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Assessing the Seasonal Incidence of Anthracnose and its Relationship with Weather Parameters in Chilli Cultivation

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ABSTRACT: The study investigates the impact of weather conditions on *Colletotrichum capsici* development in chili crops during the 2021-22 and 2022-23 Rabi seasons at the Vegetable Research Farm in Kalyanpur, CSAUA & T Kanpur, Uttar Pradesh. In the 2021-22 seasons, disease emergence was noted during the 45th meteorological week of November 2021, characterized by moderate humidity (67.50%), a maximum temperature of 28.8°C, a minimum temperature of 12.8°C, zero rainfall, and wind speed at 1.80 km/hr, 4.40 hours of sunshine, and 20.40 mm total evaporation. The peak disease index (55.63%) materialized during the 13th meteorological week of March 2022, marked by weather conditions conducive to pathogen growth. The maximum infection rate occurred during the 46th and 47th meteorological weeks of November 2021, recorded at 0.099.

In the subsequent 2022-23 season, disease onset was observed during the 45th meteorological week of November 2022, featuring higher humidity (94.0%), a maximum temperature of 29.9°C, a minimum temperature of 16.3°C, no rainfall, and wind speed at 1.40 km/hr, 4.40 hours of sunshine, and 16.80 mm total evaporation. The highest disease index (58.74%) materialized during the 13th meteorological week of March 2023, characterized by favorable weather conditions, including high humidity (82.00%), a maximum temperature of 32.2°C, a minimum temperature of 16.7°C, 39.20 mm of rainfall, wind speed at 4.60 km/hr, 7.30 hours of sunshine, and 19.80 mm total evaporation. The maximum infection rate occurred during the 46th and 47th meteorological week of November 2022 recorded at 0.084 & 0.135. These findings provide valuable insights into the weather-driven dynamics of *Colletotrichum capsici* in chili crops, offering significant guidance for the management and understanding of anthracnose in agricultural contexts.

Keywords: *Colletotrichum capsici*, Anthracnose, Weather parameters, Rabi season, Disease incidence, Infection rate, Uttar Pradesh.

INTRODUCTION

Chilli (*Capsicum annuum* L.) is one of the most economically important and widely cultivated vegetable crops globally, prized for its pungent flavor and versatile culinary applications. However, the successful cultivation of chilli faces numerous challenges, with plant diseases posing a significant threat to yield and quality. Among these, anthracnose, caused by various species of Colletotrichum fungi, stands out as a primary concern. Anthracnose disease poses a substantial economic challenge to chili production on a global scale, with particular prominence in tropical and subtropical regions (Than *et al.*, 2008). It manifests as distinctive lesions on various parts of the plant, including leaves, stems, and fruits, ultimately leading to reduced marketability and economic losses for farmers (Sarkar, 2016). The severity of anthracnose outbreaks can vary significantly depending on a multitude of factors, including host susceptibility, cultural practices, and environmental conditions. In recent years, there has been a growing recognition of the pivotal role that weather parameters play in the development and spread of anthracnose in chilli crops. Weather variables such as temperature, relative humidity, rainfall, wind speed, and sunshine hours can create favorable conditions for pathogen proliferation and disease establishment (Bhattiprolu and Monga 2018; Sahoo *et al.*, 2012). Understanding the intricate relationship between these weather parameters and anthracnose incidence is essential for developing effective management strategies and ensuring sustainable chilli production (Singh *et al*., 2018). This research aims to assess the seasonal incidence of anthracnose in chilli cultivation and unravel the intricate relationship between this devastating disease and key weather parameters. To create dependable and efficient disease control plans. Finding the link between disease progression, meteorological conditions, and yield loss estimation is of the utmost importance. To build an effective forecasting model, the study was designed to investigate the impact of weather variables in the development of chilli anthracnose and formulate a viable prediction equation for its future projection. The findings of this study hold the promise of enhancing our ability to predict and manage anthracnose in chilli crops, ultimately contributing to the resilience and productivity of this vital agricultural commodity.

MATERIALS AND METHODS

To investigate the seasonal incidence of anthracnose and its relationship with key weather parameters, a systematic study was conducted during the Rabi seasons of 2021-22 and 2022-23 at the Vegetable Research Farm, located in Kalyanpur, CSAUA & T Kanpur, Uttar Pradesh. In this study, the highly susceptible chili variety known as "Kalyanpur Chaman" was selected as the experimental crop.
The following methodology was employed:

A. Data Collection
Weekly observations were carried out throughout the Rabi seasons, spanning both 2021-22 and 2022-23. These observations focused on assessing the intensity of anthracnose in the selected chili plants.

B. Disease Identification
The observations specifically targeted anthracnose caused by *Colletotrichum capsici* a known pathogen affecting chili crops. The disease severity, measured using the Percentage Disease Index (PDI), was recorded at seven-day intervals, extending until the crop's harvesting stage. The Formula is given below
PDI (Per cent Disease Incidence) =

$$\frac{\text{Number.of infected fruit sample}}{\text{Total no.of fruit per plant}} \times 100$$

C. Meteorological Parameters
Various meteorological parameters were collected for the study and included in the analysis. These parameters consisted of the following:
X1 = Maximum Temperature (°C) (Tmax)
X2 = Minimum Temperature (°C) (Tmin)
X3 = Relative Humidity (%) (RH)
X4 = Total Rainfall (mm) (Rt)
X5 = Wind Velocity (Km/hr) (Wv)
X6 = Evaporation (mm)
X7 = Sunshine Hours (hr)

D. Data Analysis
The data collected for disease severity were statistically correlated with the meteorological parameters mentioned above. To ensure accuracy and relevance, seven-day means were computed for each weather parameter, except for the cumulative rainfall over seven days and the count of rainy days, which were calculated for the entire duration of the disease assessment.
This comprehensive approach allowed for the assessment of how the seasonal incidence of anthracnose in chili cultivation was influenced by key weather factors, providing valuable insights into disease management strategies and the cultivation of resilient chili crops.

RESULT AND DISCUSSION

The presented data and figures provide valuable insights into the effect of weather parameters on the development of *Colletotrichum capsici*, the pathogen responsible for causing Anthracnose in chilli crops during the 2021-22 and 2022-2023.
The data (Table 1& Fig. 1) revealed that the disease initiation in the field occurred during the 45th standard meteorological week of November 2021, with specific weather conditions. (O′Connell *et al.*, 2000) supports the notion that high humidity, moderate temperatures, and minimal rainfall can create favourable conditions for the development and spread of fungal pathogens like *Colletotrichum capsici*. Fungal spore germination and infection are often enhanced under conditions of high humidity (Dean *et al.*, 2012). The maximum percent disease index (PDI) of 55.63% was observed during the 13th standard meteorological week of March 2022. This peak disease incidence coincided with specific weather variables that were highly conducive to the growth and spread of the pathogen. These conditions included an average maximum relative humidity of 50.10%, a maximum temperature of 38.2°C, and a minimum temperature of 18.4°C. Biju *et al.* (2013) suggest that the, maximum temperature has negative correlation, while minimum temperature, rainfall and number of rainy days have positive correlation with the disease incidence. Prusky (1996) supports the idea that specific weather conditions, such as elevated temperatures and high humidity, can promote the proliferation of fungal diseases Elevated temperatures can accelerate fungal growth and reproduction, while high humidity provides a suitable environment for spore dispersal and infection (Roberts *et al.*, 2001). The data revealed in Table 2 states that the maximum rate of infection (0.099) was recorded during the 46th and 47th standard meteorological week of November 2021. Murmu *et al.* (2021) emphasizes that rapid disease development can occur when multiple weather factors align favorably for the pathogen. Effect of weather parameters on the development of *Colletotrichum capsici* of chili 2022-23 (Table 3 & Fig. 2) revealed that the average maximum relative humidity was 94.0%, and the maximum temperature was 29.9°C, with a minimum temperature of 16.3°C. The study found that the maximum percent disease index, reaching 58.74%, occurred during the 13th standard meteorological week of March 2023. During this period, the weather variables that favoured disease development included an average maximum relative humidity of 82.00%, a maximum temperature of 32.2°C, and a minimum temperature of 16.7°C. The study also observed the maximum rate of infection during the 46th & 47th standard meteorological week of November 2022, with a recorded infection rate of. 0.084 & 0.135 (Table 4). This finding suggests that the pathogen's growth and infection rate were influenced by meteorological conditions during this period. High

humidity can promote the germination of pathogen spores, while temperature affects the rate of pathogen growth (Begum *et al.*, 2017; Boland *et al.*, 2004). Studies have shown that disease severity often varies seasonally, with certain weather conditions being more conducive to disease outbreaks (Mahlein *et al.*, 2012). Rainfall and wind speed can impact the dispersal of pathogen spores and the spread of diseases in agricultural fields (Esdraelona *et al.*, 2007). Temperature plays a critical role in determining the development and growth of plant pathogens, with optimal ranges for different pathogens (Savary *et al.*, 2012).

Table 1: Effect of weather parameters on the development of *Colletotrichum capsici* of Chilli 2021-22.

Week No.	Dates	PDI	max temp	min temp	RH per cent	Rainfall (mm)	Wind (Km/hr)	Evapo- mm	Sunshine hr
40	4 Oct-10 Oct.	0.00	34.40	25.10	73.50	8.20	4.10	21.40	7.00
41	11 Oct.- 17 Oct.	0.00	34.40	22.70	63.50	0.00	3.40	23.80	7.70
42	18 Oct. -24 Oct.	0.00	32.40	22.50	71.50	0.00	5.30	22.40	4.60
43	25 Oct.- 31 Oct.	0.00	30.60	18.00	67.50	0.00	3.30	22.40	6.40
44	1 Nov -7 Nov.	0.00	29.70	14.20	68.00	0.00	1.70	21.60	7.20
45	8 Nov.- 14 Nov.	0.20	28.80	12.80	67.50	0.00	1.80	20.40	4.40
46	15 Nov.- 21 Nov.	0.40	27.50	11.90	69.50	0.00	1.10	19.60	5.40
47	(22 Nov.-28Nov.)	0.80	26.90	13.30	62.50	1.20	2.50	19.60	4.60
48	(29 Nov. -05Dec.)	1.07	26.30	11.90	71.00	0.00	1.20	18.80	2.50
49	(06 Dec. -12 Dec.)	1.90	26.00	13.50	69.40	0.00	2.40	16.80	4.80
50	(13 Dec -19 Dec.)	3.75	23.70	8.60	69.40	0.00	1.70	16.20	4.30
51	(20 Dec -26 Dec.)	4.75	22.10	7.10	63.70	0.00	4.10	15.40	4.40
52	(27 Dec -2 Dec)	8.80	20.00	9.00	85.80	8.60	1.70	16.40	1.20
1	(03 Jan. -09 Jan.)	10.35	20.40	8.50	83.20	23.50	3.00	11.20	2.60
2	(10 Jan. -16 Jan.)	12.45	19.60	10.30	84.40	14.60	4.10	10.00	2.30
3	(17 Jan.-23 Jan.)	16.08	15.70	4.90	82.50	0.00	3.50	9.80	2.10
4	(24 Jan.-30 Jan.)	17.58	17.90	7.70	80.60	3.00	4.80	8.60	2.30
5	(31 Jan.-06Feb.)	21.80	21.20	7.50	74.60	13.00	5.90	8.40	6.30
6	(07Feb.-13 Feb.)	28.25	22.70	8.10	72.30	0.00	4.30	9.40	6.10
7	(14 Feb.-20 Feb.)	32.15	25.00	8.10	71.40	0.00	3.90	11.00	8.40
8	(21 Feb. -27 Feb.)	36.61	27.40	12.30	64.70	0.00	6.20	13.40	8.30
9	(28 Feb.-06Mar.)	40.21	27.80	11.70	68.00	0.00	3.50	14.60	8.00
10	(07Mar.-13 Mar.)	46.78	29.20	13.90	65.60	0.00	4.80	15.40	6.00
11	(14 Mar.-20 Mar.)	50.15	33.40	17.40	63.60	0.00	4.40	16.80	7.00
12	(21 Mar.-27 Mar.)	53.19	36.40	18.60	54.80	0.00	3.70	18.20	6.00
13	(28 Mar.-03Apr.)	55.63	38.20	18.40	50.10	0.00	5.00	19.00	7.20

1st appearance of disease on 8 Nov.

Table 2: Effect of standard metrological week on Rate of Infection (r) 2021-2022.

Week No.	Dates	PDI	Rate of infection rate
40	4 Oct -10 Oct.	0.00	0
41	11 Oct.- 17 Oct.	0.00	0
42	18 Oct. -24 Oct.	0.00	0
43	25 Oct.- 31 Oct.	0.00	0
44	1 Nov -7 Nov.	0.00	0
45	8 Nov.- 14 Nov.	0.20	0
46	15 Nov.- 21 Nov.	0.40	0.099
47	(22 Nov.-28Nov.)	0.80	0.099
48	(29 Nov. -05Dec.)	1.07	0.041
49	(06 Dec. -12 Dec.)	1.90	0.082
50	(13 Dec -19 Dec.)	3.75	0.097
51	(20 Dec -26 Dec.)	4.75	0.034
52	(27 Dec -2 Dec)	8.80	0.088
1	(03 Jan. -09 Jan.)	10.35	0.023
2	(10 Jan. -16 Jan.)	12.45	0.026
3	(17 Jan.-23 Jan.)	16.08	0.037
4	(24 Jan.-30 Jan.)	17.58	0.013
5	(31 Jan.-06Feb.)	21.80	0.031
6	(07Feb..-13 Feb.)	28.25	0.037
7	(14 Feb.-20 Feb.)	32.15	0.018
8	(21 Feb. -27 Feb.)	36.61	0.019
9	(28 Feb.-06Mar.)	40.21	0.013
10	(07Mar.-13 Mar.)	46.78	0.022
11	(14 Mar.-20 Mar.)	50.15	0.010
12	(21 Mar.-27 Mar.)	53.19	0.008
13	(28 Mar.-03Apr.)	55.63	0.006

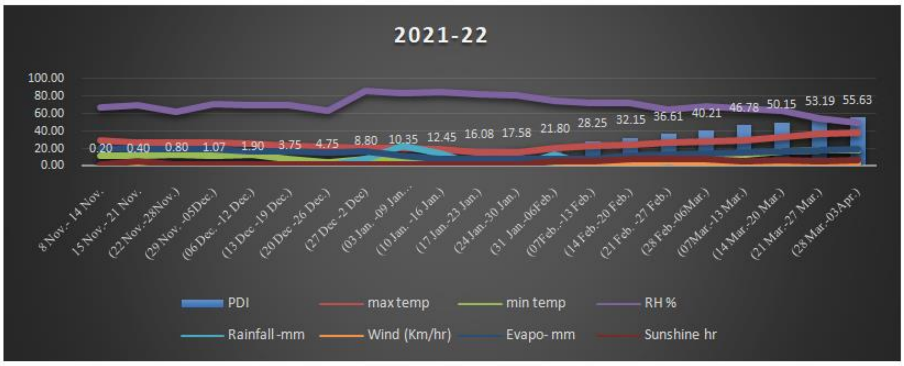

Fig. 1. Effect of weather parameters on the development of *Colletotrichum capsici* of chilli 2021-22.

Table 3: Effect of weather parameters on the development of *Colletotrichum capsici* of chili 2022-23.

Week No.	Dates	PDI	max temp	min temp	RH per cent	Rainfall - mm	Wind (Km/hr)	Evapo-mm	Sunshine hr
40	3 Oct -9 Oct	0.00	34.40	25.10	73.50	8.20	4.10	21.40	7.00
41	10 Oct -16 Oct	0.00	34.40	22.70	63.50	0.00	3.40	23.80	7.70
42	17 Oct - 23 Oct	0.00	32.40	22.50	71.50	0.00	5.30	22.40	4.60
43	24 Oct. - 30 Oct.	0.00	30.60	18.00	67.50	0.00	3.30	22.40	6.40
44	31 Oct- 6 Oct.	0.00	31.30	15.30	91.00	0.00	1.60	17.40	4.50
45	7 Nov - 13 Nov.	0.50	29.90	16.30	94.00	0.00	1.40	16.80	0.90
46	14 Nov- 20 Nov.	0.90	27.80	12.90	81.00	0.00	3.30	16.80	3.20
47	(21Nov.-27Nov.)	2.31	27.00	9.90	87.00	0.00	2.30	16.80	6.50
48	(28 Nov. -04Dec	3.14	26.80	10.30	92.00	0.00	1.20	15.60	2.40
49	(05 Dec. -11 Dec.)	4.99	24.90	9.70	91.00	0.00	2.60	15.40	1.50
50	(12 Dec -18 Dec.)	5.99	25.20	10.10	87.00	0.00	3.80	16.20	5.60
51	(19 Dec -25 Dec.)	10.04	23.30	7.50	95.00	0.00	1.80	16.00	2.40
52	(26 Dec -1/1/2023)	11.59	20.60	7.60	93.00	0.00	3.80	17.60	2.60
1	(02 Jan. -08 Jan.)	13.69	13.90	5.40	96.00	0.00	2.80	12.40	0.00
2	(9 Jan. -15 Jan.)	17.32	17.80	6.30	95.00	0.00	3.00	10.20	0.30
3	(16 Jan.-22 Jan.)	18.82	20.40	4.40	93.00	0.00	3.40	8.80	3.30
4	(23 Jan.-29 Jan.)	23.04	22.30	10.80	93.00	10.20	4.10	8.40	1.30
5	(30 Jan.-05Feb.)	29.49	22.70	9.70	91.00	1.00	5.90	9.60	5.90
6	(06Feb..-12 Feb.)	33.39	28.10	10.90	90.00	0.00	4.20	10.60	9.30
7	(13 Feb.-19 Feb.)	37.85	26.70	11.10	83.00	0.00	5.80	13.60	8.00
8	(20Feb. -26 Feb.)	41.45	31.00	11.80	92.00	0.00	2.40	14.00	7.10
9	(27 Feb.-05Mar.)	48.02	31.20	14.40	90.00	0.00	3.20	15.20	8.00
10	(06Mar.-12 Mar.)	51.39	30.40	15.10	87.00	0.00	4.80	16.00	7.10
11	(13 Mar.- 19 Mar.)	54.43	30.30	15.80	90.00	6.40	3.40	16.80	5.80
12	(20 Mar.-26 Mar.)	56.87	29.10	15.70	93.00	11.60	4.50	17.80	5.90
13	(27 Mar.-02Apr.)	58.74	32.20	16.70	82.00	39.20	4.60	19.80	7.30

1^{st}appearance of disease on 10 Nov.

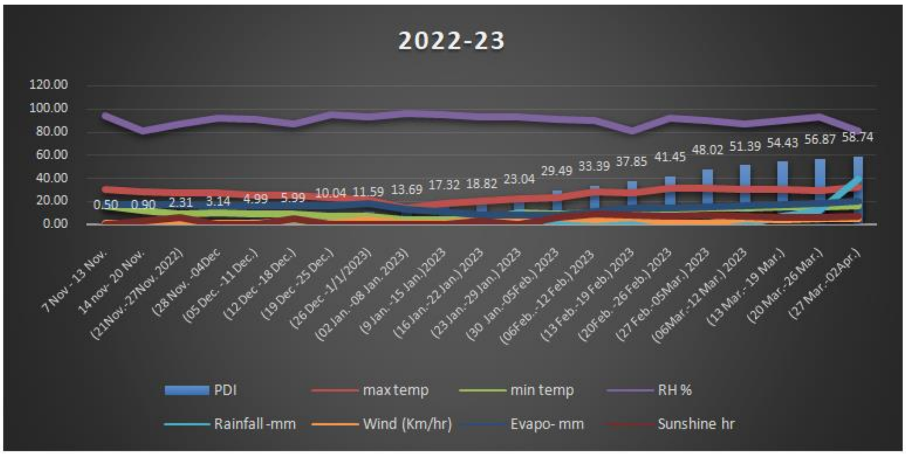

Fig. 2. Effect of weather parameters on the development of *Colletotrichum capsici* of chili 2022-23.

Table 4: Effect of Standard Metrological Weeks on Rate of infection (r) 2022-23.

Week No.	Dates	PDI	Rate of infection rate
40	3 Oct -9 Oct	0.00	0
41	10 Oct -16 Oct	0.00	0
42	17 Oct - 23 Oct	0.00	0
43	24 Oct. - 30 Oct.	0.00	0
44	31 Oct- 6 Oct.	0.00	0
45	7 Nov - 13 Nov.	0.50	0
46	14 Nov- 20 Nov.	0.90	0.084
47	(21Nov.-27Nov.)	2.31	0.135
48	(28 Nov. -04Dec	3.14	0.044
49	(05 Dec. -11 Dec.)	4.99	0.066
50	(12 Dec -18 Dec.)	5.99	0.026
51	(19 Dec -25 Dec.)	10.04	0.074
52	(26 Dec -1/1/2023)	11.59	0.020
1	(02 Jan. -08 Jan.)	13.69	0.024
2	(9 Jan. -15 Jan.)	17.32	0.034
3	(16 Jan.-22 Jan.)	18.82	0.012
4	(23 Jan.-29 Jan.)	23.04	0.029
5	(30 Jan.-05Feb.)	29.49	0.035
6	(06Feb..-12 Feb.)	33.39	0.018
7	(13 Feb.-19 Feb.)	37.85	0.018
8	(20Feb. -26 Feb.)	41.45	0.013
9	(27 Feb.-05Mar.)	48.02	0.021
10	(06Mar.-12 Mar.)	51.39	0.010
11	(13 Mar.- 19 Mar.)	54.43	0.008
12	(20 Mar.-26 Mar.)	56.87	0.006
13	(27 Mar.-02Apr.)	58.74	0.005

Week No	Dates	PDI	Rate of infection rate
40	3 Oct -9 Oct	0.00	0
41	10 Oct -16 Oct	0.00	0
42	17 Oct - 23 Oct	0.00	0
43	24 Oct. - 30 Oct.	0.00	0
44	31 Oct- 6 Oct.	0.00	0
45	7 Nov - 13 Nov.	0.50	0
46	14 Nov- 20 Nov.	0.90	0.084
47	(21Nov.-27Nov.)	2.31	0.135
48	(28 Nov. -04Dec	3.14	0.044
49	(05 Dec. -11 Dec.)	4.99	0.066
50	(12 Dec -18 Dec.)	5.99	0.026
51	(19 Dec -25 Dec.)	10.04	0.074
52	(26 Dec -1/1/2023)	11.59	0.020
1	(02 Jan. -08 Jan.)	13.69	0.024
2	(9 Jan. -15 Jan.)	17.32	0.034
3	(16 Jan.-22 Jan.)	18.82	0.012
4	(23 Jan.-29 Jan.)	23.04	0.029
5	(30 Jan.-05Feb.)	29.49	0.035
6	(06Feb..-12 Feb.)	33.39	0.018
7	(13 Feb.-19 Feb.)	37.85	0.018
8	(20Feb. -26 Feb.)	41.45	0.013
9	(27 Feb.-05Mar.)	48.02	0.021
10	(06Mar.-12 Mar.)	51.39	0.010
11	(13 Mar.- 19 Mar.)	54.43	0.008
12	(20 Mar.-26 Mar.)	56.87	0.006
13	(27 Mar.-02Apr.)	58.74	0.005

CONCLUSIONS

These findings offer valuable insights into anthracnose management in chili cultivation. Farmers and agricultural practitioners can use this knowledge to anticipate disease outbreaks based on meteorological conditions, implement preventive measures, and adjust cultivation practices. Additionally, researchers and policymakers can use this information to develop targeted strategies for disease control and crop protection, ultimately contributing to sustainable chili production.

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Conflict of Interest. None.

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