

# Orange Disease Detection and Prevention

## **B. Diseases: Citrus Black Spot, Citrus Sooty Mold, Citrus Greening (HLB), Citrus Canker, Citrus Leaf Miner**

### **1. Citrus Black Spot**

Citrus Black Spot is a fungal disease caused by *Phyllosticta citricarpa* (formerly *Guignardia citricarpa*), which affects citrus plants like oranges, lemons, and grapefruits. Citrus Black Spot thrives in warm, humid environments, making it a significant threat in tropical and subtropical citrus-growing regions.

#### **Symptoms:**

Affected fruits show reddish and dark depressed spots with brown margins. These lesions spread and coalesce, especially on fallen and harvested fruit. Severely affected fruit ripen prematurely and drop. In some cases, infected fruit that are asymptomatic at harvest may develop the symptoms in transport or storage. When severe symptoms develop before maturity, fruit often drop resulting in significant yield loss.

#### **Causes:**

Citrus Black Spot is a fungal disease caused by *Phyllosticta citricarpa* (formerly *Guignardia citricarpa*), which affects citrus plants like oranges, lemons, and grapefruits.

#### **Prevention:**

- Remove and destroy fallen leaves, infected fruits, and other plant debris where the fungus can survive and spread.
- Prune trees to improve airflow and reduce moisture, which can help slow fungal growth.
- Use disease-free, certified nursery plants when establishing new orchards.
- Avoid planting citrus trees in low-lying areas with poor drainage, as excessive moisture can promote fungal growth.

- Regularly inspect plants for early signs of infection, especially after periods of rain or high humidity.
- Quarantine new plants until they have been inspected and confirmed disease-free.

#### **Treatment Option:**

- Apply fungicides, such as copper-based products or strobilurins, following local guidelines and recommendations to prevent the disease from spreading.
- Start fungicide treatments at early fruit development and continue as needed, especially in high-risk, humid areas.

#### **Impact on fruit quality**

The disease leaves fruit speckled and lesioned but does not affect the internal quality of the infected fruit. It can lead to blemishes, premature fruit drop, and lower fruit quality, affecting both the yield and market value.

## **2. Citrus Canker**

This is a bacterial disease. It appears as brownish-yellow spots on the leaves, stems, and fruits. When spots form on the fruits, the quality of the fruit deteriorates. This disease starts spreading before the rainy season and spreads rapidly during it. The disease can be transmitted by leaf-miner insects, which carry the bacteria into the plant through wounds or damage caused by insects or other factors. Additionally, the disease can spread through pruning tools as well.

#### **Symptoms:**

Disease begins as small pimple-like spots that are about 1 mm in diameter and yellow in color. As the spots enlarge, they become brown and corky with sunken centers and raised edges. Often each of these spots have a yellow ring surrounding them.

#### **Transmission:**

This disease starts spreading before the rainy season and spreads rapidly during it. The disease can be transmitted by leaf-miner insects, which carry the bacteria into the plant through wounds or

damage caused by insects or other factors. Additionally, the disease can spread through pruning tools as well.

#### **Prevention (Management practices):**

- Obtain plants from a nursery free from disease; avoid plants from low-altitude areas.
- Prune and remove infected parts, and apply pesticide to the remaining healthy sections.
- During December–January, spray a 1% Bordeaux mixture or Copper Oxychloride at 2-3 grams per liter of water.

#### **Treatment**

- During December–January, spray a 1% Bordeaux mixture or Copper Oxychloride at 2-3 grams per liter of water.
- Mix 1 gram of Streptomycin Sulfate + Tetracycline Hydrochloride in 3-5 liters of water and spray, or
- Mix 2 ml of Kasugamycin (Kas-B) per liter of water and spray.

### **3. Huanglongbing (HLB / Citrus Greening Disease):**

#### **Early signs**

#### **Asian citrus psyllid**

- Eggs are yellow-orange and almond-shaped. They are often tucked inside crevices and leaf folds.
- Nymphs are difficult to see, but leave behind waxy, white excretions on plants.
- Adult psyllids are gnat-sized, only about 1/8-inch long. When approached, they jump or fly.
- Adults have three abdominal colors: blue-green, gray-brown, or orange-yellow.
- Adults have mottled brown wings, and the last two segments of their antennae are black.

#### **Citrus greening**

- Once infected, a tree can remain asymptomatic, serving as a source of bacteria that infects other trees.
- Over time, an infected tree will start producing fewer fruit that are partially green, smaller, shaped irregularly, and taste bitter.
- Leaves may show asymmetrical, blotchy mottling.
- Trees may show twig dieback and premature fruit drop.

### **Spread and Causes:**

The primary carrier of this disease is the Asian citrus psyllid, an insect commonly found in warmer regions below 1100 meters in altitude. They first of all affect few trees and then spread throughout the orchard.

### **Preventive Measures of Citrus Greening Disease:**

- Monitor and inspect the presence of citrus psyllid carriers in orchards located at altitudes below 1100 meters. Always obtain plants from nurseries located above 1100 meters.
- Avoid plants from infected nurseries. Use only healthy seedlings, destroy infected plants, maintain modern nursery practices, produce seedlings in screened houses, manage psyllid carriers, and apply pesticides as needed.
- Only plant certified budwood within screen houses. Use scratch tests and PCR methods to diagnose the disease.
- For integrated disease management, identify and survey affected areas, use scratch tests for disease detection, manage psyllid carriers and disease, and destroy infected plants as part of an internal control system.

### **Treatment:**

There is no treatment or cure for citrus greening. Infected trees eventually die. The best way to prevent the introduction of citrus greening is to prevent the introduction of the Asian citrus psyllid.

## **4. Citrus Sooty Mold:**

## **Identification**

This disease spreads over the leaves, branches, and fruits of the plant, partially or completely covering them with a black layer. Since it is lightly attached, it can be scraped off by hand. By obstructing light absorption, it weakens the plant's health. The shoots and branches of the affected plant start to wither. The size of the affected fruits is also slightly smaller.

## **Primary hosts:**

This disease is caused by pests like whiteflies and aphids.

## **Removal Methods:**

The fungus is lightly attached, it can be scraped off by hand. Moreover, To remove the fungus from infected plants, mix 2 grams of Mancozeb (Dithane-45) per liter of water and spray.

## **Preventive Measures of Citrus Sooty Mold:**

- This disease is caused by pests like whiteflies and aphids. To control these insects, use Dimethoate (Rogar) (डाईमैथोएट (रोगर) कीटनाशक) pesticide at 1–1.5 ml per liter of water or mix 5-7 ml of neem oil per liter of water and spray.
- Regular pruning, keeping the garden clean, and maintaining proper spacing reduce the chances of pest infestations, thereby decreasing the likelihood of this disease.
- Aphid populations tend to increase significantly from mid-May to August, which is also when this disease commonly appears. Therefore, regular inspection of the garden during this period is essential.

## **5. Citrus Leaf Miner**

### **Symptoms and Carrier:**

This disease is caused by the larva of a moth named *Phyllocnistis citrella*. It primarily affects the young leaves of orange trees, where the larvae feed by tunneling within the leaf tissue, creating silvery serpentine trails. As the infestation progresses, the affected leaves curl and distort, reducing photosynthesis and hindering plant growth. The damage also increases the vulnerability of the

plant to secondary infections like fungal diseases. While this disease does not kill the plant immediately, it weakens it significantly, affecting both fruit yield and market value.

**Preventive Measures for Citrus Leaf Miner:**

- Avoid planting seedlings from infested areas and do not distribute affected plants to prevent spreading the pest.
- Prune and destroy heavily infested shoots to reduce the larval population.
- Regularly monitor young trees and apply neem oil sprays during the active growing season to deter moths.
- Use pheromone traps to monitor and control the adult population.
- Spray chemical insecticides such as 1 mL of imidacloprid or thiamethoxam mixed with water during the early stages of infestation for effective control.

## **Healthy Citrus Plants:**

### **Visual Indicators**

The healthy plants have following characteristics:

- Fast Growth
- Healthy roots
- Healthy leaves characteristics
- Blooming
- No pests

### **Routine care tips (Seasonal care tips):**

These activities should be implemented throughout the year to ensure the health and productivity of orange trees:

#### **Poush-Magh (Flowering and Vegetative Growth Period) •**

Remove weeds and other unnecessary plants.

- Prune dead, diseased, and damaged branches, as well as any parasitic plants. Apply Bordeaux paste to cut areas immediately after pruning.
- Soil Preparation and Fertilization:
  - Create a ring-shaped basin around the plant.
  - Add 30 kg of compost or manure, 450 g of urea, 250 g of DAP, 350 g of potash, and 100 g of agricultural lime to the basin.
  - Apply half the urea and other fertilizers (around 325 grams) now; reserve the remaining half of the urea for application in Jestha.
  - Cover the fertilizer with soil and irrigate thoroughly.

#### **Baisakh-Jestha (Fruit Development Stage)**

- Prepare and spray a mixture of zinc sulfate, copper sulfate, magnesium sulfate, and ferrous sulfate.
- Apply Bordeaux paste to areas affected by gummosis.

- At the banana-seed stage of fruit development, spray a 1% Bordeaux mixture in Baisakh, and repeat after 40 days.
- For plants affected by foot rot and root rot, mix Ridomil M-72 at a rate of 2.75 grams per liter of water and drench around the basin.
- If soil pH is below 4.5–5, apply 200 grams of dolomite lime per plant every 3 years.
- Use pesticide traps and protein baits to control fruit rot.

### **Ashah-Shrawan (Intensive Vegetative Growth and Secondary Growth Phase)**

- Spray Rogar or Malathion (2 ml per liter of water) to control pests like Patero and Lahi.
- Use Servo Agro Spray (10 ml per liter of water) to manage cutworms and leaf-mining insects.
- Keep the garden clean and tidy.
- Ensure proper drainage if there is water accumulation.
- If borer damage is observed, place a cotton ball soaked in petrol or kerosene in the borehole and seal it.
- Support branches as necessary to prevent breakage.
- Apply Bordeaux paste and spray Bevishtin (2 ml per liter of water). Spray sulfur (2 grams per liter of water) to control fungal issues.
- During the rainy season, manage high temperatures and humidity, which may lead to scab disease, rot, and root rot. Apply Bordeaux mixture as needed and maintain garden cleanliness.

### **Bhadra-Kartik-Mangsir (Maturity Phase)**

- Spray Rogar or Malathion (2 ml per liter of water) to manage pests.
- Use pheromone traps (methyl eugenol) for insect monitoring.
- Apply mulch (such as straw, wood dust, or dry leaves) around the plants to retain moisture and manage temperature changes.



**Harvesting:**

- Use pruning scissors for double clipping when harvesting fruits, keeping the button (head) on the fruit to prevent disease.
- Avoid bruising or rind wounds to ensure quality, especially for export or fresh sale.
- Use bags for harvesting to prevent fruits from falling to the ground; gently transfer fruits from bags to crates.
- Keep harvested fruits off the soil and always under shade to preserve vitamins and prevent spoilage.
- For processing, place fruits on tarpaulin or cut vegetation to avoid soil contact.

**Post Harvesting**

- **Sorting of Fruits:** Sorting involves removing debris (like leaves and twigs) and any damaged, bruised, immature, or spoiled fruits. This process helps prevent fruit deterioration and reduces transportation costs. During sorting, fruits are inspected, and unripe, undersized, damaged, or decayed ones are discarded.
- **Grading of Fruits:** Grading involves grouping fruits by similar size and color to enhance marketability. Uniformity in size, color, and lack of defects is essential as it boosts product presentation and value. This practice, often overlooked, especially for citrus, is crucial for creating a standard product that's easier to handle and more appealing to buyers.
- **Packaging:** Instead of traditional heaping, fruits can be packaged in boxes (10 kg, 20 kg, 50 kg, and 500 kg) designed to reduce postharvest loss. These boxes help determine yield per unit area and support easier handling and transport.
- **Transport:** Transporting fruits from the farm to market can lead to postharvest loss, especially if the vehicle is unreliable or overloaded. Using heavy vehicles and packing fruits in boxes helps prevent damage and loss during transit.

**Common misdiagnosis:**

**Citrus Greening (HLB) vs. Nutrient Deficiency:** Citrus greening, or Huanglongbing (HLB), often shows yellowing patterns in leaves that resemble zinc or iron deficiencies. Both conditions cause leaf chlorosis (yellowing), but HLB usually has asymmetrical blotching, while nutrient deficiencies display a more uniform yellowing.

**Citrus Canker vs. Physical Damage or Sooty Mold:** Citrus canker causes raised, corky lesions on leaves, stems, and fruit, which can be confused with physical damage from pests or abrasion. Additionally, sooty mold can look similar but is caused by fungal growth on honeydew excreted by pests, lacking the canker's distinct raised lesions.

**Citrus Black Spot vs. Fungal Leaf Spots:** Citrus black spot presents with dark lesions on the fruit rind that look like common fungal leaf spots, leading to misdiagnosis. Black spot lesions, however, are generally harder and more defined compared to other fungal spots.

**Citrus Scab vs. Pest Damage:** Citrus scab causes wart-like, raised lesions on fruit and leaves, which can be mistaken for pest damage from insects that create lumps or bumps. Scab lesions are typically more widespread and irregular compared to isolated pest bite marks.

**General Plant care:**

1. **Watering:** Citrus trees require consistent watering, especially in the summer. Young trees need about 10-12 gallons of water daily during hot months. Establish a watering routine that keeps the soil consistently moist but not waterlogged.

2. **Fertilization:** Use a fertilizer specifically formulated for citrus trees. Apply it in three "meals" during the growing season (spring and summer) to provide essential nutrients like nitrogen, phosphorus, potassium, and trace minerals. Young trees should receive frequent, light doses, while mature trees should be fertilized four to five times a year.
3. **Site Selection and Planting:** Choose a sunny location with at least 15 feet of space between trees. When planting, ensure the root ball is at the same depth it was in the pot and create a basin around it to hold water.
4. **Pruning:** Remove suckers and any dead or damaged branches. Mature trees do not require heavy pruning, as excessive cutting can reduce fruit production.
5. **Pest Management:** Monitor for pests and diseases, and utilize integrated pest management (IPM) strategies, including biological and cultural controls.
6. **Soil:** Ensure the soil is slightly acidic to neutral (pH 6.0 to 7.0) for optimal nutrient uptake. Avoid letting grass or weeds grow around the tree base to prevent root rot.

[<https://sfyl.ifas.ufl.edu/media/sfylifasufledu/baker/docs/pdf/horticulture/educatorresources/Citrus-Care-Basics.pdf>]

## **A. General Treatment and Management Practices**

For effective treatment and management of citrus plants, focusing on disease prevention, pest control, and maintaining optimal growth conditions is crucial. Below is details on best

practices for citrus health and disease management, especially relevant for mandarin oranges commonly grown in Nepal.

## 1. Soil Health and Fertilization

- **Soil Preparation:** Ensure well-drained, slightly acidic soil with a pH between 5.5 and 6.5. Avoid compacted soils to prevent root rot.
- **Organic Matter:** Add compost or well-decomposed manure to improve soil fertility, structure, and drainage.
- **Fertilization Regimen:**
  - For young trees, apply nitrogen-rich fertilizers to support leaf and branch growth.
  - Mature trees benefit from balanced fertilizers containing nitrogen, phosphorus, and potassium. Apply fertilizer in early spring and post-harvest, avoiding heavy fertilization during the fruiting period to prevent excess vegetative growth.

## 2. Water Management

- **Regular Irrigation:** Young citrus plants require consistent moisture, while mature trees benefit from deep but less frequent watering to encourage deep root growth.
- **Avoid Waterlogging:** Ensure proper drainage to prevent waterlogged roots, which can lead to root rot. Mulching around the base can help retain moisture while minimizing soil compaction.
- **Drip Irrigation Systems:** These systems deliver water directly to the roots, minimizing the risk of wet foliage, which reduces fungal disease incidence.

### 3. Pruning and Canopy Management

- **Annual Pruning:** Remove dead, diseased, or excess branches to improve air circulation, which reduces fungal and bacterial disease risks.
- **Maintain Open Canopy:** Prune to create a well-spaced canopy that allows sunlight penetration, reducing humidity and the likelihood of infections.
- **Hygiene of Tools:** Sanitize pruning tools between uses to prevent disease transmission between plants.

### 4. Common Citrus Disease Management

#### Citrus Greening (Huanglongbing, HLB)

- **Symptom Monitoring:** Look for yellowing leaves, asymmetrical fruits, and misshapen leaves.
- **Immediate Removal of Infected Plants:** To prevent spread, infected trees should be removed since there is no cure for HLB.
- **Control of Psyllid Vector:** Use insecticides judiciously to control Asian citrus psyllid (ACP). Biological controls, such as predatory insects like ladybugs, can also help manage psyllid populations.

#### Citrus Canker

- **Identification and Pruning:** Recognize symptoms like raised lesions on leaves, stems, and fruits. Prune affected parts and avoid overhead watering, which spreads bacteria.
- **Copper-Based Fungicides:** Prevent the spread by applying copper-based fungicides during wet seasons or as soon as symptoms appear.

## **Phytophthora Root and Collar Rot**

- **Prevent Excess Moisture:** Ensure soil drainage to reduce the risk of root rot. Avoid water pooling around the tree base.
- **Fungicides:** Apply appropriate fungicides to soil and affected areas. Consider using resistant rootstocks when planting new trees.
- **Avoid Mechanical Injury:** Damaged roots or trunks increase susceptibility, so minimize disturbance around the root zone.

## **5. Pest Management**

### **Asian Citrus Psyllid (ACP)**

- **Insecticidal Treatments:** Apply horticultural oils or insecticides to manage psyllid populations, especially during peak season.
- **Biological Control:** Use predators like ladybugs and parasitic wasps to naturally control psyllids.
- **Pheromone Traps:** These traps can help disrupt mating cycles and reduce psyllid numbers over time.

### **Citrus Leafminer**

- **Symptoms:** Leaf miners cause curling and tunneling damage to young leaves.
- **Pruning Infested Leaves:** Remove and dispose of affected leaves to reduce the infestation.
- **Neem Oil:** Apply neem oil to prevent leafminers from attacking new growth.

## Aphids and Scale Insects

- **Control Measures:** Use insecticidal soap or horticultural oils. Wash off aphids from leaves and monitor for honeydew, which can attract sooty mold.
- **Natural Predators:** Introduce or encourage ladybugs, lacewings, and other beneficial insects to control aphid and scale populations.

## 6. Post-Harvest and Disease Control

- **Sanitization:** Clean and sterilize harvesting tools to avoid pathogen spread.
- **Storage Practices:** Store fruits in cool, dry conditions to reduce post-harvest rot. Apply safe fungicides if needed in high humidity areas.
- **Prompt Handling:** Avoid fruit bruising and handle them carefully during harvest to reduce susceptibility to fungal infections.

## 7. Integrated Pest and Disease Management

- **Regular Inspections:** Routinely check plants for any early signs of pests or diseases. This allows for early intervention and minimizes damage.
- **Rotate Chemical Treatments:** If pesticides are used, rotate them to prevent pest resistance.
- **Combine Biological, Cultural, and Chemical Controls:** Use a mix of pest control techniques such as natural predators, hygiene, and selective use of pesticides.
- **Hygiene and Quarantine:** For new plants, ensure they are disease-free before introducing them to the orchard, and quarantine them, if possible, to monitor for any issues.

## B. Organic Control Methods

Organic control methods for citrus plants focus on environmentally friendly and sustainable practices to manage pests, diseases, and general health without the use of synthetic chemicals. Here are some detailed organic practices to maintain a healthy citrus orchard:

## 1. Biological Control

- **Predatory Insects:** Introduce beneficial insects like ladybugs, lacewings, and parasitic wasps to naturally control pests like aphids, whiteflies, and psyllids, which spread diseases like citrus greening.
- **Pathogenic Nematodes:** These microscopic organisms target pests like citrus weevils by infecting them through soil. They are applied to the soil and can effectively reduce root-feeding pests.
- **Microbial Pesticides:** Bacteria like *Bacillus thuringiensis* (Bt) and fungi like *Beauveria bassiana* are effective against caterpillars, psyllids, and aphids, which damage citrus leaves. They infect and kill these pests without harming beneficial insects or the plant.

## 2. Cultural Controls

- **Pruning and Airflow Management:** Prune citrus trees to create an open canopy that allows good air circulation, reducing humidity around the leaves and minimizing fungal infections such as citrus black spot and sooty mold.
- **Crop Rotation and Companion Planting:** If possible, rotating citrus with other crops or planting pest-repelling companion plants (e.g., marigold or basil) nearby can help deter certain pests naturally. Although crop rotation is more challenging in orchards, it's effective in mixed-crop farming.
- **Trap Crops:** Planting specific plants nearby that attract pests (like nasturtiums for aphids) can divert pests away from citrus trees.

## 3. Organic Mulching and Soil Management

- **Composted Mulch:** Organic mulches, like straw, bark, or compost, conserve soil moisture, moderate soil temperature, and encourage beneficial organisms in the soil. Mulching also suppresses weeds, which compete with citrus plants for nutrients.



- **Green Manure and Cover Crops:** Planting cover crops like clover or alfalfa improves soil health by fixing nitrogen, enhancing nutrient content, and improving soil structure. Cover crops also reduce erosion and improve water infiltration.

#### 4. **Organic Pest and Disease Repellents**

- **Neem Oil:** This natural oil extracted from neem seeds acts as both a repellent and an insecticide, disrupting the life cycle of pests like aphids, leafminers, and scale insects. It can also prevent fungal diseases by acting as a fungistatic agent.
- **Insecticidal Soaps:** Organic soaps can be sprayed on pests like aphids, mites, and whiteflies to control them without damaging the plant. These soaps work by dissolving the pests' protective coating, causing dehydration.
- **Horticultural Oils:** These oils can be sprayed on citrus trees to suffocate scale insects and other pests. They're particularly effective against overwintering pest eggs and larvae.
- **Garlic and Pepper Sprays:** Homemade sprays using garlic or hot pepper can deter pests due to their strong scent and taste. These sprays can be applied periodically to repel a wide range of insects.

#### 5. **Physical and Mechanical Controls**

- **Sticky Traps and Barriers:** Yellow sticky traps placed around citrus trees attract and trap flying insects like whiteflies, aphids, and psyllids. Barrier papers or sticky bands can be wrapped around the base of the tree to prevent ants and other crawling pests from reaching the canopy.
- **Handpicking and Water Sprays:** For small infestations, handpicking pests or hosing them off with a strong spray of water can effectively reduce pest populations.
- **Bagging Fruit:** Covering young fruits with cloth or paper bags can protect them from pests like fruit flies without needing to spray pesticides.

## 6. Organic Disease Control

- **Baking Soda Sprays:** Baking soda mixed with water and a small amount of dish soap can help control fungal diseases such as powdery mildew on citrus trees. It alters the pH on the leaf surface, making it less hospitable for fungi.
- **Copper-Based Sprays:** Although used sparingly, copper-based fungicides are acceptable in organic systems and are effective against bacterial and fungal diseases like citrus canker. They should be applied preventively rather than after symptoms appear.
- **Vinegar Solutions:** Mild vinegar solutions can be applied to control certain types of molds and mildews. Avoid applying too much, as it can alter the pH around the plant roots if it drips into the soil.

## 7. Integrated Pest Management (IPM) with Organic Methods

- **Regular Monitoring:** Consistently inspecting trees for any early signs of pest or disease allows for prompt, targeted action.
- **Trap and Pest Surveys:** Use sticky traps, pheromone traps, and other monitoring tools to understand pest presence and population levels. Knowing pest cycles helps time organic treatments effectively.
- **Habitat Creation for Beneficial Insects:** Planting wildflowers or cover crops nearby provides habitat and food sources for natural pest predators, enhancing biological control.

## C. Chemical Control Methods:

Chemical treatments for citrus plants are generally used as a last resort when other control methods fail to manage pests or diseases effectively.

N.B: Use of Chemical Treatments should be used only after consultation from the agriculture experts or agriculturist.

Here is an overview of the key chemicals, their applications, and best practices for safe and effective citrus plant management.

## 1. Insecticides for Pest Control

### Synthetic Insecticides

- **Organophosphates (e.g., Malathion):** Effective against a wide range of citrus pests, including aphids, scale insects, and mites. Apply sparingly, as it can harm beneficial insects.
- **Neonicotinoids (e.g., Imidacloprid):** Target sucking insects like psyllids, aphids, and whiteflies. Often used as a systemic insecticide, it is absorbed by the roots and distributed throughout the plant. Imidacloprid can persist in the soil and affect pollinators, so soil application is often recommended over foliar sprays.
- **Pyrethroids (e.g., Bifenthrin):** Provides quick knockdown of pests such as leafminers and whiteflies but can be harmful to beneficial insects and pollinators if overused.

### Horticultural Oils

- **Mineral and Dormant Oils:** Used to smother insect eggs, scales, and mites. They provide control by coating the pests and blocking their breathing pores. Horticultural oils are usually safe for beneficial insects and can be used in combination with other treatments.

### Application Tips

- Apply insecticides during cooler times of the day (morning or evening) to reduce the impact on pollinators.
- Rotate insecticides with different modes of action to prevent pests from developing resistance.
- Follow label instructions for dosages and pre-harvest intervals to ensure fruit safety.

## 2. Fungicides for Disease Management

### Copper-Based Fungicides

- **Copper Oxychloride and Copper Sulfate:** Commonly used to prevent and control bacterial and fungal infections, including citrus canker and black spot. Copper fungicides are effective but should be used sparingly, as copper can accumulate in the soil over time.
- **Bordeaux Mixture:** A combination of copper sulfate and lime, it acts as a preventive fungicide and is suitable for treating various citrus diseases, including citrus canker and greasy spot.

### Systemic Fungicides

- **Phosphonates (e.g., Fosetyl-Al):** Effective against Phytophthora diseases, such as root and collar rot. Systemic fungicides are absorbed into the plant tissue and provide longer-lasting protection.
- **Triazoles (e.g., Propiconazole):** Target powdery mildew and other fungal infections. These fungicides interfere with fungal growth by inhibiting cell membrane production.

### Sulfur-Based Fungicides

- **Lime Sulfur:** This contact fungicide controls powdery mildew, scab, and rust diseases. Sulfur products are generally safe for plants and beneficial organisms but should be used with caution in high temperatures as they can cause leaf burn.

### Application Tips

- Apply fungicides during dry weather to maximize effectiveness and reduce the risk of runoff.
- Use protective clothing and equipment to avoid skin and respiratory exposure.
- Avoid using copper-based fungicides excessively to prevent soil contamination.

### 3. Herbicides for Weed Control

- **Pre-Emergent Herbicides (e.g., Pendimethalin):** Applied to the soil to prevent weed seed germination. Pre-emergent herbicides help control weeds without disturbing the soil.
- **Post-Emergent Herbicides (e.g., Glyphosate):** Applied directly to growing weeds to kill them. Care must be taken to avoid contact with citrus tree roots or foliage.

#### Application Tips

- Apply herbicides in calm, dry conditions to prevent drift and runoff.
- Use a directed spray to target weeds and avoid accidental application on citrus plants.
- Avoid excessive herbicide use near young trees to prevent root damage.

### 4. Growth Regulators

- **Gibberellic Acid (GA):** Applied to delay fruit aging and reduce fruit drop, especially in mandarins and other citrus varieties.
- **Cytokinins:** Used to promote flowering and improve fruit set. These regulators help achieve more uniform fruiting, which is beneficial in commercial citrus production.

### 5. Safety and Best Practices in Chemical Use

- **Follow Label Instructions:** Labels provide critical information on dosage, frequency, and any precautions needed for safe use.
- **Use Personal Protective Equipment (PPE):** Gloves, masks, goggles, and protective clothing reduce exposure risks.
- **Storage and Disposal:** Store chemicals in a locked, well-ventilated area away from children and pets. Dispose of empty containers according to local regulations to prevent environmental contamination.

- **Timing of Application:** Apply chemicals at specific times, such as early morning or late evening, to minimize the impact on pollinators and other beneficial insects.
- **Integrated Pest Management (IPM) Approach:** Combining chemical treatments with organic practices reduces the frequency of chemical applications, minimizing resistance and maintaining ecosystem balance.

## D. Pruning and Field Sanitation

### 1. Pruning

Pruning involves selectively cutting branches, shoots, or leaves to shape the tree, encourage new growth, and remove unhealthy parts.

#### Benefits of Pruning

- **Improves Airflow and Sunlight Penetration:** Pruning helps open the canopy, allowing sunlight to reach lower branches and promoting air circulation. This reduces humidity around the leaves, which is crucial in preventing fungal infections such as citrus black spot and powdery mildew.
- **Enhances Fruit Production:** Removing excess branches redirects the tree's energy to fewer branches, resulting in larger, higher-quality fruit. Pruning also encourages the growth of new fruit-bearing wood.
- **Removes Diseased or Damaged Parts:** Pruning out infected or damaged branches helps prevent the spread of diseases and pests within the tree and to surrounding trees.

#### Best Pruning Practices

- **Timing:** Prune after harvest or during the tree's dormant season to minimize stress on the plant and reduce the risk of infection. Avoid pruning during wet weather, as moisture can encourage the spread of diseases.

- **Tool Sterilization:** Disinfect pruning tools between trees with a bleach or alcohol solution to avoid transmitting diseases. This is especially important when working in an area where diseases like citrus greening are present.
- **Selective Cuts:** Focus on removing weak, crossing, or dead branches first. Cut branches back to a main branch or trunk to avoid leaving stubs, which can become entry points for diseases.

## 2. Field Sanitation

Field sanitation involves practices that reduce the spread of diseases and pests within the orchard environment.

### Benefits of Field Sanitation

- **Minimizes Disease Spread:** Removing fallen leaves, fruits, and other debris eliminates breeding grounds for pests and pathogens. For example, citrus black spot and greasy spot diseases can survive on fallen leaves, so regular cleanup helps reduce infection sources.
- **Controls Pest Populations:** Many pests, like fruit flies, lay eggs in fallen fruits. Regularly removing these fruits prevents pests from completing their life cycle and infesting healthy trees.
- **Prevents Soil-Borne Diseases:** Clearing away plant debris reduces the risk of soil-borne diseases like Phytophthora root rot, which thrive in decaying organic matter near the tree base.

### Best Sanitation Practices

- **Remove and Dispose of Debris:** Collect and dispose of fallen leaves, fruits, and branches regularly, especially after pruning or a storm. Burn or compost infected plant material to prevent pathogens from surviving and spreading.
- **Control Weeds:** Weeds can harbor pests and diseases that affect citrus trees. Keep the area around the tree base weed-free to improve air circulation and reduce competition for nutrients and water.

- **Proper Irrigation:** Avoid overhead watering to minimize water splashing onto leaves, which can spread pathogens. Use drip irrigation to keep foliage dry and reduce disease risk.
- **Quarantine New Plants:** When introducing new trees, quarantine them for several weeks to monitor for any signs of disease. This helps prevent bringing pathogens or pests into the orchard.

### **Combining Pruning and Field Sanitation in Citrus Orchards**

Together, pruning and sanitation create a healthier environment for citrus trees. By removing sources of infection and improving tree structure, these practices play a critical role in integrated pest and disease management strategies, reducing the need for chemical treatments and enhancing long-term orchard productivity.

## **E. Recommended Treatment Schedule per Disease**

### **1. Citrus Greening Disease (Huanglongbing)**

- **Insecticide Application (Psyllid Control):**
  - **Early Spring:** Apply systemic insecticides at the beginning of the growing season to control psyllids, the primary vector of citrus greening. Insecticides such as imidacloprid are effective when applied to the soil around the root zone.
  - **Throughout Growing Season:** Apply foliar insecticides every 2-3 weeks during peak psyllid activity, depending on the infestation level. Rotate insecticides to avoid resistance.
- **Nutritional Support:** Provide micronutrient sprays (containing zinc, manganese, and magnesium) every 4-6 weeks to help trees cope with greening stress.

### **2. Citrus Canker**

- **Copper-Based Fungicides:**



- **Before Rainy Season (Spring):** Apply copper fungicides to protect young leaves, fruits, and stems. Copper-based sprays should be applied as leaves flush out and start to harden to prevent bacterial infection.
- **Every 3-4 Weeks in Wet Conditions:** In regions with high humidity or frequent rain, continue copper sprays every few weeks, especially during the rainy season when bacterial spread is most active.

### 3. Citrus Black Spot

- **Fungicide Application (Preventive):**
  - **Late Winter to Early Spring:** Begin applying fungicides such as copper or strobilurin-based products in late winter to prevent infection as new growth emerges.
  - **Every 3-4 Weeks Until Harvest:** Continue applications throughout the season, particularly in warm, humid climates, as black spot can persist and infect through the summer months.
- **Post-Harvest:** Apply one final treatment to control any remaining spores on the trees and prevent contamination of new growth the following season.

### 4. Sooty Mold (Secondary to Aphids, Whiteflies)

- **Insecticides for Pest Control:**
  - **Throughout Growing Season:** Apply insecticides to control sap-sucking insects like aphids, whiteflies, and scale insects that produce honeydew, which promotes sooty mold growth. Using horticultural oils and insecticidal soaps is also effective.
- **Clean Mold off Leaves:** If mold is already present, gently wash affected leaves with water to reduce mold buildup and improve sunlight penetration for photosynthesis.

## 5. Phytophthora Root Rot and Collar Rot

- **Phosphonate Fungicides:**
  - **Early Spring and Fall:** Apply phosphonate-based fungicides to the soil around the base of the tree during periods of active root growth in early spring and fall.
- **Soil Drainage and Mulching:** Ensure well-drained soil and avoid excessive watering to prevent conditions that favor Phytophthora. Reapply fungicides as needed if symptoms persist.

### Note Well:

Always consult local agricultural guidelines and follow manufacturer recommendations for dosages, intervals, and safety practices. Additionally, consider rotating chemicals with different modes of action to avoid resistance.

Following this schedule, along with consistent pruning, sanitation, and integrated pest management (IPM), can significantly help manage citrus diseases effectively.

