

Chapter – 18

CITRUS DISEASES: ETIOLOGY, SYMPTOMS AND INTEGRATED MANAGEMENT APPROACHES

Shwati Pardhi¹ and Abhay Bisen²

¹SMS (Plant Pathology), Krishi Vigyan Kendra, IGKV, Raipur, (CG)

²Assistant Professor (Hort.), SKS CARS, Surgi, Rajnandgaon, IGKV, Raipur (CG)

*Corresponding Email & DOI:

Email: abhay_horti@yahoo.co.in

Doi:

Introduction

Citrus, belonging to the family *Rutaceae*, is one of the most important fruit crops globally, valued for its refreshing taste, high vitamin C content, and economic significance. India is among the leading citrus-producing countries, with major cultivation in Maharashtra, Madhya Pradesh, Punjab, and Chhattisgarh. The Nagpur mandarin (*Citrus reticulata*), sweet orange (*Citrus sinensis*), and acid lime (*Citrus aurantifolia*) are the dominant species. However, citrus production faces significant challenges due to the prevalence of various diseases caused by fungi, bacteria, viruses, and phytoplasmas. These diseases lead to substantial yield and quality losses. Effective disease management, therefore, requires a comprehensive understanding of the etiology, epidemiology, and management approaches.

Classification of Citrus Diseases

Citrus diseases are broadly categorized based on the causal organism as follows:

- Fungal diseases
- Citrus canker
- Gummosis or Phytophthora root rot
- Melanose
- Anthracnose
- Sooty mold

- Powdery mildew
- Bacterial diseases
- Citrus canker (*Xanthomonas axonopodis* sp. *citri*)
- Citrus greening (caused by *Candidatus Liberibacter asiaticus*)
- Viral and viroid diseases
- Tristeza virus
- Psorosis
- Exocortis
- Phytoplasmal diseases
- Witches' broom of lime

Each disease differs in symptomatology, epidemiology, and management strategies, which are discussed in the following sections.

Major Fungal Diseases of Citrus

Citrus Gummosis (*Phytophthora* Root Rot)

Causal Organism: *Phytophthora palmivora*, *P. nicotianae*, and *P. citrophthora*

Symptoms:

- Gum exudation from the trunk near the soil line is a typical symptom.
- Dark brown patches appear on bark, which later crack and exude gummy substances.
- In advanced stages, girdling of the trunk occurs, leading to leaf yellowing, defoliation, and tree death.
- Root infection causes root rot and poor nutrient uptake.

Disease Cycle:

- The pathogen survives as oospores or chlamydospores in soil and infected tissues.
- Under moist conditions, sporangia release zoospores that infect roots and stem bases.
- Rain splash and irrigation water aid in the dissemination.

Favorable Conditions:

- High soil moisture, poor drainage, and temperatures between 25–30°C favor disease development.
- Heavy rainfall during monsoon accelerates infection.

Management:

- Ensure proper field drainage and avoid water stagnation.
- Scrape infected bark and apply Bordeaux paste (1:1:10) or copper oxychloride paste.
- Drench soil with Metalaxyl (0.1%) or Ridomil MZ (0.25%).
- Use resistant or tolerant rootstocks such as *Cleopatra mandarin*.
- Maintain good orchard sanitation and avoid injury to the trunk.

Melanose

Causal Organism: *Diaporthe citri* (anamorph: *Phomopsis citri*)

Symptoms:

- Small dark brown to black raised spots on young leaves, fruits, and twigs.
- Severely infected fruits become rough and corky.
- The disease is most damaging on young growing tissues.

Disease Cycle:

- The fungus survives in dead twigs and leaf litter.
- Conidia are spread by rain splash and wind to healthy tissues.
- Infection occurs during moist, warm weather.

Favorable Conditions:

- High humidity (90–100%) and temperature between 25–30°C favor infection.
- Prolonged rainy periods enhance disease severity.

Management:

- Prune and destroy dead twigs before the rainy season.
- Spray with copper oxychloride (0.3%) or Mancozeb (0.25%) at 20-day intervals during rainy season.
- Maintain canopy aeration by proper pruning.

Anthrachnose

Causal Organism: *Colletotrichum gloeosporioides*

Symptoms:

- Appears as brownish spots on leaves and twigs that enlarge and coalesce.
- Dieback of twigs and premature fruit drop occur in severe cases.
- On fruits, dark sunken spots with pinkish spore masses appear.

Disease Cycle:

- The fungus survives on dead twigs and plant debris.
- Conidia are dispersed by rain and wind.
- Infections develop under high humidity and warm conditions.

Favorable Conditions:

- High humidity and temperature between 25–30°C.
- Occurs more during monsoon and post-monsoon seasons.

Management:

- Prune and burn diseased twigs.
- Spray with Carbendazim (0.1%) or Mancozeb (0.25%) at 15-day intervals.
- Use disease-free planting material and maintain tree vigor.

Sooty Mold

Causal Organisms: Several saprophytic fungi such as *Capnodiumcitri*, *Meliola*, and *Cladosporium*.

Symptoms:

- Black, soot-like coating on leaves, twigs, and fruits.
- It reduces photosynthesis, leading to stunted growth.
- The mold grows on honeydew secreted by aphids, whiteflies, and scales.

Disease Cycle:

- The fungus itself is non-pathogenic but depends on insect exudates for growth.
- Insect activity determines disease intensity.

Favorable Conditions:

- High humidity and dense canopy favormold formation.
- Occurs more during humid and shaded conditions.

Management:

- Control honeydew-producing insects using systemic insecticides (e.g., imidacloprid).
- Wash affected plants with mild soap solution.
- Maintain orchard sanitation and open canopy structure.

Powdery Mildew

Causal Organism: *Oidium erysipoides* var. *citri*

Symptoms:

- White powdery growth appears on tender leaves and shoots.
- Affected leaves curl and drop prematurely.
- Flower infection leads to poor fruit set.

Disease Cycle:

- The fungus survives as mycelium on host tissues.
- Conidia disseminated by wind initiate new infections.

Favorable Conditions:

- Dry climate with cool nights and warm days (20–30°C).
- Low relative humidity (50–60%) with dew formation favors sporulation.

Management:

- Spray wettable sulfur (0.3%) or Dinocap (0.05%) at 15-day intervals.
- Avoid excessive nitrogen fertilization.
- Ensure good air circulation in canopy.

Major Bacterial Diseases of Citrus

Citrus Canker

Causal Organism: *Xanthomonas axonopodis*pv. *citri*

Symptoms:

- Raised, corky lesions with a yellow halo on leaves, stems, and fruits.
- Infected leaves may drop prematurely, and fruits become blemished.
- Severe infection leads to twig dieback and yield loss.

Disease Cycle:

- The bacterium survives in lesions and fallen leaves.
- Spread occurs through rain splash, wind, and contaminated tools.
- Entry occurs through stomata or wounds.

Favorable Conditions:

- Warm, moist weather (25–35°C) and high rainfall favor infection.
- Frequent winds enhance bacterial dispersal.

Management:

- Use disease-free nursery stock.
- Prune infected twigs and burn them.
- Apply copper-based bactericides (0.3% copper oxychloride).
- Spray Streptocycline (100 ppm) with copper oxychloride (0.3%) at 15-day intervals during monsoon.
- Grow tolerant varieties where available.
- Avoid pruning during wet weather to minimize spread.

Citrus Greening (Huanglongbing or HLB)

Causal Organism: *Candidatus liberibacter asiaticus* (transmitted by *Diaphorinacitri*, the Asian citrus psyllid).

Symptoms:

- Mottled yellowing of leaves resembling zinc deficiency.
- Lopsided fruits with bitter taste.
- Reduction in fruit size and premature fruit drop.
- Tree decline and eventual death over several years.

Disease Cycle:

- The bacterium resides in phloem tissues.
- Transmitted by infected psyllids and through grafting.
- No alternate host is known.

Favorable Conditions:

- Temperature of 25–32°C and abundant vector population favor spread.

Management:

- Remove and destroy infected trees immediately.
- Use disease-free budwood and nursery plants.
- Control vector (*Diaphorinacitri*) with systemic insecticides (imidacloprid, thiamethoxam).
- Grow tolerant rootstocks such as *Rangpur lime*.
- Maintain orchard sanitation and avoid overlapping generations of flush growth.

Viral and Viroid Diseases

Citrus Tristeza Virus (CTV)

Causal Organism: *Citrus tristeza virus* (genus *Closterovirus*)

Symptoms:

- Stem pitting, yellowing, and decline of trees grafted on sour orange rootstock.
- Leaves become small, cupped, and chlorotic.
- Fruits remain undersized and yield decreases.

Disease Cycle:

- Transmitted by aphids, particularly *Toxoptera citricida*.
- Also spread through infected budwood.
- Virus persists systemically in infected plants.

Favorable Conditions:

- Warm humid conditions favor aphid multiplication.

Management:

- Use tristeza-tolerant rootstocks (e.g., *Cleopatra mandarin*, *Rangpur lime*).
- Control aphid vectors using imidacloprid or neem-based products.
- Use virus-indexed planting material.

Citrus Psorosis

Causal Organism: *Citrus psorosis virus*

Symptoms:

- Bark scaling and flaking on trunk and branches.
- Yellow flecks and rings on leaves.
- Reduced vigor and yield in advanced stages.

Disease Cycle:

- Spread primarily through grafting of infected buds.
- No known insect vector.

Favorable Conditions:

- Disease expression is more pronounced under stress conditions.

Management:

- Use virus-free budwood for propagation.
- Rogue out infected trees.
- Regular monitoring and certification of nursery stock.

Exocortis (Citrus Viroid)

Causal Agent: *Citrus exocortis viroid (CEVd)*

Symptoms:

- Bark scaling on rootstocks like trifoliate orange.
- Stunted growth and leaf chlorosis.
- Scaly cracking on exposed roots and stem.

Disease Cycle:

- Spread through contaminated budding knives and tools.
- No insect vector involved.

Favorable Conditions:

- Symptoms appear under high temperature stress (28–35°C).

Management:

- Use certified viroid-free planting material.
- Disinfect budding tools (sodium hypochlorite 10%) after each use.
- Avoid susceptible rootstocks.

Phytoplasmal Disease

Witches' Broom of Lime

Causal Agent: *Candidatus phytoplasmaaurantifolia*

Symptoms:

- Dense proliferation of small shoots resembling a broom.
- Shortened internodes, small leaves, and dieback.
- Flower and fruit production severely reduced.

Disease Cycle:

- Transmitted by leafhoppers and grafting.
- Phytoplasma resides in phloem tissues.

Favorable Conditions:

- Warm dry climate with high vector population density.

Management:

- Remove and destroy infected trees.
- Use disease-free planting materials.
- Control insect vectors with imidacloprid or thiamethoxam.
- Maintain adequate orchard hygiene.
- Integrated Disease Management (IDM) in Citrus

An integrated approach combining cultural, biological, chemical, and resistant varieties provides the most sustainable solution for citrus disease management.

Cultural Practices

- Use disease-free, certified planting materials.
- Provide proper spacing and drainage.
- Regular pruning to remove diseased twigs and improve airflow.
- Avoid mechanical injuries to bark and roots.
- Maintain balanced fertilization and irrigation.

Biological Control

- Use *Trichoderma harzianum* for soil-borne pathogens like *Phytophthora*.
- Employ *Pseudomonas fluorescens* as a biocontrol agent in nurseries.
- Encourage natural enemies of insect vectors (ladybird beetles, lacewings).

Chemical Control

- Copper-based fungicides for fungal and bacterial diseases.
- Systemic fungicides like Metalaxyl or Ridomil for gummosis.
- Insecticide applications for psyllid and aphid control.
- Periodic spray schedules based on local disease forecasting.

Resistant Varieties and Rootstocks

- Use tolerant rootstocks like *Cleopatra mandarin*, *Rangpur lime*, and *Poncirus trifoliata*.
- Select scion-rootstock combinations that minimize disease susceptibility.
- Sanitation and Quarantine
- Remove and destroy diseased plants and debris.
- Disinfect pruning and budding tools.
- Enforce quarantine measures to prevent introduction of new pathogens.
- Weather and Disease Relationship

Weather plays a pivotal role in citrus disease epidemiology:

Disease	Optimum Temperature (°C)	Relative Humidity (%)	Key Weather Influence
Gummosis	25–30	>85	High soil moisture, poor drainage
Melanose	25–30	90–100	Prolonged rainfall
Anthracnose	25–30	>85	Warm humid conditions
Canker	25–35	>80	Wind-driven rain spreads bacteria
Greening	25–32	Moderate	Vector activity peaks
Tristeza	25–30	>75	Aphid population increase

Future Prospects

With climate change, disease dynamics are shifting warmer winters and erratic rainfall are likely to increase canker and greening incidence. Future management should emphasize:

- Resistant cultivar development using molecular breeding.
- Precision agriculture and disease forecasting models.
- Biological control and nanotechnology-based formulations.
- Awareness programs for farmers regarding nursery sanitation and vector control.

Conclusion

Citrus diseases pose serious challenges to sustainable citrus production. A thorough understanding of pathogen biology, epidemiology, and weather interactions is crucial for effective control. Integrated Disease Management combining cultural, chemical, and biological methods offers the most practical and eco-friendly solution. Long-term disease management success depends on healthy nursery practices, use of resistant rootstocks, and continuous monitoring of orchards for early detection and rapid response.

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