Pests of Fruit Trees

(Citrus, Banana, Mango, Pomegranate and Sapota)

E-Pest Surveillance and Pest Management Advisory





भाकृअनुप
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Implementation : Commissionerate of Agriculture (Horticulture), Pune, Maharashtra

Project Coordination : ICAR-National Research Centre for Integrated Pest Management, New Delhi

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Foreword

The project on e pest surveillance was launched during year 2011-12 by commissionerate of Agriculture (Horticulture), Government of Maharashtra, Pune. The mega project has major objective to reduce the time lag between occurrence of the pests and application of need based pest management interventions to restrict the damage due to the pests in targeted fruit crops so as to minimize environmental hazards and adverse effect on human health and beneficial fauna. The objectives of the project are met by recording pest activities of major horticultural crops in structured formats, uploading the data on pest activities to centralized server and issuance of timely IPM advisories. The project implementation is facilitated through linkage between state agricultural universities (Mahatma Phule Krishi Vidyapeeth, Rahuri, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parabhani, Banana Research Station, Jalgaon and ICAR institutes (National Research Centre for Integrated Pest Management, New Delhi, Central Citrus Research Institute, Nagpur, National Research Centre on Pomegranate, Solapur and National Research Centre for Banana, Tiruchirapalli,) and state department of Horticulture, Government of Maharashtra, Pune.

In order to streamline the working of the project, the information on pests and diseases of banana, mango and pomegranate and e pest surveillance was compiled in year 2013 to educate and enabled the field functionaries to identify the important pests and diseases and their symptoms of damage as well as methodologies to record pest data in structured format i.e data sheet and upload such data in to the centralized server. It also facilitated the project scientists' easy accessibility of such data and department of Horticulture personnel to make available short-term & detailed IPM advisories on the internet and transmit them through SMS for benefits of farmers and other end users. As a result of addition of a few other fruit crops like sweet orange, Nagpur mandarin and sapota in the e pest surveillance programme from the year 2014-15, need was

felt to rewrite the present book to provide information on the additional crops and update and revise the information on pests and IPM technologies for the existing crops. Not only a few fruit crops have been added but area of operation of the project has also been widened. Earlier area of operation was restricted to 9 districts of the state, but now 14 more districts have been added making the total tally 23 covering 3,61,647 ha, amounting to 95.86% increase in area of operation.

With the constant and untiring efforts of the project scientists and field functionaries of the Department of Horticulture, we could successfully fulfill the objectives of the project and implement its activities. It is visible from the rising trend in productivity of mango, pomegranate and banana in year 2013-14 over years 20012-13 and 2011-12.

Updated book on e pest surveillance and information on pests and management advisories shall be able to provide specific skill to field functionaries and educate them as well as progressive farmers and other users. For this I complement the project scientists and the staff of department of Horticulture, Government of Maharashtra, Pune for their dedicated efforts and I wish them all success for future endeavours in this regard. I hope the outcome of the project shall be able to stand the test of time.

(Vikas Deshmukh)

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Introduction

Global transformation in the food system, change in the consumption pattern away from the rice, wheat and pulses and health consciousness are causing major shift in the focus towards the horticultural crops. This increasing recognition of the horticultural produce for nutritional values in human diet has resulted greater demand for fruits in the market. Innovations in production technology of horticultural crops and acceptance of these as a mean of diversification have contributed significantly in meeting the increased demand of these crops. Hence India with 2.5 per cent global land mass and 16 per cent global population also recognized the importance of horticultural crops as engine empowering not only nutritional security but also as national food security. Fruit production of India is 88.98 million tonnes from an area of 7.21 million hectares that is rated second in the world after China. Not only it rank in total fruit production but also it enjoy a privilege of growing a large variety of fruits, of which mango, banana, citrus, pomegranate, guava, grape, pineapple, papaya, apple, sapota and litchi are the major ones. Fruits are grown throughout the country, but the state of Maharashtra is contributing significantly to the extent of 15.12 per cent toward fruit basket of India followed by AP (11.81), Gujarat (8.99), TN (8.28), UP (7.74), Karnataka (7.47), MP (6.40), Telangana (4.99), Bihar (4.51). It is not only major fruit growing state of India but also growing a large variety of fruits like mango, grapes, citrus, sapota, pomegranate, banana and papaya. Mango is the most important fruit covering 30.10 per cent of the area and accounting for 9.01 per cent of the total fruit production of the state followed by citrus (sweet orange, Nagpur mandarin, lime) (17.57 % area and 13.09% production), grapes (5.75% and 16.05%), pomegranate (5.70% and 7.02%), banana (5.30 % and 35.90 %) and sapota (4.66% and 3.53%), respectively. Mango, grapes and pomegranate are the three important fruit crops exported to many countries which follows very stringent quality measures.

Having recognized the importance of cultivation of fruits in the state for greater role in providing the livelihood security to the local farmers and nutritional security at the national level, the state department of Horticulture started paying greater attention toward quality standard as well as in preventing losses due to the pests of fruits. There are many other programmes running in the state in meeting these listed objectives, but ICT based e-pest surveillance programme was started in year 2011-12 to keep a constant watch on the pests and diseases activities and issuance of timely ecofriendly integrated pest management advisories to prevent losses due to the pests so as to minimize the contamination of the produce by pesticides residues and looking after important environment and quarantine issues. Since then the project continued to meet the its targets and the objectives successively in its fourth year (2014-15) which are

reflected in the rising trend shown in the productivity of targeted fruit crops like mango, banana and pomegranate. The productivity (MT/HA) of mango, banana and pomegranate was 2.5, 58.2 and 10.5 in year 2013-14 which is higher over year 2012-13 (1.3, 43.9, 5.2) and 2011-12 (1.0, 52.6, 5.8), respectively.

It was made possible through the constant efforts of the state department of Horticulture, scientists of state agricultural university and ICAR institutes and through establishment of strong linkage among themselves, the stake holders and the end uses of the technologies and by reducing pest damage and other constraints of increasing the production and productivity. Looking to successful implementation of the e pest surveillance, three other fruit crops like sweet orange, Nagpur mandarin and sapota were also included in the project for timely application of integrated management programme against pests and diseases from the year 2014-15. This necessitated the need for development, up gradation and modification of the software and revision of the e-pest surveillance manual which is presented in the following pages. It is sincerely hoped that the present compilation shall cater the need of the field functionaries and progressive farmers in creating awareness for the correct identification of the pests, timely and ETL based application of the IPM technologies without time lag between the occurrence of the pests and their management. It will also facilitate the better implementation of the project activities.

CITRUS

A.K. Das, C.N. Rao, D.B. Ahuja, S.S. Mane, Suresh Dadmal, B.B. Bhosle, P.R. Jhanwar, A.P. Surywanshi and B.V. Bhede

Major insect pests and diseases of citrus and their management

Major Insect Pests

Citrus leaf miner *(Phyllocnistis citrella)*

Symptoms


Citrus leaf miner

- The characteristic symptom of leaf miner is presence of silvery serpentine mines usually on the under surface of the leaf. In general, each leaf has only a single mine, but in case of heavy infestation there may be several mines per leaf.
- Mining of the leaves causes them to curl up, distorted and thereby reducing the photosynthetic area of the young foliage.
- In case of severe infestation, mines can also be seen on the upper side of the leaves as well as on shoot portion of new twigs.
- Damage by this pest predisposes the acid lime plants for development of canker disease.

Pest identification

- **Eggs:** Eggs are laid singly usually on the underside of leaves near the midrib and look like tiny water droplets.
- **Larva:** The full grown larva measures 5.1 mm in length and is pale yellow or pale green with light-brown well developed mandibles. They settle down in galleries near the leaf margin for pupation.

- **Adult**: Adult is a tiny silvery-white moth about 2 mm long with fringed wings. Fore wings have brown stripes and a prominent black spot near the apical margin while hind wings are pure white with a wing spread of 4-5mm.

Biology of the pest

The eggs hatch within 3-5 days. The young pale yellow larvae immediately start feeding between epidermal layers of the leaf. They pupate, when full grown, near the margin of the mined leaf. The total life cycle is about 2 - 3 weeks.

Management practices

- Avoid pruning during active growth periods as it may induce further new flush and thereby allow the pest to have more number of generations. If necessary, prune only the infested shoots during winter from the inner canopy.
- Remove the water shoots from the tree canopy as they are the preferred sites of attack.
- The spray timings are most important in managing leaf miner because before entering in leaf tissue it is highly susceptible to the toxic effect of pesticides. Foliar application of neem oil 5 ml or imidacloprid17.8 SL @0.5 ml or phosolone 35 EC @1.5 ml or fenvalerate 20 EC @1.0 ml or spinosad 45 SC @ 0.34 ml or novaluron 10 EC @ 0.87 ml/l of water or mak all season horticultural mineral oil @ 1.5% in flushing season by directing at the new flush checks the pest.
- Conserve the bio-agents (Coccinellids, Chrysopids predators and eulophid parasitoids) by avoiding application of insecticides during late winter to early spring.

Citrus psylla *(Diaphorina citri)*

Symptoms

- The damage is caused by both nymphs and adults by sucking the cell sap from the leaves, tender shoots and flowers causing curling of leaves, defoliation and drying of twigs.
- Nymphs secrete whitish crystalline honey dew which attracts the growth of fungus, adversely affecting the

Citrus psylla on leaves

photosynthesis. Late instar nymphs and adults also transmit the citrus greening disease.

- In case of severe attack the leaf buds, flower buds and leaves may wilt and die.

Pest identification

- **Eggs:** The eggs are bright yellow and deposited on unopened leaf buds.
- **Nymph:** Early instar nymphs are green or dull orange and late instar nymphs are bright yellowish orange.
- **Adult:** It is 3-4 mm long, mottled brown in color, with transparent wings.

Biology of the pest

Eggs are laid on tips of growing shoots and between unfurling leaves. Females lay more than 800 eggs during their lives. Nymphs pass through five instars. Total life cycle requires 15 to 47 days depending upon the season. Adults may live for several months. There is no diapause, but population are low in peak Winter and Summer seasons . There are nine to ten generations a year; however, maximum of 16 have been reported.

Management practices

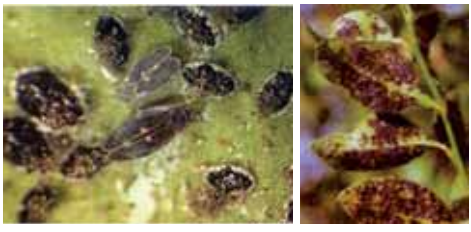
- Management of psylla during *Ambia* (March-April) and *Mrig* (June-July) flush is must as the pest causes severe damage.
- Collateral host like curry leaf *(Murraya koenigii* Linn.) plant should not be grown in the vicinity of citrus orchards as it is the most preferred host plant of psylla.
- Foliar application of quinalphos 25 EC @ 1 ml or novaluron 10 EC @ 0.55 ml or thiamethoxam 25WG @0.32g/l of water at bud burst stage. If required, second spray of any of the above insecticides should be given after 15 days.
- Conserve the bio-agents (Coccinellids, Chrysopids, Eulophids) by avoiding application of insecticides from winter to early spring.
- Two releases of Chrysopid predator, *Mallada desjardensi* @ 30 larvae/tree in each flushing season reduces the citrus psylla incidence.

Citrus blackfly *(Aleurocanthus woglumi)*

Symptoms

- Both adults and nymphs suck plant sap and results in the curling of leaves and also the premature fall of flower buds and the developing fruits thereby resulting in reducing the vitality of the tree.

- Moreover, honey dew secretion favours rapid development of black sooty mould that covers entire plant surface.
- The process of photosynthesis is hampered greatly resulting in stunted growth of plants, low intensity of flowering and scarce fruiting.



Citrus blackfly on leaves

Pest identification

- **Egg:** Yellowish brown oval and lay in whorls of lower side of the leaves.
- **Nymphs:** The nymphs are scale like, shiny black and spiny with marginal fringes.
- **Pseudo-pupa**: Oval, black in colour and its dorsum is arched with long black spines, the margins have rounded black teeth.
- **Adult:** Adults are ashy coloured with brick red abdomen, smoky wings. The adult females are about 1.2 mm long and the males are 0.8 mm in length.

Biology of the pest

The adults emerge in flushing seasons and the females lay yellowish brown oval shaped eggs which are arranged in a spiral manner on underside of leaves with 15-22 eggs in a cluster. The eggs hatch in 7-14 days and the nymphs on emergence start feeding on cell sap and settle on the lower side of the leaf. There are two distinct broods in a year. The first brood adults emerge in March-April and those of the second brood emerge in July-October.

Management practices

- Close planting, water logging should be avoided.
- Excessive irrigation and nitrogen fertilization should be avoided.
- Avoid growing collateral hosts of the pest, guava, sapota and pomegranate.
- Foliar application of imidacloprid 17.8 SL @ 0.5 ml or acephate 75 WP @ 1.25 g or phosalone 35 EC @1.5 ml or dimethoate 30 EC@ 2 ml or novaluron 10 EC @ 0.79 ml/l of water on the lower sides of leaves covering the entire tree canopy at 50% egg hatching stage. Second spray should be given after 15 days with any of the above insecticides or neem oil @10 ml/l of water.

Citrus whitefly *(Dialeurodes citri)*

Symptoms

- Both nymphs and adults suck the plant sap and secrete honeydew due to which sooty mould develops on the leaves.
- Severe infestation results in black fungal layer manifestation, covering entire plant parts including fruits due to which photosynthesis is affected.

Citrus whitefly on leaves

Pest identification

- **Egg:** Oval, pale yellow and rest on small stalks and singly on the underside of soft young leaves.
- **Nymph:** The nymphs are oval in shape, scale like, blackish with marginal bristle like fringes and are stationary.
- **Pseudo-pupa**: Oval, pale yellow, with an orange or yellow band in the middle of the body.
- **Adult:** Adult is 1.5 mm long with white or greyish wings, pale yellow body and red constricted eyes.

Biology of the pest

- The adult female lays about 150 eggs on the lower surface of leaves which hatches in about 10 days. The crawlers settle on the under surface of the leaves and suck the sap. Nymphal life averages 23 to 30 days. Pseudo pupal development requires 13 to 30 days. The adult lives an average of about 10 days, but has been known to live for as long as 27 days. The entire life cycle from egg to adult requires from 41 to 333 days.

Management practices

- Same as given for blackfly.

Citrus aphid *(Toxoptera aurantii, Myzus persicae* Sulzer, *Aphis* spp.*)*

Symptoms

- Nymphs and adults suck sap from tender leaves and shoots during winter to early spring. Affected leaves turn yellow, curled, deformed and dry up. Growth of young shoots is adversely affected. Plant growth is stunted.
- Sooty mould is produced on honeydew excreted by aphids.

- Aphids also act as the active vectors of *Citrus Tristeza Virus*.


Citrus aphid

Pest identification

- **Nymph**: The nymphs are dark reddish brown and approximately less than 0.1 mm in length.
- **Adult:** Adults are soft-bodied, pear-shaped, tiny sucking insects, measuring less than 2 mm in length and are pale yellowish green to black in colour. They have a pair of cornicles arising from vth abdominal segment.

Biology of the pest

- Each aphid produces about 5 young nymphs/day for a period of 1-3 weeks parthenogenetically. Single life-cycle normally takes 6 to 8 days.

Management practices

- Foliar application of dimethoate 30 EC @ 2 ml or acephate 75 WP @1 g or imidacloprid 17.8 SL @ 0.4 ml /l on identified infested trees during winter season reduces the infestation levels. If needed, Second and third sprays should follow at 10 days intervals.

Fruit sucking moth *(Eudocima materna)*

Symptoms

- Adult moths are active during dusk and suck the juice from the ripening yellow colour fruits during Sept.-Nov.
- The punctures produced during feeding by the adult moths leads to fruit rot due to invasion by secondary pathogens.
- Only adult moths are destructive to citrus fruits. The moths are distinguished by having particularly well developed proboscis with dentate tips with which they are able to pierce the ripening fruits.


Fruit sucking moth

Pest identification

- **Egg**: Round, translucent, measuring about 1 mm in diameter.
- **Larva:** Full grown caterpillars are 50 - 60 mm long, stout, velvety-blue with yellow colour.

- **Adult:** The adults have pale orange brown body with forewings dark greyish and the hind wings orange red with two black curved patches.

Biology of the pest

- The female moth lays eggs on weeds like *Tinospora cardifolia, T. semilacina, Cocculus hirsutus, Convolvulus arvensis etc.* where the caterpillar develops after hatching. Egg period is 8 - 10 days. The caterpillar is a semilooper, dark brown with yellow and red spots. Full grown caterpillars are 50 - 60 mm long, stout, velvety-blue with yellow patterns on dorsal and lateral sides. Larval period is 28 - 35 days. Pupation takes place in a transparent pale whitish silken cover enclosed in leaf fold. Pupal period is 14 - 18 days.

Management practices

- Destroy fallen fruits by burrying in the ground.
- Clean cultivation of the orchard is must to avoid the pest development.
- Generation of smoke in the late evening hours in orchards repels the pest.
- Systematic destruction of larval host plants during rainy season in the vicinity and surrounding the orchards in a mass campaign mode.
- Bagging of fruits is effective but very laborious and expensive.
- Poison baiting with malathion 50 EC @ 10 ml + 100 g jaggary +100 ml mandarin juice + 900 ml of water (two bottles containing poison bait per 25-30 trees).
- Foliar application of neem oil 1% or malathion 50 EC @ 2 ml at 10 -15 days interval during fruit maturity till harvest reduces the infestation levels.

Bark eating caterpillar *(Indarbela quadrinotata)*

Symptoms

- Caterpillars feed on the bark and bore at stem joints Larva remains hidden inside the tunnel during day time and becomes active in the night.
- Several caterpillars may attack the same tree at different locations which can cause serious injury to the bark and the death of small branches.
- The holes left on the trunk may lead to infestation by other insects or plant pathogens. Affected branches break at the points of attack.
- A severe infestation may arrest the growth of the tree and die within 2-3 years if untreated .

Bark eating caterpillar

Pest identification

- **Eggs:** Female lays eggs in group of 15 to 25 during May-June which remain attached to bark.
- **Larva:** Caterpillars are 50-60 mm and have pale brown bodies with dark brown heads.
- **Adult:** Adults are pale brown or grey in colour. They are 35 - 40 mm in size. The fore wings are pale rufous with numerous dark rufous bands. Their hind wings are fuscous.

Biology of the pest

- The eggs hatch in 8-10 days. The larvae have the habit of making webs along the feeding galleries. The larvae take as many as 9-11 months to complete development. When full-grown, they make a hole into the wood and pupate inside. The pupal stage lasts 3-4 weeks. The moths emerge with the onset of monsoon and are short lived. Only one generation is completed in a year.

Management practices

i. Clear the affected branches of the fross and faeces.

ii. Inject 5-10 ml of dichlorvos 76 EC @ 4 ml/l into the tunnel and cover with cotton wad is quite effective due to its contact and fumigant action.

Other Pest

Citrus rust mite *(Phyllocoptruta oleivora* Ashmead)

Symptoms

- Citrus mite attack is known as 'Rusting' on Grapefruit, '*Lalya*' on Nagpur mandarin, *Mangu* on Sathdudi sweet orange and rind disorder in Kinnow.
- Rust mite infestation produces a multitude of brown–reddish black spots on the fruit surface.
- The rust mite attacks the berry size fruits of both *Ambia* in March-April and *Mrig* in October-November inflicting undesirable brown irregular patches on them that fetches low market price to the fruits.

Citrus rust mite symptom on fruit

Pest identification

- **Eggs:** The eggs are smooth, spherical, semi-translucent and are laid in groups in indentations on fruits and on ventral surfaces of leaves.

- **Larva:** The newly hatched larva resembles the adult, changing in color from clear to lemon yellow.
- **Adult:** adults are very small (150 -165 µm), fusiform, dorsally flattened and yellow.

Biology of the pest

Egg period is 3 days and nymphal development completes in 2-11 days. The life cycle is completed in 7-10 days in summer and 14 days in winter. A female lays 20 to 30 eggs during a life span of 20 days. The pest has number of generations.

Management practices

- Water stress often aggravates mite problem. Make sure that trees are well irrigated, particularly during the stress in peak summer and winter.
- Foliar application of wettable sulfur 85 DP @ 3 g or dicofol 18.5 EC @ 2 ml or propargite 57 EC @ 1ml or ethion 50 EC @ 1 ml/l of water and make all season HMO (2%) immediately after fruit set and during active period of mites checks the pest effectively.

Major Diseases

Root rot, foot rot and gummosis of citrus (*Phytophthora* spp.)

Symptoms

Root rot, foot rot and gummosis of citrus

- Root rot occurs when the cortex of fibrous is infected trunks soft and appears water-soaked, fibrous roots slough of their cortex, learing only a white thread- like stele.
- Gummosis is identified by profuse gumming on the surface of the bark on tree trunk from which gummy substance oozes out.
- The affected bark turns dark brown and develops longitudinal cracks. The wood tissues are also affected. In severe cases, bark rots and the trees dry because of girdling effect.
- The disease is favoured by rains, heavy to ill drained soils, excessive and flood method of irrigation leading to prolonged contact of trunk and crown with water or moist soil, high water-table, deep planting, low budding and injuries to roots or base of the stem.

Pathogen dissemnation

- The primary means by which *Phytophthora* spp. are spread through citrus orchards is by use of infested nursery stock. The pathogen may be present in soil or infected roots even though disease symptoms are not readily apparent. The fungus -like organism is also carried in soil on equipment when vehicles move from infested to non-infested groves or nurseries. Flooding method for irrigation water may also move the pathogen from area to area. Within groves, dispersal by irrigation water occurs especially where furrow or flood irrigation is used. Surface water following heavy rains may carry the pathogens it drains from the grove.

Management practices

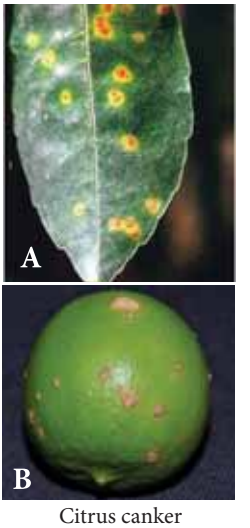
- **Trunk Paint:** Scrap the affected bark portions of the tree trunk, branches and limbs along with some healthy green bark with the help of sharp Knife or Khurpa. Properly collect and destroy the diseased bark by burning and do not allow it to fall on the ground. Apply the fungicidal paint of mefenoxam MZ (available as Ridomil Gold)with the help of painting brush twice in a year whenever symptoms appear.
- **Soil Drench:** Drenching the root zone area of the infected tree with Mefenoxam MZ (25 g / tree in 10 litres of water) twice in February-March and July-August. Trunk paint can be combined with soil drench for effective disease control.
- **Foliar Sprays:** Spray application of fosetyl aluminium (Aliette)(2.5 g/litre) can be made during September-October for the effective disease control. The spray application will check the lesions on the tree parts as well as help regeneration of feeder roots. Aliette spray can be combined with drenching of root zone area with mefenoxam MZ.
- Prefer **double ring basin method** of irrigation over flooding method of irrigation.

Citrus canker *(Xanthomonas citri* subsp. *citri)*

Symptoms

- Canker lesions start as pinpoint spots and attain a diameter of 2-10 mm.
- Their eventual size depends mainly on the cultivar and the age of the host tissue at infection.

- The lesions are initially circular but later may develop irregularly often aggregated at the leaf margin or the leaf tips or in a restricted area of the leaf. Lesion become visible on the underside of leaves about 7 days after infection and on the upper surface soon after.
- The characteristic symptom of the disease on leaves is the yellow halo that surrounds lesion. Young lesions are raised or pustular, particularly on the lower leaf surface.
- The pustules later became corky and crateriform, with a raised margin and a sunken centre. Lesions on fruit and stems extend 1-3 mm in depth and are superficially similar to those on leaves.



Citrus canker
(A) on leaf, (B) on fruit

Pathogen dissemination

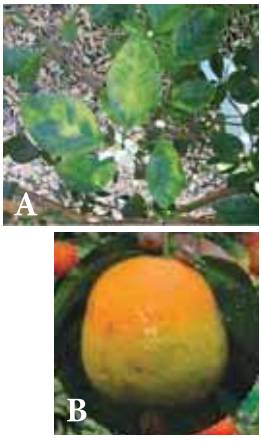
- With strong winds, high rain-fall, and temperature between 20^0 C and 30^0 C, the citrus canker disease becomes very much severe in concerned area. Strong winds and rain splashes greatly help disseminating the bacteria, while the required temperature and moisture help successful infection.

Management practices

- Eradication of the pathogen inoculum is the best method of controlling the disease. All infected and suspected trees should be burnt and workers tools and cloths should be disinfected. Where the eradication of the pathogen by burning diseased trees is not feasible, the following recommendations should be adopted : (a) Use of disease-free nursery stock for planting in new orchards, (b) Pruning of the affected twigs in old orchards and spraying with fungicides like Bordeaux mixture (1.0%) or, copper oxychloride (0.3%) at periodical intervals particularly during rainy season, and (c) Bordeaux mixture (1.0%) spray on plants before they are planted in new orchards.
- Strict quarantine measures should be followed in canker-free citrus producing areas so that the pathogen be not allowed to that area.
- Use of resistant varieties should be preferred. Although no resistant varieties to this disease has been successfully developed, varieties of mandarin oranges are resistant to canker, compared to lime/lemon groups.

Greening disease (*Candidatus liberibacter asiaticus)*

Symptoms



Greening disease
(A) on leaves, (B) on fruit

- The range and severity of symptoms vary with season, type and extent of infection, age and nutritional status of the trees.
- Greening infected citrus leaves are generally small, upright and frequently have symptoms with green veins and chlorotic interveinal areas.
- Diseased leaves also show various types of chlorotic mottling. Leaf mottle is one of the best diagnostic symptoms of greening.
- In severe cases leaves become almost chlorotic with scattered dark green islands.
- Symptoms are often seen on part of the canopy or even only in a branch or a twig.
- Infected fruits are small and mis-shapen, many fall prematurely, while those that remain on the tree do not colour properly, remaining green on the stylar (lower) end and hence the origin of the name 'greening'.

Pathogen dissemination

- Greening disease is transmitted by infected budwoods and in the orchards through citrus psylla (*Diaphorina citri*). Psylla picks the pathogen in nymphal stage and transmits it when adult.

Management practices

- The management of greening disease involves removal of affected unproductive trees and their replacement by disease-free budded plants developed on improved rootstock through proper indexing programme.
- Regulatory (quarantine) measures should be strengthened to limit movement, sale and use of infected bud wood or nursery stock. Strict control of nurseries through registered disease-free certification scheme is essential to prevent the spread of disease.
- Since the disease also spreads through the vector, citrus psylla, recommended insecticides as given under psylla management should be applied to control the disease spread.

Twig blight/twig dieback *(Botryodiplodia theobromae, Colletotrichum gloeosporioides)*

Symptoms


Twig blight/twig dieback

- Twig blight is a common problem of citrus especially mandarin plantation in India. Nagpur mandarin plants in central India show drying of twigs after one or two bearings.
- A number of stress factors like nutritional deficiencies, drought, attack of insect pests, virus and virus-like diseases and root rot infection by *Phytophthora* spp. together contribute to the problem.
- The plants affected with one or more of the above factors show drying of twigs starting from the tip and die back.
- Reduction of canopy volume due to this malady reduces the yield considerably. Blighted trees on bearing suffer heavy fruit drop. The fruit harvested from such trees develop high percentage of stem end rot during storage.

Pathogen dissemination

- Although pycnidia are commonly present in dead bark and wood, the fungus is usually considered a primary invader after tissues are wounded by pruning, mechanical damage, or unfavorable environmental conditions, such as extreme heat, cold, flooding or drought.
- The primary cause of dieback is probably a physiological weakness that renders the tissues more prone to colonization by this weak pathogen. Rain splash also help pathogen spread from one tree to another.

Management practices

- The best management strategy of this problem is to remove the predisposing factors responsible for weakening the plant vigour.
- Regular pruning of dead twigs 1 - 2 cm below the dead portion after harvest and spray of benzimidazole fungicides (e.g. carbendazim @ 0.1%) twice at monthly interval after pruning keep the problem under control.

Scab *(Elsinoe fawcettii)*

Symptoms


Scab caused on fruits

- Citrus scab attacks the fruit, leaves and twigs, producing slightly raised, irregular scabby or wart-like outgrowths.
- The scabs are grey or pinkish at first and become darker with age. They are more common on fruits than leaves.
- The raised lumps associated with scab can be confused with symptoms caused by citrus canker or with windrub abrasions.
- Spores of the fungus are readily produced on the surface of scab lesions on young fruits and leaves throughout the year.

Pathogen dissemination

- Spores of the fungus are spread in the orchard by rain, overhead irrigation and during spraying operations. Dew may also cause the spores to be liberated from the lesions but due to the limited splashing action, there would only be localised dispersal.

Management practices

- Prophylactic sprays of captafol, benomyl or methyl thiophanate at emergence of new flush provide satisfactory control.
- To control citrus scab, spray the tree with Copper oxychloride, Captan could also be applied in the late winter before the new spring growth starts and a second spray application should be applied shortly after the petals have dropped from the fruit blossoms.
- To help reduce the spread and growth of citrus scab never use a water sprinkler on a citrus tree. When watering a citrus tree, always use a soaker (or, drip) hose on the ground near the tree's drip line.

General management practices

- As precautionary measure first spray may be given as soon as the new flush is emerged.
- Destroy the ant colonies in the orchards as they are the carriers of certain pests to their feeding sites and also protect them from other harmful agencies.

- Close spacing and water logging conditions should be avoided in the orchards which help in creating micro-niche favouring the pest population.
- Avoid pruning during active growth periods as it induces irregular and frequent flushes which lead to the perpetuation of pest. If necessary, prune only the infested dry shoots after fruit harvest.
- Apply nitrogenous fertilizers as per need only as excessive and frequent applications promote new flushes which provide favourable conditions for insect pests' infestation.
- Modify canopy structure in such a way that light interception is maximum below the canopy.
- Preparations of spray solution, spraying operations, insecticide residue and compatibility in mixtures are important aspects to keep in mind before undertaking the sprays.
- The time of insecticide application should be decided after monitoring the pest incidence meticulously *viz*., only young and vulnerable life stages of the pest should be sprayed upon.
- The spray should be targeted on the lower surface of the leaves and the new flush. Canopy should be covered till the run off stage.
- Avoid the repeat application of a particular pesticide and do not use expired pesticide.
- Prepare spray solution first in small quantity and then increase the volume to desired level by adding water. In case of wettable powder take required quantity of pesticide, add a little quantity of water, mix it thoroughly to prepare the paste and then add remaining quantity of water to this paste with constant stirring.
- Avoid spraying during strong winds, cloudy days and drizzling.

BANANA

R. Thangavelu, N. B. Shaikh, Suresh Pardeshi and D.B. Ahuja

Major insect pests and diseases of banana and their management

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.

Rust thrips infestation on fingers

Pest identification

- **Egg:** Kidney shaped, invisible to naked eye, laid just below the fruit or inside the pseudostem.
- **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 moulting and after 8–10 days, mature

nymphs move 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 or polypropylene bunch leaves.
- Remove the male flower buds after opening of all hands.
- When the bud is in upright position, bud injection with imidacloprid 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 *i.e* one at the time of opening of hands and second spray after all the hands opened.
- *Verticillium lecanii* (2 x 108 cfu/g) 3g/ lit + 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.

Aphid infestation

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.
- Release predators such as lady bird beetles and lace wings @ 5 insects/ plant.
- Apply bio control agent *Beauveria bassian*a (2 ml in 100 ml water) between the leaf sheath at the base.

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 corm rhizome.
- Yellowing and withering of leaves, reduced plant vigour, root destruction, reduced fruit production and are easily blown over by the wind.

Corm weevil (A) adult, (B) Grub

Pest identification

- **Egg:** White colour, elongate to oval, about 2 to 3 mm long and present on upper surface and crevices of rhizome.
- **Grub:** Legless grubs, creamy white with red head having strong mouthparts, stout and distinctly curved.
- **Pupa:** They are white and found inside the rhizome tunnels.
- **Adult:**

a. Weevils newly emerged are reddish 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* @ 3ml in 100 ml of water 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) after or chlorpyrifhos (2.5ml/lit of water).

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.

Stem weevil

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.
- Uproot and destroy infested plants.
- Use longitudinal pseudostem traps @ 100/ha for trapping weevils.
- Swabbing with chlorpyripos 2.5ml/l + adjuvant 1ml/l on the stem prevents infestation of 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.

Other Pest

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.

Burrowing nematode [www.entnemdept.ufl.edu]

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

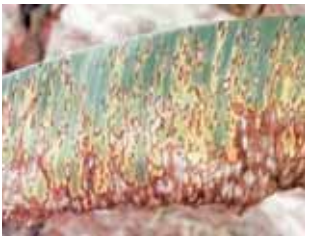
- Crop rotation with non host crops.
- Adopt soil solarization.
- Remove all the black or discolored spots on the corm and root tissue, leaving only clean white tissues.
- Grow marigold as repellent and trap crop in the inter space.
- Use of neem cake @ 500g/ plant along with anyone of the bioagents *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 into elliptical shaped dark purplish black spots 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.



Leaf spot

Pathogen dissemination

- Wind, rain water and old dried infected leaves carrying conidiophores/ ascosphores 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 phosphorus solublizing 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 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. The fungicide requirement for a litre of a water is as follows.
    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 (mancozeb and carbendazim) 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 sides 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.

Anthracnose

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 favours disease development.

Management practices

- Adopt clean cultivation and maintain proper field sanitation.
- When all the hands are opened, the distal bud should be removed to prevent infection.
- Transported bunches should be stored carefully at 14°C 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 in carbendazim 400 ppm or benomyl 1000 ppm solution.

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.

BBMV

Pathogen dissemination

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

Management practices

- Use disease free planting material.
- Avoid taking suckers for planting from the 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, 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.

BBTV

Pathogen dissemination

- 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.
- 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.

- Spray banana plants with dimethoate 30EC @ 1ml/l of water along with sticking agents to control insect vectors.

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.

Cigar end rot

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 bunches 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.

Erwinia rot infected corm

- 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 @ 8g/plant at 10 to 15 days interval for 2-3 times.
- Use healthy planting material.
- Drench plants with the solution of 300g copper oxychloride + 15g streptocycline + 300ml chlorpyriphos in liter of water.

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.

Fusarium wilt infected plant

Pathogen dissemination

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

Fusarium wilt infected corm

Management practices

- Follow proper crop rotation.
- 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.
- 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 3-4 times at monthly interval starting from 1st month of planting.

MANGO

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Major insect pests and diseases of mango and their manangement

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 for insect development.

Mango hopper

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 niveosparsus:* 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).
- Protecting and encouraging biocontrol agents like predators, *Mallada boninensis*, *Chrysopa lacciperda*, egg parasite, *Polynema spp*. *Gonatocerus sp*. *Tetrastichus sp*. and fungus, *Verticillium lecanii*.
- Application of bio-agents, *Metarhizium anisopliae* @ 1x 10^8 cfu/ml or *Beauveria bassiana* @ 10^8 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 cypermethrin 25% 3ml or fenvelerate 20% 5 ml or deltamethrin 2.8% 9 ml or profenophos 40% + cypermethrin 4% 15 ml or chlorpyriphos 50% + cypermethrin 5% 10 ml per 10 lit. of water. Second at panicle initiation stage with quinalphos 25% 20 ml or carbaryl 50% 20 gm or profenophos 50% 10 ml per 10 lit. of water. Subsequent sprays with imidachloprid 17.8% 3 ml or clothianidin 50% (WDG) 1.2 gm or thiamethoxam 25% (WDG) 1 gm or triazophos 40% 10 ml or phenthoate 50% 20 ml or diamethoate 30% 10 ml or deltamethrin 1% + triazophos 35% 10 ml or Lambda cyhalothrin 5% 6 ml per 10 lit. of water.

Mealybug *(Drosicha mangiferae)*

In India, it is widely distributed along the Indo-gangetic plains and found in Punjab, Uttar Pradesh, Bihar and Delhi causes 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.

Mango mealybug

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 moult 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* (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.

Leaf webber damage

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.

Adult, pupa & larvae of leaf webber [courtesy internet]

Management practices

- Webbed leaves should be removed

mechanically along with larva and pupa and destroyed.

- Pruning of over crowded 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.

Thrips *(Caliothrips indicus, Rhipiphorothrips cruentatus* and *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.

Thrip damage to foliage & fruit

- *C. indicus* and *R. cruentatus* feed on leaves and causes stippling on leaves.
- *S. dorsalis* mainly feed on inflorescens 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.
- 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 (0.05%) 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.

Damaged stem

Stem borer grub

Adult beetle

Pest identification

- **Grub** - Full grown grubs are cream coloured, fleshy and apodous with dark brown head and measure 90 x20 mm in size.
- **Adult** - Beetle is dark with a fine grayish vestiture and 2 kidney-shaped orange yellow spots on pronotum.

Stem Borer Grub

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. Similarly disposed off dead trees from the orchard.
- 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.

Terminal shoot damage

Adult male Adult female

Pest identification

- **Caterpillar**-Young caterpillars are yellowish orange with dark brown prothoracic 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 17.5mm 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.

Adult scales on leaf

Sooty mould

- 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 or dimethoate (0.06%) at 21 days interval.
- Elimination of ants may allow natural enemies to control the insect.

Termites (*Odontotermes* sp.)

Several species of them are found almost in all states of India viz. *Odontotermes obsesus* Ramb., *Microtermes obesi* Hilmgr., *O.assuthi* Hilmgr., *O.feae* Wasmann., *Trinervitermes beimi* Wasmann., *Coptotermes reimi* Wasmann., *Heterotermes indicola* Wasmann., and *Nevbevares gardneri* Synder.

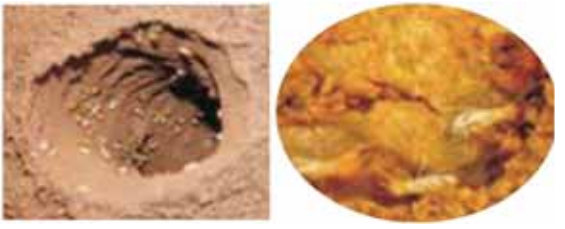
Symptoms

- 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.

Termite damage on stem
[www.infonet-biovision.org]

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.



Termite & termite mud galleries [www.infonet-biovision.org]

Biology of the pest

The larvae having hatched from the eggs turn into nymphs that 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 dust 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

Conical gall formation in leaf axis

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.

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.

Shoot gall psylla nymph

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.

Midge galls on mango leaves

[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.

Midge damage on 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 lay 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.
- Inflorescence midge lay eggs inside tissue of flowering shot, rachis developed inside forming small galls, which turn black later on. Full grown pinkish larva drop on soil for pupation.

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.

Damaged bark

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.

Larva tunnelling

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 or DDVP (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.

Fruit fly damage on mango

- Ripening fruits are more likely to be attacked.


Maggots in fruits


Adult fruit fly

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

- Sanitation of orchards.
- Removal and destruction of fallen fruits.
- Affected fruits should be collected and destroyed.
- Do not allow the fruits to ripe on tree itself. Harvest the fruits before ripening i.e. at 85% maturity.
- Install fruit fly traps @ 4 Rakshak traps/ha or 10 bottle traps/ha from March to June.
- 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 serious is 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.

Powdery mildew on
(A) leaf and (B) infloresence

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

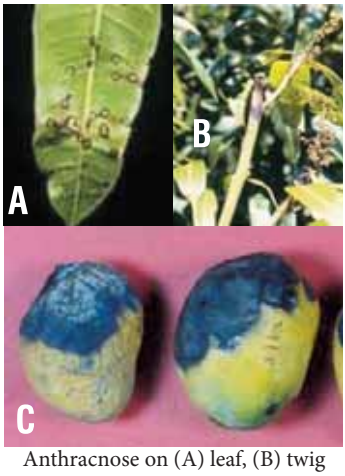
- Prune plants regularly so as to improve air circulation in the canopy.
- Remove diseased leaves, severely infected panicles and destroy them.
- After the occurrence of high humidity and low temperature for 4–5 days in disease prone areas, two sprays with wettable sulphur WP @ 0.2%, tridemorph EC @ 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.
- Numerous oval or irregular brown to deep brown spots of variable size appear on the tender peanut as well as mature fruits. Fruits are blacken and heavy fruit drop occurs during severe infection.



Anthracnose on (A) leaf, (B) twig
and (C) fruits

- 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.
- Spraying of carbendazim (0.1%) or thiophanate methyl (0.1%) or hexaconazole (0.05%) as per the weather condition.

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- die back.

Bacterial leaf blight

- 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.

Sooty mould on leaves

Sooty mould on fruit

- 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 0.2% + methyl parathion 0.1%+ gum Acacia@ 0.3%.

Mango malformation (*Fusarium* spp.)

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.

Mango vegetative malformation

Mango floral malformation

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, deblossoming.

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.

Dieback of mango

Pathogen dissemination

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

Mango gummosis

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 (thiphanate-methyl) @1 g/l or foliar spray with carbendazim @ 0.1%, or chlorothalonil @ 0.2% at fortnightly interval.
- Dolomite 2 kg/plant is recommended.

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.

Phoma blight

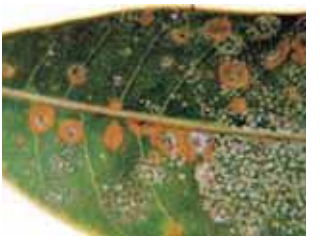
Management practices

- 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 *(Cephaleuros 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.



Red rust of mango

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.

Black banded disease

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%).

Phanerogamic parasites *(Dendrophthoe falcata)*

Symptoms

- Seeds of the parasite germinate and produce haustoria's in the bark.
- Infected host tissues sometimes swell to form tumours.
- Under severe infestation the parasite covers the entire tree.

Phanerogamic Parasites

Management practices

- Remove the parasites at its early stage by using "Amar Bandgul Cutter", a device designed by Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli specially to remove the parasite.
- Remove the *loranthus* completely on the big branches and spray glyphosate (1%) on the infested parts or apply cashew nut shell oil directly on the haustoria's with the help of brush.

Blossom blight *(Colletotrichum gloeosporioides)*

Symptoms

- On the inflorescence the typical symptoms of the disease are the production of blackish brown specks on the peduncle and flowers.
- Small black spots appear on the open flower, which gradually enlarges and

coalesce to cause death of the flower either directly or indirectly by drying up of flower stalk.

Blossom blight

- Under favorable condition the whole flower stalk may become black and set no fruits. The infected flowers and small fruits fall off.

Management practices

- The disease is mostly observed on early flowering flush of October in Konkan.
- Intermittent sprays of carbendazim (0.1%) or Propineb (0.2%) or thiphanate methyl (0.1%) or carbendazim + mancozeb (0.2%) or Tricyclazole (0.1%) control the disease effectively

Post Harvest Diseases

Stem end rot *(Diplodia natalensis/ Rhizoctonia solani)*

Symptoms

Stem end rot on fruit

- In the initial stage, the epicarp darkness around the base of the pedicel with irregular margin.
- The infected fruits became watery and air bubble oozes out from the stalk end. Later, the affected area enlarges to form brownish patch which expands rapidly and the whole fruit turns brownish in colour within 2 to 3 days.
- Frequently, the epicarp show cracks from which light tan or brown watery fluid oozes out.

Management practices

- Preharvest spray of carbendazim (0.1%) fifteen days before harvest.
- Harvest the fruits with intact stalk.
- Dip the fruits in carbendazim solution for ten minutes, dry the fruits and keep for ripening in well ventilated paddy straw.
- For effective management of post harvest fruit rot of Alphonso mango fruit dip treatment in 50^0 C hot water solution of potassium metabisulphite (0.05%) for 10 minute is recommended.

Black rot *(Aspergillus niger)*

Symptoms

- The infection starts mostly from the stalk end. Initially there is depression around the stalk.
- The colour of the infected mesocarp has whitish mycelial growth which further developed in to black necrotic area and shows copious growth of black mould.
- The fruits are rotten at the advanced stage with typical foul odour.

Management practices

- Same as given for stem end rot.

Black rot on fruits

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.

Black tip of mango

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

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.

Mango red nose

Management practices

- Harvesting of fruits at appropriate time.
- Provision of proper plant nutrient.

Woody stem gall

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.

Black banded disease

Management practices

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

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.

Narrow, chlorotic and rosette leaves due to zinc deficiency

Management practices

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

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.

Iron deficient leaves

- Excessive amounts of manganese in poorly drained soils can induce iron deficiency in plants.

Management practices

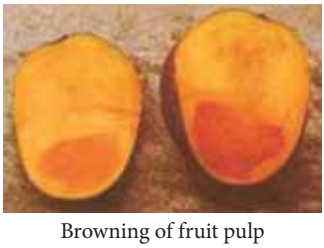
- Two sprays of ferrous sulphate (2.5 g/l) at fortnightly interval.

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.

Fruit cracking due to boron deficiency



Browning of fruit pulp

- The floral panicles are smaller and have fewer hermaphroditie 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.

Scorched, bronzed and tip burning of leaves due to salt injury

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.

POMEGRANATE

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Major insect pests and diseases of pomegranate and their management

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 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 arils.
- The striking symptom is the odious smell and excreta of caterpillars coming out of the entry holes ultimately leading to fruit rot.


Fruit borer Adult


Larva


Pupa


Bored hole on fruit with excreta

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/1.
- 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)*

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.


Adult thrips


Dried tips


Scrapping on fruit


Leaf curling

Pest identification

- **Egg:** Dirty white bean-shaped
- **Nymphs:** Newly hatched nymphs are reddish and turn yellowish brown as they grow
- **Adults:**
  - *Rhiphiphorothrips 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. This species is pale yellowish in colour and seen with two black stripes on the body.

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 oxy- demeton 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.

Larva of *Zeuzera sp.*

Bored hole

Excreta wood dust on soil

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 stage last for 9 to 10 months and pupal period is 16 to18 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* spp. is a polyphagous insect pests that feeds on a range of trees. The caterpillar bores the stem and feeds the bark of the tree at night. Neglected and ill-managed orchards witness the heavy infestation of this pest.

Symptoms

- Holes or zig zag tunnels are bored by the caterpillar on the tree trunk and it feeds inside the bark. The tunneling causes weak points on the trees where breakage occurs affecting the vitality of the trees badly.

Excreta with web around bored hole

Larva

- Several holes can be seen on the trunk at the joints of the branches. 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 reduce production.

Pest identification

- **Egg:** They are oval, reddish in colour.
- **Larva:** Larvae 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 3-4 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.

Fruit piercing/sucking moth

Three species of fruit sucking moths (FSM) i.e. *Othreis fullonia, O. materna* and *O. homaena* are found infesting pomegranate fruits of *mrig bahar* in different parts of India. They generally remain absent in a locality of fruit crop for years, then suddenly destroy orchards in few days during nights. Fruit sucking moths remains active from August to October and can be noticed in the orchards between 7 pm to late 2 am.

Symptoms

The moth pierces through the rind and sucks the juice with their long proboscis. These holes form the avenues for entry of rot causing microorganisms. The damaged fruits soon start rotting from the punctured regions and ultimately the fruits drop occurs.

Fruit piercing/sucking moth damage
(A) moth sucking fruit juice (B) pierce marks on fruits and (C) rot following fruit piercing

Pest identification

- **Adult:** *O. fullonia* is covered with orange colored scales and an inverted "C" shaped marking is seen at the centre of hind wings in both the sexes. *O. materna* is covered with orange colored scales and a black dot marking is seen at the centre of hind wings in both the sexes. *O. homaena* is covered with orange colored scales and fore wings are with parrot green color band, and an inverted "C" shape marking is seen at the centre of hind wings in both the sexes.
- **Larva:** Just hatched larvae are pale green in color and are about 5 mm in length. Full grown caterpillars are 50-60 mm long and are bright colored with orange, yellow and blue spots on speckled body and are semiloopers
- **Pupa:** Pupation takes place in a transparent pale whitish silken cover and is shiny dark brown.

Biology of the pest

- The adult moth can live up to 25-30 days and lay 200-400 spherical eggs on climbers like *Cocculus pendulus, C. hirsutus* and *Tinospora cardifolia*. Incubation period for egg is 8 -10 days. The larval stage passes through five instars which take respectively 3 -5, 3 - 5, 2 -3, 2 -5 and 4-10 days. Pupation last for 13 days and then adults emerge out.

Pest management

- Moth attack occurs mostly along the outer rows of the orchard, so, fruit crops should be planted in square blocks and not in a few long rows.

- Collection and destruction of moths using torch in the night is the usual practice adopted by growers
- Avoid taking *mrig bahar* in pomegranate, as the activity of fruit sucking moth remains from August to October.
- Cover the fruits with butter paper, newspaper or polymer bags as per the feasibility of covering materials.
- Destroy host plants of larvae viz., *Tinospora cordifolia, T. sinensis, T. smilacina, Cocculus hirsutus, Anamirta cocculus, Tiliacora acuminate, Diploclisia glaucescens, Cissampelos pareira, Convolvulus arvensis, Trichisia pattens* and *Pericampylus glaucus* present in and around the field.
- Create smoke in the fields by burning the weeds and crop waste during evening hours in the orchard at different spots. Smoke masks the odor of the mature fruit, so that, the moths fail to detect fruits and do not enter the orchard.
- Egg parasitoids, *Telenomus* sp., *Ooencyrtus* sp. and *Trichogramma* sp. are among the most successful biological control agents of FSM.
- Keep poison baits (95% molasses/jaggery + 5% malathion), in big flat earthen pots and install compact fluorescent lamps (CFL) bulb over them. Moths are attracted to light and bait which kills them through stomach action.

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.

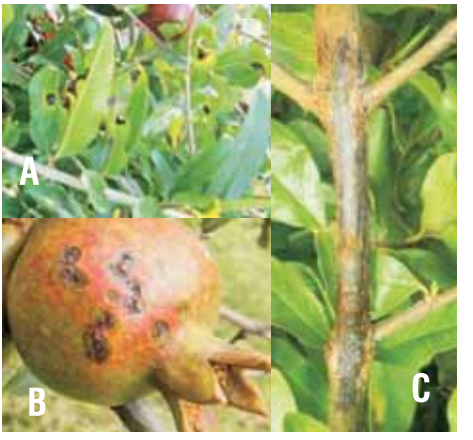
Disease build up is rapid during rainy season. High disease severity is observed from July to October. Temperatures between 25 to 35°C coupled with humidity above 50%, rains and wind favour rapid disease development. The disease affects all plant parts, but is most destructive on fruits.

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.



Bacterial blight on (A) Leaves (B) fruits (C) Stems

Pathogen 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, human being 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% but 1% just after pruning and rest period), altered with spray of streptocycline (5g/10 l) or 2-bromo, 2-nitro propane-1, 3-diol (5g/10 l) mixed with copper based formulations like copper oxychloride or copper hydroxide (20-25g/10 l) 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.

Initial yellowing in wilted plants

Advance stage of wilt

Discoloration of wood due to *C. fimbriata*

Pin holes due to shot hole borer

Knots due to root knot nematode

Pathogen 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.

Fungal spots and rots

Fruit spots and rots are responsible for qualitative as well as quantitative losses of pomegranate. Predominant fungal spots and rots are caused by *Cercopsora punicae (Cercospora* spots), scab *(Sphaceloma punicae)*, fruit rot *(Colletotrichum gloeosporioides)*, fungal blight *(Phytophthora nicotiane)* and heartrot *(Alternaria alternata)*. The fungal spots and rots are prevalent in all pomegranate growing areas in India. These may lead to heavy losses in neglected orchards or under unfavourable environmental conditions, if timely sprays are not taken.

Colletotrichum rot has recently become important in rainy season crop. Heart rot due to *A. alternate* was reported to be a serious problem in Mahaboobnagar, Telangana, India in 2014. The rot causing pathogens mostly enter through the crown end. Majority spot and rot pathogens are severe during hot humid conditions during July to September in semi arid regions.

Symptoms

- ***Cercospora* Spot:** The causal organism of these spots is *Cercopsora punicae*. On leaves the spots are irregular reddish brown spots of various sizes, which may be few to numerous. On fruit, the spots resemble bacterial blight lesions but are darker black, discrete, of various sizes without cracks and no stickiness.

Cercospora spots on leaves and fruits

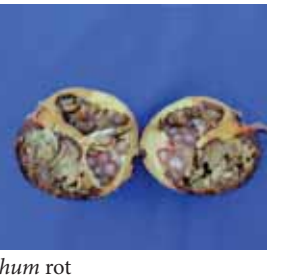
- **Scab:** The scab spots caused by *Sphaceloma punicae,*on fruits are initially small brown raised and rough to touch, later enlarge to cover almost entire fruit surface, giving russet scab appearance to the skin. The spots at times may enlarge to form larger spots with light centre and dark edge. Flower buds or small fruits when attacked become deformed.

Different symptoms of scab on fruits and flower buds

- ***Alternaria* heart rot:** There are no external signs of heart rot caused by *Alternaria alternata*, however, due to disintegration of arils the fruits may appear softer on application of slight pressure and in later stages become light weight. When the fruit is cut open, the rot is revealed. The arils inside the fruit turn brown-black. One may observe greyish black fungal growth/sporulation on the rotten arils in the advance stage. Generally, the fruit rind is not attacked. When secondary rot fungi are associated, slight rind discolouration may be seen in severe cases.

- ***Colletotrichum* rot:** Among all fruit rots, rot caused by *Colletotrichum gloeosporioides* is the most important rot causing maximum damage. Discolouration of fruits starts from calyx end or fruit surface. The discoloured area becomes reddish brown to black and is dry. The infected area covers half to full fruit within a week. The rot extends beyond rind into the arils which disintegrate and are dark grey/brown black colour but are not watery.

Alternaria heart rot



Colletotrichum rot

Pathogen dissemination

- Majority of the spot and rot pathogen species commonly occur on plant surfaces and/or in plant debris. The pathogens overwinter on plant debris in or on the soil and in mummified fruit.
- The spores are airborne and can be carried with wind, wind borne rain, soil dust/soil water and rain/spray splashes.
- Most of the fungal spots and rot infections occur at petal fall/initial fruit setting stage, which probably is the most susceptible stage, however, infection can occur throughout the bloom and fruit development periods.
- Infections may also start from injuries due to its own thorns, insect, squirrel and bird damage on fruit. Injuries on fruit surface and moisture retention in the crown end contribute towards the entry of rot pathogens.
- Rainfall, high humidity (50-80%) and a temperature range of 25-30^{o}C favour development of fruit spots and rots.

Management practices

- Change flower regulation time from rainy to winter season.
- Maintain orchard sanitation by removing plant debris, pruning of dead dry branches, drenching of ground with 2.5% bleaching powder (33.3%Cl) @25Kg/1000 liter water/ha and sterilization of pruning tools with 2.5% sodium hydroxide.
- Sprays with suitable chemicals at recommended doses, starting from flowering at 07-14 days depending up on season and nature (systemic/ non systemic) of fungicides give good control.

- Take precautionary measures/preventive sprays 10 days before and soon after the rains.
- Leaf and fruit spots as well as rots caused by different fungal pathogens are effectively managed by the sprays of carbendazim (0.2%), propiconazole (0.1%), thiophanate methyl (0.15%), mancozeb (0.2%), difenconzole 25 EC (0.05%), captan (0.2%), benomyl (0.2%), ziram (0.25%), Bordeaux mixture (0.5-1%) and copper oxychloride (0.25%).
- Combination treatments of carbendazim (0.1%) + mancozeb (0.2%) and benomyl (0.1%)+ mancozeb (0.2%) also improve fruit quality and yield. Rot of pomegranate caused by *C.gloeosporioide* can be effectively checked with a combination of tricyclazole 18%+mancozeb 62% WP @2.5g/l.
- *Phytophthora* blight/rot can be checked with sprays of metalaxyl 8% + mancozeb 64% (0.25%) or mancozeb (0.25%) or dimethomorph (0.1%) as soon as disease appears or as prophylactic in orchards where it makes yearly appearance are effective. Sprays of Fosetyl Al 80% WP (0.2%), formulation containing cymoxani l8% + mancozeb 64% (0.2%) or dimethomorph 9% WP+ mancozeb 60% (0.15%) also give effective control of *Phytophthora*.
- During rest period Bordeaux mixture (1%) alternated with copper or other economical fungicides at 15 days period helps reduce the inoculum load of pathogens for next crop season.

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

- 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.

Fruit cracking

- 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

- 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.

Sun scald

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

- 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.

Internal breakdown/aril dicolouration of fruit

- 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.

SAPOTA/CHICKOO

B. D. Shinde, Makarand S. Joshi and D. B. Ahuja

Major insect pests and diseases of sapota and their manangement

Major Insect Pests

Bud borer (*Anarsia achrasella*) (Bradley)

Symptoms

- The insect bores into the flower buds through petal and causes considerable bud and flower drops.
- Damage buds look to have small holes, entry point of the larva. One larva could damage 26-35 buds before reaching pupation.
- Shedding of buds and flowers.

Bud borer

Pest identification

- **Egg:** Female lay eggs singly which are oval and white in colour.
- **Larve:** The caterpillar is light yellow in colour and pinkish brown with black head at maturity. All the larval instars look similar except in size, shows no remarkable variation in colour.
- **Pupa:** A newly formed pupa is obtect type, brick red in colour and changed to dark brown before adult emergence
- **Adult:** Grey moth with black patches on wings.

Bud borer larva

Biology of the pest

- Eggs of *A. achrasella* are laid on flower buds or developing fruits singly and turn brown at time of hatching. The larvae passes through four instars on sapota buds. The pupation take place either inside or outside the flower buds. The duration of the pupa varied from 5-9 days with an average of 7.5 days. Life cycle completed in 27-33 days depending upon the temperature. The newly formed adults are flimsy and soft. The female is slightly bigger in size over male. The ovipositional period varies from 3-8 days. Female lays on an average 56-57 eggs and survive for 4-8 days. It is active throughout the year however, is the peak period of activity March to June.

Management practices

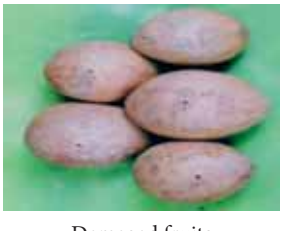
- Application of polytrin C44 (profenphos and cypermethrin) @1ml/l or Emamectin benzoate 5 SG @ 0.45 gm/lit. or Deltamethrin 2.8 EC @ 1 ml/lit. or Lambda cyhalothrin 5 EC @ 1 ml/lit. or Profenofos 40 EC @ 1 ml/lit of water at the initiation of damage and subsequent two sprays at an interval of one month.The precaution should be taken to avoid immediate repetition of any insecticide in the subsequent spray.
- Spray of azadirachtin 0.15 EC at the rate of 40 ml/10 liters of water.
- Erecting Blue light trap for monitoring population of bud borer.

Sapota seed borer *(Trymalitis margarias)* (Meyrick)

Symptoms

- Newly hatched larva enters into the seed through the pulp and feeds exclusively on endosperm of the seed.
- Its entry into the seed is seen as streak and later it disappears as the seed hardens. Black larval head capsule is seen in the hole on the cotyledons. Earlier instars are not visible in the seed and could not be detected from outside.
- Full grown larvae prepare a tunnel to come out from the fruit. Through this exit hole the fungus as well as ants enters inside the fruits and the fruit becomes unfit for consumption. It is invasive pest introduced from Sri Lanka accidentally.

Damage seed



Damaged fruits

Pest identification

- **Larvae**: The first instar larvae are very minute, white in colour with pinkish tinge possess segmented body without hair. Fully developed larva is pinkish in colour, 12 to 13 mm in length and come out of the seed for pupation.
- **Pupa**: The pupae are obtect type, brown in colour and entangled in white silken material.
- **Adult**: Adults are small (7 to 11mm long) with whitish forewings having grayish spots, hind wing creamy in colour with thick hairs at the margins. Moth looks to possess bell shaped wings and resembles bird droppings. Adult moths are weak fliers and show aggregated infestation pattern in the orchard.

Seed borer larvae

Seed borer adult

Biology of the pest

A female moth lays eggs on fruits of marble/ lime size when the seed coat is soft. The female lays eggs ranging between 7 and 272, singly or in batches of 2 to 4. Incubation period is 10-12 days. Neonate larva bores into the fruit and finally enters the seed. The larvae feeds on the endosperm of the seed, completes its larval period inside the seed. The larval period lasts for 10 to 13 days. The larval population fluctuated throughout the year with peak period of infestation in October to January. For pupation, the mature larva comes out of the seed by tunneling out the pulp coinciding with the harvesting of the fruit. Pupation takes place on leaves by folding leaf margins and pupal period lasting for 12-13 days. The adults have the chances of emergence during transport or in mandis and the fruits are the major pathways for its spread. The longevity of adults is 3-5 days. The total life cycle from egg laying to adult stage completes in 32-38 days.

Management practices

- Sanitation of the orchard eliminate the sources of seed borer infestation. Collection and destruction of the off season stray mature sapota fruits after main harvest till November. Domestic quarantine is the best way to limit its spread.
- Erects blue light traps in the orchard during cropping season that attracts adult moths that minimize the incidence.
- The time of application is crucial in the management of seed borer. First spray intervention should be made when the fruits are of small lime size and thereafter the sprayings should be repeated at fortnightly interval during main cropping season. Alternating the sprays of Deltamethrin 2.8

EC @ 1 ml/lit or Profenophos 40 EC @1ml/lit or Lambda cyhalothrin or Profenofos 50 EC at the rate of 1.5 ml/ lit or Indoxacarb 14.5SC at the rate of 0.5 ml/lit or Novaluron 10EC at the rate of 0.5 ml/lit or *Bt* @ 1 ml/lit at monthly interval may bring down the seed borer infestation.

Sapota leaf webber (*Nephopteryx eugraphella*)

Symptoms


Sapota leaf webber

- The larvae fold the leaves together and feed on green matter of leaves, often on buds and flowers and sometimes on tender fruits as well.
- The larvae bore into the buds, which wither and move on to other buds thus, damaging many of them.
- The infestation of this pest can be easily spotted by the presence of webbed shoots, the appearance of dark brown patches on leaves and clusters of dead leaves.
- Larval feeding causes serious damage to young terminals and buds which reduces flowering and fruiting.

Pest identification

- **Eggs** : Eggs are laid singly or in batches of 2-3 on tender leaves, petioles, branches or buds
- **Larva**: Neonate larva is pink in colour that turns yellow and finally green at maturity. Hairs are present on the dorsal side of the body. Head is pale yellow. Fully grown larva is of 19 mm in size with 3 longitudinal pinkish brown strips on each side of the body.
- **Pupa**: Pupation takes place in soil in earthen cell with exit hole. The newly formed pupa is green in colour that turns reddish within 24 hours of formation and dark brown on maturity. It measures 10 mm x 2.5 mm. It is broad at the posterior end and narrow at the anterior end
- **Adults**: The moth is small, gray coloured, slender bodied insect having black forewings with yellow spots on the basal half and black transverse lines on the remaining half. Both the wings are fringed at the outer margin. Wing span is 20 mm.

Biology of the pest

The pest is found throughout the year but the activity increases with the appearance of new shoots and buds. The maximum activity is seen during June-July and the minimum during winter. With the onset of spring season, the female moths start laying pale-yellow, oval shaped eggs singly or in batches of 2 or 3,

on leaves and buds of young shoots. A female may lay as many as 374 eggs in 7 days. The eggs hatch in 3-5 days. The larvae feed for 17-32 days and complete development. They undergo pupation in the soil. Pupation is completed in 7-11 days. The life-cycle is completed in 32-45 days depending upon the varying environmental conditions. There are 7-9 generations of this pest in a year.

Management practices

- Removal and destruction of infested leaves and affected fruits by sapota moth.
- Spray quinolphos 25EC @2 ml/lit of water.

Sapota fruitfly (*Bactrocera dorsalis*)

Symptoms

- Peak period of infestation is between March and July.
- The female punctures the outer wall of the mature fruits and lays egg inside the fruit.
- Maggots feed on the pulp of the fruit, which appears normal from outside. The affected portion/ fruit finally drops down and rot.

Spota fruitfly (A) Maggots feed on fruit (B) Damage fruit (C) Adults

Pest identification

- **Maggots**: Maggots are white to creamy white, legless with cylindrical body narrowed at the anterior end.
- **Pupa:** Its color ranges from dull red to brownish yellow.
- **Adult** is a brightly colored little fly, predominately black with lateral yellow stripes, approximately 5.40 mm in length.

Biology of the pest

Eight species of fruit fly genera *Bactrocera* have been reported to be of economic importance. Among them *B. dorsalis* is the most predominant species reported from India. The adult fruit flies are slightly larger than housefly and measure about 14-15 mm across the wings. The fly is dark brown in colour with hyaline wings and yellow legs. This is a polyphagus species, and nature and extent of damage depends upon type, size and condition of fruit, availability of different

hosts and population density. The most preferred host in Asia are sapota, mango, guava, litchi, citrus and papaya. Attacked fruits usually show signs of oviposition punctures and ripe fruits with high sugar content exude a sugary liquid. 6-10 eggs are laid just under the skin of the fruit. Eggs hatch within 6-8 days and hatched larvae migrate into pulp and start feeding. Feeding of maggots on the pulp induce rotting of fruits and renders them unfit for human consumptions. Infested fruit drops and the larvae pupate in soil 5-10 cm deep.

Management practices

- Collection and disposal of fallen infested fruits, undersized fruits left on the tree should be picked and destroyed. If the trees are few in number, bagging the fruit with cloth or paper bags can be resorted.
- Rake up the soil below the tree and drench with chlorpyriphos 20 EC @ 5 ml/lit.
- Monitoring of the population of adult fruit fly through methyl eugenol traps @10 /ha. This also helps in mass trapping and if done on large scale on community basis, it can reduce the pest densities to appreciable level.

Leaf miner *(Acrocercops gemoniella)*

Symptoms

- The infestation is mainly seen during the rainy season.
- The maggots feed inside the leaves by leaving characteristic mines.
- The upper portion of the affected leaves turns white in colour and dry in case of severe damage.

Leaf miner

Management practices

- Spraying of systemic insecticides like methyl demeton @1ml/l of water helps to reduce pest density effectively.

Mealy bug *(Rastrococcus iceryoides)*

Symptoms

- Pink colour nymphs and adults of the mealy bug are present in colonies on the lower surface of the leaves, inflorescence, branches, fruits and near the fruit stalk.

- Nymphs and adults suck the cell sap from the leaves and fruits weakening the fruit bearing branches. In case of severe infestation, the affected leaves turn yellowish and fruiting is reduced.
- During feeding, bugs secrete honey dew on which sooty mould develop producing characteristic black coloring on the affected part of the tree.

Pest identification

- Insects are oval in shape with pinkish waxy particle on their bodies. All three instars of female and the second instar male possessed a pair of short waxy anal projection.

Biology of the pest

The insects are oval in shape with seventeen pairs of waxy pin like marginal tussels found around their bodies. There are three nymphal instars for females and male moults to fourth instar also. Mealy bug reproduced sexually and one female lays 168-298 eggs within 5-6 days. The incubation period is 5-7 days. The nymphal period of male and female is 16-22 and 18-24 days, respectively. Total life span of the female is 45-57 days and that of males is 1-3 days. Ovipositing females remain stationary on the host plant. It also forms ovisac under their body. Population declines July onward and after August it stops reproducing and no generation was found emerging out from the ovisac. It startrs reproducing again from February onward.

Management practices

- Proper orchard maintenance by removal of the weeds that harbor mealy bugs.
- Banding of tree trunk with polythene sheet (400 gauge) 30 cm above ground level and just below the junction of branching to obstract the migration of the nymphs. Banding should be done well in advance before the hatching of eggs, i.e., around November-December.
- Application of *Beauveria bassiana* (2 g/l) or 5.00 per cent NSKE around the tree trunk.
- Release of predators, *Menochilus sexmaculatus*, *Rodolia fumida, Sumnius renardi* and Australian lady bird beetle, *Cryptolaemus montrouzieri,*@ 10-15 No./tree are effective in controlling the nymphs of the mealy bug.
- 2-3 sprayings of malathion 50 EC (0.05%) or buprofezin 25 SC @ 1.25 ml/lit (0.03%) at an interval of 15 days controls the pest effectively.

Major Diseases

Fruit drop (*Phytophthora palmivora)*

Symptoms

The disease is mainly severe during rainy season under coastal Maharashtra and South Gujarat conditions. Fruits those develop in rainy season express symptoms at any stage. However, fruits having age of 40 days or more are more prone to fungal infection.

Fruit drop disease of sapota

- Initially, there is development of minute brown blackish discolored patch of irregular shape on surface of the fruit. Such patches are only visible under critical observation as these patches merge with normal colour of fruit.
- Such fruits show conspicuous blackening after one to two weeks. Infected fruits fall down along with stalk immediately or remain in the bunch for some time and then get detached from calyx and drop down. Infected fruits cut open, there is partial or complete browning of internal immature pulp. Infected fruits undergo mummification as they gradually turn hard upon infection. During the process of mummification, infected fruits many times show development of longitudinal grooves on the fruit surface.
- Such fruits remain broad at centre and tapering at both ends. In continued rainy situation for weeks together, there is also development of whitish compact mycelial matting on infected fallen fruits. Newly developed fruits upon fertilization also turn black and hard and fall down at very early stage.

Pathogen dissemination

- The disease is caused by *Phytophthora palmivora* and also association of *Fusarium* sp. was recorded from few samples. Pathogen survives at the crown of areca nut and coconut as a dormanent mycelium. The sporangia are carried by rain splashes to infect sapota fruits.
- Pathogen also survives in soil by producing resting oospores which germinate to form sporangia. Recurring production of sporangia containing zoospores on infected fruits are responsible for subsequent secondary spread.
- Temperature 27-30^{0}C with high RH (> 82 %) are most conducive climatic factors for disease development.

Management practices

- Pruning of sapota should be done prior to rainy season during April-May every after 3-5 year especially, in old plantations above 20 years. Branches at periphery which bend towards the soil surface or remain parallel to soil surface should be pruned off in such a way so as to maintain ground clearance of are water.
- Collection and destruction of fallen fruits.
- Every year during October, ploughing in the orchard should be done. This exposes the resting bodies in the form of dormant mycelium and oospores of the pathogen.
- Spraying of a composite fungicide containing metalaxyl 8% and mancozeb 64 % when applied @ 0.2% was found to be most promising for reducing the fruit drop severity when applied for three times at an interval of one month starting from the onset of South-West monsoon.

Branch drying and flat limb

There are two distinct types of symptoms expressed by the same pathogen under different climatic conditions. In humid tropics of Maharashtra, branch drying is very common where as in semi arid tropics of South India flat limb symptoms have been described.

Symptoms

- Symptoms of branch drying are predominantly observed on shoots and branches having girth of 3-10 cm. Initially, there is development of minute longitudinal slightly raised streaks of reddish brown colour on the surface of the branch. These streaks break open to from longitudinal cracks. Gradually, bark at this point splits and get disintegrated partially to expose the internal hard wood.

Branch drying

- There is browning of the surface of internal hard wood followed by oozing of reddish brown coloured cell sap which down on the surface of the branch.
- When complete destruction of conducting vessels is accomplished, sudden drooping of leaves above the point of infection is noticed followed by complete drying of the branch within a period of two weeks. Fruits of all stages on such dried branch also dry and fall down.
- Severity of branch drying is although observed at the end of rainy season during September- October every year; the infection is established in the

early phase of rainy season.

- During the process of infection, when the necrosis of xylem tissues occurred, sprouting of dormant buds below the point of infection takes place producing 3-10 water shoots.
- Flat limb symptoms include the transformation of normal cylindrical part of the branch/shoot in to a broad flat structure with crowding of branches at its tip with somewhat reduction in the leaf size.
- Infected branches do not bear fruits. Fruits in the developmental stage turn brown hard and dry there by affecting yield.

Pathogen dissemination

- Disease is caused by a fungal pathogen *Botryodiplodia theobromae*. Besides Sapota, pathogen is known to infect mango and cashew crops more severely during rainy season under coastal Maharashtra conditions. Therefore, these three important fruit crops in the region act as complimentary hosts to each other for survival and establishment of the pathogen.
- Conidia developing on infected branches of sapota or on other hosts act as primary source of inoculum. Secondary spread of the disease is also through conidia which are carried by air and rain splashes. Ants and other surface crawling insects also carry conidia on their body parts. Rain water trickling from infected surface of branch is also responsible for spread of conidia.

Management practices

- Early detection of infection in the preliminary phase of the disease will help to save the productive branch from drying.
- Light pruning to remove weak and partially dried branches prior to onset of monsoon.
- Superficial scrapping of surface of the infected branches followed by application of propiconazole 0.1% or hexaconazole 0.1% in the form of swabbing.
- Branches showing deep necrotic development be pruned off below the point of infection followed by application of Bordeaux paste on the cut surface.
- Branches showing flat limb symptoms should be pruned below the point of infection to reduce the inoculum.
- Sapota varieties Kriti Bharathi and DHS-2 were found to be least affected by flat limb while DHS-l and cricket ball were found most susceptible.

Anthracnose
(Colletotrichun gloeosporioides, Glomerella cingulata)

Symptoms


Anthracnose disease of sapota

- Anthracnose symptoms are only observed during the rainy season. Symptoms of the disease are observed in the nursery as well as in the established plantations.
- Symptoms start appearing from the month of July as minute brick red coloured spots of about 1 mm diameter on leaves. These spots gradually increase in size and turn red brown in colour.
- Spots coalesce and form bigger necrotic irregular patches. These spots turn brown-red in colour having dark brown margin with grey center.
- Appearance of black, pin head sized dots in the centre representing formation of acervuli, the asexual fruiting bodies of the pathogen. Infection of young vegetable flush results in weakening of further growth that affect flowering and subsequent fruiting.
- There is premature drying of leaves at the top of the shoot and sometimes even there is drying of such shoot. Symptoms are commonly observed only on the young vegetative flush while matured leaves remain free from infection.

Pathogen dissemination

The *Colletotrichun gloeosporioides. Glomerella cingulata*, the perfect state of the pathogen is also reported on sapota. Conidia of the fungus act as primary as well as secondary source of inoculum.

Management practices

- carbendazim 0.1%, thiophenate methyl 0.1%, mancozeb 0.25%, and 1% Bordeaux mixture are effective fungicides for control of the disease. Two sprays at an interval of 15 days in the nursery effectively reduce the disease severity.
- Sapota varieties *viz*., Sel.-1, Sel.-2, Pilipatti, Singapuri, PKM-1 and PKM-2 were found to be moderately resistant while Cricket ball and Kalipatti were susceptible to anthracnose.

Leaf blight *(Pestaloptiopsis versicolor)*

Symptoms


Leaf blight disease of sapota

- The infection develops from the tip or at margins resulting in development of large irregular necrotic grey patches. Later on full maturity of the pathogen, dark pinhead like bodies develops on this necrotic patch.
- Sometimes defoliation of infected leaves occur. Excessive blightening and defoliation of leaves results in reduced vigor and productivity.
- Severity of the disease is more in old and poorly managed orchards.

Pathogen dissemination

- Conidia developing on infected leaves and fallen leaves due to disease act as primary and secondary source of inoculum.
- Conidia are air borne in nature.

Management practices

- As the disease is severe in poorly managed orchards, proper manuring as per recommended doses of macro and micro elements be scrupulously followed for maintaining good vigor of the plant.
- Sufficient irrigation as per the soil type during post monsoon season should be given.
- Spraying of carbendazim 0.1% is effective in reducing the incidence of grey leaf blight during post monsoon season.

Leaf spot *(Phaeophleospora indica)*

Symptoms


Leaf spot disease of sapota

The disease is characterized by the development of minute reddish brown spots. Initial infection develops in the form of minute circular pinkish spots scattered all over the lamina with whitish centre and black hemispherical pustules representing the pycnidial development. Spots are circular and measure 0.4-1.3 mm in diameter. Many spots coalesce to form bigger necrotic patches. Under heavy infection, defoliation takes place which affect vigor and productivity.

Pathogen dissemination

The disease is caused by a pycnidia forming fungus. Pycnidiospores are 2-3 septate, filiform. The primary and secondary source of inoculum is air borne pycniodiospores. It is reported that pathogen can survive in conidial state for 300 days in the laboratory.

Management practices

- Two sprays at an interval of 30 days with carbendazim 0.1%, mancozeb 0.2% Zineb 0.2%, and Propineb 0.2 % are sufficient when the disease severity is low to moderate. However, five sprays of Thiophente methyl 0.1% at monthly interval need to be applied in endemic area where disease severity is high.
- Sapota varieties *viz.,* PKM3, PKM1, PKM2, showed very less disease severity tthroughot the year while viraty Kirthabarthi showed maximum disesae severity under Periyakulum (TamilNadu) conditions.

Basal stem rot/ganoderma rot *(Ganoderma lucidum)*

Symptoms

- Occurrence of the disease is sporadic in nature but once the infection sets in, it results in to drying of productive tree. Older trees succumb to the disease earlier.
- Initial development of the disease is very slow and internal and hence it is difficult to diagnose the disease in the early phase of infection. Development of fruiting bodies of the fungus in the form of brackets on tree trunk is the visible sign of the disease. Development of such brackets on main trunk can be observed 1-2 M from ground surface.
- Fungus invades hard tissues of the stem slowly but gradually.
- It requires a period of 2-3 years right from infection to final drying of the plant.

Pathogen dissemination

- The pathogen is soil borne in nature and the basidiospores produced on brackets spread easily through rain and irrigation water.
- Formation of brackets also continues on dead infected basal part of the stem which acts as an infection foci for further spread of the disease.

Management practices

- Removal and destruction of dead stem bases of sapota and other trees in the garden should be done to avoid multiplication and deposition of

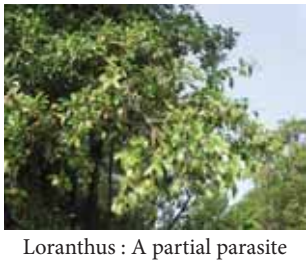
basidiospores in the garden.

- Application of Neem cake @ 5 Kg per plant once in a year in the basin to check primary infection.
- Avoid surface flow irrigation as irrigation water carries basidiospores. Drip irrigation is effective method under such circumstances.
- Immediate removal and destruction of infected plant during early stage of bracket formation helps to reduce further spread.
- Drenching of 1% Bordeaux mixture @ 20 L/tree near the tree trunk be done in those orchards where the infection is already established.

Loranthus *(Dendrophthoe falcata)*

Symptoms

The growth of parasitic on the branch derives nutrients by penetrating the stem tissues of sapota. Upon establishment of biological relationship, major flow of nutrients is diverted for parasitic development. Number of loranthus bushes on a tree totally weakens the plant which succumbs to disease and the pest attack very easily.



Loranthus : A partial parasite on sapota

Pathogen dissemination

- *Loranthus* is a flowering parasitid produce large number of berry type fruits containing hard seed. Birds get naturally attracted towards such bushes upon ripening of loranthus fruits to consume sweet sticky pulp and seed portion sticks to the tip of beak of birds. Seeds of loranthus get adhered during rubbing on the surface of the matured host branch.
- Such adhered seeds remain viable until onset of rainy season and germinate on the branch surface under favorable conditions.
- Initial growth of the parasite is slow, but haustoria of the parasite penetrate in to stem tissue, rapid vegetative growth of loranthus takes place.

Management practices

- Mechanical removal of loranthus bushes regularly prior to flowering is the most effective treatment. For safe removal of such newly establishing loranthus bushes up to age of one year, use of "Amar loranthus cutter" a serrated sickle is recommended specially developed for the purpose.
- Spot treated with 0.5% glyphosate or cashew nut shell liquid using cotton swab.

Implementation of electronic -pest (e-pest) surveillance

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Surveillance Plan

Cultivation of citrus (Nagpur mandarin/sweet orange), banana, mango, pomegranate and sapota (chickoo) is adversely affected due to damage by one or more of the documented pests but a few pests such as sigatoka leaf spot and thrips in banana, hoppers, thrips, powdery mildew and anthracnose in mango, bacterial blight, wilt, fruit borer and thrips in pomegranate, thrips, psylla, fruit sucking moth and phytophthora in Nagpur mandarin/sweet orange and bud borer, seed borer and phytophthora in sapota tree were considered most important leading to economic losses and compel 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 HORTSAP finalized the structure of pest surveillance plan, ETL's and guidelines for pest scout/monitor. Observations were recorded on weekly basis as per plan (Table 1). Pest surveillance programme was implemented in 23 districts of Maharashtra i.e. Sindhudurg, Raigarh, Ratnagiri, Thane, Aurangabad, Beed, Osmanabad for mango; Solapur, Nashik, Sangli, Ahmednagar, Aurangabad, Beed, Dhule, Satara for pomegranate; Jalgaon, Hingoli, Solapur, Nanded for banana; Akola, Amarawati, Buldhana, Nagpur, Wardha, Washim for Nagpur mandarin; Aurangabad, Beed, Jalana, Nanded for sweet orange and Thane for sapota, covering 3,61,647 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, Dr. BSKKV, Dapoli, VNMKV, Parabhani and Dr. PDKV, Akola 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. In this programme, ICAR-NRC Pomegranate-Solapur, ICAR-NRC Banana-Trichi, ICAR-CCRI- Nagpur, Dr. BSKKV-Dapoli, MPKV-Rahuri,

VNMKV-Parabhani and Dr. PDKV-Akola are co partners responsible for development of surveillance plan and issue of pest management advisory. ICAR-NCIPM, New Delhi is guiding and facilitating in finalization of pest management advisory, surveillance plan and development of software, GIS maps, data entry and overall coordination of the project activity.

Table 1: Surveillance plan (observations on weekly basis)

Day	Surveillance schedule of pest scouts & data entry operators (DEO)	No. of orchards
Monday	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.	8
Tuesday	Two fixed orchards and two random orchards /village in two villages by one scout	8
Wednesday	Data entry operator (DEO) to enter data collected on previous two days + documentation of data (Geographical, Cropping System and Agronomic details).	16
Thursday	Two fixed orchards and two random orchards /village in two villages by one scout	8
Friday	Two fixed orchards and two random orchards /village in two villages by one scout	8
Saturday	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.	16

Table 2: Area of operation under e-pest surveillance of Citrus (Nagpur mandarin/sweet orange), Banana, Mango, Pomegranate and Sapota crops (pest scout and pest monitor)

Crops	No. of Districts covered	No. of Taluka's covered	No. of Villages covered	Area's covered (ha.)
Banana	4	13	462	53,881
Mango	7	45	3670	1,07,182
Pomegranate	8	32	1121	64,928
Nagpur mandarin	6	25	944	73,381
Sweet orange/ mosambi	4	23	574	56,859
Sapota	1	4	42	5,416
Total	**23**	**142**	**6813**	**3,61,647**

Table 3: Economic threshold levels (ETL) for various pests in HORTSAP crops as per recommendation of universities/ICAR institutes

Crop	Pest	Recommended stage of the Spray	Proposed ETL
Citrus (Nagpur mandarin/ Sweet orange)	Whiteflies and Black flies	5-10 nymphs	5-10 nymphs
	Psylla	6 psylla/leaf	6 psylla/leaf
	Thrips	10 thrips per branch tapping	10 thrips per branch tapping
	Leaf miner	10% affected leaves	10% affected leaves
	Mites	2 % infested fruits or 10% infested leaves	2 % infested fruits or 10% infested leaves
	Bark eating caterpiller	10% trees are found infest ed	10% trees are found infested
	Fruit sucking moth	10% fruits are found punctured due to this pest	10% fruits are found punctured due to this pest
	Phytophthora	Immediately on appearance of incidence	10 cfu/cc soil propagule density or disease severity rating score is 1 or more
Banana	Sigatoka leaf spot	After appearance of yellow spots on lower leaves	0.1(10 spots/leaf)
	Thrips	At flag leaf stage	Score 2.1 or 1.1% fruit infestation
Mango	Hoppers	10 Hopper/panicle/vegetative flush	10 Hopper/panicle/ vegetative flush
	Thrips	Immediately after appearance of thrips on inflorescences >10/panicle and appearance of scrapping symptoms on fruits.	Score 1.25 on fruits
	Powdery Mildew	After appearance of incidence on panicles	1 Score
	Anthracnose	After appearance of incidence on foliage/fruits/panicles	1 Score

Pomegranate	Bacterial blight	Appearance on any plant part	(Grade 1 or more) Appearance on any plant part
	Wilt	Appearance of single partial / completely wilted plant	Appearance of single partial/ completely wilted plant
	Thrips	Wait and watch Curative sprays	If fruit infestation is ≤ 1% If fruit infestation is > 1%
	Fruit Borer	Wait and watch Curative sprays	If fruit infestation is ≤ 1% If fruit infestation is > 1%
Sapota	Bud Borer	At bud stage	5% bud borer infestation
	Seed Borer	Immatured fruit stage	1% seed borer
	Phytophthora	After appearance of incidence on fruits	1 score

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 scouts for different crops

Guidelines to pest scout for citrus (Nagpur mandarin/sweet orange)

Selection of orchards and trees

Two fixed orchards and two random orchards/ village are selected by one scout who covers two villages per day. One village may be covered in the morning and another in the evening. In each orchard, 4 trees are observed by selecting one tree from each direction (E, S, W, and N). Select orchard having at least one acre area and assigned fixed ½ and random ½. 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 number of grower to be noted for fixed plots only (Annexure I).

Method of observations

Insects:

Citrus Psylla: Weekly observation on number of citrus psylla per 10 cm shoot may be recorded on four selected shoots per tree, four each from E, S, W and N of the tree. Record observations on four trees in each selected orchard. While observing the pest population, both nymphs and adults of the pest may be taken into account and total number on 4 shoots (10 cm size) per tree need to be noted. Total number of shoots observed will be 16 per orchard.

White fly and Black fly: Weekly observation on number of white fly and black fly (both nymphs and adults) per 5 leaves from each direction (E, S, W, N) of the tree. While observing the pest population, both nymphs and adults of the pest may be taken into account and the number per 5 leaves in one direction of the tree need to be noted. Total number (white fly/black fly) on 20 leaves per tree need to be recorded. Total number of leaves observed will be 80 per orchard.

Leaf miner: Weekly observation on number of mined leaves per 5 leaves from each direction (E, S, W, N) of the tree may be recorded.. Record total number of mined leaves per 20 leaves per tree. Total number of leaves observed will be 80 per orchard.

Thrips: To record the observations on thrips population one terminal branch from each direction (E, S, W, N) should be selected. Each selected branch should be tapped and number of thrips fallen should be recorded. From each tree 4 branches should be tapped and from one orchard there will be total 16 branches.

Mites: Weekly observation on number of fruits or leaves as the case may be infested with mites per 5 leaves/fruits from each direction (E, S, W, N) of the tree may be recorded.. Record the total number of infested leaves/ fruits per 20 leaves/fruits per tree. Total number of leaves/fruits observed will be 80 per orchard.

Fruit sucking moth: Move diagonally in the field and select 10 spots. At each spot collect total drop fruit and count the fruit damaged by fruit sucking moth on the basis of punctured fruits.

Bark eating caterpillar: Observe 25 trees randomly from the orchards of the fixed plot and Random plot and count the number of infested trees due to the bark eating caterpillar.

Diseases:

Phytophthora: The percentage phytophthora incidence will be estimated by counting the number of trees infected with gummosis/ foot rot out of total trees in the orchard of one acre size.

Disease Assessment :

i. Disease Incidence

% Disease incidence = No. infected tree/ No. trees observed x 100

ii. Disease Severity

The disease severity may be categorised on 0-4 scale as given below:

0 = No gum oozing or lesion

1 = 1 – 10 % (Light, mostly on trunk)

2 = 10.1 – 25 % (Medium, mostly on trunk)

3 = 25.1 – 50 % (Heavy, some large, on trunk/scaffolds)

4 = > 50.1 % (Severe, gum spots coalescing, bark splitting)

Select 20 trees (Oct-Dec is the best time for taking gummosis lesion observations) in an orchard. Mean disease severity rating score is calculated (Total No. of values/20) and on this basis advisory is issued.

Example of Disease Severity Rating Scale for Phytophthora Gummosis of Nagpur mandarin

Crop conditions: Fruit bearing may be rated as heavy (number of fruits are >1000/tree), optimum (number of fruits are 500 – 800 / tree) and poor (number of fruits are <300/tree).

Guidelines to pest scout for 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 perpared for scout (Annexure II) 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 – >75% 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:

Infection index = nb X 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

Guidelines to pest scout for 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 III) 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 assesed. 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

$$\% \text{ Per cent thrip damage} = \frac{\text{Sum of all numerical rating}}{\text{No. of fruit observed x Maximum rating}} \times 100$$

Powdery mildew and anthracnose

The same shoots/ panicles is observed for disease intensity. The disease intensity is score in zero to five scale

Rating Scale

0 = No. intensity

1 =1 - 20% intensity

2 = 21 - 40% intensity

3 = 41 - 60% intensity

4 = 61 -80% intensity

5 = 81-100% intensity

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

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

Guidelines to pest scout for 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 IV). 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 1plant 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.

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

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.

#Abbreviations for cause of wilt	
Abbr.	Cause
Cf	*Ceratocystis fimbriata*
RRF	Root Rot Fungi
SHB	Shot hole borer
N	Root Knot Nematode
O	Others

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 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. Caclulate % 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 1or 2 out of 20 sites and that too upto 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 through out 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 optimum, check **heavy**, for trees with optimum bearing, check **optimum** and for lower than optimum, check **poor**.

Age (yrs)	Optimum No. of fruits/tree
2	15-20
3	30-35
4	60-80
>5	100-120

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 writ 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.

Guidelines to pest scout for sapota

Selection of orchards and trees

Select the orchards randomly. One village may be covered in the morning and another in the evening. In each orchard, 4 trees are observed by selecting one tree from each direction (E, S, W, and N). Select orchard having at least one acre area and assigned random ½. 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 number of grower to be noted for fixed plots only (Annexure V).

Method of observations

Insects:

Sapota bud borer: Record weekly number of buds infested due to the pest and total number of buds on ten shoot in each direction i.e. E, S, W and N of the tree. Observe four trees in each of the selected orchard. While observing the pest population, identify the symptoms of the bud borer by concentrating on the holes made by the pest .Total number of shoots observed will be 160 per orchard. Per cent bud damage will be worked out ETL will be based on the per cent bud damaged.

Sapota seed borer: Observe the total number of harvested fruits on the daily basis from the orchard and from the total harvested fruit record the number of fruits damaged due to the seed borer. Add up the data for all the five days and record it into the data sheet on Saturday. Also two light traps per ha are installed in the selected orchards and weekly count of the seed borer trapped in each trap is taken.

Phytophthora diseases :- Observe 10 shoot in each direction of the tree for the diseases. Grade the disease intensity on each shoot on the 0-4 scale as follow

Rating Scale :-

0 = No. incidence.

1 =1 - 20% incidence

2 = 21 - 40% incidence

3 = 41 - 60% incidence

4 = 61 -100% incidence

Percent disease incidence will be calculated by following formula

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

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

Guidelines to pest monitors for different crops

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 six crops, select five orchards per day randomly and record observations in the structured sheet for Citrus (Nagpur mandarin/ sweet orange)(Annexure VI), Banana (Annexure VII), Mango (Annexure VIII), pomegranate (Annexure IX) and sapota (Annexure X). 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 4-8. 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
Citrus (Nagpur mandarin/Sweet orange)

Sr. No.	Pest/Disease	Crop stage	Low	Medium	High
1.	Whiteflies and Black flies	Leaf at Fruit formation stage	2-4 nymphs/leaf	5-9 nymphs/ leaf	10-15 nymphs/ leaf
2.	Psylla	Flower, new flush (leaf)	1-3 Psylla/leaf	4-5 leaf/leaf	6-8 psylla /leaf
3.	Thrips	Flower, fruit, new leaf tender twigs	5-6 thrips/ branch trapping	7-9 thrips/ branch trapping	10-12 thrips/ branch trapping
4.	Leaf miner	Leaf, nursery and fruit formation stage	3.-5% leaf incidence	6-8% leaf incidence	10-12 % leaves incidence

5.	Mites	Leaf and fruit	Less than 1% fruit infestation or 3-5 % leaf infestation	1% fruit infestation or 6-9% leaf infestation	2-5% fruit or 10-12% leaf incidence
6.	Bark eating caterpiller	Tree branches and trunk	3-5% trees	6-9% trees	10-15 % trees
7.	Fruit sucking moth	Fruit stage (colour break stage)	3-5% trees are punctured	6-9 % fruits are punctured	10-12% fruits are punctured
8.	Phytophthora	Tree trunk, Collar and Fibrous Roots	1-2% tree infestation	3-4% tree infestation	>5% trees infestation

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

Sr. No.	Pest/Disease	Crop stage	Low	Medium	High
1.	Banana leaf spot disease	Vegetative stage	0.1 to 5% leaf area infected	6 to 10 % leaf area infected	> 10% leaf area infected
2.	Banana thrips	Flag leaf or just shooting stage	10 to15 thrips/ bract	16 to 20 thrips / bract	> 21 thrips/ bract
		Opening of hands	1.1%fruit infestaion	1.1% to 10 % fruit infestation	> 10% fruit infestation

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

Sr. No.	Pest/Disease	Crop stage	Low	Medium	High
1.	Mango hopper	Flowering flush	1 to 5 hopper/ panicle	6 to 10 hopper/ panicle	> 10 hoppers/ panicle
2.	Mango thrips	Flowering flush	1 to 5 thrips/ panicle	6 to 10 thrips/ panicle	> 10 thrips/ panicle
		Peanut marble stage fruits	1.25% incidence	1.25% to 10% incidence	> 10% incidence
3.	Powdery mildew	Flowering flush	1 to 25% incidence	26 to 50% incidence	> 50% incidence
4.	Anthracnose	Flowering vegetative flush	1 to 5% incidence	6 to 10% incidence	> 10% incidence
		Fruit	1 to 5% incidence	6 to 10% incidence	> 10% incidence

Table 7: Guidelines for Pest Monitors for rating the intensity of pest damage (Pomegranate)

Sr. No.	Pest/Disease	Crop stage	Low	Medium	High
1.	Pomegranate incidence Bacterial Blight	Vegetative/ flowering	Up to 10% incidence on any part with average severity grade up to 1	11 to 20% incidence on any part with average severity grade >1 to 2	More than 20% incidence on any part with average severity grade >2 to 5
		Fruit Bearing	Up to 5% incidence with average severity grade up to 1	6 - 10% incidence with average severity grade >1- 2	More than 10% incidence with average severity grade >2-5
2.	Pomegranate Wilt	Any stage	Up to 5% incidence	6 - 10% incidence	More than 10% incidence
3.	Pomegranate Thrips	New flush / tender twigs / fruits	1 to 5% infestation	6 to 10% infestation	More than 10% infestation
4.	Pomegranate Fruit borer	Fruits	1 to 5% infestation	6 to 10% infestation	More than 10% infestation

Table 8: Guidelines for Pest Monitors for rating the intensity of pest damage (Sapota)

Sr. No.	Pest/Disease	Crop stage	Low	Medium	High
1.	Bud Borer	Bud stage	1-2% buds infestation	3-4% bud infestation	5-8% bud infestation
2.	Seed Borer	Fruit formation	Less than 1% fruit infestation	1-2% fruit infestation	2-4% fruit infestation
3.	Phytophthora	Fruit formation	0.3-0.7 scores	0.8-1 scores	More than 1 score

Pest management advisory for different crops

Based on the recommendation of ICAR Institutes and University, the two types of pest advisory were issued for all the three crops. The details of advisory is given crop wise 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 and other stakeholders.

1. Pest management advisory for citrus (Nagpur mandarin/sweet orange)

(C. N. Rao, A.K. Das, S. S. Mane, Suresh Dadmal, B. B. Bhosle, P. R. Jhanwar, A.P. Suryawanshi, B.V. Bhede and D. B. Ahuja)

S. No.	Situation	Short Advisory	Detailed Advisory
1.	Presence of nymphs of whiteflies and blackflies, honey dew excretion and development of sooty mould	Spray imidacloprid 17.8 SL @ 0.5 ml or acephate 75 WP @ 1.25 g or phosalone 35 EC @ 1.5 ml or dimethoate 30 EC @ 2 ml or novaluron 10 EC @ 0.79 ml/l of water.	Nymphs present on leaves secretes honey dew on which sooty mould grows widely that leads to fungal manifestation locally called as Kolshi. If 5-10 nymphs/ leaf are present then spray imidacloprid 17.8 SL @ 0.5 ml or acephate 75 WP @ 1.25 g or phosalone 35 EC @ 1.5 ml or dimethoate 30 EC @ 2 ml or novaluron 10 EC @ 0.79 ml/l of water @ 10 ml/l of water.
2.	Presence of nymphs of psylla on young flush	Spray quinalphos 25 EC @ 1ml or novaluron 10 EC @ 0.55 ml/l of water	Observe psylla nymphs (6-10 nymphs/ 10 cm shoot) after the starting of new flush i.e February-March in Ambia and June-July in Mrig flush. Spray quinalphos 25 EC @ 1ml or novaluron 10 EC @ 0.55 ml/l of water when infestation is noticed. If required, second spray of any of the above insecticides should be given after 15 days.

3.	Upward curling of leaf margin and presence of mined leaves	Spray of neem oil 5 ml or imidacloprid 17.8 SL @ 0.5 ml or phosalone 35 EC @ 1.5 ml or fenvalerate 20 EC @ 1 ml or spinosad 45 SC @ 0.34 ml or novaluron @ 0.87 ml /l of water.	Observe the upward curling of leaf margin and presence of mined leaves (10 % affected leaves). Foliar spray of neem oil 5 ml or imidacloprid 17.8 SL @ 0.5 ml or phosalone 35 EC @ 1.5 ml or fenvalerate 20 EC @ 1 ml or spinosad 45 SC @ 0.34 ml or novaluron @ 0.87 ml /l of water by directing at the new flush.
4.	mottling of the leaves and presence of whitish silvery ring around the fruit neck.	Spray dimethoate 30 EC @ 2 ml or acephate 75 WP @ 1.25 g or phosalone 35 EC @ 1.5 ml/l of water	Observe the thrips population by tapping panicles on white papers. Thrips population exceed more than 10/branch spray dimethoate 30 EC @ 2 ml or acephate 75 WP @ 1.25 g or phosalone 35 EC @ 1.5 ml/l of water at bud burst stage and on berries.
5.	Presence of rigid and curling of leaves and brown-reddish black spots on the fruit surface	Spray wettable sulfur 85 DP @ 3 g or dicofol 18.5 EC @ 2ml or propargite 57 EC @ 1 ml or ethion 50 EC @ 1 ml/l water	Observe the mite population on leaves as well as on fruits, if 2% infested fruits or 10% infested leaves are observed foliar application of wettable sulfur 85 DP @ 3 g or dicofol 18.5 EC @ 2ml or propargite 57 EC @ 1 ml or ethion 50 EC @ 1 ml/l water.
6.	Presence of fecal matter and wooden frass hanging on the tree trunk and branches	Application of 5-10 ml of dichlorvos 1% into the tunnel	Presence of fecal matter and wooden frass hanging on the tree trunk and branches are symbolic of larval presence inside the tunnel. If 10% trees are found infested inject 5-10 ml of dichlorvos 1% into the tunnel and cover with cotton wad.
7	Presence of fallen punctured fruits in the orchard	Spray neem oil 1% or malathion 50 EC @ 2ml of water.	If 10% fruits are found punctured due to pest, foliar application of neem oil 1% or malathion 50 EC @ 2ml of water at 10-15 days interval during fruit maturity till harvest

8	Trees declining after growing normally, gum oozing from trunk, decay of fibrous roots, leaves chlorotic, chlosrosis intense in midrib	Apply Bordeaux paste during pre-monsoon (June) and post monsoon (Oct-Nov). Scrap the infected portion with a sharp knife and then pasting the affected portion with mefenoxam MZ 68 & carbendazim (60g : 20g/l) paste.	Avoid flood irrigation and deep ploughing; Pre- and post-monsoon application of Bordeaux Paste (1 kg $CuSo_4$: 1 kg Lime: 10 lit. of water) on tree trunks up to height of 60 cm by paint brush. Soil drenching+foliar spraying of mefenoxam MZ 68 (0.25%) 8-10 litres per plant or, foliar spraying of fosetyl Al (0.25%); (twice during Aug-Oct at 40 days interval); Cleaning the wound on the gum oozing trunk with sharp knife and then pasting the affected portion with mefenoxam MZ 68 & carbendazim (60g : 20g/l) paste.

2. Pest management advisory for banana

(N. B. Shaikh, Suresh Pardeshi, R. Thangavelu and D.B. Ahuja)

S. No.	Situation	Advisory	Detailed Advisory
1.	Initiation of yellow spots	Spray carbendazim 50 WP at 0.1%	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
2.	Spots turns brown colour	Spray with Propiconazole 0.05%	The colour of the spot changed yellow to brown spray with Propiconazole 0.05% 1ml/l+ sticker 1ml/l of water.
3.	The spots further increase in size, intermingled with each other forming large dry leaves(gray spots)	Carbendezim 0.5% (0.5 g/l) + Mineral oil 1%	The spots further increase in size, intermingled with each other forming large gray spots spray each other forming large with Carbendezim 0.5% (0.5 g/l) + Mineral oil 1% (10ml/l)
4.	More than 4-5 no of leaves infected	Remove infected part of the leaves and spray with Propiconazole 0.05% (0.5 ml/l) + Mineral oil 1%	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)

5.	As disease intensity increases	Remove infected part of the leaves and repeat the spray with above mention fungicides alternatively	Remove infected part of the leaves and repeat the spray with above mention fungicides alternatively
6.	Flag leaf stage or just shooting stage (observe for thrips)	Spray with acetamiprid 20SP at 0.0025% or *Verticillium lecanii* ($2x10^8$ CFU/g) 3g/l+ Sticker 1ml/l or NSKE 5%	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%
7.	Opening of all hands (observe for thrips)	Spray with acetamiprid 20SP at 0.0025% or Verticillium lecanii ($2x10^8$ CFU/g) 3g/l+ Sticker 1ml/l or NSKE 5%	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%

3. Pest management advisory for mango

(S. K. Godse, Pushpa D. Patil, A.Y.Munj and D. B. Ahuja)

S. No.	Situation	Short Advisory	Detailed Advisory
1.	Egg laying site and curling of leaves. Nymphs of hopper on panicles at early stage.	Spray Quinalphos (25 EC) 20 ml/10 lit water or Phozalone (35 EC) 15 ml/10 lit water	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.
2.	Honey dew excretion due to hopper observed on panicles and foliage.	Spray Imidachloprid (17.8 SL) 3 ml/10 l water or Thiamethoxam (25 WG) 1g/10 l water	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 l water or Thiamethoxam (25 WG) 1 gm/10 l water
3.	Honey dew excretion due to hopper and growth of sooty mould	Spray Chlothianidin (50 WDG) 1.2g/10 l. water	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 l water

4.	Brown streaks on panicle rachis due to thrips	Spray Phozalone (35 EC)15 ml/10 l or Diamethoate(30 EC) 10 ml /10 l water	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 l or Diamethoate 30 EC at 0.03 % i.e. 10 ml/10 l.
5.	Scrapping injury on fruits rind result in development of brown spot	Spray Spinosad (45 SL) 2.5 ml/ 10 l water or Thiamethoxam (25 WG) 2 g/10 lit. water	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 l or Thiamethoxam at 0.005 % i. e. 2 gm/10 lit.
6.	Powdery growth of powdery mildew on panicles	Spray Sulphur (80 WP) at 0.2 %, 20 g/10 l water	Powdery growth noticed on panicles. Spray Sulphur (80 WP) at 0.2%,20 g/10 l water concentration along with insecticidal sprays.
7.	Powdery growth of powdery mildew on panicles rachis and fruit stalk	Spray carbendazim (50 WP) at 0.1 % , 10 g/10 l water	Powdery growth noticed on panicle rachis and fruit stalk. Spray carbendazim (50 WP) at 0.1%, 10 g/10 l water along with insecticidal sprays.
8.	Powdery growth of powdery mildew on all the paniclepar ts.	Spray Hexaconazole (5 EC)at 0.05 %, 5 ml/10 l water	Powdery growth covered all the par ts of panicles, flowers and fruits drops is noticed spray Hexaconazole (5 EC) at 0.05 %, 5 ml/10 l water
9.	Black/Brown spot on panicles rachis and fruit of all stages due to Anthracnose.	Spray carbendazim (50 WP) at 0.1%, 10 g/10 l water or Thiophenate methyl (70 WP) at 0.1%, 10 g/10 lit water or Propineb (70 WP)at 0.2%, 20 g/10 l water	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 l water or Thiophenate methyl (70 WP) at 0.1%, 10 g/10 l water or Propineb (70 WP) at 0.2 %,20g/10 l water
10.	Puncture injury due to fruit fly, maggots in ripped fallen fruits, fruit fly population in traps	Install fruit fly trap at 4 trap/ha.	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.

4. Pest management advisory for pomegranate

(Jytosana Sharma, Sachin Suroshe, K. S. Raghuwanshi, S.G.Borkar and S. R. Kulkarni)

Disease	Situation	Short Advisory	Detailed Advisory
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 Bordeaux mixture (1%) altered with streptocycline (2.5 g/ (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.

Disease	Situation	Short Advisory	Detailed Advisory
	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 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 star ting 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.
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.	1. On observing first symptoms of wilt first ascertain the causes. 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 (25 g) 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 to plant space in a row, or in a ring, on the border of plant basin. For effective results these should be grown for more than 4-5 month 4. Once disease is detected in the orchard, dig about 3-4 feet long trench between the wilted and healthy plant/s. The partially wilt affected plant/s should be treated with a systemic fungicide and dead plants should be removed and burnt, they should not be kept dumped in the orchard for firewood. While removing the wilted plants from the orchard for burning, protect the entire root zone with cover.

			5 .Pruning tools should be disinfected and cut ends painted with fungicidal oil based paints. Pruning should be avoided during spring to summer and done in winter months. Affected plants within the buffer zone should be treated with a systemic fungicide; neighboring asymptomatic apparently healthy plants should also be treated with appropriate systemic fungicides. Plants with more than 30% canopy loss should not be treated, they should be uprooted and burnt.
Thrips	Leaf curling; tender tip drying; scrapping marks on buds, flowers and fruits due to thrips.	Spray thiamethoxam 25 WG @ 3 gm/ 10 l or acetamiprid 20 SP @ 3 gm/ 10 l 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 aonla and tamarind in the pomegranate orchard.

5. Pest management advisory for sapota/chickoo

(B. D. Shinde, Makarand S. Joshi and D. B. Ahuja)

Pest	Situation	Short advisory	Detailed advisory
Bud borer (*Anarsia achrasella*)	The larva bores through the upper tapering part of the flower bud and eats up the inner content leading to no flower setting or retention. The infested buds shows milky appearance and presence of larval excreta. The larva also cuts the margin and leaf lamina of the newly emerged leaves.	Spray Emamectin benzoate 5SG @ 0.45 g/lit or Deltamethrin 2.8 EC @ 1 ml/lit or Lambdacyhalothrin 5EC @ 1ml/l or Profenofos 40EC@1ml/lit.	Observe the bud boring insect spray Emamectin benzoate 5SG @ 0.45 g/ lit or Deltamethrin 2.8 EC @ 1 ml/l or Lambdacyhalothrin 5EC @ 1ml/l or Profenofos 40EC@1ml/l the precaution should be taken that there should not be immediate repetition of any insecticides in the subsequent spray. All mature fruits should be harvested before each spray.
Seed borer (*Trymalitis mxargarias* Meyrick)	The adult lays eggs on outer rough surface of the fruits. The just hatched larvae makes holes on the surface of the fruits and make galleries through the fruit pulp. If finally reaches to the seed where it bores through the seed coat and finally damages the kernel of the fruit seed.	Spray of Profenofos 40EC@1ml/lit orDeltamethrin 2.8 EC @ (0.003%) 1ml/l or Lambdacyhalothrin 5EC @ 1ml/l or Indoxacarb 14.5SC @ (0.0072%) or Novaluron 10 EC @ (0.005%) or	Observe the seed borer and spray Profenofos 40EC @1ml/l or Deltamethrin 2.8 EC @ 1 ml/l or Lambdacyhalothrin 5EC @ 1ml/l or Indoxacrb 14.5SC @ 0.5ml/l or Novaluron 10EC@ 0.5ml/l of water.

Annexure

PEST SCOUT SURVEY PROFORMA FOR CITRUS (NAGPUR MANDARIN/SWEET ORANGE) INSECT PESTS AND DISEASES IN MAHARASHTRA

Date of Survey.....**Orchard Type:** Fixed1/Fixed2/ Random1/ Random2..... **Cultivar:** Nagpur mandarin (santra)/ sweet orange (mosambi).....**Orchard area** .....**Cropping season during observation :** *Ambia* (Jan-Feb flowering)/ *Mrig* (June-July flowering)/*Hasta* (October- November flowering) **Name of Grower**..... **Contact Number**..... **No. of trees/ Acre/Orchard** ..... **Village Name**.....**Taluka Name**..... **District Name**..... **Crop stage:** Flowering/ Fruitlet/ Fruit maturity/ Preharvest, **Fruit Bearing:** Heavy/ Optimum/ Poor, **Weather parameters:** Temperature (max-min), rainfall (mm) & humidity (morning and evening) in meteorological weeks

DATA SHEET

Tree No.	Citrus psylla population/ 10 cm shoot				Whitefly population/ 5 leaves				Blackfly population/ 5 leaves				Leaf miner (mined leaves/5 leaves)			
	East	South	West	North	East	South	West	North	East	South	West	North	East	South	West	North
1																
2																
3																
4																

DATA SHEET

Tree No.	Mite (infested leaves/fruits per 5 leaves/fruits)								Thrips population				Fruit sucking moth		Bark eating caterpillar	*Phytophthora* gummosis/ root, collar or foot rot & brown rot in fruits incidence %	
	East		South		West		North		East	South	West	North					
	L	F	L	F	L	F	L	F					Fruits punctured/ 10 spots	Total fruits/ 10 spots	No. of trees infested/ 25 trees	Trees infected	Total trees
1																	
2																	
3																	
4																	

PEST SCOUT SURVEY PROFORMA FOR BANANA INSECT PESTS AND DISEASES IN MAHARASHTRA

Date of Survey:.....**Orchard Type:** Fixed1/Fixed2/ Random1/ Random2, **Plantatlon Area:** ..... **Nama 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 includingremovalof dried leaf

DATA SHEET

Pest			Sigtoka leaf spot disease score																
Plant No.	Thrips (Score scale) at the time of flowering / fruiting	Leaf No./ Plant No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total Grade	No. of green leaves
1		1																	
2		2																	
3		3																	
4		4																	
5		5																	
6		6																	
7		7																	
8		8																	
9		9																	
10		10																	
11		11																	
12		12																	
13		13																	
14		14																	
15		15																	
16		16																	
17		17																	
18		18																	
19		19																	
20		20																	

PEST SCOUT SURVEY PROFORMA FOR MANGO INSECT PESTS AND DISEASES IN MAHARASHTRA

Date of Survey.....**Orchard Type** Fixed1/Fixed2/ Random1/ Random2 **Orchard Area** ..... **Nama 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

	Shoot/ Panicle No.	Hopper	No. of Thrips	Thrips on fruits						Powdery Mildew intensity	Anthracnose intensity
				No. Of Fruits	Fruits Damaged						
					0	1	2	3	4		
Tree 1	1										
	2										
	3										
	4										
	5										
Tree 2	1										
	2										
	3										
	4										
	5										
Tree 3	1										
	2										
	3										
	4										
	5										
Tree 4	1										
	2										
	3										
	4										
	5										

Fruit Fly	
Trap No.	Fly No.
1	
2	
3	
4	

Annexure IV

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

Date of Survey.....**Orchard Type:** Fixed1/Fixed2/ Random1/ Random2 **Orchard Area** ..... **Nama of Grower** ..... **Contact Number** ..... **No. of trees/ha** ..... **Village Name**..... **Taluka Name** ..... **District Name** ..... **Orchard Sanitation:** (Poor/Good/Excellent **Crop condition**: **Foliage:**(Good/Average/Poor) **Fruit stage:** Ready/ Not Ready for harvest **Fruit bearing:** (Heavy/Optimum/Poor) **Stage of crop on the day of survey:** Rest/Stress/Defoliation/Flowering/Fruiting/Ready for harvest **Pomegranate Variety:** Bhagawa/Ganesh/Arakta/Mridula/any other

DATA SHEET

Bacterial Blight								
Site No	Total no. of trees affected out of 5	*Severity Grade (0-5) on leaf (L), Stem (S), Fruit (F)						
	A	Unit	Plant Number B.					Average Grade C
			1	2	3	4	5	
1		L/F						
		S						
2		L/F						
		S						
3		L/F						
		S						
4		L/F						
		S						
5		L/F						
		S						
6		L/F						
		S						
7		L/F						
		S						
8		L/F						
		S						
9		L/F						
		S						
10		L/F						
		S						

Thrips		
Pl. No.	% Affected Twigs	% Affected fruits
	G	H
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Fruit Borer	
Pl. No.	No. of Bored Fruits out of 100
	I
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Other Diseases/Insect Pests Incidence		
S. No.	Diseases/Insect Pests	Severity Rating
	J	K
1	*Cercospora* Fruit spot	Nil/Low/Moderate/Severe
2	Fruit Scab	Nil/Low/Moderate/Severe
3	*Colletotrichum* fruit rot	Nil/Low/Moderate/Severe
4	Mites	Nil/Low/Moderate/Severe
5	Fruit sucking moth	Nil/Low/Moderate/Severe
6	Stem/Shot hole borer	Nil/Low/Moderate/Severe
7	Any other	Nil/Low/Moderate/Severe

Wilt						
Total Plants	Total wilted plants	# Tick(√) the Major causes				
D	E	F				
		Cf	RRF	SHB	N	O

Other Activities
Pruning After harvesting/Before flower regulation
Training (No.of main stems) : 1/2/3/4/>4
Irrigation (quantity of water/plant) ….. l/day
Fertilizers Used (Dose/plant and source)
FYM .....
N .....
P .....
K .....
Micronutrients .....
.....
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 SCOUT SURVEY PROFORMA FOR SAPOTA INSECT PESTS AND DISEASES IN MAHARASHTRA

Date of Survey..... **Orchard Type**: Fixed1/Fixed2/ Random1/ Random2 **Orchard Area**.....
Name of Grower..... **Contact Numbe**..... **No. of trees/ha.**.....
Village Name..... **Taluka Name**..... **District Name** .....
Sapota Variety..... **Crop condition:** Flowering : Good / Average/Poor **Crop stage**.....
Fruit Bearing : Heavy/ Optimum/ Poor

DATA SHEET

Tree No	Pest												Diseases																Pest		
	Total number of buds/ 10 Shoot in each direction (Y)				No. of buds infested / 10 Shoot in each direction (X)				No. of Fruits				Phytophothera intensity																Seed Borer		
													0				1				2				3				4				No. of Seed borer Trapped		Total No. of bored fruits out of 25 fruits
	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	Trap No.	Seed borer no.	
1																																	1		
2																																	2		
3																																	3		
4																																	4		

PEST MONITOR SURVEY PROFORMA FOR CITRUS (NAGPUR MANDARIN/SWEET ORANGE) INSECT PESTS AND DISEASES IN MAHARASHTRA

Date of Survey.....**Orchard Type:** Random1/ Random2 ..... **Cultivar:** Nagpur mandarin (santra)/ sweet orange (mosambi)..... **Orchard area**..... **Cropping season during observation** : Ambia (Jan-Feb wering)/ Mrig (June-July flowering)/Hasta (October- November flowering) **Name of Grower**.....**Contact Number**.....
No. of trees/Acre/ Orchard..... **Village Name**..... **Taluka Name**..... **District Name**.....
Crop stage: Flowering/ Fruitlet/ Fruit maturity/ Preharvest **Fruit Bearing** : Heavy/ Optimum/ Poor **Weather parameters**: Temperature (max-min), rainfall (mm) & humidity (morning and evening) in meteorological weeks

DATA SHEET

Tree No.	Citrus psylla population/ 10 cm shoot				Whitefly population/ 5 leaves				Blackfly population/ 5 leaves				Leaf miner (mined leaves/5 leaves)			
	East	South	West	North	East	South	West	North	East	South	West	North	East	South	West	North
1																
2																
3																
4																

Tree No.	Mite (infested leaves/fruits per 5 leaves/ fruits)								Thrips population (nos./ branch tapping)				Fruit sucking moth		Bark eating caterpillar	*Phytophthora* gummosis/ root, collar or foot rot & brown rot in fruits incidence %	
	East		South		West		North		East	South	West	North					
	L	F	L	F	L	F	L	F					Fruits punctured/ 10 spots	Total fruits/ 10 spots	No. of trees infested/ 25 trees	Trees infected	Total trees
1																	
2																	
3																	
4																	

PEST MONITOR SURVEY PROFORMA FOR BANANA INSECT PESTS AND DISEASES IN MAHARASHTRA

Date of Survey..... **Orchard Type**: Random1/ Random2 **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

Pest			Sigtoka leaf spot disease score																
Plant No.	Thrips (Score scale) at the time of flowering /fruiting		Leaf No./ Plant No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total Grade	No. of green leaves
1			1																
2			2																
3			3																
4			4																
5			5																
6			6																
7			7																
8			8																
9			9																
10			10																
11			11																
12			12																
13			13																
14			14																
15			15																
16			16																
17			17																
18			18																
19			19																
20			20																

PEST MONITOR SURVEY PROFORMA FOR MANGO INSECT PESTS AND DISEASES IN MAHARASHTRA

Date of Survey..... **Orchard Type**: 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

	Shoot/ Panicle No.	Hopper	No. of Thrips	Thrips on fruits						Powdery Mildew intensity	Anthracnose intensity
				No. Of Fruits	Fruits Damaged						
					0	1	2	3	4		
Tree 1	1										
	2										
	3										
	4										
	5										
Tree 2	1										
	2										
	3										
	4										
	5										
Tree 3	1										
	2										
	3										
	4										
	5										
Tree 4	1										
	2										
	3										
	4										
	5										

Annexure IX

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

Date of Survey..... **Orchard Type**: Random1/ Random2 **Orchard Area** .....
Name of Grower..... **Contact Number** ..... **No. of trees/ha.** .....
Village Name..... **Taluka Name** ..... **District Name** .....
Orchard Sanitation:(Poor/Good/Excellent **Crop condition**: Foliage:(Good/Average/Poor)
Fruit stage: Ready/Not Ready for harvest **Fruit bearing**: (Heavy/Optimum/Poor) Stage of crop on the day of survey: Rest/Stress/Defoliation/Flowering/Fruiting/Ready for harvest
Pomegranate Variety: Bhagawa/Ganesh/Arakta/Mridula/any other

DATA SHEET

Bacterial Blight								
Site No	Total no. of trees affected out of 5	*Severity Grade (0-5) on leaf (L), Stem (S), Fruit (F)						
	A	Unit	Plant Number B.					Average Grade C
			1	2	3	4	5	
1		L/F						
		S						
2		L/F						
		S						
3		L/F						
		S						
4		L/F						
		S						
5		L/F						
		S						
6		L/F						
		S						
7		L/F						
		S						
8		L/F						
		S						
9		L/F						
		S						
10		L/F						
		S						

Thrips		
Pl. No.	% Affected Twigs	% Affected fruits
	G	H
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Fruit Borer	
Pl. No.	No. of Bored Fruits out of 100
	I
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Other Diseases/Insect Pests Incidence		
S. No.	Diseases/Insect Pests	Severity Rating
	J	K
1	*Cercospora* Fruit spot	Nil/Low/Moderate/Severe
2	Fruit Scab	Nil/Low/Moderate/Severe
3	*Colletotrichum* fruit rot	Nil/Low/Moderate/Severe
4	Mites	Nil/Low/Moderate/Severe
5	Fruit sucking moth	Nil/Low/Moderate/Severe
6	Stem/Shot hole borer	Nil/Low/Moderate/Severe
7	Any other	Nil/Low/Moderate/Severe

Wilt						
Total Plants	Total wilted plants	# Tick(√) the Major causes				
D	E	F				
		Cf	RRF	SHB	N	O

Other Activities
Pruning After harvesting/Before flower regulation
Training (No.of main stems) : 1/2/3/4/>4
Irrigation (quantity of water/plant) ….. l/day
Fertilizers Used (Dose/plant and source)
FYM .....
N .....
P .....
K .....
Micronutrients .....
.....
Spray schedule Daily/after 2-3 days/ after 5-7 days / after 10-15 days
Major Pesticides used with dose
Any other essential information

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Collected by
Name and Signature of Scout with date

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Data Verified by
Name and Signature of Pest Monitor with date

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

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Counter Signed by
Name and Signature with Date and Time

PEST MONITOR SURVEY PROFORMA FOR SAPOTA INSECT PESTS AND DISEASES IN MAHARASHTRA

Date of Survey..... **Orchard Type:** Random1/ Random2 **Orchard Area**..... **Nama of Grower** .....
Contact Number ..... **No. of trees/ha.** ..... **Village Name** ..... **Taluka Name** .....
District Name ..... **Sapota Variety** ..... **Crop condition:** Flowering : Good / Average/ Poor **Crop stage** ..... **Fruit Bearing** : Heavy/ Optimum/ Poor

DATA SHEET

Tree No	Pest												Diseases																				Pest		
	Total number of buds/ 10 Shoot in each direction (Y)				No. of buds infested / 10 Shoot in each direction (X)				No. of Fruits				Phytophothera intensity																				Seed Borer		
													0				1				2				3				4				No. of Seed borer Trapped		Total No. of bored fruits out of 25 fruits
	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	Trap No.	Seed borer no.	
1																																	1		
2																																	2		
3																																	3		
4																																	4		

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch