Major Diseases of Citrus and Their Management

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Diseases of Horticultural Crops

Diagnosis and Management

Volume 1: Fruit Crops




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DISEASES OF HORTICULTURAL CROPS

Diagnosis and Management

Volume 1: Fruit Crops

CHAPTER 8

MAJOR DISEASES OF CITRUS AND THEIR MANAGEMENT

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ABSTRACT

Citrus fruits are among the most consumed fruits in the world. Citrus fruits are very common and the most important fruit crops in India, and are grown in 9.85 lakh hectares with a total production of 114.19 lakh tons. Low productivity in citrus is caused by many factors such as, plant pathogens, insect-pests, nutritional imbalances, and physiological disorders. However, the world production of citrus fruits is faced with several constraints which hinder its development. Furthermore, the spread of pests such as mealybugs, mites, and Mediterranean fruit fly has impacted negatively on citrus quality and yield. Therefore, the main objectives of this review were to identify the key harmful organisms to the citrus crops and to highlight the appropriate methods to manage them.

8.1 INTRODUCTION

The citrus fruits include lemons, orange limes, tangerines, pomelo, and grapefruit. Not only the citrus fruits in this varied group have delicious and

refreshing all star fruits in this varied group, they all include compound flavonoids. Compound flavonoids have anticancer effects.

Citrus fruits are very common and the most important fruit crops in India, and are grown in 9.85 lakh hectares with a total production of 114.19 lakh tons (Anonymous, 2017a). Low productivity in citrus is due to many factors such as pathogens, insect-pests, nutritional imbalances, physiological disorders, and improper cultural practices. Citrus fruits growing countries are Brazil, Cuba, Israel, Japan, Morocco, Spain, South Africa, Turkey, USA, and India in the world. India ranks sixth in the worldwide production of citrus fruits. After mango and banana production, citrus fruits occupy third place in production in India. Citrus fruits originated in Southeast Asia's tropical and subtropical areas, essentially India and China. Northeast India is the native site of numerous citrus plants. Citrus fruits hit with a high content of vitamin C and a refreshing drink. India grows and produces several commercially important citrus fruits, such as orange (mandarin or santra), sweet orange (mosambi, malta, or satgudi), lime, and lemon (Anonymous, 2012).

Citrus plants are very liable to infestation many diseases, these are as given below:

Diseases

(1) Gummosis: *Phytophthora parasitica, P. palmivora, P. citrophthora*
(2) Scab/Verucosis: *Elsinoe fawcetti Sphaceloma fawcettii (anamorph)*
(3) Canker: *Xanthomonas campestris* pv *citri*
(4) Tristeza or fast decay: *Citrus tristeza virus* (CTV)
(5) Huanglongbing/Citrus greening: *Candidatus Liberibacter asiaticus*

8.2 GUMMOSIS: *PHYTOPHTHORA* SPP.

Introduction/Economic Importance:

There are six *Phytophthora* spp. capable of causing disease in citrus fruit trees, but the greatest reduction in fruit yield may be attributed to the following two spp.: (1) *Phytophthora parasitica* Dast. (mostly in tropical and subtropical regions), (2) *Phytophthora citrophthora* (R.E. Srn. and E.H. Srn.) Leonian (mostly in temperate climates; Timmer and Menge, 1988). *Phytophthora* spp. has a back history as a major constraint in citrus fruit production throughout the world. Gummosis or Phytophthora disease occurred and reported from Australia in 1860 and later in Florida in 1952 (Broadbent, 1977). Considerable losses to the citrus industry in South Africa by root pathogens including

Phytophthora spp./Gummosis in every year (Kotze, 1984). The loss due to *Phytophthora* spp. was estimated by Themann and Werres (1995) in citrus nurseries alone up to 80%. Gummose is a common disease which occurs as frequently in Punjab and Assam, India. Lemons are more vulnerable than lemons and whole grapefruits. In Southern Indian regions, it is very popular in sweet orange.

Symptoms:

Symptoms appeared when large patches of water soaked nearly ground level on the basal portions of the stem. Bark of such parts of stem/trunk showed symptoms in lengthwise vertical strips such as dries, shrinks, and cracks and shreds. Stem/trunk bark profuse later stage gum exudation (Anonymous, 2018a).

FIGURE 8.1 Citrus gummosis disease.

Casual Organism: *Phytophthora parasitica, P. palmivora, P. citrophthora, P. hibernalis, P. syringae, P. cactorum*

Pathogen:

Phytophthora spp. have various types of inoculum: mycelia, chlamydospores, sporangia, zoospores, and oospores.

Scientific Classification (Kirk et al., 2008)

Kingdom:	Fungi
Phylum:	Oomycota
Class:	Oomycetes
Order:	Pythiales
Family:	Pythiaceae
Genus:	*Phytophthora*

Disease Cycle and Epidemiology:

Species of *phytophthora* can spread in many ways, including soil movement with nursery stocks, irrigation water, and infected root sections. Irrigated citrus often suffers as runoff water can carry the pathogen into channels, streams, or rivers. Water from those sources can then contaminate areas that were previously uninfected. On farm machinery, the fungus may be brought into the soil. Seeds taken from contaminated fruits are rarely contagious (Graham and Menge, 1999).

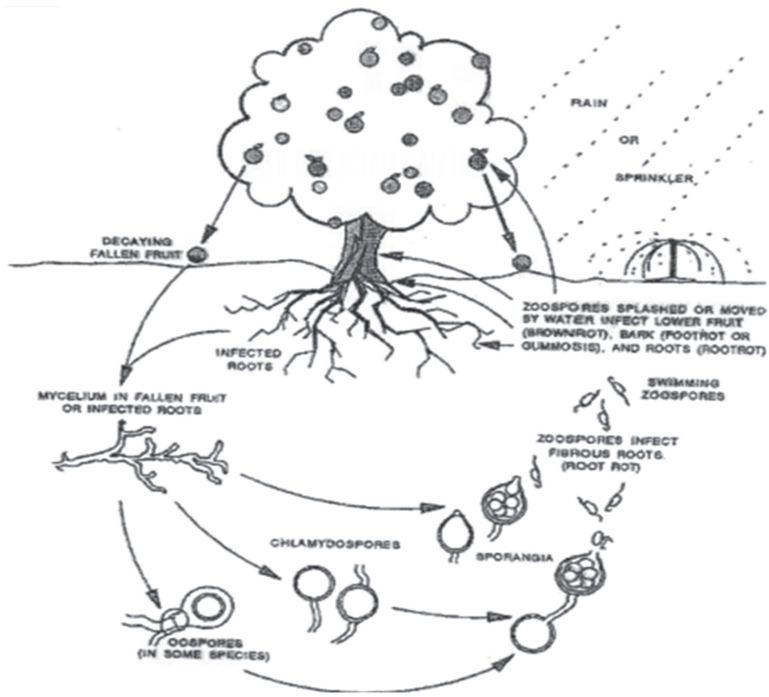

FIGURE 8.2 The disease cycle of gummosis.

Favorable Conditions:

High soil moisture increases infection, mainly due to increased sporangia formation and improved conditions for zoospore release, motility, and movement to the site of infection. In soils with restricted drainage and soil pH between 6.0 and 6.5, the occurrence of the disease is typically more extreme. Stress from either excess moisture or low moisture can also make certain hosts more vulnerable to infection (Erwin and Ribeiro, 1996).

Management:

Preventive Measures:

- Selecting of field for planting of citrus fruits with well developed drainage system for water.
- Citrus plant must be planted with little higher than the ground level.
- Avoiding excess irrigations.
- Range of planting material (30–45 cm or above) with large budded grafts.
- Prevent mechanical damage to the crown roots of citrus trees or stem base during cultural activities.
- To propagate popular/commercial varieties, use resistant sour orange or trifoliate orange rootstock.
- Citrus trees paint root at almost ground level with Bordeaux paste at least once a year or with $ZnSO_4$ + $CuSO_4$ + lime (5:1:4) at a height of around 60 cm above ground level.
- Apply *Trichoderma viride* multiplied on neem cake.

Curative Measures:

- Injuries to coronary roots or stem base should be avoided during cultural operations.
- Scrape/chisel the sick part out.
- Protect the Bordeaux paste cut surface.
- Two sprays, drilled with Aliette (2.5 g/L) or Ridomil MZ-72 (2.50 g/L) covering the entire plant canopy and basin of the affected plant at a 40-day interval from the onset of the monsoon provided considerable control (Anonymous, 2018b).

8.3 SCAB/VERUCOSIS: *ELSINOE FAWCETTI* (ANAMORPH: *SPHACELOMA FAWCETTII* JENK)

Introduction/Economic Importance:

Disease from citrus scab is common in regions. In areas with rainfall to provide favorable temperature and high humidity, the disease is prevalent. Apart from that, disease that occurs on a new flush and fruit setting coincides with warm and humid weather. The disease often occurs when planting citrus in warm, low-lying soils and dense or shaded conditions. Serious outbreaks of citrus scab disease only occur in areas where susceptible species or cultivars of citrus fruits are produced. Yield losses often rely on seasonal and local weather variations. In which areas where annual rainfall is limited (<1300 mm) the disease is not an issue. Citrus-developing zones with a dry climate state, whether normal, rare, or immaterial (Gopal et al., 2014).

FIGURE 8.3 Citrus scab disease (a) Citrus scab symptoms on sour orange leaves; (b) Citrus scab symptoms on sour orange fruit.

Symptoms:

Symptoms occur on citrus leaves and berries, as wart lesions/pustules. The lesions on the leaf are initially semitranslucent dots that become tiny nipple-like projections with pale yellow cream. Lesions can go up by as much as 3 mm in diameter and grow a scab-like appearance. Older scab lesions are usually colored, warty, deeply cracked, from cinnamon to honey, and can separate as they mature. Young shoots and fruit that develop similar leaf symptoms but are not seen as much as they do as young shoots. Pustules are the location where the fungal spores are produced. The lesions on grapefruit appear to be flattened scabby sheets, and sweet orange. Tissue age and time of infection also affect the lifting and size of the lesions. The lesions on young tissues appear to grow, and those on mature tissues are more flatter.

Because of variations in cultivars and infected tissue age it is difficult to differentiate between citrus scab and citrus cancer based on symptoms alone (Gopal et al., 2014).

Casual Organism: *Elsinoe fawcetti* (Anamorph: *Sphaceloma fawcettii* Jenk)

Pathogen:

Citrus scab disease is caused by the *Elsinoe fawcetii* Bitancourt and Jenkins. *E. Fawcetii* and that contains a number of pseudothecial locules with round asci. Growing ascus contains eight filamentous ascospores in sizes of 5–6 × 10–12 µm, hyalin and elongated circular. *Elsinoe* spp. produce two conidium types, such as hyaline conidia and spindle conidia (Gopal et al., 2014).

Scientific Classification (Kirk et al., 2008)

Kingdom:	Fungi
Phylum:	Ascomycota
Class:	Dothidiomycetes
Order:	Myriangiales
Family:	Elsinoaceae
Genus:	*Elsinoe*

Disease Cycle and Epidemiology:

Over the course of the year, young fruits and leaves produce spores on the surface of scab lesions. Rough lemon rootstock is also very susceptible to scabbing and can act as a source of fungal inoculum. Fungal spores are distributed by splashes of rain, overhead irrigation, and spray operations. Dew may also cause the spores to be released from the lesions but due to the inhibited splashing action, only localized dispersal may occur (Whiteside, 1975).

Favorable Conditions:

Citrus scab disease can be especially serious on flushes from summer development. Summer wet cycles linked to rain showers and dew are highly favorable for spore germination and infection (Anon., 2018a).

Management:

- Follow the crop sanitation practices.

- Establishment of citrus nurseries in appropriate drainage soil, in dry areas or in greenhouses and appropriate treatment may help to produce pathogen-free rootstocks and bud wood.
- Protective fungicides (copper, ferbam, thiram, difenoconazole, and chlorothalonil) or systemic fungicides, such as benomyl, carbendazim, may be applied prior to flushing and after petal fall. Certified citrus planting material should be planted in a newly established orchard (Anonymous, 2018c).

8.4 CANKER: *XANTHOMONAS CAMPESTRIS* PV. *CITRI*

Introduction/Economic Importance:

Among all citrus diseases, Citrus canker is the most devastating disease. The disease affects all of the important crops of citrus fruits in that region. The disease causes tremendous losses to the citrus, and along with cultivars and the prevailing climate, the severity of the disease varies. The prevalence of the disease as endemic in India, Japan, and other countries of Southeast Asia but except in all other continents producing citrus except Europe. In arid citrus growing areas, canker usually does not occur. However, the occurrence of the disease worldwide in many areas is a continuous threat to citrus fruit production, particularly in canker-free zones. Citrus canker disease in India appears to be a serious problem wherever acid lime (*C. aurantifolia*) is grown on a large and commercial scale and has become a major permanent problem for citrus growers. In 1942, Luthra and Sattar first reported Citrus canker disease from Punjab (Luthra and Sattar, 1942; Bedi, 1961). In 1954, Ramakrishan further recorded the occurrence of citrus canker disease in Tamil Nadu (Ramakrishnan, 1954). Canker has also been reported from the Punjab at kinnow, mandarin nursery (Anonymous, 2000).

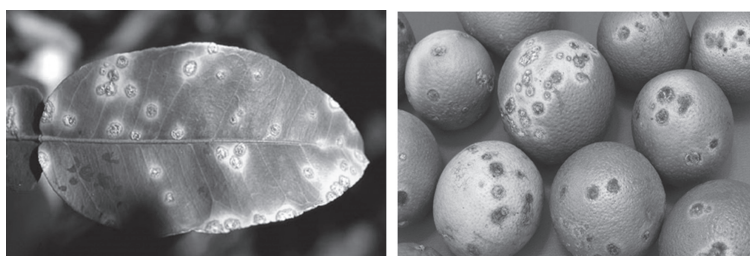

FIGURE 8.4 Citrus canker disease (a) Citrus canker symptoms on sour leaves; (b) Citrus canker symptoms on citrus fruits.

Symptoms:

Leaf Lesions:

Canker lesions are evident on the leaves' underside, and then on the upper surface, about 7–10 days after infection. With the elevated margin and sunken middle, the pustules are corky. The yellow halo around it is a common symptom of the disease on the leaves.

Fruit and Stem Lesions:

In fruit and roots, citrus canker lesions range up to 1 mm in size and are close to those on leaves. Crop deficiency results in the premature fall of the crop. Usually, the fruit's internal quality is not affected but individual lesions penetrate the rind deeply enough to expose the fruit's interior to secondary microorganism infection. Stem lesions allow the bacteria to live in the long term.

Casual Organism: *Xanthomonas campestris* pv. *citri*

Pathogen:

The causal organism is the bacterial pathogen *Xanthomonas citri*, now called *X. campestris* pv. *citri* (Hasse) Dowson. Single polar flagellum (monotrichous). It lacks endospore formation. It is a Gram-negative, aerobic form surrounded by a capsule (Anonymous, 2017b).

Scientific Classification (Kirk et al., 2008)

Kingdom:	Bacteria
Phylum:	Proteobacteria
Class:	Gammaproteobacteria
Order:	Xanthomonadales
Family:	Xanthomonadaceae
Genus:	*Xanthomonas*

Disease Cycle and Epidemiology

Bacteria grow on leaves, stems, and fruit in lesions. The bacteria ooze out when free moisture is present on the lesions. Rain splash is the principal dispersal agent and wind helps to penetrate bacteria through natural openings or wounds created by thorns, pruning, and insects (leaf miner). Bacterial

death increases when exposed to direct sunlight. These bacteria can live in infected tissues of plants that have been kept dry and free from the soil for years.

Favorable Conditions:

Wind-driven rain plays a major role in the dispersal of *Xanthomonas* spp. Sprinkled rain and wind, and the volume of *Xanthomonas* spp., should easily disperse the bacteria. Decreases with wind-blown rain dispersal after the main event. Besides that, bacteria also prefer warm weather. Citrus infection is increasingly extreme in regions with high precipitation and high mean temperature (Bock et al., 2005).

Management:

- Complete eradication of infected trees is advised.
- Remove contaminated branches from pruning scissors and then spray the trees with 1% of the Bordeaux mixture at regular intervals. Falling infected leaves and twigs should be gathered and burned.
- Spray 1 g streptocycline and 30 g copper oxychloride in 10 L of water at intervals of 15 days in nurseries and at intervals of fortnight in orchards during rainy season.

8.5 TRISTEZA: CTV

Introduction/Economic Importance:

Tristeza is common in India in Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Bihar, West Bengal, Sikkim, and others. Side effects indicate snappy or ceaseless declines in tree species are especially common and extreme on trees spread over hard orange root stocks. To represent the tragic appearance of the ailing citrus trees, the name "Tristeza" has been proposed.

Symptoms:

The initial stages of infected trees appear chlorotic and sickly. Gradually the leaves fall and result in the appearance of die-back. Pitting stem seen on infected trees. Honeycombing, a fine pitting of the inner side of the bark in the portion of the trunk under the bud union, is the principal symptom of Tristeza in sweet orange. Tristeza contaminated citrus trees on rootstocks of

sour orange cause the phloem at the graft union to become necrosed. Ailing trees appear to bloom heavily. Stunted are the trees with stem pitting and set fewer fruits.

Casual Organism: CTV

Flexible filamentous virion with +ve ssRNA belonging to Closterovirus group.

Survival and Spread:

Long distance dissemination occurs through the movement of infected citrus planting material, or through the movement of infested plant material with infected aphids.

Management:

- Implement strict quarantine legislation.
- Use certified and healthy planting materials. Destroy all diseased trees whenever and when the disease happens.
- Daily insecticidal sprays such as dimethoate or 1 ml/l methyl-*o*-demetone to avoid further spread of the disease.

8.6 GREENING OR HUANGLONGBIN (HLB)

Introduction/Economic Importance:

In sweet oranges, kinnow, lemons, and other members of the citrus family, citrus greening/huanglongbing disease also occurred. Citrus-greening disease is a major citrus disease in India. Several Asian and African countries confirmed the disease (Garnier and Bove, 1996). The disease was documented for the presence of citrus greening bacterium disease in different parts of India in different citrus species.

Symptoms:

- Stunting of leaves, scant foliage, twig dying back, bad harvest of mostly greenish, useless fruits. The twigs are upright and grow smaller leaves.
- Young leaves appear normal but soon assume an upright position, become leathery, and develop prominent veins and a slender green color.

- Small, curved fruit columella. Low in juice, and solids soluble, high in acidity.

Casual Organism: *Candidatus Liberobacter asiaticus* (Fastidious Phloem limited Bacterium), obligate Gram-negative bacterium.

Mode of Spread:

The disease is transmitted by Diaphorina citri, an infected wood bud and citrus psylla. The illness is also transmitted through the dodder from the citrus to the Periwinkle (*Catharanthus roseus*).

Management:

- Control psyllids with insecticides.
- Use healthy bud wood for propagation.

KEYWORDS

- **citrus**
- **disease**
- **etiology**
- **symptomatology**
- **management**

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