Project No. 4

Weather-pest-disease relations in ber:

Powdery mildew

Objectives:

1. Association of weather variables with powdery mildew incidence in ber
2. Development of weather based forecast models for powdery mildew in ber
3. Identification of lead time, important weather variables and their critical limits for forecast of powdery mildew on ber.

Results:

1997-1998-1999

- Disease incidence was less in Kadaka variety than Umaran variety
- In both varieties, the highest growth rate of disease incidence was during the month of September
- The lowest incidence of powdery mildew disease in ber was noticed if pruning was performed during mid-April in case of Kadaka variety and at April end in case of Umaran variety.
- The highest incidence of the disease was noticed if pruning was performed during May end in case of Kadaka variety and mid May in case of Umaran variety.
- Thus the optimum time of pruning window is very little for Umaran variety, whereas the pruning can be performed in larger time window for Kadaka variety.
- The growth rate of powdery mildew disease was noticed to be highest within the month of September in case of Umaran variety, but the growth rate is slower and extends till Mid October in case of Kadaka variety.
- Lower rainfall at four weeks lead time increased powdery mildew disease in ber.
- Higher rainfall at two weeks lead time increased the disease.
- Cooler nights at 4-5 weeks ahead are favorable for disease development.
- Higher temperature range is favorable for increase in disease level in the succeeding 4-5 weeks.
- The disease incidence had significant positive association with relative humidity range at three weeks lead time.
- Thus, warm and dry weather is favorable for higher disease incidence 3-4 weeks later.

2000

Correlation analysis was performed between disease incidence and antecedent meteorological variables at one to four weeks lead-time. All the data of the experiment from 1997 to 2000 were utilized to develop models for powdery mildew disease incidence for Umaran variety. The models are given in Table 4.1.

S. No.	Model developed	Forecast lead time	R^2
1.	Y= - 20.0 + 0.3 RH1(4)	4 Weeks	0.36
2.	Y= - 90.1 +2.7 RH2(3) + 7.2 TR(4) – 3.3 MinT(4)	3 Weeks	0.55
3.	Y= - 34.5 + 3.1RHR(3) + 4.4 RH2(3) - 0.9 RH1(2) - 1.3 RH2(4) - 3.7 TR(4) – 4.5 MinT (4)	2 Weeks	0.69

Table 4.1 Multiple regression models developed for powdery mildew disease incidence in Ber

Thus, it is noticed that the accuracy of the models increased as the lead time reduce. With this concept of lead time, we can progressively indicate the disease level with passage of time. For example, at the end of the current week (say, Week No. 43), we can forecast the disease incidence in the Week No. 47 with an accuracy of 36%. One week later, i.e. Week No. 44, we can update the forecast for disease incidence in Week No.47, with an accuracy of 55%. With passage of one more week, that is, at the end of Week No. 45, we can further refine the forecast for Week No. 47, with an accuracy of nearly 70%. Such an approach can be easily fit in for possible use in Agrometeorological Advisory Services.

2001

Correlation analysis was performed between disease incidence and antecedent meteorological variables at one to four weeks lead-time individually as well as in combinations. Meteorological data were averaged for different lead time combinations of 4 -3, 4-2, 4-1, 3-2, 3-1 and 2-1 weeks. Analysis was performed for individual years from 1997 to 2001, and also for progressively pooled data, i.e., 1997-98, 1997-99, 1997-2000 and 1997-2001. Consistency in the values of correlation coefficients was noticed after four years. The analysis was performed using seven different meteorological variables, namely, rainfall, maximum temperature, minimum temperature, temperature range, morning relative humidity, afternoon relative humidity and relative humidity range.

Keeping in view the rainfall pattern of the region –wherein September and October are the main rainy months – and the temporal profile of disease incidence, it was assumed that the temporal dynamism of temperature and humidity caused by the rainfall pattern would alter the progress of the disease in each month, and hence separate analysis was envisaged for the four months. Accordingly correlation analysis was performed, and the results with respect to afternoon relative humidity are presented in Table 4.2 for the 1997-2001.

Table 4.2 Correlation coefficients for antecedent afternoon relative humidity at different lead times for month-wise observations of powdery mildew on ber

Month	Lead time in weeks and week combinations									
	4	3	2	1	4321	432	321	21	32	43
September	-0.37	-0.37	0.41	0.21	0.22	0.34	0.38	0.15	0.30	-0.72
October	0.68	0.48	-0.14	-0.45	0.38	-0.02	-0.46	0.47	0.21	0.62
November	0.09	-0.24	-0.34	-0.45	-0.28	-0.40	-0.41	-0.16	-0.33	-0.01
December	-0.65	-0.45	-0.05	-0.31	-0.41	-0.29	-0.17	-0.39	-0.24	-0.55

Similar information was drawn with respect to other weather variables.

2002

The most suitable parameters influencing the disease incidence were identified, and the lead time at which they could be used for forecasting the disease was also determined.

For disease incidence in September, November and December months, Maximum temperature and afternoon relative humidity are important for analysis, whereas rainfall has dominating influence on disease in October. Further, it was noticed that the lead times at which these parameters influenced the disease incidence in various months were different. The responsible meteorological variables and the lead time of influence are provided in Table 4.3.

Month of disease incidence	Influencing Meteorological Variables	Lead time of influence (weeks)
September	Afternoon relative humidity	3-4
	Rainfall	4
October	Rainfall	3
November	Maximum temperature	1, 3
December	Relative humidity	3, 3-4

Table 4.3 Meteorological variables - their influence on powdery mildew disease on ber – Their lead-time for forecast

The fact that the parameters influencing the powdery mildew disease in different months were different, vindicate the proposition of the scientist. Accordingly, regression models were developed for individual months and presented in Table 4.4.

Table 4.4 Disease forecast models for powdery mildew on ber in different months

Month	**Model**	**R**
September	D= -0.19RF(4) – 0.12.60RH2(4:3) + 693.89	0.90**
October	D= -0.51RF(3) + 77.98	0.80**
November	D= 62.74TX(3) + 11.48TX(1) – 2264.2	0.92**
December	D= -3.44RH2(4) + 2.44RH2(4:3) + 91.92	0.74*

Where,
RF= Rainfall, RH2= Afternoon relative humidity, TX= Maximum temperature
Numerals in parentheses indicate lead time in weeks.
Combination of numbers indicates the average of the week numbers.

* Significant at 5% level; ** Significant at 1% level

It is thus clear that, the models have good forecast capability not only in terms of the high multiple correlation coefficients, but also in terms of the lead-time at which the forecast can be made. The models have good accuracy, except in case of December. They provide an opportunity to forecast the powdery mildew disease well ahead of the event at least one week ahead of occurrence.

The models were put to field-testing by the collaborating plant pathologist for accuracy, and they provided qualitative assessment.

Graphical presentation was followed for identifying the limits of relative humidity and maximum temperature for higher values of powdery mildew disease on ber. An example for the months of November is provided in Fig 4.1. It is clear that high disease incidence of more than 70 percent is influenced by maximum temperature of more than 31 C and afternoon relative humidity of less than 50 per cent. Based on such condition the forecast of disease can be made one week in advance.

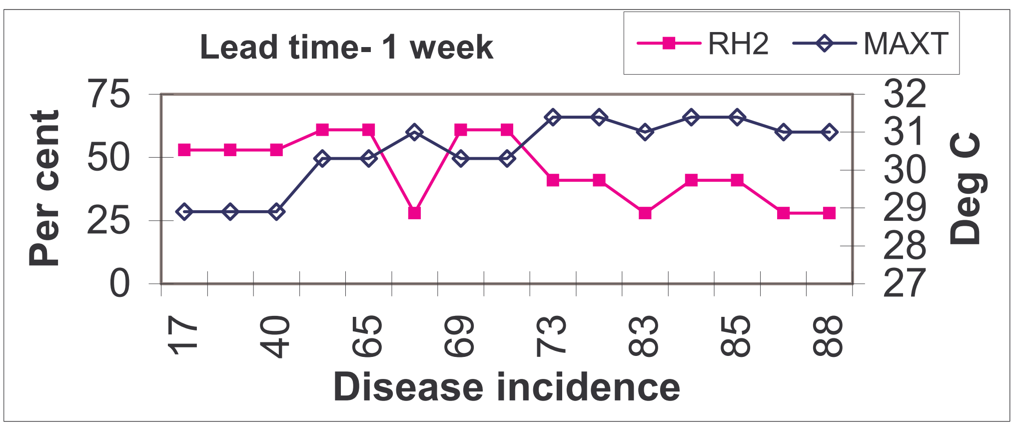

Fig 4.1 Role of maximum temperature and afternoon relative humidity at on high disease incidence of powdery mildew on ber

Similar presentations for disease incidence in September indicated that if these limits of maximum temperature and afternoon relative humidity prevail, then the forecast can be made three to four weeks in advance (i.e., in august itself). High disease incidence in December can be forewarned three to four weeks in advance, if the maximum temperature crosses 30 C and afternoon relative humidity is below 50 percent.

In view of the complicated nature of computations for the type of analysis presented above, a software package has been developed for help in pest-disease weather studies.