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Research Article

Influence of Meteorological Parameters on Cercospora Leaf Spot of *kharif* Mungbean under Ludhiana Conditions

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ABSTRACT

Pulses have an important place in Indian agriculture as pulses are leguminous so improve the fertility of soil. Among pulses, mungbean is an important pulse can be grown during summer and *kharif* season. But during *kharif* season, mungbean is attacked by different pathogens and *Cercospora canescens* an important pathogen attacks mungbean and cause significant losses. Most of the diseases are influenced by prevailing weather conditions so the experiment was planned with three mungbean varieties (ML 1808, ML 2056 and ML 818) sown under different sowing methods viz., flat sowing and raised bed sowing method on two date of sowing (1st July and 25th July) at the research farm of PAU, Ludhiana during *kharif* 2024. The main aim of experiment was to identify the effect of meteorological parameters on occurrence and development of disease under different environments. Cercospora leaf spot severity was observed higher in variety ML 818 (60% & 67%) than in ML 1808 (54% & 57%) in flat and raised bed sowing under 1st July sowing. The correlation coefficient studies of disease severity with meteorological parameters revealed that maximum temperature, minimum temperature and sunshine hours were negatively correlated whereas the morning and evening relative humidity and rainfall showed a positive correlation. For the forecasting of Cercospora leaf spot regression models were developed which gave significant R^2 values indicating the important role of meteorological parameters in development of disease.

Key words: Cercospora leaf spot, Correlation coefficient, Meteorological parameters, Mungbean, Sowing method

Introduction

Moong (*Vigna radiata*) is indeed a vital pulse crop in India, with cultivation in *rabi, kharif* and summer seasons. The maximum area of cultivation is during *Kharif* season. Some of the popular intercropping choices with moong in India include maize, cotton, castor, pearl-millet, sorghum, pigeon pea *etc*. This crop is quite adaptable and has the advantage of being suitable for various cropping systems, such as intercropping, relay cropping and catch cropping, due to its short growth duration of approximately 60-70 days. In Punjab, during 2022-23 moong was cultivated on an area of 3.8 thousand hectares with production of 3.0 thousand tones. Its' average yield was 7.80 quintals per hectare (Anonymous, 2024).

In northern India, particularly in Punjab, the dominant crop sequence is often the highly remunerative rice-wheat rotation, which substituted pulses from the cropping pattern. But now Punjab is facing one of the major crises in form of ground water depletion due to over use of ground water for paddy cultivation. So, farmers of Punjab are being advised

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to adopt crop diversification and moong being a short-season crop that may be a better alternative for agricultural diversification in some areas.With the increasing population growth in India, the main challenges in mungbean cultivation and output include abiotic stresses, low soil fertility, unavailability of resistant cultivars, insect pests and diseases. The diseases are primarily caused by plant pathogenic microorganisms such as fungi, viruses, phytoplasma, bacteria, and nematodes, resulting in considerable production losses globally. Among the biotic stresses, fungi are major contributors to mungbean diseases, such as *Cercospora* leaf spot (*Cercospora canesens*) and anthracnose (*Colletotrichum lindemuthiaum*). *Cercospora* leaf spot is considered as an important pathogen not only because of its vast distribution but also due to the susceptibility of many economical crops to this disease (Wang *et al.,* 1998; Windels *et al.,* 1998).

The *Cercospora* leaf spot disease is a significant and damaging disease of *Vigna radiata L*. This disease has the potential to diminish crop yields by as much as 60%. The occurrence of the disease is heavily influenced by field conditions and key environmental factors. The optimal conditions for the development of *Cercospora* leaf spot in mungbean occur at temperatures between 26.0 and 32.0°C, with 4 to 6 hours of daily sunlight, and a relative humidity level ranging from 61 to 79% (Kanade *et al.,* 2015). The experiment conducted at Department of Plant Pathology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir indicated that crops planted on May 26 exhibited significantly reduced leaf spot intensity (25%) and pod infection (34%). In contrast, crops sown on June 5, June 15, June 25, and July 5 showed higher leaf spot intensity and pod infection rates, ranging from 32% to 47% and 39% to 64%, respectively (Bhat, 2015). Under severe conditions, *Cercospora* leaf spot can lead to significant leaf loss in mungbean, particularly when the plant is maintained at its optimal temperature range of 25-30°C and experiences relative humidity levels between 90 and 100% (Shahabaz *et al.,* 2014). So keeping this in view study was panned to identify the important weather parameters influencing cercospora leaf spot on *kharif* mungbean under Ludhiana conditions.

Materials and Methods

The study was conducted during the *kharif* 2024 at the Research Farm, Department of Climate Change and Agricultural Meteorology, Ludhiana. The field experiment was performed using three mungbean varieties (ML 1808, ML 2056 and ML 818) and two sowing methods (raised bed and flat sowing) under two date of sowing viz., 1st July and 25th July under control and recommended spray conditions. The experiment was planned in "split plot design". The fungicide application and sowing dates were assigned to the main plot and the mungbean varieties and method of sowing were assigned to the sub-plots. The cultural practices for raising crop were followed according to the package of practices for *kharif* crops published by Punjab Agricultural University, Ludhiana.

The disease severity associated with Cercospora leaf spot was recorded on the basis of rating scales given by Mehta and Mondal (1978) (Table 1). The disease severity was recorded at three days interval (twice a week), once disease symptoms were observed visually by using rating scale and per cent disease severity was calculated by using following formula:

$$\text{Disease severity (\%)} = \frac{\Sigma \text{ Number of infected leaves} \times \text{Scale}}{\text{Total number of leaves} \times \text{Maximum grade}} \times 100$$

To conduct the statistical analysis, correlation coefficients were worked out between meteorological parameters and disease severity. Weather based regression models were also developed for cercospora leaf spot disease.

Table 1. Cercospora leaf spot disease rating scale (Mehta and Mondal, 1978)

Sr. No.	Disease grade	Per cent leaf area affected	Description
1	0	0	0% infected area
2	1	1-10	One spot to 10% infected area
3	3	11-30	11-30% infected area
4	5	31-50	31-50% infected area
5	7	51-70	51-71% infected area
6	9	>71	>71% infected area

Results and Discussion

The Cercospora leaf spot severity was observed in different mungbean varieties (ML 2056, ML 818 and ML 1808) sown on 1st July under the flat sowing and raised bed method in both control and sprayed conditions. The disease was managed under recommended fungicide application plots so there was no disease incidence to record. Under control conditions, disease was observed at three days interval as presented in Fig.1. The results revealed a significant effect of variety resistance level on disease severity. ML 818 showed the highest disease severity, reaching up to 60% and 67% at 55 days after sowing in flat sowing and raised bed sowing method respectively. ML 1808 exhibited the lowest disease severity, with approximately 54% and 58% at 55 days after sowing in flat sowing and raised bed sowing, respectively.

The per cent severity of Cercospora leaf spot in different mungbean varieties (ML 818, ML 2056, and ML 1808) sown on 25th July under the flat sowing method and raised bed sowing methods in control plots is presented in Fig. 2. The results revealed that the disease severity increased progressively over time in all varieties. ML 818 exhibited the highest disease severity, reaching approximately 62% and 67% at

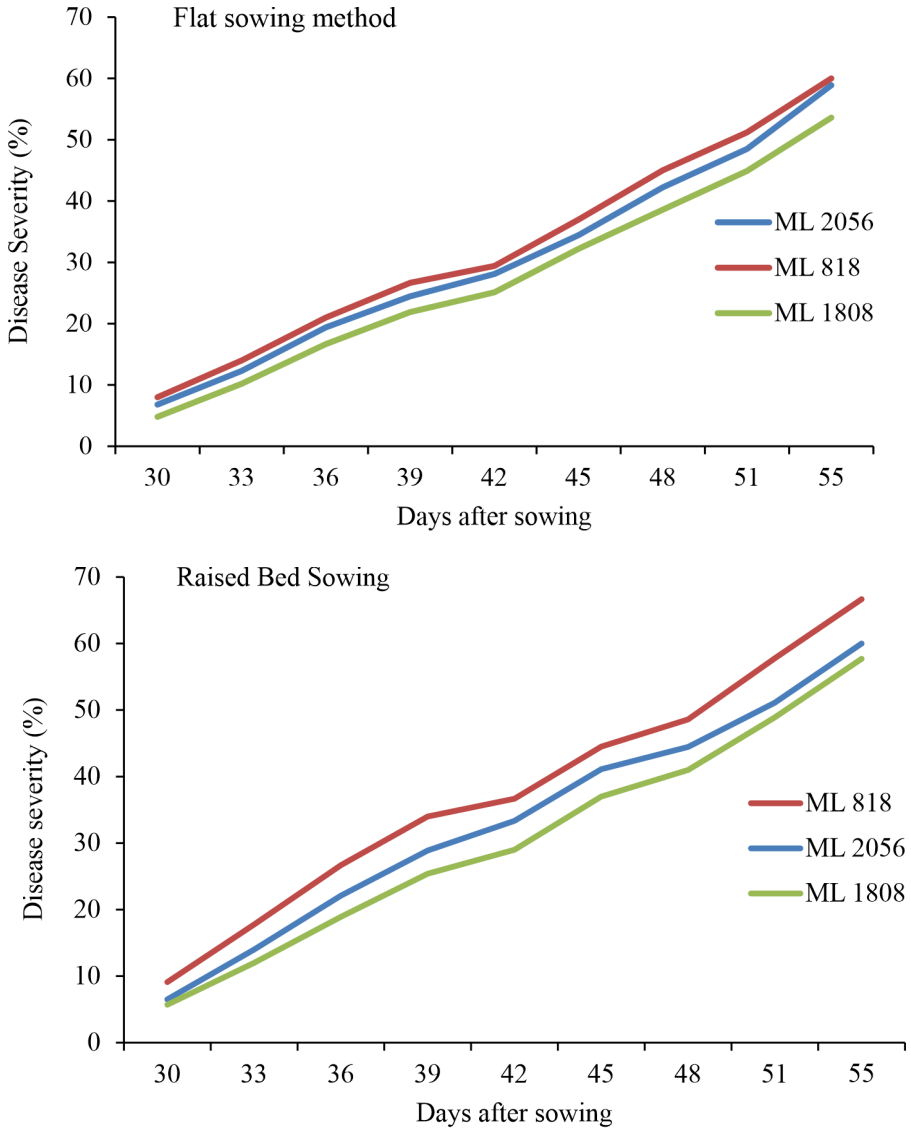

Fig. 1. Cercospora leaf spot severity in 1st July sown mungbean

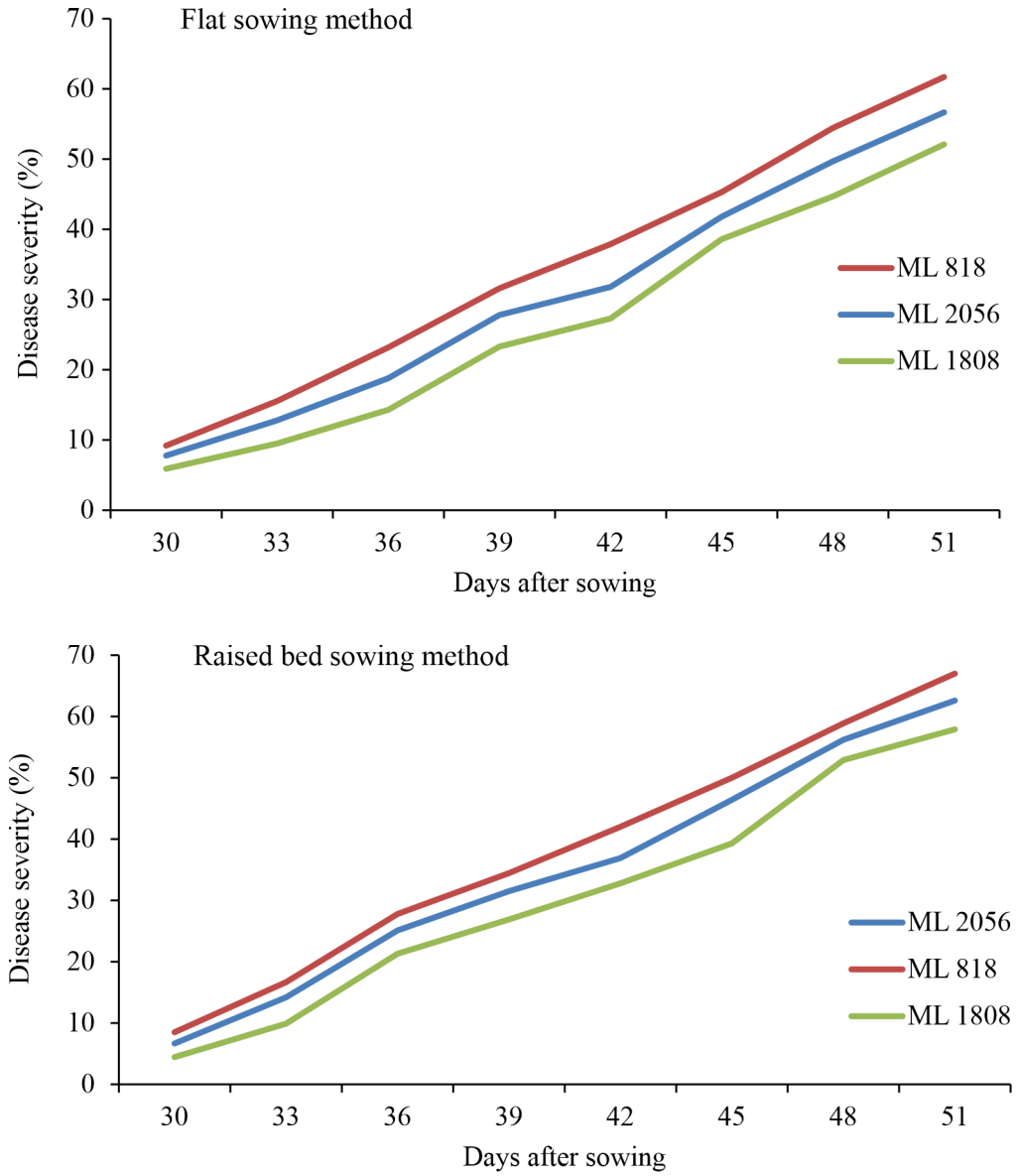

Fig. 2. Cercospora leaf spot severity in 25th July sown mungbean

51 days after sowing in flat sowing and raised bed sowing method, respectively. The severity of cercospora leaf spot varied across different mungbean varieties, sowing dates and methods. ML 818 was most susceptible to disease, showing the highest severity, reaching more than 60% in both flat and raised bed sowing methods. On the other hand, ML 1808 showed the least severity, with the disease affecting only around 50% of the plants, suggesting that this variety had better resistance to the disease. Chankaew *et al.* (2011) conducted quantitative trait loci (QTL) mapping and identified specific genomic regions associated with resistance to this disease, underscoring the role of genetic factors in varietal susceptibility. Mahapatra *et al.* (2023) confirmed the presence of genetic variability in resistance levels, supporting the notion that certain varieties possess inherent resistance. Patel *et al.* (2019) also found that the timing of sowing played a role in disease progression, with later sowing dates like 25th July leading to higher disease severity due to more favorable conditions for the disease.

Correlation coefficients between different meteorological parameters like maximum and

minimum temperature, morning and evening relative humidity, rainfall and sunshine hours and disease severity were worked out (Table 2). In flat sowing on 1st July, maximum temperature (Tmax) and minimum temperature (Tmin) exhibited a strong negative correlation with Cercospora leaf spot severity (-0.95 and -0.92, respectively), indicating that lower temperatures were associated with reduced disease severity. For flat sowing on 25th July, Tmax showed a negative correlation (-0.50) compared to the earlier sowing date, while Tmin remained strongly negative (-0.91). In raised bed sowing on 1st July, both Tmax and Tmin showed strong negative correlations (-0.90 and -0.84, respectively), similar to flat sowing. For raised bed sowing on 25th July, Tmin showed the strongest negative correlation (-0.93), while Tmax had a moderate negative correlation (-0.54). RHm and RHe were positively correlated (0.28 and 0.62, respectively). Similarly, Rajput *et al.* (2021) demonstrated that increased rainfall led to a higher incidence of cercospora leaf spot in mungbean, where rainfall had a high positive correlation with disease severity. Khan *et al.* (2020) showed that the sunlight influenced fungal diseases. They confirmed that reduced sunlight exposure decreased disease severity, which aligns with our findings that sunshine hours (SSh) had a moderate to strong negative correlation with disease severity, particularly in raised bed sowing methods. Chauhan *et al.* (2018) observed the positive correlation between humidity and the incidence of fungal infections, particularly in environments with higher morning humidity.

The stepwise regression analysis between different meteorological parameters like maximum and minimum temperature, morning and evening relative humidity, rainfall and sunshine hours and disease severity was conducted. For variety ML 1808, the results showed that temperatures and humidity levels influenced disease severity. The accuracy of the prediction was moderate, with R^2 values of 0.59 and 0.63 in flat and raised bed method sowing (Table 3 and 4). In ML 2056, the third model showed significant R^2 values between 0.64 and 0.65 in flat sown and raised bed sown mungbean. This indicated that 64 and 65 % variability in disease severity was because of different meteorological parameters. Sharma and Sharma (2015) revealed that temperature, humidity, and rainfall were significant determinants of disease dynamics, particularly for diseases like cercospora and anthracnose. They also revealed that sunshine hours can influence disease development depending on other climatic factors. Kumar and Singh (2018) concluded that environmental factors, especially temperature and humidity, affect the incidence of plant diseases in mungbean. They showed that higher temperatures reduce disease severity in mungbean crops. They also observed that rainfall can mitigate disease development, particularly for foliar diseases like cercospora. Sharma and Joshi (2017) predicted the impact of climatic factors on the spread of cercospora leaf spot disease in pulses. The study highlighted the importance of temperature, rainfall, and sunshine hours in determining disease severity.

Table 2. Correlation coefficients between meteorological parameters and Cercospora leaf spot severity

Date of sowing	Tmax (°C)	Tmin (°C)	RHm (%)	RHe (%)	SSh (hrs/day)	RF (mm)
Flat Sowing Method						
1st July	-0.95*	-0.92*	0.92*	0.91*	-0.39	0.83*
25th July	-0.50*	-0.91*	0.22	0.65*	-0.59*	0.32
Raised Bed Sowing Method						
1st July	-0.90*	-0.84*	0.86*	0.88*	-0.40	0.75*
25th July	-0.54*	-0.93*	0.28	0.62*	-0.61*	0.26

*Significant at 5% level of significance

Where, Tmax - Maximum Temperature (°C) Tmin - Minimum Temperature (°C)
RHm - Morning Relative Humidity (%) RHe - Evening Relative Humidity (%)
SSh - Sunshine Hours (hours/day) RF - Total Rainfall (mm)

Table 3. Regression analysis between Cercospora leaf spot severity (Y) in flat sown moong and meteorological parameters

Treatment	Regression Equations	R^2
ML 1808	Y= 150.1-3.19 Tmax-2.61Tmin-0.73RHm-0.39RHe	0.59*
	Y = 129-2.76Tmax-2.77Tmin+0.94 RHm-0.46 RHe-0.56SSh	0.59*
	Y=47.7-7.43Tmax-0.17Tmin-0.09RHm+2.87RHe+11.4SSh-0.36RF	0.60*
ML 2056	Y = 106.6-0.69Tmax-5.06Tmin+0.73RHm+0.02RHe	0.62*
	Y = 86.8–0.29Tmax-5.21Tmin+0.93RHm-0.04RHe-0.53SSh	0.63*
	Y = 7.26-4.85Tmax-2.67Tmin-0.08RHm+3.16RHe+10.8SSh-0.35RF	0.64*
ML 818	Y = 93.7+0.18 Tmax-6.14Tmin+0.85RHm+0.06RHe	0.68*
	Y = 59.9+0.87Tmax-6.40Tmin+1.20RHm-0.05RHe-0.90SSh	0.68*
	Y=-17.9-3.60Tmax-3.91Tmin+0.20RHm+3.09RHe+10.3SSh-0.34 RF	0.69*

*Significant at 5% level of significance

Table 4. Regression analysis between Cercospora leaf spot severity (Y) in raised bed sown moong and meteorological parameters

Treatment	Regression Equations	R^2
ML 1808	Y= 222.1-5.39Tmax-1.71Tmin+0.70RHm-0.68RHe	0.63*
	Y = 214.2-5.23Tmax-1.77Tmin+0.78RHm-0.71RHe-0.21SSh	0.63*
	Y=137.2-9.65Tmax+0.68Tmin-0.02RHm+2.40RHe+10.8SSh-0.34 RF	0.64*
ML 2056	Y = 179.0-3.63Tmax-3.15 Tmin+0.85 RHm-0.48RHe	0.62*
	Y = 123.2-2.49Tmax-3.58Tmin+1.42 RHm-0.68RHe-1.49SSh	0.64*
	Y = 44.2-7.03Tmax-1.05Tmin+0.40RHm+2.51RHe+9.86SSh-0.35RF	0.65*
ML 818	Y = 151.0-3.32Tmax-3.17Tmin+1.10RHm-0.49RHe	0.60*
	Y = 116.6-2.61Tmax-3.44Tmin+1.46RHm-0.61RHe-0.92SSh	0.61*
	Y = 42.8-6.85Tmax-1.08Tmin+0.51RHm+2.36 RHe+9.67SSh-0.33 RF	0.62*

*Significant at 5% level of significance

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