RESEARCH ARTICLE

Progression of bacterial blight disease (*Xanthomonas axonopodis pv. cyamopsidis*) of clusterbean relation to weather parameters

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Clusterbean is the bushy annual herb has a deep-rooted system, is resilient and drought resistant pulse crop grown on sandy soil of arid and semi-arid region. The decline in clusterbean crop productivity is often attributed to several bacterial, fungal and viral diseases, including Bacterial blight (*Xanthomonas axonopodis pv. cyamopsidis*), vascular wilt (*Fusarium moniliformae* and *Fusarium sp*.), Charcoal rot (*Macrophomina phaseolina*), Powdery mildew (*Leveillula taurica*), Anthracnose (*Colletotrichum capsici*), and Alternaria blight (*Alternaria cyamopsidis*). Similarly, the limited and inconsistent national yield of grain and fodder can largely be ascribed to diseases caused by various plant pathogens. Among them, bacterial blight disease caused by *Xanthomonas axonopodis pv cyamopsidis* is a major disease in Rajasthan and India. The correlation between individual weather variable and disease intensity indicated that progression of bacterial blight disease intensity was strongly significantly negative correlated with maximum temperature (X_1) and minimum temperature (X_2). Relative humidity morning (X_3) and relative humidity evening (X_4) was strongly significantly positive correlated with disease intensity. Rainfall (X_5), rainy days (X_6) and sunshine (X_7) were none significantly positive correlated with disease intensity. The coefficient of multiple determinations (R^2) was 94.95 per cent in Kharif 2023. Which means that 94.95 per cent disease intensity was depend on the weather parameters.

Key Words: *Clusterbean; Correlation; Disease intensity; Weather variable*

INTRODUCTION

Clusterbean (*Cyamopsis tetragonaloba*) commonly known as "guar" is an arid and semi-arid legume crop belonging to the family Leguminaceae. Its resilience to drought, attributed to its extensive taproot system and ability to withstand water stress effectively. The name "guar" originates from the Sanskrit word "GAUAAHAR," which translates to "food of cow" or "fodder for livestock". Additionally, referred to by various other names such as khutti, dararretic and guari, this crop is particularly suited for cultivation in rainfed conditions during the Kharif season in India. Notably, it contributes to soil fertility enhancement through atmospheric nitrogen fixation. While predominantly grown during the rainy season, it can also thrive in irrigated settings during the summer period. The seeds are highly valued for industrial gum. It is cultivated mainly in the rainy season as a rainfed crop in arid zones of India and various other parts of the world [1]. The clusterbean seed consists of three parts seed coats (14-17%), the endosperm (35-42%) and the kernel (43-47%). Guar gum (19-43% of the whole seed) is derivative from the endosperm, which is the major beneficial product of the plant. Clusterbean is grown for different purposes, namely vegetables, green fodder, green manure and seed production. Beside all this, used as a concentrate for animals and for the extraction of gum mainly present in the endosperm of the seed, provide a useful raw material for a wide range of industrial products. It is additionally grown for the seeds and drawing out of guar gum manufacturing in India. The clusterbean gum is likewise regarded to contain medicinal significance inside the remedy for diabetes and excessive cholesterol [2]. Clusterbean is commercially grown in India, Pakistan and USA and to a limited extent in Australia, Brazil and South Africa. It has grown in the share of 1:10 as a mixed crop. Overall, India produces approximately 80% of worldwide clusterbean production. It is cultivated on more than 4 m ha in India, Rajasthan only accounts for approximately 80% of the region and production. Left behind to its need in the international market, it has been introduced in the non-conventional growing areas including Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Chhattisgarh [3]. In India, the total area under the clusterbean crop is 39.36 lakh hectare, production 16.24 lakh tones and with yield 428 kg/ha. In Rajasthan, total area under the clusterbean crop is 28.41 lakh hectare, production 12.84 lakh tones and with yield 452 kg/ha. Rajasthan is the leading state in clusterbean production and share more than 70% production in India.

The decline in clusterbean crop productivity is often attributed to several bacterial, fungal and viral diseases, including bacterial blight (*Xanthomonas axonopodis pv. cyamopsidis*), vascular wilt (*Fusarium moniliformae* and *Fusarium sp*.), charcoal rot (*Macrophomina phaseolina*), powdery mildew (*Leveillula taurica*), anthracnose (*Colletotrichum capsici*) and alternaria blight (*Alternaria cyamopsidis*). Similarly, the limited and inconsistent national yield of grain and fodder can largely be ascribed to diseases caused by various plant pathogens. Among them, bacterial blight disease caused by *Xanthomonas axonopodis pv. cyamopsidis* is a major disease in Rajasthan and India. Bacterial blight has become a serious problem in many cluster bean production areas, during monsoon season i.e., July-October [4,5].

MATERIALS AND METHODS

Effect of environmental factors on disease development

The field experiments were conducted under artificial field conditions during kharif season. Observations on the severity of bacterial blight disease of clusterbean were recorded 7 days after inoculation from each plots at weekly interval (July-November). To find out the effect of environmental factors on the progression of bacterial blight disease of clusterbean. Weather variables *viz*., temperature, relative humidity, rainfall, rainy day and sunshine etc., were recorded and correlation among environmental factors and bacterial blight disease progression was worked out. Means of maximum temperature, minimum temperature, relative humidity (morning), relative humidity (evening), rainfall, number of rainy days, sunshine hours, were symbolized as X_1, X_2, X_3, X_4, X_5, X_6 and X_7, respectively. The per cent disease intensity was calculated and symbolized as Y.

Establishment of linear relationship between per cent disease index and key abiotic factors

The per cent disease index was correlated to the prevailing mean a biotic environmental factor (maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, rainfall, number of rainy days and sunshine). The correlation coefficient values (r) between the per cent disease index and the abiotic factors were computed using the standard methodology as given by Karl Pearson. To study the relationship between seven independent variables (maximum temperature, minimum

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temperature, maximum relative humidity, minimum relative humidity, rainfall, number of rainy days and sunshine) and dependent variables i.e., per cent disease index, multiple linear regression analysis were done by fitting this equation. The analysis (s) is as under:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 \left(R^2\right)$$

Where,

R^2=Multiple correlation coefficients

Y=Per cent disease incidence (depended variable)

a=Constant (intercept)

b_1 to b_7=Partial regression coefficients

X_1=Maximum temperature (°C)

X_2=Minimum temperature (°C)

X_3=Maximum relative humidity (%)

X_4=Minimum relative humidity (%)

X_5=Rainfall (mm)

X_6=Number of rainy days

X_7=Duration of sunshine (h/day)

RESULTS AND DISCUSSION

The effect of weather parameters *viz*., temperature maximum (X_1), temperature minimum (X_2), relative humidity morning (X_3), relative humidity evening (X_4), rainfall (X_5), number of rainy days (X_6) and sunshine hours (X_7) on the progression of bacterial blight of clusterbean studied in Kharif 2023 (Table 1 and Figure 1).

TABLE 1

Progression of bacterial blight on clusterbean in relation to weather parameters epiphytotic conditions during Kharif 2023

Standard meteorological interval	Temperature		Relative Humidity		Rainfall	Rainy days	Sunshine	PDI
	Maximum	Minimum	Morning	Evening				
	X_1 (°C)	X_2 (°C)	X_3 (%)	X_4 (%)	X_5 (mm)	X_6 (days)	X_7 (hour)	
22 July-28 July	41.1	26.6	71.8	43.6	0	0	8.1	3.2
29 July-4 Aug	42.5	27.8	83.4	48.7	20.6	1	8	8.7
5 Aug-11 Aug	42.3	26.1	77.3	49.6	2.3	0	7.9	9.1
12 Aug-18 Aug	41.7	26.9	74.1	45.7	2.1	0	7.2	11.1
19 Aug-25 Aug	39.3	24.2	89.2	63.6	14.2	1	8.9	17.5
26 Aug-1 Sept	39.7	25.5	81.1	48.3	0	0	8.5	18.3
2 Sept-8 Sept	40.7	26.1	78.5	46.4	0	0	7.1	19.1
9 Sept-15 Sept	38.2	24.8	89.3	54.4	8.1	1	7.4	22.8
16 Sept-22 Sept	36.9	23.1	90.2	57.4	17.4	1	8.3	25.7
23 Sept-29 Sept	38.5	22.2	87.9	56.3	0	0	7.6	25.9
30 Sept-6 Oct	39.5	23.1	87.2	55.5	0	0	9.4	26.4
7 Oct-13 Oct	36.2	18.9	91.6	60.4	0	0	7.2	33.5
14 Oct-20 Oct	35.7	16.7	92.1	61.7	20.3	1	9.1	35.7
21 Oct-27 Oct	35.5	17.3	85.5	51.4	17.5	1	8.7	30.6
28 Oct-3 Nov	33.5	16.3	87.3	54.7	15.2	1	9.2	31.1
Mean	38.75	23.04	84.43	53.18	7.85	0.47	8.17	21.25

Note: X_1: Maximum temperature; X_2: Minimum temperature; X_3: Relative humidity (maximum); X_4: Relative humidity (minimum); X_5: Rainfall; X_6: Number of rainy days; X_7: Sunshine hours; PDI: Per cent Disease Intensity.

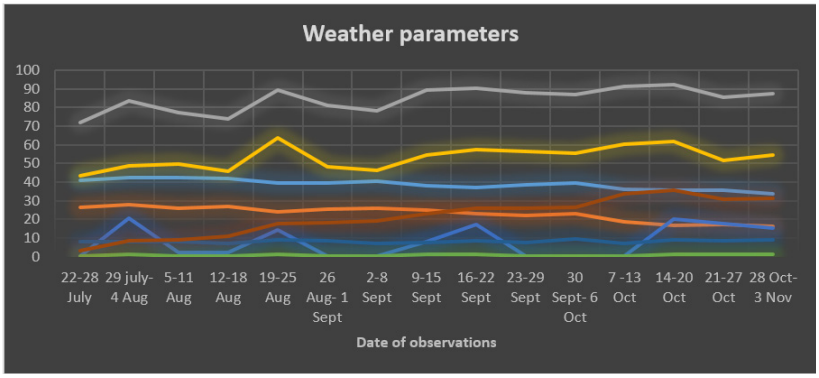

Figure 1) *Per cent disease intensity of bacterial blight of clusterbean in relation to weather parameters.* **Note:** (▬): *Temperature maximum (°C);* (▬): *Temperature minimum (°C);* (▬):*Relative humidity morning;* (▬): *Relative humidity evening;* (▬): *Rainfall (mm);* (▬): *Rainy days;* (▬):*Sunshine (hours);* (▬): *Per cent disease intensity*

The disease first appeared on July 25th and became more conspicuous from the last week of August to the first week of November and declined after mid-November. The correlation between individual weather variables and disease intensity was determined for Kharif 2023 (Table 2). The results indicated that progression of bacterial blight intensity was strongly significantly negative correlated with maximum temperature (X_1). Minimum temperature (X_2) were significantly negative correlated with disease intensity. Relative humidity morning (X_3) and relative humidity evening (X_4) was strongly significantly positive correlated with disease intensity. Rainfall (X_5), rainy days (X_6) and sunshine (X_7) were none significantly positive correlated with disease intensity. The coefficient of multiple determinations (R^2) was 94.95 per cent in Kharif 2023. Which means that 94.95 per cent disease intensity was depend on the weather parameters (Table 3).

TABLE 2

Correlation matrix for bacterial blight disease progression on clusterbean in relation to weather parameters under epiphytotic conditions during Kharif 2023

Season	Weather parameters						
	X_1 (°C)	X_2 (°C)	X_3 (%)	X_4 (%)	X_5 (mm)	X_6 (days)	X_7 (hrs)
Kharif 2023	-0.886**	-0.884**	0.824**	0.702**	0.282	0.326	0.324

Note: X_1: Maximum temperature; X_2: Minimum temperature; X_3: Relative humidity (maximum); X_4: Relative humidity (minimum); X_5: Rainfall; X_6: Number of rainy days; X_7: Sunshine hours; (*, **): Significant at 5% and 1% respectively.

TABLE 3

Regression equation for bacterial blight of clusterbean in relation to weather parameters

Season	R	R^2
Kharif 2023	0.974**	0.950**

Note: (*, **): Significant at 5% and 1% respectively; R: Correlation coefficient values; R^2: Multiple correlation coefficients.

$$Y = 4.436 - 0.812X_1 - 1.116X_2 + 1.253X_3 - 0.499X_4 + 0.059X_5 - 5.933X_6 - 0.367X_7$$

The analysis of all the seven independent variables individually and in combinations revealed that every weather parameter played a major role in disease development in clusterbean. Similar finding is supported with results obtained by earlier workers by Shah et al., [6] they observed that the temperature ranges of 20-30°C and relative humidity between 70% and 80% favored the rapid progress of the bacterial blight of clusterbean. Also Similarly, reported by Yadav et al., [7] and Amin et al., [8].

CONCLUSION

Clusterbean is the legume annual herb has a deep-rooted system, is resilient and drought resistant pulse crop grown on sandy soil of arid and semi-arid region. A number of pathogens causes diseases in this crop. Among them, bacterial blight disease caused by *Xanthomonas axonopodis pv cyamopsidis* is a major disease in Rajasthan and India. The leaf blight pathogen *Xanthomonas pv. cyamopsidis* causes harsh reduction in plant stand and yield as high as 58% in cultivar. The seed borne pathogen can survive in seeds for up to one year. The favorable conditions causing spread of this disease. Weather parameter plays a major role in bacterial blight disease development in clusterbean. The analysis of all the seven independent variables individually and in combinations revealed that every weather parameter played a major role in disease development in clusterbean. The correlation between individual weather variable and disease intensity was determined. The results indicated that progression of bacterial blight disease intensity was strongly significantly negative correlated with maximum temperature (X_1) and minimum temperature (X_2). Relative humidity morning (X_3) and Relative humidity evening (X_4) was strongly significantly positive correlated with disease intensity. Rainfall (X_5), rainy days (X_6) and sunshine (X_7) were none significantly positive correlated with disease intensity. The coefficient of multiple determinations (R^2) was 94.95 per cent in Kharif 2023. Which means that 94.95 per cent disease intensity was depend on the weather parameters.

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