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The impact of meteorological variables on the development of blackgram anthracnose caused by *Colletotrichum lindemuthianum*

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Abstract
The purpose of the experiment was to study the correlation between weather conditions and the blackgram anthracnose disease, which is highly damaging in major blackgram cultivating region. Generally, black gram is widely cultivated in India in kharif and summer season. In correlation study of 2019, maximum temperature and wind velocity were found non-significant while minimum temperature was significant with negative impact whereas relative humidity in the morning and evening were found positively significant whereas in year 2020, maximum temperature and minimum temperature were found non-significant whereas morning and evening relative humidity and wind velocity were found significant with positive impact on anthracnose disease of black gram.

Keywords: Colletotrichum lindemuthianum, relative humidity, wind velocity, temperature, blackgram, anthracnose and correlation

1. Introduction

Blackgram or Urdbean (*Vigna mungo*) is semi erect to spreading plant belongs to the family *fabaceae*. It is cultivated as a *kharif* crop in tropical and subtropical regions. (Gopalan *et al*., 1971) [5]. It is one of the important pulse crops in India. Black gram is a crucial component of the vegetarian diet as it contains ample amounts of proteins, carbohydrates, soluble and insoluble fibers along with the good amount of folic acid and iron. India produces about 28.4 lakh tonnes of blackgram annually from 47.6 lakh hectares of area, with an average productivity of 596 Kg per hectare in 2021-22 (Anon., 2013) [2]. It has poor tolerance of wet tropical climates but in high rainfall areas it can be grown during the dry period on residual moisture. It grows better on rich black vertisols or loamy soils, well drained soils with a pH 6-7 (Baligar and Fageria, 2007) [4]. It is drought tolerant and thus suitable for semi-arid areas (Arora *et al*., 1989) [3]. *Vigna mungo* is sensitive to saline and alkaline soils (Sharma *et al*., 2011) [7].

All aerial parts of plants are attacked by the fungus Colletotrichum spp. during every stage of their growth. On leaves and pods, the symptoms are round, black, sunken dots with a dark center and a brilliant red-orange border. The cotyledons of the seedlings have dark brown to black sunken patches that, in damp weather, may harbor pink spore masses of the fungus. Shortly after the seeds germinate, the infection causes blight. When an infection is severe, the infected areas-particularly the leaves-wither away. The pathogen endures on the diseased plant detritus, in the soil, and on the seeds. In the field, conidia carried by the air transmit disease. In the chilly, rainy season, the illness is more severe (Anon., 2013) [2]. Black gram anthracnose was once thought to be of little significance in India, but as black gram farming has become more intensive, the disease's severity has gradually grown. This disease, which caused 80–100% yield loss in cool, humid conditions, is now recognized as one of the main constraints along with powdery mildew and web blight. (Sumitkumar, 2014) [8].

Crop epidemiological studies are crucial for creating models that foresee and predict disease development with respect to environmental variables and disease severity. This pathogen is able to survive during the periods of poor environmental circumstances in a variety of forms. For effective management of the disease, the pathogen's survival and spread method must be carried out to break the infection chain at the correct moment.

2. Materials and Methods

2.1 Isolation: Black gram pods and leaves infected with anthracnose disease which showed typical symptoms were first microscopically examined to confirm the presence of the fungus. The isolation of the pathogens was made by following standard tissue isolation technique as described below. Isolation of the fungi was made by tissue isolation technique. Small pieces of tissues from infected leaves and pods (3 mm) along with some healthy tissues were cut using sterilized scalpel and the cut tissues were surface sterilized with 1 percent sodium hypochlorite solution for about 30 to 45 seconds. They were then washed three times with sterilized distilled water to remove the excess of sodium hypochlorite. Finally, they were transferred under aseptic condition on to Petri plates containing solidified potato dextrose agar (PDA) medium and incubated at 27 ± 20 ^{0}C. The resulting fungal cultures were purified by hyphal tip method. Purified cultures of test pathogens maintained on PDA slants by storing it under refrigeration at 4 ^{0}C. To maintain the cultures for further studies, periodical transfers were made once in a month. The fungi were isolated, purified and sub cultured in aseptic condition under a laminar flow.

2.2 Identification of the fungus

Pathogen *Colletotrichum lindemuthianum* was primarily identified by morphological characters such as mycelia and cultural characters, mode of conidial production, conidiophores and length and breadth of conidia, were studied by using microscope. Final identification was done by genome sequencing of ITS region with accession number MW856786.

2.3 Collection of weather data

The field investigation was carried out in the seasons of *kharif* in 2019 and 2020. In this experiment, the GU-1 variety of black gram was sowed in June. Black gram crop was raised using regular agronomical procedures together with other cultural practices. By comparing the severity of the anthracnose leaf spot disease with corresponding meteorological data, the impact of weather conditions on the occurrence and development of leaf spot was investigated.

The disease incidence was recorded from five tagged plants on 0-5 scale given by Rajkumar and Mukhopadhyay (1986) [6] at weekly interval starting from initiation of disease.

The formula mentioned below was used to compute the percentage of disease intensity.

$$\text{PDI} = \frac{\text{Sum of individual disease ratings}}{\text{No. of observation assessed} \times \text{Maximum disease score}} \times 100$$

The experiment was conducted under natural condition without protection measures against any disease. Weekly averages of the various observations were calculated using meteorological data gathered from University Research Farm's observatory. The study evaluated many weather factors, including average rainfall (mm), wind speed (km/h), bright sunshine hour (h), morning and evening relative humidity (RH %), and maximum and minimum temperatures (^{0}C). The Department of Meteorology at JAU, Junagadh, provided the meteorological parameter data. According to standard meteorological weeks, the weather parameter data during the crop period was computed as an average over seven days. Tables 2 and 3 shows the experimental station's current meteorological conditions for the cropping seasons of 2019 and 2020. By evaluating the Karl Person's correlation coefficient (r), the weekly disease incidence correlated with the weather factors. The following formula was used to determine the significance of each correlation coefficient value at the 5% and 1% probability levels:

$$t = \frac{r\sqrt{n} - 2}{\sqrt{1 - r}}$$

Where,
t= Test of significance,
r= Correlation coefficient and
n= Number of observation

Table 1: Disease scale for anthracnose disease of black gram (0-5)

Disease rating (Grade)	Infection on leaf (%)
0	No infection
1	1-5% leaf area covered
2	6-10% leaf areas covered
3	11-25% leaf areas covered
4	26-50% leaf areas covered
5	> 50% leaf areas covered
(Rajkumar and Mukhopadhyay, 1986) [6]	

3. Results and Discussion

Plant diseases are more common and severe in humid areas with warm temperature. During pathological investigations, the pathogen population was studied in host population under the influence of environmental factors. The environmental conditions prevailing in both air and soil, after contact of pathogen with its host, may affect the development of disease. The most serious environmental factors, which affect the initiation and development of infectious plant diseases, are temperature and moisture. For a disease to occur and to develop, a combination of three factors *viz.* susceptible plant, infective pathogen and favorable environment must be present. The environmental conditions may change more or less suddenly to various degrees and such changes may influence disease initiation or development.

Colletotrichum lindemuthianum is the causal organism that initiates the black gram anthracnose disease, which results in significant yield losses. On the other hand, not much has been researched about how the weather affects the disease initiation. As a result, research was done to determine how meteorological conditions affected the growth of the anthracnose disease in black gram.

The maximum and lowest temperatures recorded throughout the crop season in 2019 and 2020 were 35.6 ^{0}C to 24.8 ^{0}C and 34.0 ^{0}C to 24.2 ^{0}C, respectively. In both years, the relative humidity ranged from 51 to 96% in the morning and evening, while the range of precipitation was 0.5 to 248 mm and 0.0 to 250.7 mm, respectively. It was evident from the meteorological data (Tables 2 and 3) that the environmental parameters, including temperature, relative humidity, and amount of precipitation, seemed to be favorable for the growth of black gram anthracnose in the months of *kharif* in 2019 and 2020.

Weather parameters greatly influenced the development of anthracnose disease in black gram crop. Crop was sown in last week of June, 2019 (26th standard week) in first season and in case of second season it was sown in last week of July, 2020 (30th standard week).

Environmental factors have been noticed to influence the development of anthracnose disease in open field condition. On the 30th standard meteorological week of 2019 and the 34th standard meteorological week of 2020, the first signs of anthracnose on black gram crops were observed. Weekly observations were made from the 26th to the 36th SMW in the *kharif* 2019 and from the 30th to the 40th SMW in the *kharif* 2020. From the 30th to the 36th SMW and the 34th to the 40th SMW in both years, there was a steady progression of the disease.

The disease symptoms initially developed in the last week of July 2019 (SMW-30), when the maximum and minimum temperatures were recorded at 31.9 ^{0}C and 25.5 ^{0}C, and in the last week of August 2020 (SMW-34), when maximum and minimum temperature were 29.3 ^{0}C and 24.9 ^{0}C with minimum disease intensity of 8.2% and 14.8%, respectively. Week by week, it continued to grow till the end of the crop season. The maximum anthracnose intensity in 2019 was recorded in the first two weeks of September (SMW-35 and 36), at 73.4% and 78.8%, respectively while in 2020, the highest disease intensity was recorded in the first two weeks of October (the 39th and 40th SMW), at 74.2 and 75.4%, respectively.

Table 2: Effect of weather factors on anthracnose development recorded during the year 2019 (weekly mean)

Std. week No.	Temp.(^{0}C)		Relative humidity (%)		Rain fall (mm)	Wind speed (km/h)	Sunshine hour	Disease intensity (%)
	Max.	Min.	RH-I	RH-II				
June-2019								
26	35.6	27.2	85	59	6.3	8.8	1.9	0.0
July-2019								
27	35.2	27.5	85	58	2.6	9.9	0.7	0.0
28	35.6	27.5	80	51	0.5	14.6	1.9	0.0
29	34.5	26.2	87	58	63.7	8.8	3.3	0.0
30	31.9	25.5	91	79	114.3	8.7	1.0	8.2
August-2019								
31	28.3	24.9	96	95	213.3	9.7	0.0	14.1
32	28.9	25.5	96	92	180.6	11.0	0.0	29.5
33	30.6	25.3	96	84	22.9	7.7	1.3	41.2
34	32.4	24.8	90	73	3.9	4.9	5.3	58.9
September-2019								
35	30.9	25.5	96	88	49.6	5.5	0.9	73.4
36	31.1	25.4	94	86	248.0	2.7	1.4	78.8

Table 3: Effect of weather factors on anthracnose development recorded during the year2020 (weekly mean)

Std. week No.	Temp.(^{0}C)		Relative humidity (%)		Rain fall (mm)	Wind speed (km/h)	Sunshine hour	Disease intensity (%)
	Max.	Min.	RH-I	RH-II				
July-2020								
30	33.1	26.3	94	82	37.6	5.2	3.5	0.0
August -2020								
31	33.2	25.9	86	76	53.8	3.6	4.6	0.0
32	31.3	25.5	93	83	203.4	6.4	0.9	0.0
33	28.6	25.3	96	92	224.4	6.9	0.0	0.0
34	29.3	24.9	93	87	133.7	6.8	0.7	14.8
September -2020								
35	30.2	24.5	96	87	250.7	6.2	2.5	15.8
36	33.9	25.9	84	59	0.0	2.9	8.3	31.4
37	32.9	25.4	90	73	112.6	3.6	4.0	45.2
38	33.2	25.6	89	70	23.5	3.0	4.5	62.7
October-2020								
39	32.5	24.8	83	56	0.0	4.0	6.5	74.2
40	34.0	24.2	84	51	19.1	3.0	9.0	75.4

3.1 Study of correlation

The maximum temperature (r = 0.514) was non-significant and the minimum temperature (r = 0.642) was significant at 5% with a negative influence on anthracnose of black gram disease, in accordance with the correlation coefficient study demonstrated in Table 2. Morning relative humidity (r = 0.641) and evening relative humidity (r = 0.608) were significant at 5% with positive effect on anthracnose disease development. Additionally, it was noted that wind velocity (r = 0.795) had a negative effect and appeared to be highly significant. This might because of high wind velocity causes reduction in humidity and also high wind velocity does not allow spores to settle on leaf surface and initiate infection process. Sunshine hour and rain fall were found non-significant with anthracnose disease in the year 2019. In 2020, the development of anthracnose disease was positively impacted by morning relative humidity (r = 0.684), evening relative humidity (r = 0.837), and maximum temperature (r = 0.525) and minimum temperature (r = 0.475), all of which were found to be non-significant. Rainfall remained non-significant with a favorable effect, but wind speed (r = 0.690) was shown to be significant at 5% with a negative effect on the development of anthracnose disease. Though rain fall remain non-significant, it was positively correlated that means it may not significantly affect disease intensity but it might help to maintain or increase relative humidity conducive for disease development. It was also noticed here that in the year 2020, sunshine hour (r = 0.716) was found significant at 5% with positive effect. This might because of in case of year 2020, the minimum temperature was relatively low as compared to year 2019, and so sunshine hour may be increased temperature level to optimum for disease development. Positive but non-significant correlation was observed between rainfall and disease intensity which suggested that rainfall did not influence disease development much, but probably helps in germination of pathogen spores and increased atmospheric humidity. Previous reports by Satpathy *et al*. (2012) [9], Kaura *et al*. (2014) [10], agree with these correlation results, while studying the correlation between environmental factors and development of Colletotrichum diseases on various pulse crops. They found that the anthracnose disease was correlated with the temperature and bright sunshine hours and positive correlation was found with relatively humidity and number of rainy days. When investigating kidney bean anthracnose, also noticed the similar correlation analysis. It was revealed that the disease developed more seriously during relatively low to moderate temperatures. In the present study the high or low temperatures operated in black gram plants probably by affecting the genetic machinery of the cell by favoring or inhibiting the expression of certain genes involved in disease resistance or susceptibility. The disease was also favored by moisture of air or dew. Agrios (2005) [11] also confirmed that occurrence of a disease in a particular area was closely correlated with amount and distribution of rainfall within a year. Roberts *et al*. (2009) [12] found that infection of *Colletotrichum* spp. (C. *capsici*, C. *gleosporioides* and C. caccodes) took place in pepper during warm and dry weather at optimum temperature of 27 ^{0}C although infection may occur at both higher and lower temperatures.

Table 4: The correlation coefficient for the year 2019 between weather parameters and the intensity of anthracnose disease

Weather parameter	**Correlation coefficient 'r' value**
Maximum temperature	-0.514
Minimum temperature	-0.642*
Morning relative humidity	0.641*
Evening relative humidity	0.608*
Rain fall	0.284
Wind speed	-0.795**
Sunshine hour	0.122

*Significant at (p=0.05) level (R value 0.602), n = 11 (df, n-2=9) **Significant at (p=0.01) level (R value0.735).

Table 5: The correlation coefficient for the year 2020 between weather parameters and the intensity of anthracnose disease

Weather parameter	Correlation coefficient 'r' value
Maximum temperature	0.525
Minimum temperature	-0.475
Morning relative humidity	0.684*
Evening relative humidity	0.837**
Rain fall	0.586
Wind speed	-0.690*
Sunshine hour	0.716*

*Significant at (p=0.05) level (Rvalue0.602),n= 11 (df,n-2=9) **Significant at (p=0.01) level (R value0.735).

4. Conclusions

Climatic conditions greatly influence development of anthracnose disease. Thus, in 2019 and 2020, meteorological data were assessed against the intensity of the anthracnose disease. The 30th standard week of 2019 and the 34th standard week of 2020 observed the initial appearance of anthracnose symptoms, with the lowest disease intensity levels being 8.2% and 14.8%, respectively. The highest disease intensity of 74.8% was reported in the second week of September (SMW-36) in 2019, whereas the highest disease intensity of 75.4% was recorded during the 40th SMW in 2020. A correlation analysis between the percentage of disease intensity and meteorological data in 2019 showed that the minimum temperature (r = 0.642) had a significant negative impact on anthracnose disease at 5%, while the maximum temperature (r = 0.514) was non-significant. Morning relative humidity (r = 0.641) and evening relative humidity (r = 0.608) were significant at 5% with positive effect on anthracnose disease development. Additionally, it was observed that wind velocity (r = 0.795) had a negative effect and was found to be highly significant. This might because of high wind velocity may cause reduction in humidity and also high wind velocity does not allow spores to settle on host surface and initiate infection process. Sunshine hour and rain fall were found non-significant with positive effect disease in the year 2019.

When it came to the development of disease in 2020, the maximum temperature (r = 0.525) and minimum temperature (r = 0.475) were found to be non-significant, but the morning and evening relative humidity (r = 0.684 and 0.837, respectively) were found to be significant at 5% and 1%, respectively. The development of disease was found to be negatively affected by the velocity of the wind (r = 0.690) at 5%, but the precipitation was not found to be statistically significant. Additionally, it was noted that sunshine hour (r = 0.716) had a positive impact and was significant at 5% in 2020.

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6. References

1. Anonymous. Directorate of Economics & Statistics, Ministry of Agriculture and Farmers Welfare; c2022.
2. Anonymous. Commissionerate of Agriculture, Jaipur, Rajasthan; c2013.
3. Arora RK, Mauria SS. Record from Proseabase. In: van der Maesen LJG, Somaatmadja S, editors. PROSEA (Plant Resources of South-East Asia) Foundation. Bogor, Indonesia; c1989.
4. Baligar VC, Fageria NK. Agronomy and physiology of tropical cover crops. J Plant Nutr. 2007;30(8):1287-1339.
5. Gopalan CBV, Shastri R, Subramaniam B. Indian Council of Medical Research. Hyderabad, India; c1971. Report No.: 63.
6. Rajkumar GS, Mukhopadhyay AN. Field evaluation of Urdbean germplasm lines against Colletotrichum capsici. Indian J Mycol Plant Pathol. 1986;17:66-72.
7. Sharma OP, Bambawale OM, Gopali JB, Bhagat S, Yelshetty S, Singh SK, *et al*. Field guide mung bean and urd bean. Government of India, Department of Agricultural and Co-operation, NCIPM, ICAR. New Delhi, India; c2011.
8. Sumitkumar A. Management of Colletotrichum

lindemuthianum causing anthracnose of blackgram [*Vigna mungo* (L.) Hepper]. M. Sc. (Agri.) Thesis. Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India; c2014.
9. Zigmond E, Varol C, Farache J, Elmaliah E, Satpathy AT, Friedlander G, *et al*. Ly6Chi monocytes in the inflamed colon give rise to proinflammatory effector cells and migratory antigen-presenting cells. Immunity. 2012;37(6):1076-90.
10. Kaura V, Prasad CS, Sharma S. Impact of service quality, service convenience and perceived price fairness on customer satisfaction in Indian retail banking sector. Management and Labour Studies. 2014;39(2):127-39.
11. Agrios AG, Pichat P. State of the art and perspectives on materials and applications of photocatalysis over TiO 2. Journal of Applied Electrochemistry. 2005;35:655-63.
12. MacCann C, Duckworth AL, Roberts RD. Empirical identification of the major facets of conscientiousness. Learning and individual differences. 2009;19(4):451-8.