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RESEARCH ARTICLE :

Correlation of weather factors with downy mildew of cucumber

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SUMMARY : Downy mildew of cucumber caused by *Pseudoperonospora cubensis* is the economically most important and widespread in India and the world. As the rate of disease increase is dependent on weather factors, weather-based forewarning system enable to guide farmers to take protection measures timely. The objective of this experiment was to find out the influence of weather parameters on the initiation and spread of the cucumber downy mildew disease and develop a suitable weather based disease forewarning equation. The correlation study revealed that cucumber downy mildew disease intensity showed significantly negative correlations with minimum temperature (-0.721)and wind velocity (-0.690). In Best fit linear regression equation, intensity of downy mildew decreased with rise in Min temperature (-4.163) and evaporation (-0.882). Co-efficient of determination R^2 value (0.63) represent that 63 per cent influence on the intensity of downy mildew by two independent variables *viz*., min temperature and evaporation.

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KEY WORDS :
Downy mildew, Cucumber, Correlation, Regression, Weather

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BACKGROUND AND OBJECTIVES

Cucumber (*Cucumis sativus*) is one of the most important vegetable fruit grown in India and the world. Cucumber is more susceptible to downy mildew than other cucurbits (Ojiambo *et al*., 2010).Downy mildew of cucumber caused by the oomycetes *Pseudoperonospora cubensis* (Berkeley and Curtis) Rostov is one of the most economically important and widespread plant pathogens in India and all over the world (Palti and Cohen, 1980; Lehman, 1991; Tsai *et al*., 1992 and Lebed and Cohen, 2011). Downy mildew of cucumber causes serious losses under favourable environmental conditions. In many regions with high humidity, disease is the main limiting factor for cucumber production (Shetty and Wehner, 1997). The downy mildew incidence and severity ranged from 50 to 100 per cent and 20 to 78 per cent during 1998 crop season (Sharma *et al*., 2003).

RESOURCES AND METHODS

The experiment was conducted at the experimental farm, All India Coordinated Research Project (Vegetable Crops), Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India. Non-replicated trial of Cucumber cv. PUNE KHIRA was laid out during *Kharif* season

2014-15 having a plot size 25 x 25 m. The soil type was black basalt soil. No plant protection measures were applied. All the standard agronomic practices were adopted during the experiment.

Regular monitoring for the date of disease onset and subsequent symptom development of downy mildew was recorded during early morning. Once the initial downy mildew symptoms were observed on the plant in the field, the lesion colour changed from light yellow to dark yellow tolight brown to dark brown/necrotic with the progress of thedisease. The nature of the spread of the disease was studiedthrough visual observation from the initiation of the diseaseat seven days interval till final harvest or death of the plant. The severity of downy mildew was recorded by using the disease rating scale of 0 to 5 as described by Jamadar and Desai (1997) in Table A.

Table A : Disease rating scale for downy mildew

Grade	Per cent disease severity
0	No infection
1	0.1-10% leaf area covered with downy mildew growth
2	10.1-15% leaf area covered with downy mildewgrowth
3	15.1-25% leaf area covered with downy mildew growth
4	25.1-50% leaf area covered with downy mildewgrowth
5	More than 50% leaf area covered with downy mildew growth

The Per cent disease index (PDI) was calculated as given below by Wheeler (1969).

$$\text{Per cent disease index (\%)} = \frac{\text{Sum of numerical rating}}{\text{Total no. of samples x Max. rating grade}} \times 100$$

Meteorological data related to the temperature, relative humidity, rainfall, bright sunshine hrs, evaporation and wind velocity during growth period of the crop were obtained from the adjoining Meteorological Observatory of the Department of Agricultural Meteorology, VNMKV, Parbhani.

Statistical analysis :

At the end of season, the data obtained were subjected to statistical analysis. The correlations as well as multiplelinear regression between weather factors and downy mildew of cucumber were estimated. Data was analyzed by OPSTAT statistical data analysis software.

OBSERVATIONS AND ANALYSIS

Data regarding the weather parameters during *Kharif* season and downy mildew intensity presented in Table 1 revealed that, Periodic intensity of downy mildew was recorded at seven days interval in cucumber starting from 28th Standard Meteorological Week (SMW) *i.e.* 9thAugust to 39th SMW *i.e.* 30th September till harvest of the crop. Initiation of downy mildew was recorded during 35th SMW indicated that high morning relative humidity (96%), high evening relative humidity (84%) and slightly low temperature triggered the initiation of downy mildew of cucumber. Since then there was linear progress of disease upto harvest. Disease was initiated on 28th August and reached at its highest on 30th September (15.34 %). The intensity of disease was increased progressively. Environmental factors play a great role in buildup pathogen population and subsequent disease development.

Correlation co-efficient between downy mildew intensity and different meteorological parameters

Table 1 : Weather parameters and downy mildew severity of cucumber during *Kharif* 2014-15

Meteorological week	Rain fall (mm)	Temperature ^{0}C		Relative humidity (%)		Evaporation (mm)	Bright sunshine (hrs)	Wind velocity (Kmph)	Downy mildew PDI
		Max.	Min.	AM	PM				
28	73.8	33.7	23.0	84	56	4.4	7.8	7.8	0
29	1.5	31.3	23.0	84	61	1.9	8.0	8.0	0
30	26.2	30.8	21.5	87	69	3.9	6.9	6.9	0
31	32.4	31.6	22.2	83	65	3.5	7.3	7.3	0
32	16.7	32.0	20.9	83	54	7.9	5.8	5.8	0
33	0.0	34.1	22.4	77	44	8.8	6.4	6.4	0
34	59.8	33.5	22.0	89	61	7.2	3.6	3.6	0
35	91.0	27.9	21.5	96	84	0.7	3.8	3.8	8.19
36	33.9	28.6	21.2	89	74	2.8	5.5	5.5	12.70
37	7.4	30.5	21.0	82	68	5.5	3.9	4.3	11.43
38	3.4	31.8	21.2	85	58	4.9	6.8	4.4	13.06
39	0.0	34.4	18.4	80	38	6.1	9.1	2.9	15.34

determined are presented in Table 2. Among these parametersrainfall showed non-significant and negative correlation with downy mildew incidence (-0.203). The maximum temperature showed non-significant and negative correlation (-0.276) with disease. The minimum temperature showed highly significant and negative correlation (-0.721) with disease. Morning and evening relative humidity were non-significant and positively correlated with downy mildew incidence (0.100 and 0.047, respectively). Evaporation and wind velocity showed non-significant and negative correlation with downy mildew. Whereas, bright sunshine hrs was significant and negatively correlated with downy mildew severity (-0.690).

It is obvious that no single weather parameter could independently influence the disease development. The influence of interactions among various weather parameters was probably involved in affecting the disease

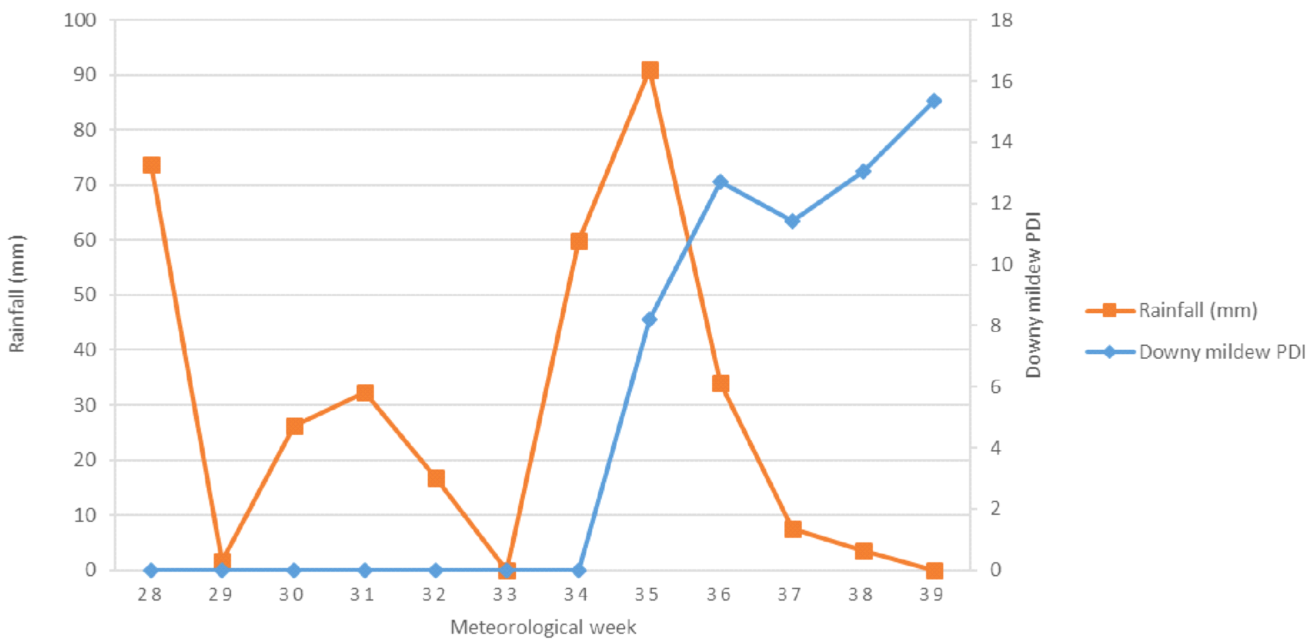

Fig. 1 : Rainfall (mm) vs Downy mildew intensity

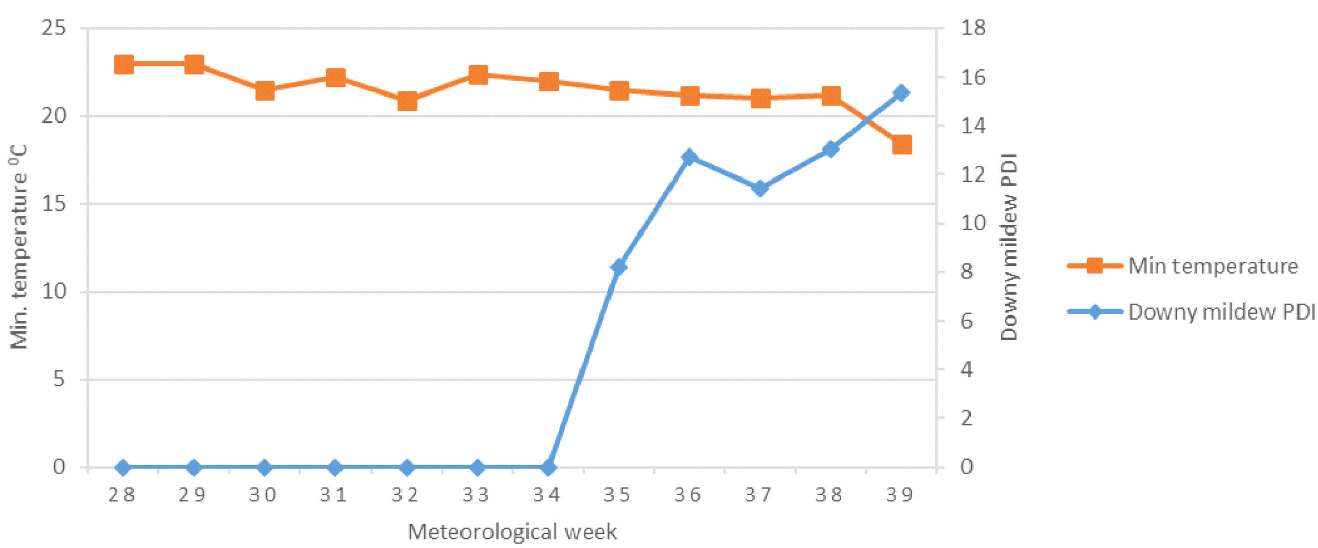

Fig. 2 : Min Temperature (°C) vs Downy mildew intensity

Table 2 : Correlation of environmental factors with downy mildew severity of cucumber during *Kharif* 2014-15

Weather parameters	Correlation co-efficient
Rainfall (mm)	- 0.203
Maximum temperature ^{0}C	- 0.276
Minimum temperature ^{0}C	- 0.721 **
Morning relative humidity (%)	0.100
Evening relative humidity (%)	0.047
Evaporation (mm)	- 0.172
Bright sunshine (hrs)	- 0.040
Wind velocity (kmph)	- 0.690*

** = Highly Significant (P<0.01); * = Significant (<0.05)

development. Therefore,for multiple linear regression, the best fit model was selected and the co-efficient of determination (R^2)was developed for the prediction of downy mildew disease incidence in cucumber as given below.

Regression equation:

Downy mildewintensity = 98.909-4.163Min temperature* -0.882Evaporation*

The Best fit regression analysis revealed that, Min. temperature and Evaporation were negatively correlated with Downy mildew disease intensity with R^2 value of 0.63. Co-efficient of determination R^2 value (0.63) represent that 63 per cent influence on the intensity of downy mildew by two independent variables *viz*., Min temperature and Evaporation. These results are in conformity with those reported by Bains and Jhooty (1978); Ullasa and Amin (1988); Prakash and Saharan (2002); Krishnaveni *et al*. (2008) and Ghosh *et al*. (2015).

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