*, vegetative and floral

- **Vegetative malformation** is more pronounced on young mango seedlings and plants. The affected plants develop swollen abnormal vegetative growth with short internodes. Leaves are small, narrow and often produced on the top of seedlings in clusters, giving it a bunched appearance.
- **Floral malformation** is characterised by compact and clustery appearance of flowers. The flower buds transform into vegetative forms and leaves the flower bud seldom opens and remains dull green in colour. Some malformed panicles are not compact but both types of malformed panicles do not bear fruit.

### Procedure for observation

- *Vegetative malformation:* Count all the malformed shoots/twigs in a tree and record.
- *Floral malformation:* Count all the inflorescences with malformation in a tree and record.



Vegetative malformation



## Dieback

**Causal organism:** *Lasiodiplodia theobromae*  
(*Botryodiplodia theobromae*)

### Symptoms of disease

- Drying of twigs from top to down in trees followed by dying of leaves are seen.
- Dark patches are seen on young green twigs
- Cracks are seen on branches and gum exudes from the cracks before its death

### Procedure for observation

- Die back severity counted on (1-5 scale) out of 10 trees per orchard

### Disease scoring scale for die back disease:

- 1 : Trees free of disease
- 2 : An early stage of infection characterized by browning of leaf petioles and mild veins and presence of distal or marginal leaf blade necrosis in one or two branches.
- 3 : The presence of dead leaves, which may remain attached in the tip of several branches, vascular browning and evidence of pathogen invasion of vascular tissue, formation of tylosis in xylem vessels, and dark inclusions and fungal hyphae present in stem upon breaking
- 4 : Dead leaves and progressive defoliation extend to many larger branches along with increased severity and spread of vascular system.
- 5 : Severe die-back that extended to major portions of the tree.



Severe dieback (score 5)

## Anthracnose on fruits

**Causal organism:** *Glomerella cingulata*



### Symptoms

- On green fruits infection remains latent and largely invisible until ripening and hence cannot be sampled.
- On ripe fruits anthracnose infection causes sunken, prominent, dark brown to black decay spots before or after picking. Fruits may also drop from trees prematurely. Fruits can show “tear stain” symptoms, resulting in “alligator skin” effect. Such infection causes fruits to develop wide and deep cracks on the skin that extend into the pulp. Lesions on fruits may also produce conspicuous, pinkish-orange spore masses under wet conditions.
- The disease may also start from injured portion on the fruit surface. Entire fruit surface is covered with the dark brown to black area and complete fruit rots in 2 to 3 days.

### Procedure for observation

- Number of anthracnose infected fruits in respect of the severity scale (0-4) out of 10 fruits selected *in situ* (not to be plucked) on trees at random in the orchard being monitored should be recorded.

### Disease scoring scale for anthracnose on fruits:

- 0 : No lesions
- 1 : 1 to 3 fruit lesions
- 2 : 4 to 6 fruit lesions
- 3 : 7 to 15 fruit lesions
- 4 : > 15 fruit lesions



Lesions on green fruit



Lesions on ripe fruit



## 2.4. Additional information to be collected from fixed orchards

### 2.4.1. Trap catches

#### Description

Pheromone trap for fruit flies@ one / fixed orchard has to be installed at the start of fruit set till the completion of fruiting season. Install the trap in the centre of the selected fixed orchard. During each week of surveillance the number of fruit fly adults found in traps should be counted and entered. Emptying fruit flies from fly collecting container/bag and ensuring the trap presence/ readiness to replace in case of breakage/missing events should be followed meticulously.



Fruit fly adult

Therefore after initial installation surveillance team or member should carry few traps and lures during each week of surveillance for attending to missing traps immediately.

Adult flies are light brown and yellow with transparent wings.

#### Procedure for observation

- Total number of fruit flies/trap/ week should be recorded during fruiting season. Empty the trap after each recording and destroy the trapped flies.

### 2.4.2. Assessment of fruit damage

- **Fruit borer** : A small hole is seen at the distal end of the fruit. The hole is encircled by a dark ring. The entry hole is plugged with excreta. Wet looking frass is seen on the outside of the fruit. After hatching, the larvae will initially feed by chewing the surface of the skin of the fruit and then tunnel into the flesh. Both immature and mature fruits are affected. Full grown larvae were with dark brown head, mandible heavily sclerotized and white body ornamented with inter segmental red bands.
- **Stone weevil** : Symptoms of damage due to stone weevil are not easily deductible on the fruits. Oviposition injuries on marble sized



Fruit borer damage and larva

fruits and grub makes zigzag tunnels in pulp while feeding on unripe tissues. Fruit dropping occurs when the unripe fruits are marble sized. Fruits have to be cut to inspect for the presence of grubs and pupae of the weevils. Grubs of the weevil can be located by slicing the seed of the mango. The stones show holes and the seed reserves turn black and become a rotten mass.

- **Spongy tissue** : Fruits look normal from outside. Inside of the fruit has a patch of flesh that is yellowish, spongy and sour. The affected spongy tissue is visible only when ripe fruit is cut into two halves.
- **Bacterial canker (fruit lesions)** : Lesions on fruits are raised and dark brown to black which gradually develop in to cankers. Under favourable condition lesions increase in size and sometimes cover complete fruit. Such lesions often burst extruding gummy substances containing bacterial cells of the pathogen. Fruits may drop off, if infection comes at stem end.
- **Fruit flies** : The eggs laid by the females into the fruits hatch to maggot that are apodous and bore into semi ripen fruits. Decayed spots that are brownish rotten patches are visible on the fruits. Oozing of fluid is also common.



Grub of stone weevil



Canker of fruits



Fruit fly damage

### Procedure for observation

- Twenty fruits of harvestable stage from different trees of the orchard should be collected randomly by plucking. The infestation due to different categories of pests based on the characteristic symptoms caused by fruit borer, stone weevil, fruit flies and for symptoms of spongy tissue, anthracnose and bacterial canker as described above should be examined and recorded.

### 2.4.3. Cultural practices

During each time of visit to the fixed orchards *i.e.*, once in a week the details on application of farm yard manure (FYM), the inter cultural operations carried out *viz.*, deep ploughing, pruning, weeding, fertilizer used, and nutrient (micronutrient or hormonal) sprays should be noted in consultation with the farmers and recorded in the table of **Page 4 of Proforma 2 (Annexure III)**.

### 2.4.4. Plant protection sprays

During each time of visit to the fixed fields *ie.*, once in a week, the plant



protection sprays taken up against insects, diseases, weeds and use of any biorational or bio-pesticides including bioagents, botanicals and microbials along with their name, dosages and number of applications should be collected from the farmer and entered in the table of **Page 4 of Proforma 2 (Annexure III)**.

#### 2.4.5. Weather of the week

Details of weather that is prevailing during the week of surveillance in respect of the farm/village should be stated in an objective pattern of YES or NO. If any other weather pattern prevails, other than those mentioned in the table it can be written against 'Any other remarks' as a short phrase.

#### 2.4.6. End season records on yield and price

The average yield of fruits per tree from each of the fixed orchards should be recorded. Market prices of mango fruits prevailed at the time of sale during the season also should be noted.

### 2.5. Random field survey

#### 2.5.1. Field selection for random survey

The survey is to be conducted once in a week (preferably Friday) by scientists along with project staff in the area/villages not covered for fixed field surveillance. During the survey, the team will cover eight orchards selected at eight different villages having large area under mango in the vicinity of about 70-80 km distance and the villages being selected randomly. Around 7-8 km distance can be maintained between two villages for random survey. In each village one mango orchard has to be selected for surveillance.

#### 2.5.2. Guidelines for pest observations

All relevant details of random survey *viz.*, date of survey, GPS coordinates, village name, age of orchard and cultivar should be recorded and the pest observations are to be carried out as per the **proforma 2 (pages 1- 3) (Annexure III)**. Eight individual data sheets (**Proforma 2**) should be used for the eight orchards across eight villages during random survey. Additional details such as cultural practices, plant protection sprays, fertilizer management, and weather of the week and trap installation **need not be** done for fields of random survey.

#### 2.5.3. Record of meteorological information

Daily records of weather data from the observatory of the research station or any other nearest location should be collected as per the **Proforma 3 (Annexure IV)**. Their upload can be once a week.



### 3. General instructions

Depending on the agro climatic zone the species of insects/diseases vary. There could be occurrence of additional species of the same group of insect or altogether a new species so far. Therefore the hitherto unrecorded species needs to be collected and preserved for identification. Preservation of insects has to be done in 70% ethyl alcohol in screw capped glass vials. Identification and reporting can be done at institution level directly or through crop coordinators of NICRA. Description of some of the insects and diseases of importance that are of varying significance to mango production are given in **Annexure V** for reference and reporting separately.

In case of closed holidays, the surveillance should be adjusted so as to cover the orchards on the subsequent day and the same flexibility applies to upload of data also. Ensure quality data collection by adhering to datasheet and guidelines.

Only presence of pests on the crop need sampling and recording of their counts/severity etc., and the columns of pests not present should be left empty.

In case of non-recording of observations in any of the orchards during any of the weeks, it should be reported as not recorded with reasons, in the provision that would be made in the software.

Each farmer whose field has been selected can be given a diary for record keeping on the intercultural operations, plant protection sprays, fertilizer application, weather events, yield and market price of paddy at harvest. By visiting the fixed fields in villages on fixed days in a week for surveillance, farmer too can be made to be an effective partner of the programme. Their contact details including postal address and phone numbers (land line and mobile, whichever is available) must be maintained for feedback and impact assessment in future.



## Annexure I

### Schedule for Surveillance

Day	Surveillance Schedule of pest scouts & data entry operators (DEO)	No. of orchards
Monday	Two fixed orchards (Fixed 1: Unprotected) and (Fixed 2: Protected) at research station; Documentation of historical data of the centre	Two
Tuesday	@ two fixed orchards / village in two villages by one scout (Total of eight orchards at four villages by two scouts); DEO to enter the data collected on previous day + documentation of historical data	Eight in four villages
Wednesday	@ two fixed orchards / village in two villages by one scout (Total of eight orchards at four villages by two scouts); DEO to enter the data collected on previous day + documentation of historical data	Eight in four villages
Thursday	@ Two fixed orchards / village / scout (Total of four orchards at two villages by two scouts) Scouts would also look for presence of new pests (insects and diseases) and outbreaks for general reporting under pest alerts	Four in two villages
Friday	Random orchard survey across eight villages (@ one orchard / village) by scientist and in eight surveillance team; look for new/emerging pests for reporting in addition to using prescribed data sheet (proforma 2; Page 1 to 3 only)	Eight in eight villages
Saturday	Checking data / upload of pest and weather data	–

*\*Kindly maintain a diary of surveillance for reporting during monitoring by officials of funding agency/lead centre*



*Proforma 1*

**Annexure II**

**Data Sheet for General Information of Fixed Orchards**

**REAL TIME PEST SURVEILLANCE (MANGO)**

(General Information for Fixed Orchards-to be filled only once in the beginning of the season)

**Geographic Details**

Agro Climatic zone	Slate	District	Tehsil/Block	Experimental Station/ Village Name	Latitude	Longitude	Altitude

**Cropping system details of the region**

Major Cropping Systems of region	Age of orchard	Flowering period From.....to.....	Fruiting period From.....to.....	New crops of the region (during last five years)	Major insect pests & diseases (during last five years)

**Agronomic details of the Orchard**

Orchard	Name of the Farmer	Name of Cultivar		Bearing habit (regular/alternate)	Spacing (cm)	
		Variety	Hybrid		Plant to plant	Row to row
Fixed 1						
Fixed 2						

Orchard	Approx. Area of the orchard	Soil type	Soil health (Excellent/Good/Poor)	Crops in the adjacent orchards	Source of irrigation (Canal/Well/Tubewell)	Method of irrigation (Flood/drip)
Fixed 1						
Fixed 2						



Annexure III

Data Sheet for Pest Observations in Fixed and Random Fields

Profroma 2

NICRA REAL TIME PEST SURVEILLANCE (MANGO)														Page 1						
State		Surveillance unit		Experimental station				Orchards of farmers												
District		Location/Village name																		
Tehsil		Orchard type & no.		Unprotected (Fixed 1)/protected (Fixed 2)				Fixed 1 / Fixed 2												
Random Survey		Village Name	Latitude	Longitude	Altitude	Area of surveyed Orchard (approx) in acres				Variety	Age of orchard									
Date of observation																				
Crop Stage		Vegetative/Emergence of inflorescence/full bloom/fruit set/Fruit stages (pin head, pea, marble, fully grown)/Harvesting																		
Crop health		Excellent / Good / Poor																		
Tree No.	Leaf hopper nos. per panicle or sweep				No. of mealybug infested panicles or shoots (s / direction)				No. of webs in each direction				No. of thrips / shoot or panicle in one tap per direction				No. of stem borer infested trees / spot*			
	East	South	West	North	East	South	West	North	East	South	West	North	East	South	West	North				
1																				
2																				
3																				
4																				
5																				
Tree No.	No. of infested shoots per five tender shoots				Scale insect				Red ants (no. of nests)				Leaf miner (No. of infested leaves/10 leaves of a shoot)				No. of termites infested trees / spot*			
	East	South	West	North	East	South	West	North	East	South	West	North	East	South	West	North				
1																				
2																				
3																				
4																				
5																				

\* Five trees per spot



**NICRA REAL TIME PEST SURVEILLANCE (MANGO)**

Page 2

Tree No.	Shoot gall due to <i>Psylla</i> per five shoots					Midge (No. of infested) per five panicles and on five new shoots										
	East		South		West		North		East		South		West		North	
	No. of infested shoots	No. of galls / one shoot	No. of infested shoots	No. of galls / one shoot	No. of infested shoots	No. of galls / one shoot	No. of infested shoots	No. of galls / one shoot	Panicles	New Shoots	Panicles	New Shoots	Panicles	New Shoots	Panicles	New Shoots
1																
2																
3																
4																
5																

Tree No.	No. of natural enemies / m <sup>2</sup>															
	Coccinellids				Hoverflies				Chrysopids				Spiders			
	East	South	West	North	East	South	West	North	East	South	West	North	East	South	West	North
1																
2																
3																
4																
5																



**NICRA REAL TIME PEST SURVEILLANCE (MANGO)**

Page 3

Powdery Mildew		Assessment of Powdery mildew 0 : inflorescence free from infection. 1 : Less than 25% of the inflorescence covered by powdery mildew 2 : 26-50 % of the inflorescence covered by powdery mildew 3 : 51-75% of the inflorescence covered by powdery mildew 4 : More than 75% of the inflorescence covered by powdery mildew				Tree No.		Anthracnose of rachi		Assessment of Anthracnose on rachi
						No. infected out of 10 random inflorescence (Severity on 0-4 scale)	0	1	2	
1							1	0%	0% No infection	
2							2	1-5%	1-5% affected leaves per rachi (Mild)	
3							3	6-10%	6-10% affected leaves per rachi (High)	
4							4	> 11%	>11% affected leaves per rachi (Severe)	
5							5			

Bacterial Leaf Blight		Sooty mold No. infected out of 10 Shoots (Severity on 0-4 scale)					Assessment of Bacterial Leaf blight & Sooty mold		Mango malformation	
							Tree No.	No. infected / tree		Vegetative
1		0	1	2	3	4	0 : Shoots free of infection	1		
2							1 : 1 to 10 % of leaf area covered	2		
3							2 : 11 to 25 % of leaf area covered	3		
4							3 : 26 to 50 % of leaf area covered	4		
5							4 : > 50% of leaf area covered	5		

No. of trees with Die back (Severity (1-5 scale) out of 10 trees/Orchard)		Die back (Severity (1-5 scale out of 10 trees / orchard) 1 : Trees free of disease 2 : An early stage of infection characterized by browning of leaf petioles and mild veins and presence of distal or marginal leaf blade necrosis in one or two branches					Anthracnose of mango fruits		Assessment of Anthracnose fruits
							Tree No.	No. infected out of 10 fruits based on fruit lesions (0-4 scale)	
1							1	0	0 : fruits free from infection
2							2	1	1 : 1 to 3 fruit lesions
3							3	2	2 : 4 to 6 fruit lesions
4							4	3	3 : 7 to 15 fruit lesions
5							5	4	4 : > 15 fruit lesions

**NICRA REAL TIME PEST SURVEILLANCE (MANGO)**

Record the following only for fixed fields

Page 3

No. of fruit flies per Trap (To deploy trap in fixed orchard from fruit set stage)	
Trap 1	

No. of fruits affected out of 20 randomly collected fruits	
Due to fruit borer	
Due to stone weevil	
No. of fruits infested with fruit flies	
Due to spongy tissue	
Due to anthracnose	
Bacterial canker (fruit lesions)	

Cultural Management Practices	
FYM applied	Yes / No
Deep ploughing	Yes / No
Pruning	Yes / No
Type of weeding	Manual / weedicide
Type of fertiliser use	Over use / optimal / deficit use
Name of the nutrient / hormone sprayed:	

Plant protection sprays	Name of chemical	No of spray
Against insects		
Against diseases		
Against weeds		
Use of biorationals		

Unusual weather events of the week, if any	
Unseasonal rains	Yes/No
Hail storms	Yes/No
High intensity rains	Yes/No
Prolonged dry spells	Yes/No
cloudiness/cloudy days	Yes/No
Floods	Yes/No
Temperature	High/Low/Normal
Any other remarks	

End Season Record	
Fruit yield (Kg/tree)	Price per quintal (Rs)



**Annexure IV**

**Data Sheet for Meteorological Observations**

**Proforma 3**

NICRA REAL TIME PEST SURVEILLANCE (MANGO)							
Location Name :				Latitude :			
Longitude :				Altitude :			
METEOROLOGICAL INFORMATION for NICRA (based on the nearest location / research station)							
Date	Max. Temp (°C)	Min. Temp (°C)	RH		Rainfall (mm)	Sun Shine (hrs.)	Wind velocity (kmh <sup>-1</sup> )
			Morning	Evening			
			%				
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
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29							
30							
31							



### Additional Insects, Diseases and Disorders

Depending upon the agro climatic zones some of the following pests of insect and disease categories are found occurring on mango. Since not all the documented pests of mango figure in the data sheet formats prepared, mention and description of the symptoms of important insects, diseases and disorders are made below. In case of their occurrence they should be identified following the descriptions given and recording should be made separately during the surveillance. Their reporting should be made in excel or word formats of MS office.

#### Insect pests

##### Leaf cutting weevil

<b>Scientific name</b>	:	<i>Deporus marginatus</i>
<b>Family</b>	:	Curculionidae
<b>Order</b>	:	Coleoptera



#### Description

Yellowish grubs feeding on tender leaves through mining are seen. The leaves present whitish blotches. Leaves twist and roll. Terminal leaves are partially cut mainly due to the feeding by adults that are reddish brown weevils with snout

#### Procedure for observation

Number of infested shoots out of five tender shoots from each of the four directions of selected tree should be counted and recorded.



Damage due to leaf cutting weevil



## Bark-eating caterpillar

**Scientific name** : *Indarbela (Ludarbella) quadrinotata*

**Family** : Cossidae

**Order** : Lepidoptera



### Description

Larvae also make shelter tunnels inside the stem in which they rest. Stem entry is achieved by way of cracks. The caterpillar spins brown silken web on the tree which consists of their excreta and wood particles that hang loosely on the tree trunks more commonly at the junction of branches. The affected areas crack and scale off. In severe infection the bark becomes thickened, twigs get enlarged but remain stunted and the foliage becomes sparse and finally dries up.

### Procedure for observation

Presence or absence of symptoms of bark eating caterpillar on each of the selected tree should be looked for and recorded.



Damage due to bark eating caterpillar

## Tea mosquito bug

**Scientific name** : *Helopeltis antonii*

**Family** : Miridae

**Order** : Hemiptera

### Description

Necrotic lesions are found on petioles, tender shoots and leaf veins. Symptoms should be confirmed with the presence of adult bugs that are reddish brown with black head, red thorax and black and white abdomen.

### Procedure for observation

Number of infested shoots out of five tender shoots from each of the four directions of selected tree should be counted and recorded.

## Diseases

### Phoma blight

**Causal organism:** *Phoma glomerata*



### Symptoms

Disease is noticed on matured and old leaves only. The spots on leaves are characterised by dark margin and dull grey necrotic centre. The spots coalesce to form patches that lead to defoliation and withering of infected leaves.

### Red rust

**Causal organism:** *Cephaleuros virescens*



### Symptoms

- Initially the spots are greenish grey and velvety in texture which finally turn to reddish brown.
- After shedding the spore the algal matrix remains attached to leaf surface, leaving a creamy white mark at the original rust spot.



Rust spots



## Gummosis

**Causal organism:** *Lasiodiplodia theobromae*



### Symptoms

- The disease occurs on stem and branches of the plants
- Profuse oozing of gummy substances on the wood surface and bark of the cracked branches is the characteristic symptom of the disease.
- With increasing severity, the gumdrops may roll down the stem bark, setting off rotting of the bark.
- Bark rots completely, and the tree dries up

## Black banded disease

**Causal organism:** *Rhinocladium corticolum*



### Symptoms

Disease symptoms appear in the form of black velvety fungal growth on midribs, twigs and branches of mango tree. The disease is seen in to black colour bands on twigs (hence named as black banded). The infected portion of the bark contains mycelial growth and cluster of conidiophores which are confined to upper layer only.

## Scab

**Causal organism :** *Elsinoe mangiferae*



### Symptoms

Spots that are circular, slightly angular and brown are seen on leaves, panicles, blossoms, twigs, bark of stems and fruits. Symptoms are similar to anthracnose. Infection is grey to greyish brown with dark irregular margins and on fruits.

### Procedure for observation:

Diseases described above should be recorded following the widely adopted standard procedures available.

### Disorders

Mango crop is also known to suffer many physiological disorders such as black tip, fruit clusters (Jhumka), woody stem gall, red or soft nose and fruit tumours. Nutritional deficiencies of potash, zinc, iron, copper and boron also produce typical symptoms on foliage. Salt injury due to excess salt can also be possible.

### Physiological disorders

- **Black tip:** Also referred as Chimney disease occurs on developing mango fruits. Black area develops around nose of the fruit. The blacked area is hard and fruit growth is affected.
- **Fruit clusters :** Also referred as Jhumka. Many fruits are formed at the tip of panicle. Fruitlets are smaller, dark green and slightly curved at the nose. Fruits do not have seeds and do not grow further.
- **Woody stem gall :** Woody galls are found on branches and the number of galls varies with cultivars.





- **Red nose** : Also known as soft nose largely occurs on late maturing varieties late in the season. The distal end *i.e.* nose shows red coloration that turns soft with time.
- **Fruit tumours** : Pea to marble sized tumours occurs on developing fruit and are ugly to look at. The tumours are found mostly at the distal/nose end with the top portion of the fruit attached to the stalk free of tumours.

### Nutritional disorders

- **Potassium deficiency** : Scorching of leaf margins is typical symptom of potassium deficiency.
- **Zinc deficiency** : The leaf become smaller and narrow with margins bent upwards or downwards. Internode length is reduced and the twigs with clustered leaves give rosette appearance. Green veins with intermittent pale areas are common.
- **Iron deficiency** : Green coloured leaves get bleached in to white color *i.e.* chlorosis. Severe iron deficiency causes drying of leaves from tip to base.
- **Copper deficiency** : Terminal shoots become weak and defoliation and die back symptoms occur. Braches are seen drooping.
- **Boron deficiency** : Leaves loose lustre and become leathery. Leaf veins are thickened. Cracking of fruits is characteristic of boron deficiency. The yellow pulp of fruit shows conspicuous brown areas.
- **Salt injury/toxicity** : Leaves are scorched and turn bronze in colour. Tip burning is seen in severe cases of salt injury.

### Procedure for observation

- Disorders described above should be recorded following the widely adopted standard procedures available.

Such additional insects, diseases and disorders could be sporadic or evolving with the changing soil-plant-climatic interactions across mango growing regions. Such changes may be captured with the help of specialists using any of the scientifically based procedures and reported separately.

## NOTES

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## NOTES

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