

## Artificial Intelligence in Disease Detection of Horticulture Crops

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### Article History

Received: 5. 2.2026

Revised: 10. 2.2026

Accepted: 15. 2.2026

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### INTRODUCTION

Imagine walking through a mango orchard. The leaves look green, but a few have tiny spots. To a farmer's eye, it may look normal. But to Artificial Intelligence (AI), those spots may signal the beginning of a devastating disease. Plant diseases are one of the biggest threats to horticulture crops like mango, citrus, apple, grape, tomato, and vegetables. These diseases reduce yield, damage quality, and reduce farmers' income. Early detection is critical but it has always been difficult.



Now, Artificial Intelligence is changing everything. AI can “see,” “learn,” and “diagnose” plant diseases faster and more accurately than humans. It can detect diseases early even before symptoms become visible. This is not science fiction. This is today's reality. AI is becoming the doctor of horticulture crops.

## Why Disease Detection is Important in Horticulture

Horticulture crops are considered high-value crops because they provide higher returns per unit area compared to many field crops. However, this high value also means that even small disease damage can result in huge economic losses for farmers. Plant diseases can reduce yield by 20-80 percent, lower the quality of fruits, reduce their export value, increase the cost of pesticides, and in severe cases, lead to gradual orchard decline. Traditionally, disease detection in horticulture depends on farmer experience, expert consultation, and laboratory testing. While these methods are useful, they are often slow, expensive, and not always accurate, especially when early symptoms are difficult to recognize. Artificial Intelligence (AI) is helping to overcome these challenges by detecting plant diseases quickly, automatically, and accurately. AI-based systems analyze plant images and identify diseases within seconds, reducing human effort and error. As a result, artificial intelligence techniques can identify plant diseases in less time and with lower error compared to traditional manual methods, making disease management more efficient and reliable.

### What is Artificial Intelligence?

Artificial Intelligence is computer technology that can:

- Learn from data
- Recognize patterns
- Make decisions

AI works like the human brain but faster.

AI systems use:

- Cameras
- Sensors
- Computers
- Algorithms

AI analyzes images of plant leaves and detects diseases.

### How AI Detects Diseases in Horticulture Crops

AI disease detection follows simple steps:

#### Step 1: Image Collection

Images for AI-based disease detection are captured using different tools such as mobile phones, drones, digital cameras, and satellites, depending on the scale of observation. Mobile phones are the most commonly used because farmers can easily take close-up pictures of infected leaves, fruits, or stems directly in the field. Drones are useful for covering large orchards and capturing images from above, helping in early detection across wide areas. Digital cameras provide high-quality detailed images, while satellites are used for monitoring large agricultural regions. For example, clear images of leaves from horticultural crops such as mango, grape, citrus, and tomato are collected and used by AI systems to identify disease symptoms accurately.

#### Step 2: Image Processing

After capturing the images, the computer improves their quality through image processing techniques. During this process, unwanted elements that can interfere with accurate disease detection are removed. This includes noise, which appears as random distortions or grain in the image, shadows that may hide the actual symptoms, and unnecessary background that is not part of the plant. By removing these disturbances, the computer creates a clearer and more focused image of the plant part, making it easier for the Artificial Intelligence system to accurately detect and identify diseases.

#### Step 3: Feature Extraction

After image processing, the AI carefully studies important visual features of the plant to identify any disease. It analyzes spots present on the leaves or fruits, changes in color such as yellowing or browning, the shape of the affected area, and the texture, whether it appears rough, dry, or damaged. These visual characteristics are key indicators of plant health. By examining these features and comparing them with previously learned disease patterns, the AI can accurately identify the type of disease affecting the crop.

#### Step 4: Disease Identification

Once the features are analyzed, the AI compares the image with a large database of previously stored plant images that include both healthy and diseased samples. Based on

this comparison, the AI identifies the closest match and provides important information to the user. It tells the name of the disease, estimates its severity level, and also suggests suitable treatment or management practices. This helps farmers take timely and correct action to control the disease and protect their crops.

### Technologies Used in AI Disease Detection

#### 1. Machine Learning

Machine Learning teaches computer using data.

Example methods:

- Support Vector Machine (SVM)
- Decision Tree
- K-Nearest Neighbor

These methods identify disease patterns.

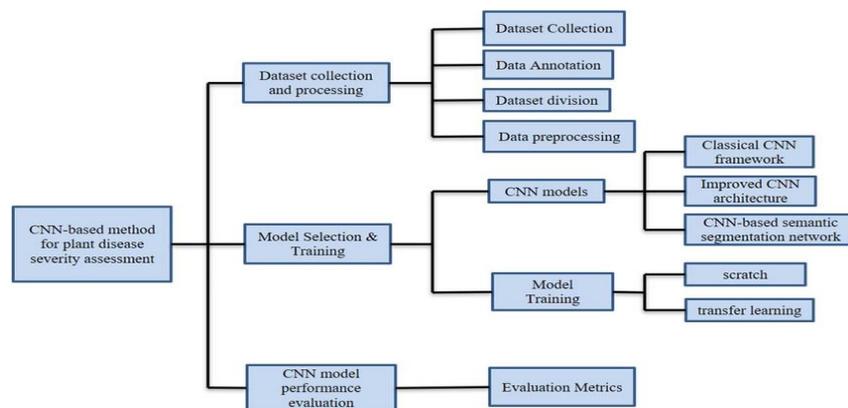
#### 2. Deep Learning

Deep Learning is advanced AI.

It uses artificial neural networks.

Example:

- Convolutional Neural Network (CNN)
- ResNet
- EfficientNet



CNN models achieved 96-99% accuracy in plant disease detection across crops like tomato, potato, and coffee.

#### 3. Computer Vision

Computer vision enables AI to see and analyze plant images. It detects disease symptoms such as leaf spots, lesions, and discoloration. This technology provides fast and non-destructive disease diagnosis, allowing accurate detection without harming the plant.

#### 4. Internet of Things (IoT)

Sensors measure important environmental factors such as temperature, humidity, and soil moisture. AI analyzes this data along with plant information to predict the chances of disease occurrence, helping farmers take preventive action in advance.

#### AI in Major Horticulture Crops

##### Mango

AI can detect common diseases such as anthracnose, powdery mildew, and leaf spot by analyzing plant images. Farmers simply take a photo of the affected leaf using a mobile phone, and the AI system provides an instant

diagnosis, helping them take timely control measures.

##### Citrus

AI can detect major citrus diseases such as citrus canker and greening disease by analyzing plant images. Using advanced detection models, AI systems have achieved accuracy levels of up to 94%, making disease identification faster and more reliable.

##### Grapes

AI can detect important grape diseases such as downy mildew and powdery mildew by analyzing leaf images. In many studies, AI models have achieved nearly 100% accuracy in grape disease classification, showing their high reliability for disease diagnosis.

##### Tomato

AI can detect major tomato diseases such as early blight, late blight, and leaf curl by analyzing plant images. These AI models have achieved accuracy levels above 98%, making

them highly effective for rapid and precise disease diagnosis.

**Apple**

AI can detect important apple diseases such as apple scab and rust by analyzing leaf images. These systems have achieved accuracy of up to 95%, enabling reliable and timely disease diagnosis.

**AI Devices and Tools Used**

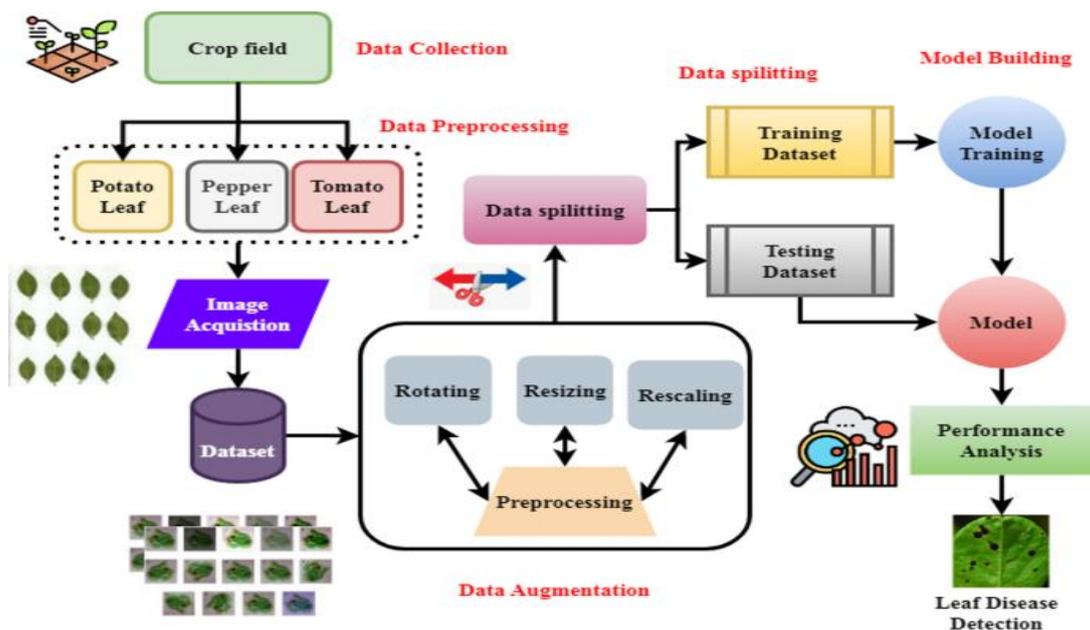
AI tools include:

**Smartphones**

Using smartphones, farmers can simply take a photo of a plant leaf, and the AI system analyzes the image and provides the result instantly, helping in quick and easy disease diagnosis in the field.

**Drones**

Drones scan the entire orchard from above and capture images of plants across large areas, allowing AI to detect diseases quickly and efficiently over a wide region.



**Robots**

Robot detects disease automatically.

**Sensors**

AI can detect diseases even before visible symptoms appear. For example, AI-based

spore detection devices can identify fungal spores in the environment at an early stage, helping farmers take preventive measures and avoid major disease outbreaks.

**Table 1: AI in Disease Detection of Horticulture Crops**

Crop	Disease Detected	AI Technology Used	Accuracy	Benefit
Mango	Anthraxnose	CNN	96–99%	Early detection
Citrus	Canker	Faster-RCNN	94%	Prevent spread
Grape	Downy mildew	EfficientNet	99%	Protect yield
Apple	Apple scab	YOLO	95%	Improve fruit quality
Tomato	Early blight	CNN	98%	Reduce loss
Banana	Leaf spot	SVM	95%	Increase production
Potato	Late blight	Deep learning	98%	Save crop
Vegetables	Fungal disease	AI sensors	High	Early prevention

**Real Example from India**

Indian scientists have developed an AI model that can detect crop diseases in real time with high accuracy. The system achieved about 97% overall accuracy and around 96% accuracy in maize disease detection. This

technology helps farmers identify diseases directly in the field without needing expert assistance, enabling faster and more effective disease management.

**Benefits of AI in Horticulture Disease Detection**

### 1. Early Detection

AI enables early detection of plant diseases, allowing farmers to identify problems at the initial stage and take timely action to control the spread and minimize crop loss.

### 2. Accurate Diagnosis

AI-based disease detection systems achieve accuracy above 95%, which is often better than manual diagnosis, making disease identification more reliable and precise.

### 3. Reduce Pesticide Use

AI helps identify only the infected plants, so farmers spray pesticides only where needed. This saves money and reduces unnecessary chemical use, helping protect the environment.

### 4. Save Time

AI provides instant disease diagnosis directly in the field, eliminating the need for laboratory testing and saving both time and effort.

### 5. Increase Yield

Healthy plants produce more.

### 6. Reduce Crop Loss

Disease controlled early.

### Future of AI in Horticulture

Future will see:

- AI robots in orchard
- Mobile apps for farmers
- Automatic disease treatment
- Fully smart orchards

### Challenges of AI

Some problems still exist:

- High cost
- Need internet
- Need training data
- Small farmers awareness low

But future is promising.

### CONCLUSION

Artificial Intelligence is revolutionizing disease detection in horticulture crops by making the process fast, accurate, and reliable. It helps farmers identify diseases at the right time, protect their crops, increase their income, and reduce unnecessary pesticide use. AI is not replacing farmers but supporting them in making better decisions. In this way, AI is becoming the future doctor of horticulture crops, helping ensure healthier plants and more sustainable production.