# A Survey on Plant Ailment Detection Using Machine Learning

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**Abstract-** *In this paper, different vegetables and horticulture plant diseases and the numerous machine learning techniques used for identifying and detecting the same have been discussed. It is necessary to identify and detect early disease of a plant at the initial stage so that desirable measures may be adopted to prevent the destruction and low yield of the plants. Also, this paper discusses existing plant disease detection techniques, and most of the techniques usually involve basic preprocessing techniques such as image acquisition, resizing, RGB to Grey conversion, segmentation techniques, feature extraction methods using classifiers to identify the infected leaves. We have also identified the reasons for resizing, color conversion and segmentation techniques applied for plant images and also discussed the comparative analysis of plant diseases and various classifier's accuracy in detecting the diseases; and limitations of the techniques and thereby finding a more appropriate algorithm to increase the plant disease identification efficiency. The paper involves the diseases of the leaf related to banana, potato, pomegranate, Grapes, Rice, Cotton, Tomato, Corn, Apple at the same time, a significantly less image database approximately 450 to 20000 is considered which in turn results in low validation of the system. To get more accuracy and exact results, the size of the image database needs to be increased. Hence, this paper summarizes numerous image processing techniques and machine learning algorithms used to predict plant disease in various stages of plants growth, both in vegetables and horticulture plants. Also, we have identified the more precise method to identify the disease of a plant and thereby helping farmers to increase the plant yield.*

***Keywords:*** *Plant diseases; Image processing; Machine learning*

## 1. Introduction

In a country like India, villages play a vital role in deciding the GDP of the country. People residing in the villages are dependent on agriculture for their livelihood. Most of the farmers here are small-scale farmers with a land of 2 to 5 Acers. The major reason for plant diseases may be classified as biotic and abiotic. Biotic includes disease caused by bacteria, fungus, and viruses, whereas abiotic include disease caused due to temperature, humidity, and nutrients deficiency and both types of diseases are interrelated to each other. Hence the early prediction or recognition of disease will be more helpful in avoiding the destruction of the plant and thereby resulting in high crop yield. One of the usual practices followed for recognition of the disease is unaided eye perception which is manual. This requires an expert who can predict plant disease accurately. The farmers need to show the diseased plant to an expert, which indeed is a tidy, time-consuming, more expensive and challenging job. Hence to overcome these issues, pretrained model developed using machine learning could be used to get accurate results.

Plant diseases are major issues for the low yield of the plants. Proper diagnosing of plant disease, their occurrences are important from the point of early detection, their treatment and planning strategies to prevent the diseases and thereby avoiding low yield. Image processing techniques could be used for the identification and classification of the plant disease.

Image processing techniques involve steps that are followed to identify the diseases:

1. Image acquisition
2. Image pre-processing
3. Segmentation
4. Feature Extraction
5. Classification.

For segmentation, feature extraction, and classification of plant diseases, various methods have been utilised. The major goal of our research is to investigate the various forms of illnesses that affect vegetable and horticultural plants, as well as to examine the various ways for identifying and detecting plant diseases using machine learning.

## 2. General methodology

The common steps involved in image processing are shown in the flow chart.

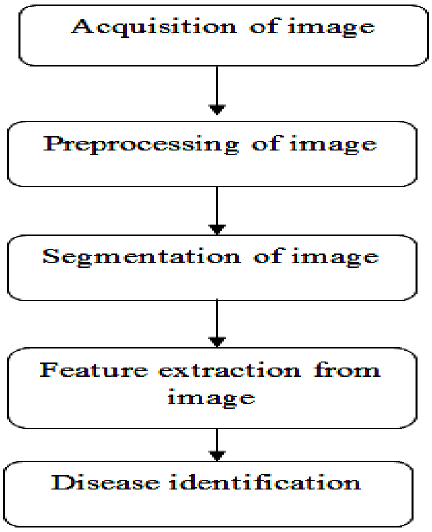


**Figure 1:** Steps followed for plant ailment detection.

i. Image acquisition: At this step, different image of leaves are collected, either with a camera or from an online database.
ii. Image preprocessing: Using filters, the obtained images are pre-processed to improve image quality and reduce noise.
iii. Image segmentation: To separate the plant image into multiple parts, the image segmentation process is performed. This can be used to detach the ill area of the leaf by removing the backdrop.
iv. Feature extraction: The color, shape, and texture aspects of the diseased portion of the leaf are extracted here. Feature Extraction aids in the classification of diseases based on their shape, texture, and color.
v. Disease identification: Leaf disease is detected using a variety of machine learning algorithms.

## 3. Types of Plant Pathogens

Viruses, bacteria, and fungi primarily impact leaves. These signs and symptoms are readily apparent [20]. A change in colour or shape of the plant could be one of them. Some symptoms for detecting infections in plants while they are growing are listed below.

a. ***Viral diseases:*** When a virus infects a plant, it lodges itself inside its cells and hijacks the machinery, causing the plant to manufacture additional viruses. This process prevents the plant's cells from operating as they should weaken it. Common plant virus's diseases are mosaic virus, spotted wilt virus, yellow leaf curl virus, African cassava mosaic virus, Plum pox virus. Figure 2 shows symptoms of impatiens necrotic spot virus on pepper leaves.

**Figure 2:** symptoms of impatiens necrotic spot virus on pepper leaves

b. ***Bacterial diseases:*** Bacteria will spread throughout the plant, weakening it until it no longer has the vitality to expand. Microscopic living creatures, most of which are one-celled, infect plants. Spots, wilts, and scabs appear on the leaves, fruit, and roots when a bacterial infection occurs. Wilts, leaf spots, specks and blights, soft rots and scabs, and cankers are all bacteria-caused diseases. Pathogen-induced leaf spot disorders caused by bacteria are depicted in Figure 3.

**Figure 3:** Pathogen-caused leaf spot diseases

c. ***Fungal diseases:*** Fungi, which create spores and feed on other organic materials, can potentially harm plants. Fungal infections frequently result in the growth of mould or mildew on the plant. Location of interest, Blackleg, Gummy stem blight, Alternaria leaf spot, Ring spot, Late blight, Cercospora leaf spot, Leaf blight spot, Leaf blight Figure 4 depicts fungus-caused rust infections on an apple leaf.


**Figure 4:** Cedar-apple rust symptoms on the top and bottom of an apple leaf.

## 4. Literature Review

Iqbal, M. A., [3] the author developed an algorithm for identifying early blight and late blight ailment among potato plants. Four hundred fifty images of the potato plant, including 150 images belonging to early blight, 150 images belonging to late blight, and 150 images of healthy leaf, were taken as input. The database of the diseased leaves was preprocessed to eliminate the noises present in the images. Image segmentation was adopted to obtain the region of interest. The global feature descriptor technique was used for the purpose of obtaining feature extraction from the segmented image. Among 450 images collected as input, 360 images were considered as training sets, and 90 images were treated as test images. Different algorithms were tested for accuracy in identifying and classifying the disease. Random forest gave an accuracy of 97%, while LR gave 94%, KNN 91%, NB 84%, LDA 78%, and SVM 87%. The algorithm developed was trained to identify two diseases that occur in potato plants. Fewer numbers of data sets were considered for training the algorithm for identifying the diseases. No medication was prescribed for plant disease during the work. The author concluded that the proposed methodology could be further used in identifying diseases among different plants by training the algorithm for different diseases.

Sharma, P., [4] proposed a hybrid model using machine learning languages to identify leaf diseases. Two thousand images concerned with different plant leaf diseases like rot, rust, bacterial spot, early blight, late blight, leaf scorch, target spot, mosaic were selected as input. The noises present in the images were eliminated by using Gaussian Blur. K-means clustering, an unsupervised learning technique, was used for obtaining the segmentation of the image. Four algorithms were developed for classifying and identifying the diseased images from the input data set. Among the four algorithms developed to identify and classify the disease CNN algorithm gave an accuracy of 98%, while logistic regression gave 66.4%, KNN 54.5%, and SVM 53.4%. The paper concluded that CNN gave a precise result compared to the rest of the algorithm. However proposed methodology couldn't identify diseases during the initial stage, and no remedies were suggested for identified plant disease and also proposed method gives more false-positive and false-negative results.

Chaudhari, V., [5] developed a model using machine learning to identify diseases like Sigatoka, CMV, bacterial wilt, and Panama that occur in the banana plant. Six hundred eighteen images of the diseased banana leaf were collected as an input dataset. Image filtering techniques were adopted to eliminate the noises from the input data set. K-mean algorithm was used for the purpose of getting the image segmentation. Feature extraction was obtained from a segmented image using GLCM technology. SVM algorithm designed to identify and classify the diseased leaves were trained with 60%trainning set images and 40% test images. The proposed SVM algorithm gave an efficiency of 85% in identifying the diseased leaf. However, the algorithm was restricted in identifying only four diseases that occur in banana plants and also, the algorithm was trained with a lesser number of images.

Swetha, V., [6] developed a hybrid model for identifying and classifying disease in horticulture and vegetable plants. Images of horticulture and vegetable plants for the database were obtained from the plant village. Images of the database were preprocessed to eliminate noises and were segmented. Feature extraction was done using histogram oriented gradient (HOG) technique. Algorithms such as random forest, decision tree, SVM, linear regression were developed to identify and classify the diseases. The random forest algorithm proved to be more accurate in identifying and classifying diseases.

Doh, B., [7] developed a machine-learning algorithm to identify citrus fruit diseases, mainly anthracnose, black spot, citrus scab, and melanosis. Different images of the diseased citrus fruit were captured using the camera. K means clustering was used for obtaining the segmentation of the images. Feature extraction based on color, texture, and structure of the hole on the fruit was extracted from the segmented image using a multiclass SVM algorithm. Two classifier algorithms, SVM and ANN, were used to identify and classify diseased fruits. Among the two algorithms used to classify and identify ANN proved to be more accurate compared to SVM. The proposed algorithm was restricted to four diseases of citrus plants, and different feature extraction techniques and classifier algorithms could be used in order to improve the accuracy rate.

Gulshan, A. S., [8] designed a model using machine learning for identifying disease among seven different plants. Seventy-five images with a pixel goal of 568*1020 were captured. Region-based K-mean segmentation was used for image segmentation as more noise immune works well in the homogeneous region. GLCM algorithm was used to extract the features from the segmented image. Two classifiers algorithms, KNN and SVM, were developed to identify and classify the disease leaves. KNN gave an accuracy of 98.56%, and SVM gave an accuracy of 97.6%. The paper concluded that KNN could identify any number of diseases and gave the exact name of the disease, while SVM could identify only two diseases. The proposed work considered only seventy-five images of different diseased plants for training the classifier algorithm. Further work could be carried out by increasing the database size and using a different algorithm for classifying and identifying the disease.

Chokey, T. [9] this paper proposes different algorithms to identify common diseases in maize plants. Common rust, fusarium eat rot, common smut these diseases are considered during the work. Labelled images of these images are taken as input. Speeded up robust feature (SURF) is used for extracting the feature of images stored in a database. Cross-validation is used for evaluating machine learning algorithms. Three machine learning methods, namely linear SVM, medium tree, quadratic SVM, and Cubic SVM, were considered for image identification. It was concluded that quadratic SVM gives the best result. The algorithm developed was only able to identify the disease among the maize plant, and further, the accuracy could be improved by increasing the dataset.

Panchal, P., [10] designed a model to identify plant diseases like bacterial blight, early blight, and late blight. Images of the diseased leaves were captured, and smoothing filters were used to remove noises. K-means and HSV algorithms, based on statistical methods, were used to extract the desired features. The model developed consisted of four algorithms for identifying and classifying the diseased images from the dataset. The data set consisted of 100 images, among which 25 images were of healthy leaves, and the remaining 75 images belonging to three diseases. Among the four algorithms developed to identify and classify the diseased leaves, the Random forest algorithm gave an accuracy of 98%; the decision tree gave 94%, KNN 92%, and SVM 90%. In the end, we could conclude, the random forest gave precise results compared to the rest of the algorithms. However, the algorithm was restricted to identify only four diseases that occur among the plants, and future work could be carried out for different diseases among the different plants.

Shruthi, U., [11] reviewed different image processing techniques and machine learning algorithms that are used in identifying various plant diseases. Image processing techniques involved capturing high-quality images of various diseased plants using the camera. Image preprocessing and segmentation were done on the input database to remove noises and to obtain the segmented image. GLCM, Blend Vision, Machine intelligence techniques were used to extract the features. The paper reviewed five classifier models, namely SVM, ANN, KNN, Fuzzy, and CNN, used to identify and classify the diseases. The study concluded that the CNN classifier detects more diseases with high accuracy and efficiency compared to SVM, ANN, KNN, Fuzzy techniques.

Ramesh, S., [12] discussed various machine learning languages to differentiate between healthy and diseased leaves of papaya. One hundred sixty images, including diseased and healthy papaya leaf, were captured to create the data set. The captured images were preprocessed to reduce noises. HOG methodology was used to extract the features from the database. HOG feature extraction technology operates on cells created, and any transformation doesn't affect it. Various classifier algorithms like the random forest, SVM, K-NN, CART, Naive Bayes were used for the identification and classification of diseased images. Among the different algorithms used, Random forest gave a high efficiency of 70.14%, and the results could be further improved by increasing the trained image set. The proposed machine learning model is trained for identifying the diseases that occur only in papaya plants. This limitation could be carried out in future work by designing and training the algorithm to identify diseases among different plants.

Govardhan, M., [13] proposed an automated system for identifying and classifying diseases among tomato plants using machine learning and image preprocessing. The use of random forest overcomes the problem of overfitting to the training set, which is the major problem with the decision tree. Images of tomato leaf subjected to diseases like late blight, septoria leaf spot, spider mite, target spot, healthy, early blight, mosaic virus, yellow leaf curl were captured. Images captured were preprocessed using image processing and segmentation techniques to remove the noises present in the captured images and to obtain the segmented image. Feature extraction was further carried out using Haralick texture analysis, color histogram, and Hu moments for extracting shape, color, and texture features. Extracted features were labelled and stored as 90% training data and 10% test data in the database. K-fold cross-validation technique was used to find the overall efficiency of the model. The proposed work developed a multimodal algorithm to identify and classify the diseases, and these algorithms gave accuracy, RF-95%, LR-84.01%, KNN-52.3%, DT-82.9%, SVM-22.3%. The paper concluded that among the different algorithms developed to classify and identify the disease, Random-forest proved to be more accurate. However, the paper is restricted to identify only diseases related to the tomato plant and fewer numbers of data sets were considered for training the program. Further work could be carried out by increasing training sets of the data and using the model to identify the diseases among the different plants.

Ahmed, K., [14] proposed a machine-learning algorithm to identify three common diseases among rice: leaf smut, bacterial leaf blight, and brown spot disease. The proposed work initially collected forty images of diseased rice leaf to form a database, and by performing augmentation on the captured images, the size of the database was further increased to 480. Basic image processing techniques like image preprocessing, image segmentation and feature extraction were adopted to eliminate noises in the images and to obtain desired features of the images. Four algorithms were developed for identifying and classifying the diseases from the data sets. Logistic regression gave an accuracy of 75.4%, k-nearest gave 91.667, decision tree gave 94.9%, and Nair Bayers gave the lowest Accuracy. The work concluded that the Decision tree was more accurate at identifying the diseases more precisely. The proposed work is restricted in identifying diseases among rice plants, and fewer number data sets were used during the work. Further work could be carried out in identifying different diseases among the different plants, and medication could be prescribed to control the disease.

Ramesh, S., [15] presented a machine learning algorithm for identifying rice blast disease. Three hundred diseased images of rice were captured using the camera to form the database. Image preprocessing was done by converting RGB to HSV to reduce the noise present in the images, and image segmentation was carried out by k-means clustering technique. Feature extraction was done by calculating mean value, standard deviation, and GLCM to obtain statistical features. Artificial neuron technique, a machine learning algorithm, was used to identify and classify the diseased leaf images. Out of three hundred images, one-eighty images were treated as sample images, and one twenty images were taken as test images. Artificial neuron algorithm gave 99% accuracy in identifying the rice plant disease. The proposed worked concentrated only on rice blast disease, and this work further could be enhanced by training the model for identifying different diseases of rice and different plants.

Sarangdhar, A. A., [16] developed a model used to identify five common diseases, namely Bacterial Blight, Alternaria, Gray Mildew, Cereospra, and Fusarium wilt, that occur in cotton plants and Raspberry PI model to monitor the soil condition. Nine hundred different images of the diseased cotton leaf were captured in JPEG format. Image preprocessing and segmentation was carried out to enhance the image quality. Mean, and standard deviation technique was used to obtain color feature while 2D Gabor filter was used to derive texture features. Gaussian Kernel SVM classifier was developed for identifying and classifying the disease, and the efficiency of the algorithm was found to be 83.26%. The proposed work was restricted to identifying diseases of the cotton plant, and the prediction rate could be improved by training the algorithm for a number of data sets.

Pooja, V., [17] developed a model for identifying five common diseases in plants-like Alternaria alternate, anthracnose, bacterial blight, Cercospora leaf spot, mosaic. Two fifty images of different plants, which included the above disease, were collected to form the database. Image preprocessing was done to eliminate noises present in the image. Segmentation was done using a K-means clustering algorithm to obtain the region of interest. The correlation was used to obtain a set of desired features, namely color co-occurrence and contrast skewness from segmented data. SVM algorithm was used as a classifier to identify the diseased leaves from the dataset, and the recognition rate was found to be 92.4%. The proposed algorithm was trained with a fewer number of image samples, and four diseases were diagnosed. The paper did not provide any medication for the disease identified, and further work could be carried out to give medication for identified diseases.

Prajapati[18] reviewed identifying and classifying disease in a cotton plant using machine learning techniques. The study concentrated on four diseases in cotton plants, mainly Alternaria leaf spot, Cercospora leaf spot, Bacterial blight, and Red spot. The survey also included background removal and segmentation techniques. The study concluded the following points; thresholding techniques give good results compared to background removal. Applying ostu thresholding was good to obtain better Feature extraction. Finally, among different machine learning techniques used for classification and image identification, SVM proved to be more accurate.

In his paper, Joshi, A. A., [19] emphasized identifying four diseases in rice: bacterial blight, Blast brown spot, and sheath rot. One hundred fifteen diseased images of rice leaves were collected to form the database. Image preprocessing and segmentation was carried out on input images to reduce the noises in the input images. Feature extraction was done to extract color features by calculating value mean and standard deviation. The shape feature was done by calculating the area and centroid of each pixel component. Among the one hundred fifteen images present in the database, eighty images of the database were used for training purposes, and the rest, thirty-five, were used for test images. Two machine learning classifiers MDC and k-NN were used for the identification and classification of diseases. MDC algorithm gave an efficiency of 89.23%, while the KNN algorithm gave 87.03% accuracy in the identification of diseases. The paper concluded that the result could be improved by adding texture features. The proposed work was restricted to identifying only four diseases among rice plants, and further models could be trained for identifying the different diseases among different plants.

Waghmare, H[20] presented a technique of identifying a grape disease by diagnosing the leaf. Downy mildew, powdery mildew, and black rot leaf diseases were taken into consideration while developing the algorithm. Four hundred fifty captured images were included in the database, including healthy, diseased, and pest-infected images. Preprocessing of images was done to eliminate the noises and to improve the quality of input images. The texture of the leaf was considered to extract the feature. The database was divided into a training set consisting of hundred images and a testing set containing thirty images for experimental purposes. A multiclass SVM classifier with the principle of minimal risk was used as an algorithm to identify and classify the disease, and the algorithm provided an accuracy of 96.6%. This result could be further improved by increasing the testing ratio and training the algorithm for different plant diseases.

**Table 1: Comparative analysis of plant diseases and accuracy of different classifiers:**

| Author | Plants | Images considered | Diseases | Feature extraction | Classifiers and their Accuracy |
|---|---|---|---|---|---|
| [3] Iqbal, M. A | Potato | 450 | Late blight and early blight | GFD | RF-97%, LR-94%, KNN-91%, SVM-37%,DT-91% NB-84%,LDA-78% |
| [4] Sharma, P | Apple, corn, grape, potato tomato | 20000 | Rot, rust, bacterial spot, early blight, late blight, leaf scorch | k-mean clustering | KNN-54.5%,SVM-53.4%,LR-66.4% CNN-98% |
| [5] Chaudhari, V | Banana | 600 | Sigatoka, CMV, bacterial wilt panama | GLCM | SVM-85% |
| [8] Gulshan, A. S | Plants | 75 | Fungal diseases, early scorch, leaf spot, frog eye leaf spot, powdery mildew, | GLCM | KNN-98.56% SVM-97.6% |
| [10] Panchal, P., | Plants | 3823 | Bacterial spot, early blight, and late blight. | GLCM | RF-98%,DT-94% KNN-92%,SVM-90% |
| [13] Govardhan, M | Tomato | 140 | Late blight, septoria leaf spot, spider mite, target spot, healthy, early blight, mosaic virus, | HU moment | RF-95% LR-84.01% KNN-52.3% DT-82.9% SVM-22.3% |
| [15] Ramesh S | Rice | 300 | Rice blast | GLCM | ANN-99% |
| [16] Sarangdhar, A. A | Cotton | 900 | Bacterial Blight, Alternaria, Gray Mildew, Cereospra, | 2D Gabor | Gaussian kernel SVM-83.26 |
| [17] Pooja, V., | Plants | 250 | Alternaria alternate, anthracnose, bacterial blight, Cercospora leaf spot, | Co-occurrence, skewness, correlation | SVM-92.4% |
| [19]Joshi, A. A | Rice | 115 | Bacterial blight, Blast, brown spot, sheath rot | Color texture, shape texture | MDC-89.23% KNN-87.02% |
| [20] Waghmare, H | Grapes | 450 | Downy mildew, powdery mildew, black rot | Local binary pattern | Multiclass SVM-96.6% |

## 5. Plant diseases and algorithm accuracy

Figure 5 shows different plant diseases and approaches with their respective accuracies. From the results and discussion, we conclude that CNN and KNN classifiers have been found to be more accurate in identifying and classifying plant leaf diseases.

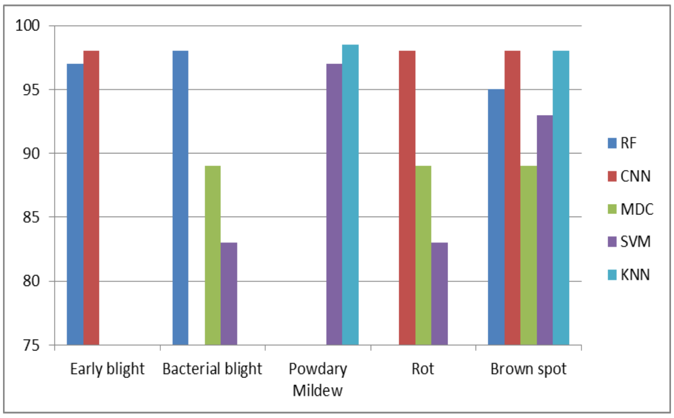


**Figure 5:** Detection Accuracy using Random Forest, CNN, MDC, SVM and KNN

## 6. Conclusion

In this paper, we discuss the main disease, namely biotic and abiotic, that affects the overall yield of crops and the works which have been carried out in identifying and classifying the various plant diseases. The disease detection techniques involve the steps that are commonly followed, like image acquisition, image pre-processing, image segmentation, feature extraction, and disease detection and classification techniques. We concluded that compared to the manual method, which requires an expert to identify and classify the disease, image processing and machine learning techniques have been proved to be more accurate, less time consuming and cost-effective. The studies conducted so far conclude that the excess use of chemical fertilizers and pesticides to improve the crop yield, control pests and diseases among the plants have resulted in a decrease in soil fertility, carbon and nitrogen levels in the soil. In future, work could be carried out for developing a hybrid model for identifying different diseases among the different plants with more accuracy and suggestions of organic pesticides like neemasthra, bramasthra for controlling leaf diseases and methods to improve soil fertility could be provided.

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