

# Preserving Mango Quality: Integrated Approaches to Post-Harvest Disease Management in Telangana

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## ABSTRACT

Mango (*Mangifera indica* L.) is a vital fruit crop in Telangana, India, but post-harvest diseases threaten its production, causing significant economic losses. This study examines the prevalence, impact, and management of post-harvest diseases in Telangana's mango production, emphasizing integrated disease management. Recommendations for efficient harvesting, handling, storage, transportation, and marketing are provided to mitigate losses and enhance competitiveness. By integrating cultural, biological, physical, and chemical control methods and fostering collaboration among stakeholders, Telangana can sustainably manage post-harvest diseases, ensuring the long-term success of its mango industry.

## INTRODUCTION

**M**ango (*Mangifera indica* L.) is one of the most economically significant fruit crops grown in Telangana, India. Renowned for its delectable taste, vibrant colours, and rich nutritional profile, mangoes are not only a cherished fruit

for locals but also hold considerable importance in international markets. Telangana, a state located in southern India, stands as a prominent contributor to the nation's mango production, holding a significant share of the market. Renowned for

its diverse range of mango varieties cultivated across fertile lands, mango holds immense economic and cultural importance in the region. However, despite its agricultural prowess, Telangana grapples with challenges related to post-harvest disease losses in mangoes, which can severely impact fruit quality, marketability, and economic returns for growers and stakeholders (Kadam JA. *et.al.*, 2002).

Post-harvest diseases represent a formidable threat to mango production in Telangana, causing extensive losses throughout storage, transportation, and marketing phases. Various factors contribute to the prevalence of these diseases, including environmental conditions, agricultural practices, handling techniques, and the presence of pathogenic microorganisms. Anthracnose, stem-end rot, Alternaria rot, and bacterial rots emerge as primary post-harvest diseases plaguing mangoes in Telangana, resulting in fruit decay, spoilage, and diminished market value (Dofuor AK. *et.al.*, 2023). According to statistical data from the Telangana State Horticulture Department, post-harvest disease losses in mango production have been notable in recent years. For instance, in the fiscal year 2020-2021, post-harvest diseases accounted for an estimated 15% of total mango production losses in the state. This figure represents a significant economic setback for mango growers, translating to millions of rupees in lost revenue.

Efficient management of post-harvest diseases is imperative to sustain mango production and bolster the profitability of the mango industry in Telangana. Through the implementation of integrated disease management strategies, mango growers and stakeholders can mitigate losses, preserve fruit quality, and enhance the competitiveness of Telangana mangoes in domestic and international markets. This study endeavors to delve into the prevalence, impact, and management of post-harvest diseases in

mango production in Telangana, offering insights and recommendations for sustainable disease control practices. By fostering collaboration among researchers, agricultural extension services, policymakers, and industry stakeholders, Telangana can develop and deploy holistic approaches to address post-harvest disease challenges in mango production (Arauz LF. *et.al.*, 2000). By leveraging scientific research, technological advancements, and best management practices, the state can reinforce its position as a leading producer of premium-quality mangoes while ensuring the long-term viability and resilience of its mango industry.

### Harvesting Practices:

**Timing:** Mangoes should be harvested at the appropriate stage of maturity to ensure optimal flavour, texture, and sugar content. The timing of harvest varies depending on the mango variety and local climatic conditions. Typically, mangoes are harvested when they attain physiological maturity, characterized by changes in skin colour, firmness, and aroma. In Telangana, harvesting usually occurs from March to July, depending on the variety.

**Visual Indicators:** Visual cues such as skin colour, size, and blush development can help determine the readiness of mangoes for harvest. For instance, most mango varieties exhibit a change in skin colour from green to yellow, orange, or red as they ripen. Additionally, mature mangoes often develop a sweet aroma around the stem end.

**Hand Harvesting:** Hand harvesting is the most common method employed for picking mangoes. Skilled laborers carefully pluck the fruit from the tree using pruning shears or by hand. It's essential to handle mangoes delicately during harvest to avoid bruising or damaging the fruit.

**Avoiding Damage:** Mangoes are susceptible to bruising and physical damage during

harvesting, which can provide entry points for pathogens and accelerate post-harvest decay. Harvesters should be trained to handle the fruit with care and avoid dropping or mishandling them.

**Pruning:** Pruning excess foliage and branches around the fruit clusters can facilitate easier access during harvest and minimize damage to both the fruit and the tree. Proper pruning practices also improve air circulation and sunlight penetration, promoting overall tree health and fruit quality.

**Harvesting Tools:** High-quality pruning shears or loppers should be used for harvesting mangoes to ensure clean cuts and minimize stem damage. It's advisable to sanitize harvesting tools regularly to prevent the spread of diseases between trees.

**Frequency:** Mango trees often produce fruit in multiple flushes throughout the growing season. Harvesting should be conducted regularly to ensure that ripe mangoes are picked promptly, preventing over-ripening or fruit drop.

#### **Post-Harvest Handling and Storage:**

**Cleaning and Disinfection of Storage Facilities:** Thoroughly clean and disinfect storage areas, including cold storage rooms and packing facilities, before storing harvested mangoes. Regular cleaning helps prevent the build-up of pathogens and mould.

**Proper Packaging:** Use clean and hygienic packaging materials such as food-grade crates, boxes, or bags to prevent contamination during storage and transportation.

**Maintaining Cleanliness:** Keep storage areas clean and free from spilled fruit juices, debris, and standing water, which can harbour pests and diseases.

**Regular Inspection:** Regularly inspect stored mangoes for signs of decay or disease. Remove any affected fruit promptly to prevent the spread of pathogens to healthy fruit.

#### **Temperature and Humidity Management:**

**Temperature:** Mangoes are best stored at temperatures between 10°C to 13°C (50°F to 55°F). This temperature range helps slow down the ripening process, reducing respiration rates and delaying the onset of decay.

**Humidity:** Mangoes require relatively high humidity levels to prevent dehydration and maintain fruit firmness. Ideally, humidity levels should be maintained between 85% to 90%.

**Ventilation:** Proper ventilation in storage areas is essential to prevent the build-up of moisture, which can lead to the growth of fungi and bacteria.

#### **Transportation and Marketing:**

**Clean Transportation Vehicles:** Ensure that transportation vehicles used to transport mangoes are clean and sanitized to prevent contamination during transit.

**Temperature Management:** Maintain appropriate temperature and humidity levels during transportation to slow down ripening and reduce the risk of post-harvest diseases.

**Proper Handling Practices:** Train workers involved in loading and unloading mangoes to handle the fruit with care and maintain hygiene standards to minimize damage and contamination.

**Sanitation:** Ensure that all equipment used during harvesting and handling is clean and sanitized to prevent the spread of diseases. Proper sanitation practices also include keeping the storage area clean and free from debris.

## Common Post-Harvest Diseases affecting Mango:

Post-harvest control Diseases are primary causes of post-harvest loss. Although anthracnose is most important, stem-end rots (caused by several different fungi), *alternaria* black spot, and other post-harvest diseases can also be significant. The relative importance of each disease depends on the production area, cultivar, and pre- and post-harvest disease management tactics. Different approaches that have been used to directly affect disease development during the post-harvest handling of this fruit are discussed below.

**Anthracnose:** It is a common fungal disease caused by the fungi *Colletotrichum gloeosporioides*. It is highly prevalent in regions with frequent rainfall during mango fruit development and maturity. The disease spreads through spores that are dispersed by wind, rain, insects and pruning tools. The spores can enter the mango tree through wounds. Fruits can become infected at any time when weather conditions are favourable, such as optimal temperatures (20-30°C), high relative humidity, prolonged rainfall or heavy dew.

### Symptoms of Anthracnose in Mango

Anthracnose disease affects leaves, twigs, young flowers and fruits causing blighted foliage, blossom blight, withered tip and fruit rot. Anthracnose affected fruits will show dark, irregular sunken lesions or spots on the fruit surface. These lesions may start small and gradually grow larger leading to fruit rot. They often have a slightly raised, corky texture. The whole fruit may turn black and shrivel under severe infection. In some cases, anthracnose infection can lead to gumming or oozing of a dark-coloured sap from infected areas on the fruit, leaves, or twigs.

**Stem End Rot:** It is caused by the soil borne fungus *Lasiodiplodia theobromae*. The disease

primarily targets the stem end or pedicel region of the fruit. This disease incidence is favoured by high temperature and rainfall.

### Symptoms of Stem End Rot in Mango

Infected fruits exhibit dark brown to black discoloration at the stem end, spreading towards the upper portion of the fruit. The affected area appears sunken or depressed, often surrounded by a water-soaked margin. Under humid conditions, these affected areas rapidly expand and within just a couple of days, the entire fruit turns completely black. As the disease progresses, an unpleasant odour may be emitted from the decaying fruit.

**Aspergillus Rot:** Also known as black mould rot, is caused by various species of the fungus *Aspergillus* sp. The fungus primarily infects ripe or overripe fruits, particularly those that have cut surface or wounds or injured during harvesting or handling. The disease development is more prevalent under high temperature (30 – 36°C).

### Symptoms of Aspergillus Rot in Mango

Greenish-black or greyish-green mould growth on the fruit's surface. As the disease progresses, the infected areas become sunken or depressed, often with a soft, decayed texture beneath the mouldy surface. Affected fruits may emit a characteristic musty or mouldy smell. The fungus may produce abundant spores, which form a dusty or powdery black fungal layer on the fruit surface.

**Alternaria rot:** It is a common post-harvest disease affecting mangoes, caused by fungi of the *Alternaria* genus, primarily *Alternaria alternata* and *Alternaria tenuissima*.

### Symptoms of Alternaria rot:

The initial symptoms of *Alternaria* rot appear as small, circular, or irregularly shaped lesions

on the surface of the mango fruit. These lesions are typically dark brown to black in colour and may have a sunken appearance. As the disease progresses, the lesions enlarge and merge together, covering larger areas of the fruit surface. The affected tissue becomes soft and watery, with a mushy texture. In some cases, concentric rings or zones of dark and light brown may develop within the lesions, giving them a target-like or bull's-eye appearance. This characteristic pattern is typical of *Alternaria* infections. Infected mangoes may emit a foul odour, resembling that of rotting or decaying fruit, due to the breakdown of organic matter by the fungal pathogens and associated microorganisms. In advanced stages of infection, the fungi may penetrate the fruit's skin and cause internal decay. This can lead to extensive tissue breakdown and loss of fruit quality, making affected mangoes unfit for consumption.

#### **Integrated Pest Management (IPM):**

Adopting an integrated approach that combines cultural, biological, and chemical control methods can effectively manage post-harvest diseases while minimizing environmental impact (Chiangsing R. *et.al.*, 2016).

#### **Sanitation Practices:**

**Cleaning and Disinfection:** Regularly clean and disinfect all equipment used during harvest and handling, such as picking poles, bins, and knives. For example, wash equipment with a detergent solution to remove organic residues and then apply a disinfectant like sodium hypochlorite (bleach) at the recommended concentration for sufficient contact time.

**Debris Management:** Promptly remove and dispose of any infected or rotting fruit, leaves, or branches from the orchard floor. Decomposing plant material can serve as a reservoir for pathogens. Proper disposal

methods may include composting or burning to prevent disease spread.

#### **Cultural Practices:**

**Orchard Management:** Proper spacing between mango trees ensures adequate airflow and sunlight penetration, reducing humidity and creating an environment less favourable for disease development. For example, maintain a distance of at least 10 to 15 meters between trees in commercial mango orchards.

**Harvesting Practices:** Harvest mango fruit carefully to avoid bruising or injuring the skin, which can create entry points for pathogens. Use sharp, sanitized tools, and handle fruit gently to minimize damage. Harvest fruit at the right maturity stage based on variety characteristics and intended market requirements.

#### **Biological Control:**

**Biocontrol Agents:** Introduce beneficial microorganisms to suppress the growth of pathogenic fungi. For example, *Trichoderma* spp. are commonly used biocontrol agents against post-harvest diseases of mango. Apply *Trichoderma* formulations to fruit surfaces or incorporate them into post-harvest treatments to competitively exclude pathogens. Gram-positive bacterium *Bacillus licheniformis*, that resists desiccation and also is food safe. In general, minor reductions in disease occur at 10°C and 25°C, either alone or in combination with fungicides.

**Microbial Antagonists:** Utilize microbial antagonists that produce antimicrobial compounds or enzymes to inhibit the growth of pathogens. For instance, yeast-based formulations containing antagonistic bacteria can be applied as biopesticides to control post-harvest diseases.

#### **Physical Control:**

**Pre-cooling:** Implement pre-cooling methods such as hydrocooling or forced-air cooling to quickly lower the temperature of harvested mango fruit. For example, immerse fruit in cold water or place them in refrigerated chambers to remove field heat and slow down ripening processes, reducing susceptibility to post-harvest diseases.

**Modified Atmosphere Packaging (MAP) and Controlled Atmosphere (CA) Storage:** Package mango fruit in specially designed containers with modified or controlled atmospheres to prolong shelf life and suppress microbial growth. For instance, use low-oxygen, high-carbon dioxide environments to inhibit fungal and bacterial proliferation.

**Heat Treatments:** Apply heat treatments to mango fruit to kill surface pathogens without causing significant damage. For example, immerse fruit in hot water or expose them to steam at specific temperatures and durations to eliminate fungal spores and bacteria.

**Fruit Ripening Control:** Hormones such as ethylene are involved in fruit ripening processes. Controlling fruit ripening can indirectly affect susceptibility to post-harvest diseases.

**Ethylene Inhibitors:** Inhibiting ethylene production or perception can delay fruit ripening and senescence, reducing the window of susceptibility to decay-causing pathogens.

**Ethylene Releasers:** Conversely, accelerating fruit ripening using ethylene releasers may promote disease development if not carefully managed.

**Senescence Inhibition:** Hormones like abscisic acid (ABA) are associated with plant senescence and stress responses. Inhibiting senescence can extend the shelf life of fruit, reducing susceptibility to post-harvest diseases.

## Chemical Control:

### Pre-harvest Management with fungicides:

1. Regularly remove and destroy infected plant debris, fallen fruits and diseased plant material from the orchard.
2. Do not harvest immature fruits.
3. Harvest the fruits with 10 mm stalk (in case of stem end rot).
4. Spray Carbendazim 50% DF (2 gm/lit of water) or Thiophanate methyl 70% WP (0.5 gm/lit of water) or Mancozeb 75% WP (3 – 4 gm/lit of water) at weekly interval during flowering, followed by monthly sprays until harvest. Cease spraying 14 days before harvest.
5. During dry weather, flower sprays can be reduced to 2 weeks intervals.
6. Spraying Copper oxychloride at 2 g/lit of water can also help control anthracnose. However, avoid using copper oxychloride during flowering.

### Post-harvest Management with fungicides:

1. Dip the fruit within 24 hours of harvest in hot water at a temperature of 52°C combined with 0.5 – 1 ml of Carbendazim per litre of water. Treat the fruits by fully submerging them for 15 minutes in this dip solution.
2. Store the fruits in a well-ventilated place.
3. Handle mangoes with care during harvest to minimize physical damage that can provide entry points for fungal infection.
4. Avoid long term storage of fruits from the orchards with history of stem rot losses. (Note: The dipping temperature should not exceed 52°C to avoid skin damage. During wet weather condition, reduce the temperature to 50°C).
5. Fungicide Rotation: Rotate between fungicides with different modes of action to prevent the development of resistance in target pathogens. For example, alternate between contact and systemic

fungicides to manage a broad spectrum of post-harvest diseases and reduce the risk of resistance development.

#### Post-Harvest Treatments:

- 1. Fungicidal Dips or Sprays:** Treat harvested mango fruit with fungicidal solutions immediately after harvest and before storage to control latent infections and reduce post-harvest losses. For example, immerse fruit in a solution containing a recommended fungicide at the appropriate concentration and duration to ensure thorough coverage and efficacy.

Fungicide	Dosage	Timing	Dipping Time
Thiabendazole	0.1 - 0.2% (1000 - 2000 ppm)	Immediately after harvest	3 - 5 minutes
Imazalil	0.1 - 0.2% (1000 - 2000 ppm)	Immediately after harvest	3 - 5 minutes
Sodium Hypochlorite	100 - 200 ppm	Immediately after harvest	2 - 3 minutes
Chlorine Dioxide	3 - 5 ppm	Immediately after harvest	1 - 2 minutes
Hydrogen Peroxide	1 - 2%	Immediately after harvest	3 - 5 minutes

- 2. Wax Coatings and Edible Films:** Apply wax coatings or edible films enriched with antimicrobial compounds to create a protective barrier against pathogens and extend fruit shelf life. For instance, coat mangoes with a thin layer of food-grade wax containing natural antimicrobial agents like citrus extracts or essential oils to inhibit fungal growth and reduce moisture loss.
- 3. Bio fungicides and Botanical Extracts:** Explore the use of bio fungicides derived from microbial or plant-based sources, as well as botanical extracts with antifungal properties, as alternative post-harvest treatments. For example, apply formulations containing beneficial

microorganisms or plant extracts known for their antifungal activity to control post-harvest diseases while minimizing chemical residues.

#### 4. Monitoring and Record-Keeping:

- a. Disease Surveillance:** Regularly inspect mango orchards, packinghouses, and storage facilities for signs of disease incidence and severity. Monitor environmental conditions such as temperature and humidity that can influence disease development. Use visual assessments and diagnostic tools to identify pathogens and assess disease progression.
- b. Record Management:** Maintain detailed records of disease observations, control measures applied, and their effectiveness over time. Keep records of weather data, fungicide applications, and any changes in cultural practices. Analyse trends in disease incidence and treatment outcomes to inform decision-making and optimize disease management strategies.

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**Figure1: Post-Harvest Diseases in Mango**

