



## Influence of weather parameters on the development of anthracnose in cucumber

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### Abstract

The field experiment was conducted to study the influence of weather parameters on the severity and development of anthracnose of cucumber during *Kharif* 2023-24 at the University of Agricultural Sciences, Raichur. The minimum temperature and wind speed showed a significant negative correlation and among the interaction effect rainfall and relative humidity showed a significant positive correlation. The multiple regression analysis showed a coefficient of multiple determinants ( $R^2$ ) was 0.82 indicating that these weather factors are responsible for up to the extent of 82.00 per cent of the anthracnose disease development.

**Keywords:** Anthracnose, cucumber, PDI, weather parameters, correlation, regression

### Introduction

Cucumber (*Cucumis sativus* L.) belonging to the family Cucurbitaceae, is the most widely cultivated vegetable within the genus *Cucumis*. It is the fourth most commonly grown vegetable worldwide, after tomatoes, cabbage, and onions (Ejaz and Bahadur, 2024) [2]. In Karnataka, cucumber is cultivated on 8,12 ('000ha), with an annual production of 117.55 MT (Anonymous, 2021) [1]. It is predominantly grown as a sole crop during the *Zaid* and *Kharif* seasons. Cucumber is highly valued for its water content, nutrient composition, and phytochemicals, making it an essential component of salads, soups, and smoothies (Muruganantham *et al.*, 2016) [10]. Additionally, it contains cucurbitacins, bitter-tasting compounds associated with anticancer and antidiabetic properties, attributed to kaempferol (Ibitoye *et al.*, 2018 [4]; Jia and Wang, 2021) [5]. Despite its nutritional benefits, cucumber production is significantly affected by fungal, bacterial, and viral diseases, causing substantial economic losses globally. Among these, anthracnose caused by *Colletotrichum orbiculare* (Berk. & Mont.) is one of the most devastating diseases of cucurbits. Mundkar in 1937 originally documented the disease in India on 'Kakri' (*Cucumis melo* var. *utilissima*) and 'kaddu' (*Lagenaria vulgaris* Ser.) from Punjab. *Colletotrichum lagenarium* is regarded as a synonym of *Colletotrichum orbiculare* (Von Arx, 1957) [15]. The pathogen infects all aboveground parts of the plant, causing leaf lesions with shot-hole symptoms and sunken, water-soaked lesions on fruits, which darken and develop pink spore masses (Keinath *et al.*, 2017 [7]; Palenchar *et al.*, 2012 [11]; Goldberg, 2004) [3]. Yield losses due to anthracnose can reach up to 60 per cent in cucumbers and 30 per cent in watermelons (Parris, 1949 [12]; Thompson and Jenkins, 1985) [13].

The occurrence and severity of anthracnose are influenced by biotic and abiotic factors, with meteorological parameters being critical components of the disease triangle. The disease thrives in moist and humid conditions and spreads through wind, rain, and human activity. Given the critical role of weather conditions in disease development and dissemination, this study aims to evaluate the influence

of weather parameters on the development and severity of anthracnose in cucumbers.

### Materials and methods

A study was conducted at the PG Block, Department of Plant Pathology, University of Agricultural Sciences, Raichur, during the *Kharif* season of 2023-24 to evaluate the influence of weather parameters on the severity and progression of anthracnose in cucumbers, using the Nethra 007 variety. The research site, located in Karnataka's North-Eastern Dry Zone (Zone 2), is positioned at 16°12' N latitude, 77°21' E longitude, and 389.37 m altitude, with an average annual rainfall of 660 mm.

Disease severity was assessed weekly from the onset of symptoms using a 0–9 rating scale (McKinney, 1923) [8], and the scores were converted into a percentage disease index (PDI). Weather data, including maximum and minimum temperatures, morning and evening relative humidity, rainfall, wind speed, and sunshine duration, were recorded for each standard meteorological week (SMW) and obtained from the Meteorological Division of the Main Agricultural Research Station (MARS), Raichur. The data were analyzed using simple correlation and multiple regression methods to determine their relationship with disease development.

### Results and discussion

**Disease development (PDI):** The disease began in the 32<sup>nd</sup> week at a 2.11 per cent PDI and steadily increased to 40.45 per cent by the 39<sup>th</sup> week (Table 1).

**Correlation and multiple regression analysis:** The analysis of Table 2 reveals the correlation coefficients for *Kharif* 2024, highlighting the relationships between weather parameters and the percent disease index (PDI). Minimum temperature (-0.799\*\*) exhibited a significant negative correlation with PDI at the 0.01 level, while wind speed (-0.690\*) was significantly negatively correlated with PDI at the 0.05 level. In contrast, sunshine hours (0.698\*) were positively correlated with PDI at the 0.05 level. Other weather parameters, including rainfall (-0.072) and evening

relative humidity (-0.077), showed negative correlations with PDI, whereas maximum temperature (0.140) and morning relative humidity (0.031) were positively correlated.

The weather variables were found to be interdependent, and their interaction effects played a substantial role in the development of anthracnose disease. In the present study, the interaction between evening relative humidity and rainfall (0.821) and morning relative humidity (0.913) demonstrated a significant positive correlation with disease severity. Similarly, the interaction between morning relative humidity and rainfall (0.849) exhibited a significant positive correlation with disease development. The relation of weather parameters to the PDI is illustrated in the figure 1.

The results of the multiple regression analysis aimed to establish a relationship between the dependent variable, PDI, and various independent weather variables. The regression equation incorporated coefficients for weather parameters (X1 to X7) and the intercept (a). These coefficients quantify the influence of each independent variable—maximum temperature (X1), minimum temperature (X2), morning relative humidity (X3), evening relative humidity (X4), wind speed (X5), rainfall (X6), and sunshine hours (X7)—on PDI.

The multiple linear regression analysis for *Kharif* 2024 indicated that the regression coefficients for maximum temperature, minimum temperature, rainfall, morning relative humidity, evening relative humidity, sunshine hours, and wind speed were 2.34, -15.15, -0.92, -0.95, -0.23, -9.16, and -3.61, respectively. This analysis revealed that a one-unit increase in minimum temperature, morning relative humidity, evening relative humidity, wind speed, rainfall, and sunshine hours resulted in a decrease in PDI by 15.15, 0.92, 0.95, 0.23, 9.16, and 3.61 units, respectively. Conversely, a one-unit increase in maximum temperature led to an increase in PDI by 2.3 units.

The coefficient of determination ( $R^2$ ) represents the proportion of variance in the dependent variable (PDI) explained by the independent variables. The model achieved an  $R^2$  value of 0.82, indicating that 82% of the variation in PDI could be explained by the weather parameters included in the regression model. From Table 3, it is evident that incorporating all the weather variables (X1 to X7) resulted in a robust model with an  $R^2$  value of 0.82, demonstrating a good fit.

These findings are in accordance with Joshi (2019) [6] examined the relationship between disease intensity and weather parameters during *Kharif* and *Rabi* 2018-19. The study reported disease severities of 62.31 and 55.71 was recorded during 2018 and 2019. Correlation analysis showed that minimum temperature was significantly and negatively correlated with PDI. In contrast, The significant and positively correlated weather parameters were relative humidity, wind speed, and bright sunshine hours. During the *Rabi* season, minimum temperature, morning relative humidity, and wind speed were significantly positively correlated. However, evening relative humidity, bright sunshine hours and maximum temperature were non-significant. The multiple regression analysis revealed that weather factors influenced the disease intensity by 84 per cent.

In the same way, Vishal (2018) [14] recorded the progress of cucumber anthracnose disease with the weather parameters and correlation analysis performed. They found that maximum temperature and maximum relative humidity were significant and positively correlated whereas the minimum temperature and minimum relative humidity were non-significant. The value of multiple determinations ( $R^2$ ) was 0.7359 showing perfect association between disease severity and environmental factors.

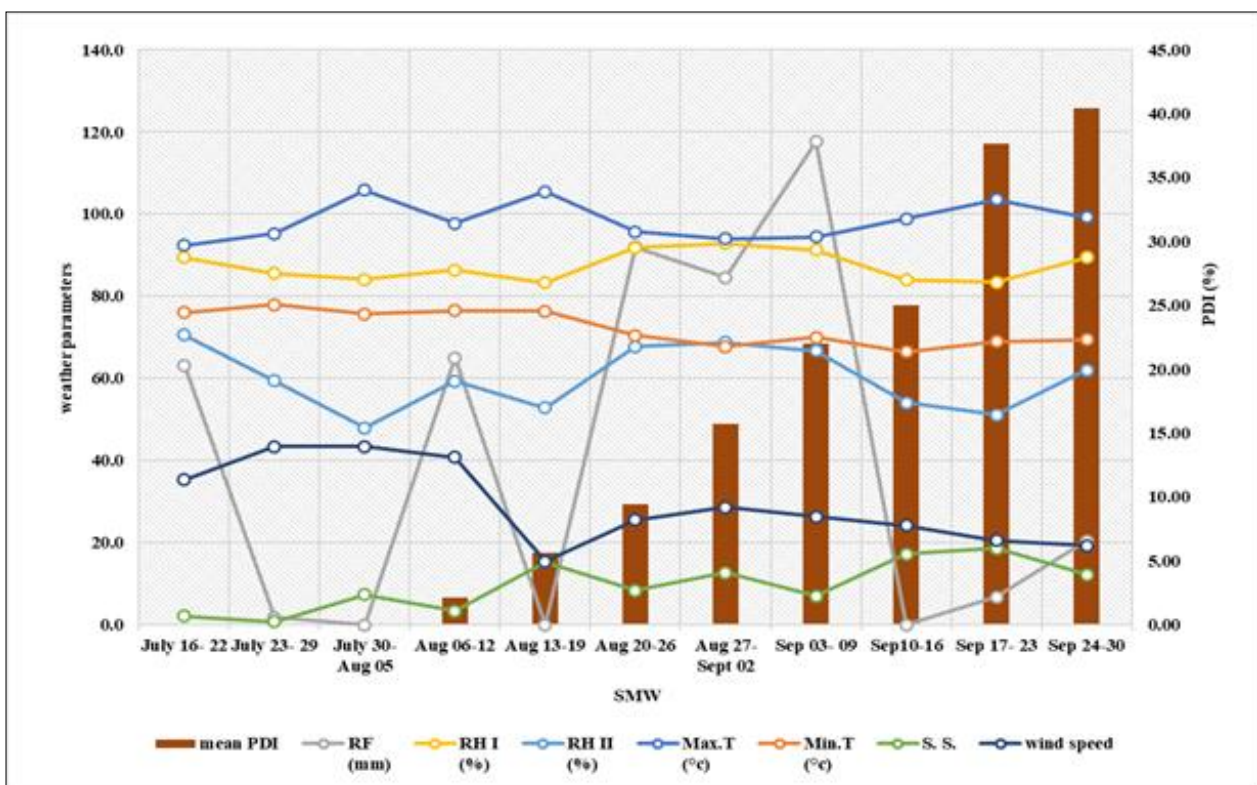


Fig 1: Effect of weather parameters on anthracnose of cucumber

**Table 1:** Progression of anthracnose of cucumber in relation to weather parameters

Sl. No.	Standard meteorological week	Date	Temperature (°C)		Rainfall (mm)	Relative humidity (%)		Sunshine (hrs)	Wind speed (km/hr)	PDI	Increase in PDI
			Maximum	Minimum		Morning RH	Evening RH				
1	29	16-07-2024 to 22-07-2024	29.7	24.4	63.2	89	71	0.7	11.4	0.0	0.00
2	30	23-07-2024 to 29-07-2024	30.6	25.1	1.8	86	59	0.3	14.0	0.0	0.00
3	31	30-07-2024 to 05-08-2024	34.0	24.3	0.0	84	48	2.4	14.0	0.0	0.00
4	32	06-08-2024 to 12-08-2024	31.4	24.6	65.0	86	59	1.1	13.1	2.11	2.11
5	33	13-08-2024 to 19-08-2024	33.9	24.5	0.0	83	53	4.9	4.9	5.60	3.49
6	34	20-08-2024 to 26-08-2024	30.8	22.7	92.0	92	68	2.7	8.2	9.44	3.84
7	35	27-08-2024 to 02-09-2024	30.2	21.8	84.6	93	69	4.1	9.2	15.75	6.31
8	36	03-09-2024 to 09-09-2024	30.4	22.5	117.6	91	67	2.3	8.5	22.0	6.25
9	37	10-09-2024 to 16-09-2024	31.8	21.4	0.0	84	54	5.5	7.8	25.0	3.00
10	38	17-09-2024 to 23-09-2024	33.3	22.2	6.8	83	51	6.0	6.6	37.65	12.65
11	39	24-09-2024 to 30-09-2024	31.9	22.3	20.4	89	62	3.9	6.2	40.45	2.80

**Table 2:** Correlation coefficient between weather parameters and anthracnose of cucumber

	Max. temp	Min. temp	Rainfall	Morning. RH	Evening. RH	Sunshine (hrs)	Wind speed (km/h)	PDI
<b>Max. temp</b>	<b>1</b>							
Min. temp	0.101	1						
Rainfall	-0.699*	-0.215	1					
Morning. RH	-0.775**	-0.320	0.849**	1				
Evening. RH	-0.901**	-0.151	0.821**	0.913**	1			
Sunshine (hrs)	0.536	-0.696*	-0.335	-0.298	-0.417	1		
Wind speed (km/h)	-0.252	0.600	0.026	-0.012	0.003	-0.798**	1	
PDI	0.140	-0.799**	-0.072	0.031	-0.077	0.698*	-0.690*	1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

**Table 3:** Multiple linear regression of disease intensity of cucumber anthracnose in relation to weather parameters

SL. No.	Intercept (a)	X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>	X <sub>6</sub>	X <sub>7</sub>	R <sup>2</sup>
<b>1.</b>	<b>456.374</b>	<b>2.348</b>	<b>-15.15</b>	<b>-0.92</b>	<b>-0.955</b>	<b>-0.235</b>	<b>-9.168</b>	<b>-3.612</b>	<b>0.82</b>

Where, X<sub>1</sub> = Maximum temperature, X<sub>2</sub>= Minimum temperature, X<sub>3</sub>= Morning relative humidity, X<sub>4</sub>= Evening relative humidity, X<sub>5</sub>= Wind speed, X<sub>6</sub> = Rainfall, and X<sub>7</sub>= sunshine hours.

## Conclusion

Epidemiological studies revealed that minimum temperature (-0.799) and wind speed (-0.690) were negatively correlated with the percent disease index (PDI) at significance levels of 0.01 and 0.05, respectively, while sunshine (0.698) showed a positive correlation at 0.05 significance. Positive correlations were also observed between disease severity and interactions of evening relative humidity with rainfall and morning relative humidity, as well as between morning relative humidity and rainfall. Multiple regression analysis indicated that 82 per cent of the variation in PDI was explained by the model.

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