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Impact of Epidemiological Factors on the Incidence of Charcoal Rot of Sesamum incited by *Macrophomina phaseolina*

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ABSTRACT: Charcoal rot of sesame incited by *Macrophomina phaseolina* is one of the foremost yield-reducing factors in sesame (*Sesamum indicum* L.). In the present studies which were carried out at the experimental farm of SKRAU, Bikaner during *kharif* 2017. The study focused on relationship of different meteorological variables with the development of charcoal rot of sesame disease under field conditions. A positive and non-significant correlation was observed between disease and temperature while a significant, negative correlation was noticed between disease development and relative humidity. Assessment of yield losses in sesame due to *M. phaseolina* was done at the capsule formation stage. The data also revealed that maximum relative humidity was more correlated with the disease intensity as compared to the minimum relative humidity in all three varieties. Sunshine hours exhibited a negative and non-significant correlation with disease progression. Although the total rainfall showed a positive correlation with the disease intensity it was not significant. While the number of rainy days was significantly positively correlated in RT-125 as compared to the other two varieties *i.e*. RT- 46 and RT- 351 in the crop season.

Keywords: Charcoal rot, *Macrophomina phaseolina*, Sesame, and Weather parameters.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is commonly known as 'Til' also called as "Queen of oil seeds". In India, an area of 20 lakh hectares with an annual production of 8.66 lakh tonnes and productivity 405 kg ha^{-1} (Pocket Book of Agricultural Statistics 2016-17). In India, Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, West Bengal, Andhra Pradesh, Tamil Nadu, Karnataka, and Maharashtra are the major sesame growing states. In Rajasthan, sesame is mainly cultivated as an oilseed crop. It hasoccupied 3.66 lakh hectares and produced 1.15 lakh tonnes with a productivity of 314 kg ha^{-1} (Anonymous 2015-16) and an average yield of 270 kg ha^{-1} (IOPEPC *Kharif*-2017 Survey of Sesame Crop). It is an important edible oilseed crop of the tropical and subtropical region next to groundnut, rapeseed, and mustard. The regular occurrence of charcoal rot disease has been recorded from different districts of Rajasthan Tonk, Pali, Bikaner, Jodhpur, Bhilwara, Karauli, and Jalore.

Charcoal rot of sesame caused by *M. phaseolina* (Tassi.) Goid. was first reported from Uttar Pradesh. The crop is severely infected by *M. phaseolina* and is widely distributed in all sesame growing regions. *M. phaseolina* infected seeds show drastically reduced germination and seedling stand. Charcoal rot is also responsible for heavy losses in sesame, maize, soybean, sorghum, and other economically important crop plant every year in India. Similar results were found by Khare *et al*. (1973); Manici *et al.* (1992). Sesame crop is severely infected by *M. phaseolina* and is widely distributed in all sesame growing regions. *Macrophomina phaseolina* infected seeds show drastically reduced germination and seedling stand (Indra, 2020). The losses from the disease are 5-100% in farmers and experimental fields. Environmental factors play an important role in the development of charcoal rot on sesame, caused by *M. phaseolina* (Min and Toyota, 2019). Temperature (maximum and minimum) and relative humidity play a major role in the growth of the pathogen and disease development (Satpathi and Gohel, 2018). The yield losses due to charcoal rot generally depend upon conducive soil and environmental circumstances, inoculum amount, and host susceptibility. Cost-effective management approaches can be developed by understanding the role of soil and environmental conditions (Bashir, 2017). The present investigation was directed to assess the impact of epidemiological factors on the charcoal rot incidence in sesamum crop during *kharif* 2017.

MATERIAL AND METHODS

A. To correlate weather parameters with disease progression

To study the relationship of different meteorological variables (Table 1) with the development of charcoal rot of sesame disease under field conditions. Three varieties *viz.* Susceptible RT-125, Resistant RT-46, and Moderate Resistant RT-351 were tested based on the following weather parameters by using a disease rating scale 0-9 (Table 2) (Abawi and Corrales, 1990). Observations were taken from affected stem parts marked randomly on each variety and disease progression was measured on two alternate days. The data on weather parameters were obtained from meteorology observatory, Agricultural Research Station, SKRAU, Bikaner, and correlated with disease progressed.

Table 1: Different weather parameters with disease progression.

I	Maximum Temperature (°C)		- X_1
II	Minimum Temperature (°C)		-X_2
III	Relative humidity (%)	(a) Maximum	- X_3
		(b) Minimum	-X_4
IV	Sunshine hours		-X_5
V	Rainfall (mm)		- X_6
VI	No. of rainy days		- X_7

Table 2: Rating scale of disease incidence of charcoal rot of sesamum (Abawi and Corrales, 1990).

Rating scale	Description
0	No visible symptom
1	The lesion is limited up to 2.0 cm
3	The lesion has progressed up to 4.0 cm of stem tissue
5	The lesion has progressed up to 6.0 cm of stem tissue
7	The lesion is extensive on half of the stem and branches
9	The foliage exhibits chlorosis most of the stem petioles and growing points or whole plants are infected

The percent disease intensity and incidence were recorded using the formula of Wheeler (1969) in each treatment:

Disease intensity (%) =

$$\frac{\text{Sum of all numerical ratings } \times 100}{\text{Total observed plant} \times \text{Maximum disease grade}}$$

RESULTS AND DISCUSSION

A. Progression of charcoal rots intensity on three varieties of sesame with weather parameters

The progress of charcoal rot intensity in three cultivars of sesame with weather variables was studied in one crop season *i.e. kharif* 2017 under field conditions. Three sesame cultivars *viz.*, RT-125 (Susceptible), RT-46 (Moderately Resistant), and RT-351 (Resistant) were used in the present investigation. The first observation on disease severity was recorded from 10th August to 5th September at 48 hours interval. Thus, a total of 14 observations on disease severity was recorded during the crop season. The percent disease intensity was recorded using the formula of Wheeler (1969). The disease intensity was noted at 48 hours interval using a standard rating scale. The weather variables *viz.*, maximum temperature (X_1), minimum temperature (X_2), relative humidity maximum (X_3), minimum (X_4), sunshine hours (X_5), rainfall (X_6), and a number of rainy days (X_7) were recorded periodically from weather station situated near the experimental field. The data given in Table 3 revealed that charcoal rot intensity was much higher in RT-125 as compared to the other two varieties *i.e.* RT-46 and RT-351. The mean disease intensity in RT-125, 27.33 percent as compared to 23.99 percent in RT-46 and 11.07 percent in RT-351. The charcoal rot intensity progressively increased during the observation period *i.e*. 10th August to 5th September in all three varieties in the crop season. However, the perusal of the data revealed that the progression was relatively faster from 24th August to 5th September onwards in all three varieties in season. The one season data of disease progression given in Table 3 also indicate that the disease progression was faster during 24th August to in all three varieties in crop seasons. The mean of three varieties also showed disease intensity ranged from 21.47 to 33.88 percent in all test sesame varieties. During this period *i.e.*, 24th August to 5th September the minimum to maximum temperature ranges were 29 to 39.8°C and 24.5 to 26.5°C, respectively, while the maximum and minimum relative humidity prevailed 60.0 to 92.0 and 39 to 81 percent, respectively. The number of rainy days was two while the rainfall was maximum 30 mm during the crop season. Similar observations have been reported in sesame by various workers Gemawat and Verma (1974); Sharma and Tripathi (2001); Sabalpara *et al.* (2007).

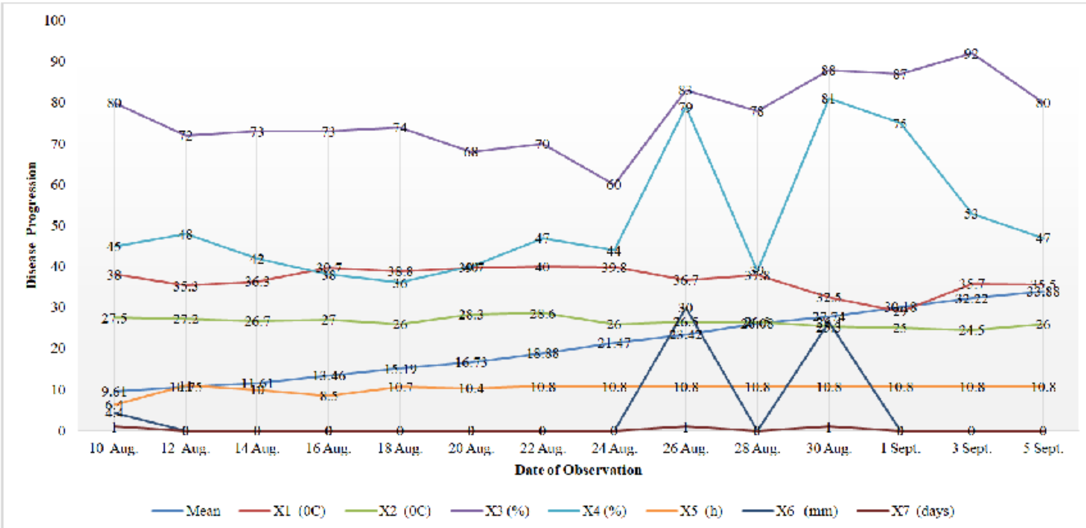
B. The correlation coefficient between disease intensity and meteorological factors

The correlation coefficient between individual weather variables and disease intensity was determined for one crop season. The results given in Table 3 and Fig. 1 indicated that the progression of charcoal rot intensity in three varieties was not significantly negatively correlated with maximum temperature (X_1) and further the minimum temperature was found negatively correlated but significantly with disease intensity during *Kharif* 2017 crop season. Relative humidity maximum (X_3) was found significantly positively correlated and relative humidity minimum (X_4) was not significantly positively correlated with the charcoal rot intensity in all three varieties.

Table 3: Progression of charcoal rot intensity on three varieties of sesame with weather parameters *Kharif* 2017.

Date of observation	Intensity of charcoal rot (%)				Weather parameters						
	RT-125	RT-46	RT-351	Mean	X_1 (°C)	X_2 (°C)	X_3 (%)	X_4 (%)	X_5 (h)	X_6 (mm)	X_7 (days)
10 Aug. 2017	15.50 (23.18) *	11.11 (19.47)	2.22 (8.57)	9.61 (17.07)	38.0	27.5	80.0	45.0	6.4	4.4	1
12 Aug. 2017	16.66 (24.09)	12.20 (20.44)	3.40 (10.63)	10.75 (18.39)	35.3	27.2	72.0	48.0	11.0	0	0
14 Aug. 2017	17.00 (24.35)	13.33 (21.41)	4.50 (12.25)	11.61 (19.34)	36.3	26.7	73.0	42.0	10.0	0	0
16 Aug. 2017	18.88 (25.75)	15.50 (23.18)	6.00 (14.18)	13.46 (21.04)	39.7	27.0	73.0	38.0	8.5	0	0
18 Aug. 2017	20.00 (26.56)	17.77 (24.93)	7.80 (16.22)	15.19 (22.57)	38.8	26.0	74.0	36.0	10.7	0	0
20 Aug. 2017	22.00 (27.95)	20.00 (26.56)	8.20 (16.64)	16.73 (23.72)	39.7	28.3	68.0	40.0	10.4	0	0
22 Aug. 2017	24.44 (29.61)	22.22 (28.12)	10.00 (18.43)	18.88 (25.39)	40.0	28.6	70.0	47.0	10.8	0	0
24 Aug. 2017	28.88 (32.50)	24.44 (29.61)	11.11 (19.47)	21.47 (27.19)	39.8	26.0	60.0	44.0	5.2	0	0
26 Aug. 2017	31.11 (33.89)	26.66 (31.07)	12.50 (20.70)	23.42 (28.55)	36.7	26.5	83.0	79.0	6.5	30.0	1
28 Aug. 2017	33.33 (35.26)	31.11 (33.89)	13.80 (21.81)	26.08 (30.32)	37.8	26.5	78.0	39.0	10.8	0	0
30 Aug. 2017	35.50 (36.57)	32.22 (34.57)	15.50 (23.02)	27.74 (31.39)	32.5	25.3	88.0	81.0	5.0	26.4	1
1 Sept. 2017	37.22 (37.59)	35.55 (36.60)	17.77 (24.93)	30.18 (33.04)	29.0	25.0	87.0	75.0	5.8	0	0
3 Sept. 2017	40.00 (39.23)	36.66 (37.26)	20.00 (26.56)	32.22 (34.35)	35.7	24.5	92.0.	53.0	5.0	0	0
5 Sept. 2017	42.22 (40.52)	37.22 (37.56)	22.22 (28.12)	33.88 (35.40)	35.5	26.0	80.0	47.0	10.2	0	0
Mean	27.33 (31.22)	23.99 (28.91)	11.07 (18.68)								
	SEm±	CD(P=0.05)	CV (%)								
Variety Days Variety X Days	0.26 0.56 0.93	0.73 1.58 2.74	8.11								

X_1 = Maximum temperature (°C), X_2 = Minimum temperature (°C), X_3 = Relative humidity maximum (%), X_4 = Relative humidity minimum (%), X_5 = Sunshine hours (h), X_6 = Rainfall (mm), X_7 = Number of rainy days,
*Figure in parentheses are angular transformed value



X_1 = Maximum temperature (°C), X_2 = Minimum temperature (°C), X_3 = Relative humidity maximum (%), X_4 = Relative humidity minimum (%), X_5 = Sunshine hours (h), X_6 = Rainfall (mm), X_7 = Number of rainy days,

Fig. 1. Progression of charcoal rots intensity of sesame in relation to weather parameters *Kharif* 2017.

The data also revealed that maximum relative humidity was more correlated with the disease intensity as compared to the minimum relative humidity in all three varieties. Sunshine hours (X_5) exhibited a negative and non-significant correlation with disease progression.

Table 4: Correlation coefficients between disease intensity and meteorological factors.

Varieties	Weather parameters						
	Temperature (°C)		Relative Humidity (%)		Sunshine hours	Rainfall (mm)	Rainy days
	Max.	Min.	Max.	Min.			
RT-125	-0.509	-0.677*	0.579*	0.511	-0.409	0.222	0.002
RT-46	-0.512	-0.663*	0.579*	0.500	-0.381	0.193	-0.039
RT-351	-0.481	-0.660*	0.561*	0.446	-0.337	0.146	-0.087

*Significant correlation

Although the Table 4 indicated clearly that total rainfall (X_6) showed a positive correlation with the disease intensity it was not significant. While the number of rainy days (X_7) was significantly positively correlated in RT-125 as compared to the other two varieties *i.e.* RT- 46 and RT- 351 in the crop season. Similar results also reported by Patel and Patel (1990); Deepthi *et al.* (2014) observed maximum temperature (31.6°C), minimum temperature (24.0°C), and relative humidity (88%) favored high disease development. A positive and non-significant correlation was observed between disease and temperature while a significant negative correlation was noticed between disease development and relative humidity.

CONCLUSION

The disease progression was observed relatively faster from 24th August to 5th September in all three cultivars. The mean of three varieties also showed disease intensity ranged from 21.47 to 33.88 percent in three test sesame cultivars. During this period *i.e.*, 24th August to 5th September the minimum to maximum temperature ranges were 29 to 39.8°C and 24.5 to 26.5°C, respectively, while the maximum and minimum relative humidity prevailed 60.0 to 92.0 and 39 to 81 percent, respectively. Relative humidity maximum (X_3) was found significantly positively correlated with the charcoal rot intensity in all three varieties in the crop season. The maximum and minimum temperatures were found negatively correlated with the progression of disease intensity during the season. The Charcoal rot intensity progressively increased during the observation period *i.e.* 10th August to 5th September in all three varieties in the crop season. The disease progression was faster from 24th August to 5th September in all three varieties in the crop season. Relative humidity maximum (X_3) was found significantly positively correlated with the charcoal rot intensity in all three varieties in the crop season.

FUTURE SCOPE

The present investigation has opened up new information and given rise to new ideas on charcoal rot disease of sesame incited by *Macrophomina phaseolina*. The maximum and minimum relative humidity, sunshine hours, maximum and minimum temperature and rainfall plays akey role in development of the disease. With the help of this study we can assess the natural occurance of the disease. In future, with the help of this investigation we can apply different tactics to manage the charcoal rot disease.

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Conflict of Interest. None.

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