Design and testing of a software tool for prediction of late blight in potato crop

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***Abstract* - Potato crop is largely effected by late blight which causes great damages to the yield and quality of potato crop. A system for predicting the occurrence of late blight disease in potato is designed and tested to help reduce the damaging effects of the disease on the potato crop. This paper includes the comprehensive study of designing and testing of a software for prediction of late blight in potato crop. Finally we conclude with discussions of proposals for further research.**

***Index Terms* - Potato crop, Late blight, prediction system, matlab.**

I. INTRODUCTION

Potato is considered as one of the major food crops in the world. Large quantities of potato crop is lost to the late blight disease which appears in winter season, in parts of lower Himalayas and some districts of Punjab state [8]. Late blight is known to cause maximum damage to the potato [5]. The appearance of late blight depends on the weather conditions of the region. Hence, using this information a software prediction system can be designed in order to predict the occurrence of the disease, beforehand, and preventive methods can be applied to save the potato crop.

Disease prediction, means forecasting the onset or occurrence and severity of the disease in a particular region, before it actually appears in the fields. It can be used as an aid for timely application of chemicals in order to save the produce. A disease prediction system becomes a very important instrument for the cultivators of the crop.

Late Blight (phytophthora infestan (mont.) de Bary) is a fungal disease which effects large quantity of potato crop[5]. It effects all the parts of the plant anatomy like the leaves, stem and tuber . Its identified by the symptoms which appear on the leaves and stem of the crop but sometimes its spreads very rapidly and results into an epidemic for the potato crop. Most easily noted symptoms appears on the leaves of the plant which develop pale green irregular spots which enlarge into large water soaked lesions. On stem a light brown elongation of lesion is seen encircling the stem. Tuber is the most readily infected while in soil by rain. In initial stages , the tuber shows an shallow reddish brown dry rot that spreads from the surface to the skin depth in an irregular fashion and can easily be seen in some potatoes which we have in household kitchens as well.

The build up and appearance or occurrence of late blight depends on the weather condition of the particular area in which the crop is grown. If the temperature and humidity levels reach a certain level it can cause the build up and appearance or occurrence of late blight. Favorable condition for the disease are the low temperature levels of the winter where the temperature touches around 7 to 25 degree Celsius and the relative humidity is more than 90% . Disease severity varies from 0 to 4 level, in which, 0 shows that no disease present and level 4 show the total destruction of the crop by late blight disease.By monitoring these favorable condition with help of the latest technology , we can predict the onset of late blight in the potato crop which can help us apply disease management steps in order to save the crop to maximum extent.

Timely and accurate prediction of a disease in a crop can help save money and labor resources for the cultivator. Potato production is grossly effected by the late blight disease , which in turn affects the economic state of cultivators, who suffer heavy losses due to crop loss. It has a much adverse affect on the small scale cultivators , who are driven to suicides due the economical losses in farming.

It also helps in effective time management for cultivators and provides a guideline on how to and when to apply chemicals for the good yield and mange their efforts and finances for chemical application. It can been done at a large scale such as a state or a region in which the crop is grown or even a single field level where the crop is planted , specially for late blight. It helps in taking proper preventive disease management steps at the correct time frame to save the entire crop , instead of taking action after the disease has made its appearance.

II. LITERATURE REVIEW

Sharma et al [5] investigates the fungal disease which occur in potato and goes on to give their management methods. The author discusses fungal disease in detail and its management as fungal disease are considered to cause maximum damage to potato crop.

Stein et al [14] discusses the critical timing of application of foliar fungicides to limit further infection of potato foliage by Phytophthora infestans. The critical threshold of foliar infection level at which individual or combinations of specific fungicides limited further spread of infection with P. infestans have also been determined.

Aggrewal et al[3] discusses different forecasting techniques for crops according to the main factors effecting the crop yield. The main factors which are taken into consideration are input and weather parameters. .
Thind et al[8] introduces and designes the web-based decision support system for late blight disease for potato. The author studies the relationship of weather parameters with the development and spread of late blight in potato. The author develops a web-based system for the easy access to framers / other users for timely control measures of the disease.
Sekhon et al[9] discusses a dynamic risk evaluation model based on the duration of relative humidity of more than 90% at a range of temperature favorable for the occurrence of late blight was used for the forecasting potato late blight. Weather data was collected and analyzed from 6 districts of Punjab based on which a model was designed to provide information on the severity of disease and help farmers to take corrective measures to protect the crop from late blight disease.
Nærstad et al[12] discusses a potato late blight forecasting model based on hourly weather date is developed based on trials with spore traps and trap plants. The model is built up of sub models for the different steps in the disease cycle, spore production, spore release, survival and infection of spores.
Henshall et al[13] investigates numerous disease prediction models for potato late blight based on recognition of weather conditions suitable for infection.

III. SCOPE OF WORK

Late blight prediction in potato is done with the help from an extensive hourly survey of weather parameters in an open field. After collecting the required data from the field , a decision support system is used for the getting the disease severity values. In this system, we use the weather parameter data that has been collected and then give the severity.
A late blight support system can be more efficient if the occurrence of late blight can be predicted before the disease appears. Hence, a prediction system is need which can take into consideration the future weather parameters and predict the disease severity value for potato late blight.
Such a prediction system can forecast the occurrence of the disease beforehand, which will allow us to use preventative method on the crop rather than damage management .

IV. METHOD USED FOR PREDICTION OF LATE BLIGHT IN POTATO CROP

A successful web-based decision support is in place in PAU, Ludhiana, which use the risk evaluation model to determine the disease severity of late blight in potato .Prediction of Late Blight in potato depends on the humidity and temperature present in the region of potato cultivation. The duration of relative humidity should be greater than 90% over a period of time at a particular temperature range for the late blight to appear on the crop. The disease severity value is then determined ranging from 0 to 4 depending on hours of in which temperature and relative humidity values are favorable for the disease to occur.
Disease severity is the intensity of the disease in the region which gives the value of how much damage the crop is in from the late blight disease. Its calculated based on the weather conditions prevalent in the region using the risk evaluation model.

Temp range(°C)	Hours with relative Humidity > = 90%				
7.1-11.0	=15	6-18	9-21	2-24	5-27
11.1-20.0	=12	3-15	6-18	9-21	2-24
20.1-25.0	=9	0-12	3-15	6-18	9-21
Disease Severity Value	0	1	2	3	4

Modified from Johnson (1998)

Table 1. Risk evaluation model used to determine disease severity value

a) DISEASE SEVERITY WITH TEMPERATURE RANGE FROM 7.10C TO 110C: If in this temp range relative humidity >90% prevails for less than 15 hours the disease severity value will be 0. If in this temp range relative humidity >90% prevails for 16 to 18 hours the disease severity value will be 1. If in this temp range relative humidity >90% prevails for 19 to 21 hours the disease severity value will be 2. If in this temp range relative humidity >90% prevails for 22 to 24 hours the disease severity value will be 3 and if in this temp range relative humidity >90% prevails for 25 to 27 hours the disease severity value would be 4

b)DISEASE SEVERITY WITH TEMPERATURE RANGE FROM 7.10 C TO 110 C : at the temperature range from 11.10 C to 200 C, less hours of relative humidity >90% are required for the same disease severity values. Disease severity value is zero if relative humidity >90% prevails for less than 12 hours at this temp range. To get disease severity value of 1,2,3 and 4 at this temperature range , duration of relative humidity >90% will be required for 13-15hrs, 16-18hrs, 19-21hrs and 22-24 hrs, respectively. .

c) DISEASE SEVERITY WITH TEMPERTURE RANGE FROM 20.10 C TO 250C: Still less hours of relative humidity >90% are required to get these disease severity values at this temperature range. Disease severity value is zero if relative humidity >90% prevails for less than 9 hours at this temp range. To get disease severity value of 1, 2, 3 and 4 at this temperature range , duration of relative humidity >90% will be required for 10-12hrs, 13-15hrs, 16-18hrs and 19-2421 hrs, respectively.

VI. SOFTWARE TOOL FOR PREDICTION OF LATE BLIGHT IN POTATO

In order to design a system for the prediction of late blight , it's important to understand that the occurrence of late blight depends on the weather conditions which prevail in the region. Therefore, a detailed hourly data of weather conditions is required. This data is stored in datasheets in date and time specific format. This same data is used by the system to predict the occurrence and severity of the disease.

Firstly, the data is extracted from the datasheets, then as late blight only occurs at a certain humidity . A humidity check is applied to the data, which allows humidity which is greater than 90% to be valid for occurrence of late blight. Data samples which pass the humidity check are collected along with the temperatures to which they are attached to or correspond to. After the temperature data is collected , temperature checks are applied to the temperature data samples, to all the temperature to the range of temperature, in order to compare the data with the hours from the model and apply severity checks. Number of hours that have been collected our then counted and compared to the severity check values. the comparison gives us the disease severity value.

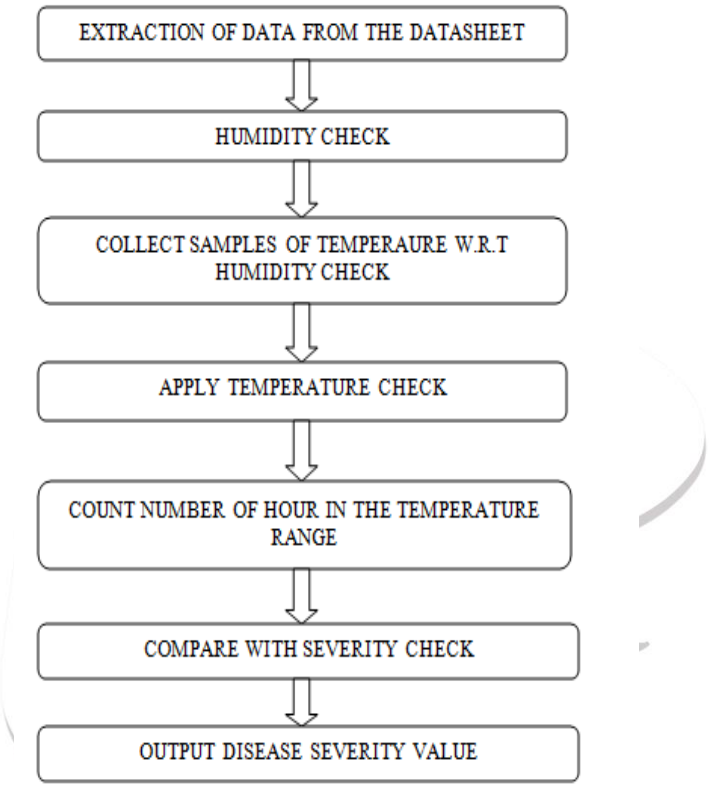


fig1. flowchart

V. RESULTS

In order to authenticate the designed software, we compare the results obtained by the software to results of the decision support system available on the PAU website. As we get the same result for a given day on the software tool and the decision support system, we can conclude that the software tool results are correct. Given below are the results obtained from both the software tool and decision support system.

Given below is the result of Ropar district of a single day, on 15 Feb 2014 of the software tool and a snapshot the PAU website with same disease severity value is one.

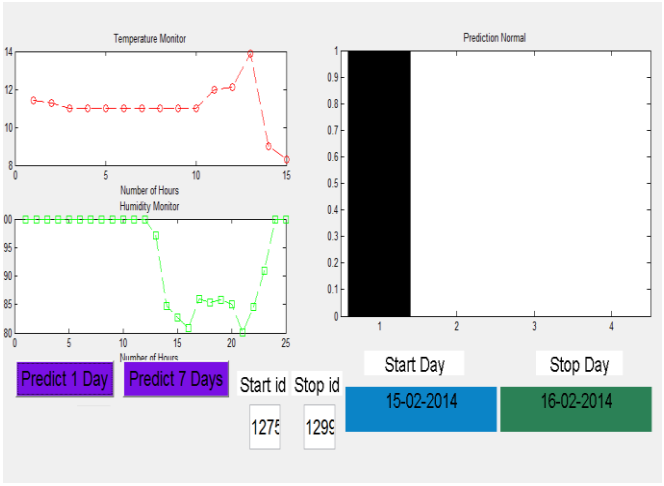


fig2- shows disease severity value one

fig3-shows disease severity value one

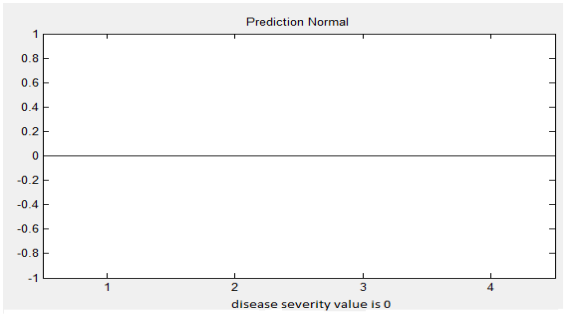
From the snapshot and software output, we can conclude that our software is working is authenticated. Similar results are shown in the table below.

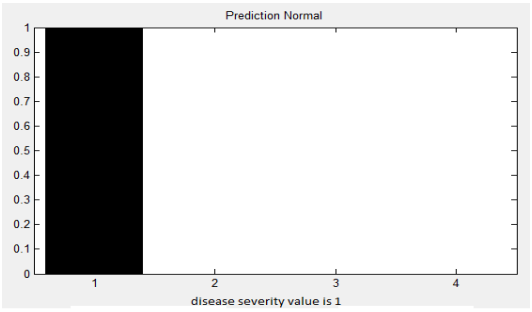
This tables show all the results obtained by using the software tool and PAU website, for a single day prediction, using the same datasheets.

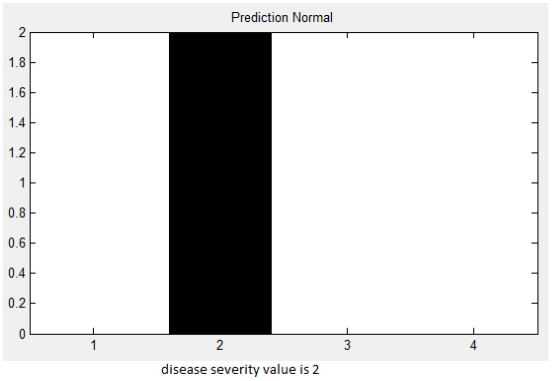
DATE	PAU WEBSITE RESULT	SOFTWARE TOOL RESULT
01 JAN 2014	3	3
03 FEB 2014	1	1
05MAR 2014	0	0
07 DEC 2014	0	0
08 JAN 2014	3	3
13NOV 2014	0	0
15 FEB 2014	1	1
17 FEB 2014	0	0
19 FEB 2014	2	2
18 JAN 2014	0	0
23 DEC 2014	0	0
23 JAN 2014	2	2
24 DEC 2014	0	0
24 FEB 2014	1	1
28 DEC 2014	0	0
30 JAN 2014	0	0
31 JAN 2014	0	0

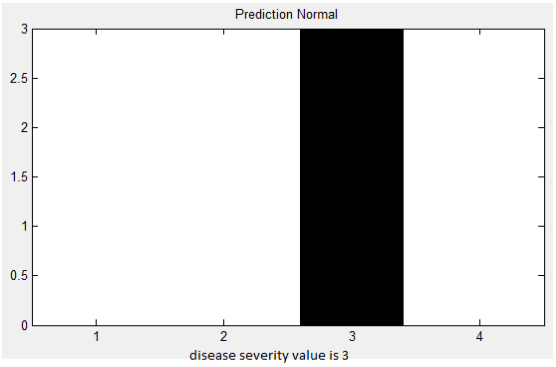
Table 2- results of single day

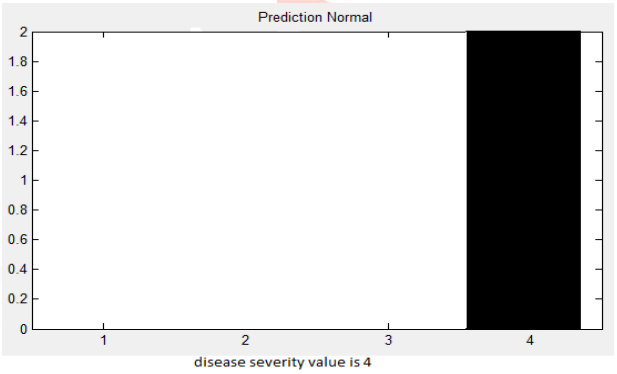
Different levels of disease severity are shown by different graph representations in the figures with disease severity value from zero to four, where zero is the lower value which means there is no disease probability and four is the maximum value which means that the crop is completely destroyed and is equivalent to an epidemic.











Given below is the result of Ropar district of a week , from 1 Feb 2014 to 7 Feb 2014 and disease severity value is four.

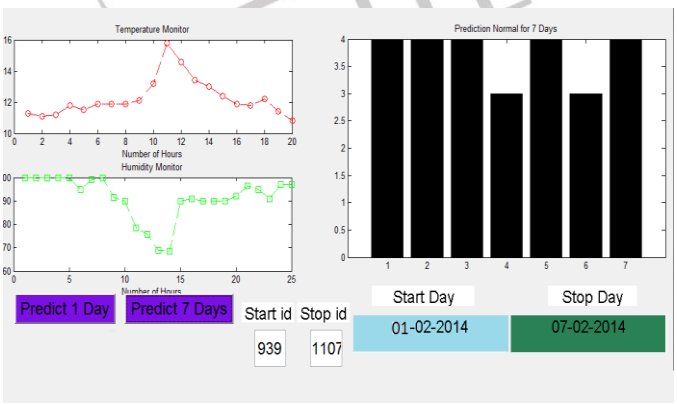


fig4-shows disease severity value four

From the snapshot and software output, we can conclude that our software is working is authenticated. Similar results are shown in the table below.

fig5- shows disease severity value four

This tables show all the results obtained by using the software tool and PAU website, for a single week prediction, using the same datasheets.

WEEK	PAU WEBSITE RESULT	SOFTWARE TOOL RESULT
1st WEEK FEB 2014	4	4
2nd WEEK JAN 2014	1	1
3rd WEEK JAN 2014	3	3
4th WEEK JAN 2014	2	2
4th WEEK FEB 2014	0	0

table 3 -results of the single week

The PAU system is a web-based decision support system for late blight which use the real-time field weather conditions as data to give the disease severity of late blight, in which case only disease management steps can be applied but if we can predict the onset of the late blight disease, we can apply take steps to prevent the occurrence of the disease, which is more beneficial for the framers. Hence , using the software tool , we can predict the onset of the disease, using Weather parameter for the prediction from the internet.

Given below is the result of the software tool of Ropar district of a single day, 05 Aug 2015 and disease severity value is zero.

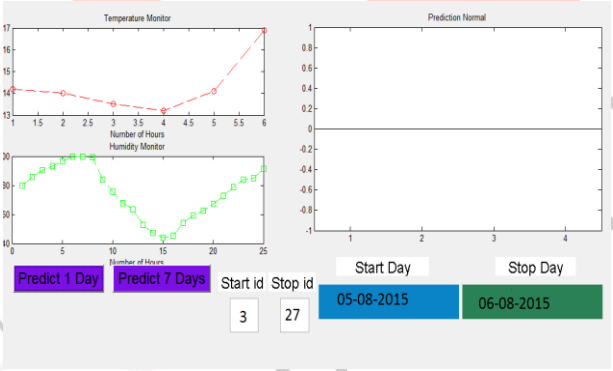


Fig 6-shows disease severity value zero

VI. CONCULSION

This paper studies the design and testing of a software tool for the prediction of late blight in potato crop. This prediction system is of highly valuable to farmers both at large scale and small scale as late blight disease in potato crop is known to cause maximum damage to yield and quality of the produce . It also shows the disease severity values in a particular region which help to decide which and how much fungicide is required in order to save the crop from the appearance of the disease and its spreading to epidemic proportions. In order to make it more useful and helpful to the framers, it is inexpensive and open software for the prediction of late blight in potato. It has a very high accuracy rate and is user-friendly.

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