e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.2, 2022
 UGC CARE Listed (Group -I) Journal

A Technical Review On Paddy Plant Leaf Disease Detection And Classification

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Abstract

One of the biggest revolutions of modern history is the invention of agriculture for a healthier lifestyle. It significantly changed the human culture and played an important role in the development of the population and biological improvements in food production and domestication. The frequency of pests on food crops increased because environmental circumstances were changing, and diseases on crops increased rapidly. These diseases inflict catastrophic social, economic, and ecological casualties, and this extraordinary challenge is a concern for the correct and prompt detection of diseases. In this contest, IT (Information Technology) has left its mark on the potential of farmers and is still to be exploited. As input for making the right decision, farmers need timely and credible sources of knowledge. Study into agriculture is then planned by improving the disease diagnostics method with the use of newer information technology to enhance efficiency and quantity for agricultural production and its allied operation. Early forecasting of disease epidemics will help farmers to choose the right fertilizer, pesticides, and fungicides in the right amount.
In this paper, we discussed and surveyed various research articles based on paddy crops disease detection and classification of exiting methods that will make use of a future framework for developing a disease predicting model using weather parameters associated with the development of the disease outbreak.

Keywords: Paddy crops, detection and classification, Crop diseases, climate, machine learning, farmer.

1. INTRODUCTION OF PADDY IN INDIA

Paddy or rice is a staple food for a large part of the world's human population, especially in Asia and Africa. According to an estimate, paddy is the highest world's third-highest agricultural commodities after maize and sugar cane. Rice is a monocot and is normally grown as an annual plant, although its survival in tropical areas is perennial allowing for ratoon crop production up to 30 years. Rice Production requires a hefty amount of irrigation for growth. The traditional methods for rice cultivation involve the flooding of fields while or after setting of young seedlings[1].

(A)

(B)

Fig 1.1. (A) Rice Seed (B) Rice crop

Paddy or Rice makes a significant contribution to the total food grain production in India. Rice is one of the chief grains of India. India has one of the largest areas under rice cultivation as it is one of the countries principal food crops. Rice is the most popular part of Indian cuisine and is consumed at least once a day in every region.

In terms of rice production, India is the largest global rice producer in terms of area harvested. While some of the rice produced is exported globally most of it is used to meet the local demand. In the year 2019 the rice yield was estimated to be around 2.6 thousand kilograms per hectare over the years there has been an increase in overall yield figures to compete with china [2].

Detailed statistics of Rice production over the years has been described below in figure 1.1

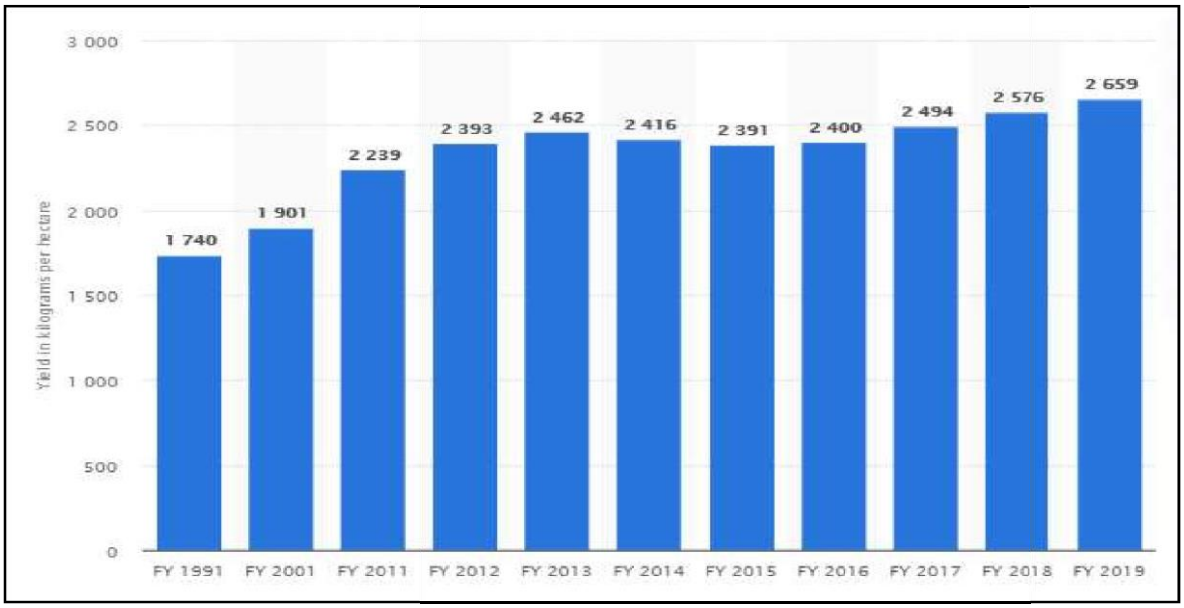

Fig. 1.2. Rice production over the years from(1991-2019)

From the above statistics, we can see the rice production in India has increased over various passing years in 2019 India produced 2,659 kg/hector of rice as compared to 1,740 kg/hector in 1991

2. EFFECT OF PEST AND DISEASE IN RICE

Every year a significant amount of rice yield is lost to various natural causes one of them being the infestation of pests and diseases. Every year farmers may lose an estimated 30% of their produce to pest attacks and disease infestation. Due to rapid change in the climatic pattern across the globe, there has been a rise in disease and pest epidemics which has a significant impact on the world food supply. Agricultural stakeholders are under constant pressure to adapt to new climatic changes to minimize

yield loss. Over the years rice yield in the country has faced a significant challenge from pest and disease epidemics. In some states in India disease like rice blast amount to maximum yield loss[3]. Rice diseases like Leaf Blast caused by Magnaporthe grisea proved to very destructive for rice. The pathogen is most common on leaves's causing leaf blasts during the vegetative stage of growth. Leaf Blast can prove to be fatal as it spreads rapidly within suitable environment conditions and may also lead to total yield loss.

Fig 1.3. Rice Leaf infected with blast Disease

Pest like yellow steam borer also proved to be destructive as they feed damage at the base of the plant or along the central steam causing dead tillers as vegetative state and unfilled panicle at reproductive stages.

Fig 1.4. Rice steam ate by yellow steam borer

Weather plays an important role in the development of disease epidemics as it is one of the significant stakeholders that influence their growth other two being genetic makeover of a host and pathogen life cycle. Early forecasting of disease epidemics will help farmers to choose the right fertilizer, pesticides, and fungicides in the right amount. To counter the loss caused by disease epidemics[4].

3. FACTORS AFFECTING PADDY PEST & DISEASES

3.1 Effect of temperature:- Temperature is one of the important factors which influence the development of the diseases. Some diseases tend to be severed at low temperatures while others have an affinity for high temperatures. This is because like other environmental factors temperature has an important influence over the life cycle of pathogens. Exposure to extreme temperature before inoculation may increase and decrease the suspicatiblity of disease. For example, when an apple is kept for 17 days at 30-degree Celcius it shows signs of Botrytis all[5].

3.2 Effect of moisture:-For considering moisture one has to keep in mind to important factors mainly soli moisture and humidity since various problem arises due to while studying the effect of

both soil moisture and humidity that it is advised to study their impact from isolation to one another[5].

(I) Soil moisture:- Succuptability of a disease depends on the moisture content of the soil. Some diseases are most severe in wet soil while others prefer dry soil. For example, the clubroot of crucifers often infects in the presence of wet soil while diseases like sclerotium ciborium of onion are most severe on dry soil.

(II) Atmospheric humidity:- nearly all of the diseases that affect above-ground parts of plants are affected by atmospheric humidity. During the time of spore germination, a thin film of moisture is required on the plant surface. This requirement of leaf wetness exists during the period that may vital for a disease to infect a host. for example, for the phytophthora infestations to occur to potato leaves a water droplet must persist on potato leaves for at least three to eight hours while diseases like Venturia inaequalis require a much longer period of wetness duration

3.3 Effect of light:-The effect of light and duration of light and darkness on fungal sporulation in cactus has been studied. Light may influence the spore germination of the plant. The intensity of light reduces the level of club rot attack on Cabbige's except in the case where the soil is heavily contaminated by Plasmodiophora brassicae [6].

3.4 Soil Reaction:- Soil pH play's an important role in influencing the severity of disease as seen in the case of clubroot of crucifer's which is very severed in acidic soil and can sometimes be controlled by liming. Streptomyces Scabies does not reply in fact potato when the soil pH is below 5.2 this has been attributed to inhibition growth of fungus in high acidity[2].

3.5 Soil Nutrient's:- The presence of essential soil nutrient's in plants namely nitrogen, phosphorus, and potassium may increase or decrease the susceptibility of disease. Indeed increase the nitrogen content in soil may increase the susceptibility of Cytosporina bidubunda in an apple but decrease susceptibility to another variety[4].

3.6 Rainfall:- Rain can prove to be both a blessing and a curse for crops. An Ideal amount of rainfall is both needed and beneficial for a plant's life. While excess rainfall may both affect the external and internal structure of the crop. If the crop gets too wet then it can attract bacteria, mold, and fungi[5]. Also, excess rainfall can accelerate the spread of disease in the plant which can lead to yield loss

3.7 Wind Speed: wind speed is another critical that affect the growth of Disease and pest in the plant. Wind often act as a carrier for pest and pathogens and can lead to a rapid spread of a disease outbreak in a given area[4].

4. OVERVIEW OF DISEASE FORECASTING SYSTEM'S

Disease Forecasting systems are designed to Predict Change in occurrence in the severity of crop disease. These systems are used by growers to make crucial economic decisions regarding the treatment and control of disease epidemics. Often these systems require information such as susceptibility of a host crop and incorporate current and forecast weather conditions to make recommendations whether a disease treatment is necessary or not[7].

Environmental conditions also have a huge impact on the pathogen that causes disease Example for leaf spots to occur their environment should contain the minimum value of leaf wetness[8]. A Good disease Forecasting system must be reliable, simple, cost-effective, and work for a variety of diseases. As such there designed usually for diseases that generally irregular enough to warrant a prediction system rather than a disease that occurs annually and can be dealt with with regular treatment.

5. ROLE OF MACHINE LEARNING IN DISEASE FORECASTING

With the advent of the computer revolution, mankind took a giant leap of faith. Computer systems are now able to analyze and perceive information far more effectively than before. With recent advancement in Machine Learning and data science, we can make a correct prediction for a variety of subjects in various fields of Science

In Agriculture, Machine Learning has revolutionized various aspects of traditional agricultural practices. For example, using past data machine learning system can identify and predict annual yield that can be generated from a particular piece of Land. Using image processing intelligent systems can identify various health issues associated with various plants

In the field of disease Forecasting or Forewarning, machine learning techniques proved to be far superior when compared with traditional regression mechanism. Machine Learning techniques like Artificial Neural Network, Decision Tree, Random forest, etc provided better performance as well as reduced the number of false-positive and false-negative generated by a system In this research, we have compiled a collection of recent research work that has been done in the field of disease Forecasting using Machine learning. A compiled analysis of all the survey research work is provided below [9-10].

5.1 RESEARCH WORK IS DONE IN CROP DISEASE FORECASTING USING MACHINE LEARNING

Peter Skelsey uses machine learning technology to predict the outbreak of late blight in potatoes. The author compared the performance of different chatting algorithm namely K means, Gaussian mixture model, kernel density estimation, one-class support vector machine, and isolation forest. The result show that the SVM and Gaussian mixture model provided the highest accuracy of 98% and 97%[9-10]

Develop the model to predict the outbreak of Tikka and rust in groundnut the author made use of a decision tree for creating a core relational model of Tikka and rust within concerning weather parameters. The result showed the best showing date to minimize the last and maximize the yield.[17]

Compare the performance of artificial neural network decision tree algorithm diagnosing various diseases in rice the result showed that the decision tree provided better accuracy[19]

Thomas Truong developed a system that was capable of communicating field data over cloud storage to detect the presence of the Fusarium app and Puccinia. The author made use of support vector regression to predict short-term weather parameters using real-time field data. The baby result shows that SVM based prediction system most effective in predicting day to day weather parameter and showed improvement as more experimental data was collected[20]

Haiguang Wang developed a model for predicting the outbreak of wheat stripe rust based on the support vector machine. Analyze past incidents of disease to develop a correlational for weather based parameters. SVM provided a maximum accuracy of of100% and fitting accuracy of 95.45%[21]

Umair Ayub compares various classification techniques to develop a model that predicted the damage caused by grass grub. The author compared the performance of decision tree, random forest, neural network, support vector machine, k nearest neighbor, Gaussian naive bias. The results showed that the neural network provided the highest mean accuracy of 37%[22]

DC Hooker made use of weather variables to predict the high level of Deoxynivalenol in winter wheat. The author made use of a multilevel regression model. The result showed 89% of correct DON content[23]

K. Klem's main use of a neural network for predicting Deoxynivalenol content in wheat using weather data. The results show that the coefficient of correlation between observed and predicted value reached r=0.87[24]

S.Sannakki et. al. (2013) made use of metrological parameters such as temperature and humidity for a forecasting disease outbreak in grapes using a combination of k- nn classifier and feedforward neural

network .for this research purpose past 10-year data for Belgaum samagra (15.85 lats,74.61 long and 758 alt for prediction)[23]

Priyanka Sharma et. al. (2018) made use of Artificial Neural Network(ANN) for predicting the outbreak of late bright in potato using past weather data obtained from sites in Patnager(India). The author's compared the performance of ANN concerning different activation functions(Sigmoidal, TanH, RU).the result provided an accuracy of about 90.909% for sigmoidal, 79.545% for TanH, and 90% for RLeU[24]

Henderson et. al. (2007)[25] discovered that weather variables were useful for forecasting outbreak late blight in potatoes in southern Idaho. The main aim of the study was

(I) Discover local weather variables associated with the incident of southern Idaho
(II) Whether or not these variables can be used to decide the severity of late blight
(III) Validation of performance in predicting late blight incident in Columbia Basin The model provided an accuracy of 84% for a dataset with duration (1995 to 2003) using logistics regression analysis[10-23]

S. Ramesh and DeVeydik used a machine learning technique to find the presence of blast disease in rice leaves with the help of image segmentation and processing they made use of Artificial Neural Network (ANN) and K-NN for Identifying the presence of blast disease in rice leaves using image segmentation and processing. They compared the performance of both K-NN and ANN to find the best suiting algorithm for identification. ANN achieved a maximum accuracy of 99 to 100%[12]

R. Sahite and P. Vijaya used the Machine Learning Technique to identify the presence of 3 rice diseases such as bacterial blight, Brown spot, and Leaf smut. They collected 120 images of diseased plants and used image processing and machine learning technique to build a classification model. They compared the performance of various Decision Tree algorithms like Random Forest, REP Tree, and J48. The result showed that Random Forest proved to be superior providing maximum accuracy of 76.19%[13].

Suki Skewang used a Machine Learning Technique for predicting the population density of rice pests. They used past weather data from field trials carried out for brown planthopper using a light trap experiment. The authors made use of an Artificial Neural Network to build a regression model for predicting the population density of brown planthopper during the cropping season. The result showed that the Artificial Neural Network performed better as compared to old traditional algorithms by providing R2=0.77 and RMSI=1.68[14].

Rakesh Kundal and Amar S Kapoor used Artificial Neural Network for forecasting the occurrence of leaf blast in rice using past weather data. For forecasting, the occurrence of leaf blast in rice six significant weather variables was identified namely Temperature, Humidity, Rainfall, and wind speed. The result showed that the Support Vector Machine or SVM generated minimum mean absolute error(%MAE) OF 44.12% compared to other alternatives[15].

Jia-You and Hsieh used Artificial Neural Network(ANN)[23] for predicting the presence of rice blast disease using historic weather data from 2014 to 2018 of several districts in china. The result provided an accuracy of 89% in identifying the presence of rice blast in a given district

Studied the performance of LSTM(Long Short-Term Memory Recurrent Neural Network)[18] to provide early forecasting of blast disease in rice. Historic weather data from three locations in china namely Chelwon, Icheon, and Milyang were used. The model showed a maximum accuracy of 62% for cheown 61.5 for Iceolwon and 46.9% for Milyang [18-25].

Rajni Jain et. al. (2009) performed a case study on the performance of various machine learning algorithm(Logistic regression, Decision tree, C 4.5, Rough Set Theory, Rough set based decision Tree(RDT)) for predicting the outbreak of Powdery Mildew of mango(PWM) caused by Oidium mangiferae Bertehet. The author's used metrological parameters temperature and humidity for forewarning the spread of an outbreak. The results showed. that JCP and RJP had better prediction accuracy than other models[11].

Yongseon Kim et. al. (2017) developed a model for predicting the outbreak of rice blasts using a long-term memory network(LSTM). the dataset consisted of historical data on rice blast occurrence in 3 regions of Cheol won, Iheon, and Milyong in Korea as well as climatic data associated with the regions for the duration of 2003-2006. The result provided a maximum accuracy of 79.4% with LSTM[16]
In used a data mining method to detect disease in Cherry plant using Discriminant classification analysis. The data set consisted of metrological parameters such as temperature, humidity, rainfall, and wind speed. The author's performed a comparison of various algorithms that come under Discriminant analysis namely Linear Discriminant Analysis, Quadratic Discriminant Analysis, Pseudo Linear Discriminant Analysis, and Compact classification tree. The result showed that the compact classification tree provided maximum prediction accuracy of 93.6%[25].
Patil N. et. al. developed a system for forecasting Anthracnose and Botrytis Fruits Rots in strawberry. The model used leaf wetness and temperature to perfect the outbreak of disease. The author's developed an online advisory system to predict the outbreak of these diseases using the Florida agriculture weather network[22].
Jia-you Hsieh et. al. Developed a model for predicting rice blast disease based on machine learning and neural network. The dataset used in the experiment used weather data collected from different zones of Taiwan from 2014 to 2018. The author mainly used two parameters namely temperature and humidity. The classifier provided with an accuracy of 72%[18].

Table 2.1: Shows a detailed overview of various research articles that have used a Machine learning approach for predicting crop diseases.

Crop	Disease/Pest	Objective	Algorithm	Conclusion	Author
Rice	Blight, Brown Spot, False smut, white tip nematode, and steam rot sequence	Diagnose of major rice disease of Egypt	Decision Tree & Artificial Neural Network(ANN)	Decision tree provide accuracy of 98.55%and Artificial Neural Network Provided accuracy of 97.18%	Mohammad El-Tebbny [10]
Rice	Blast	Predicting the presence of Blast disease in rice leaves using metrological parameter	Artificial Neural Network(ANN)& KNN	Maximum Accuracy of 99%	S.Ramesh and DeVeydik[12]
Rice	(Bacterial blight, Brown spot, and Leaf smut)	Using Image Processing and Machine Learning to predict disease in rice	Decision Tree	Maximum Accuracy with 76.19%	R.Sahite and P.Vijaya [13]
Rice	Brown Planthopper	Predicting population Density Of Rice Pest	Artificial Neural Network	R^2=0.77&RMSI=1.68	Suki Skewing [14]
Rice	Blast	Forecasting Leaf Blast in Rice using past weather data	SVM	%MAE=44.12%	Rakesh Kundal and Amar S Kapoor [15]
Rice	Blast	Predicting Rice Blast using past weather data	Artificial Neural Network	Maximum Accuracy of 84%	Jia-You and Hsieh[18]
Rice	Rice Blast	Studied the performance of Long Short Memory Network(LSMN) in predicting the presence of Rice Blast	Long Short Memory Network(LSMN)	79.4% Accuracy	Yongseon Kim et. al (2017)[16]

Rice	Blast	Use Temperature and Moisture to predict Blast in Rice	Artificial Neural Network(ANN)	The average Accuracy of 72%.	Jia-you Hsieh et. al. (2019)[17]
General Crop	Fungal disease Fusarium spp and Puccinia graminis	Developing an IoT based Environment data collection system for the detection of fungal disease	SVM	SVM correctly predicted daily weather parameter	Thomas Trung[20]

6. CONCLUSION

Weather is an important factor that influences the development of Crop diseases and pest infestations. Paper with viewed various research studies that made use of weather data to predict and forecast the pest attacks as well as crop disease using various machine learning techniques analyzed various parameters algorithms implemented in detail. Rice is one of the major cash crops in India and has been eaten in every part of the Indian subcontinent in every shape or form.

In terms of production, India is one of the top producers of rice in the world along with China. Every year farmers lose a large amount of their produce to pest and disease infection. Often the change in climatic conditions favors the development of pests and diseases. In this research paper, we discuss the possibility of using machine learning techniques to identify the climatic conditions which are favorable to pest and disease associated with rice The scope of this study covered the implementation of various supervised learning algorithms like K-NN, Logistic Regression, Decision Tree, Random Forest, and SVM. All the algorithms were tested against datasets of three major rice pest namely Yellow steam borer Gallmidge and Green leaf hopper.

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