Jainpal Rathore
M.Sc. (Ag), Department of Plant
Pathology, Jawaharlal Lal
Nehru Krishi Vishwa Vidyalaya,
Jabalpur, Madhya Pradesh,
India

Dr. KN Gupta
Assistant Professor Scientist, PC,
Unit JNKVV, Jabalpur, Madhya
Pradesh, India

Babli Verma
Ph.D., Research Scholar,
Department of Plant Pathology,
Rajmata Vijayaraje Scindia
Krishi Vishwa Vidyalaya,
Gwalior, Madhya Pradesh, India

Dwarka Prasad Athya
Ph.D., Research Scholar,
Department of Entomology,
Jawaharlal Lal Nehru Krishi
Vishwa Vidyalaya, Jabalpur,
Madhya Pradesh, India

Effect of weather parameters on disease development of root and stem rot of sesame caused by *Sesamum indicum* L.

Jainpal Rathore, Dr. KN Gupta, Babli Verma and Dwarka Prasad Athya

DOI: https://doi.org/10.22271/chemi.2021.v9.i1ad.11534

Abstract
Sesame (*Sesamum indicum* L.) is an ancient oilseed crops cultivated in semi-arid Tropics and sub tropics regions in India. It play an important role in the oilseed economy throughout the world. The fungal disease root and stem rot caused by *M. phaseolina* (Tassi) Goid is the most important disease and is widely, distributed in sesame growing region. The pathogen attacks plant at all growth stages. Due to soil borne nature practically no effective field control and no source of resistant is available. So for the presented investigation entitled field experiment was also conducted with three date of sowing using susceptible cultivars VRI-1.Root and stem rot intensity was higher in all the three date of sowing. Correlation of disease with the weather parameter indicate that root and stem rot disease was negatively relationship with all weather parameter *viz,* maximum temperature, minimum temperature, rain fall (mm), no of rainy days, relative humidity (morning and evening).

Keywords: Sesame, *Macrophomina phaseolina*, weather parameters

1. Introduction
Sesame (*Sesamum indicum* L.) is the oldest among the oilseeds crops cultivated in semi-arid tropics and sub tropics to temperate regions in India. Sesame which was originated in Africa is probably the most ancient oil seed plant cultivated in many parts of the world. Myanmar, India, China are the world's largest producers of sesame in the major sesame growing states are Uttar Pradesh, Rajasthan, Madhya Pradesh Chhattisgarh, Andhra Pradesh, Maharashtra, Gujarat, Tamil Nadu, West Wangal and Orissa Uttar Pradesh, Rajasthan, Madhya Pradesh or Chhattisgarh and contribute about half of the total sesame production of the country. However, a distressing feature is that the productivity of sesame in these states is very low. The main reason for low productivity of this crop is due to the attack of various weather factors and diseases, such as root and stem rot, Alternaria leaf spot (*Alternaria sesame*), Bacterial blight (*Xanthomonas campestris* pv. *sesame*), Powdery mildew (*Erysiphe cichoracearum),* Cercospora leaf spot *(Cercospora sesame*) and phyllody *(Mycoplasma)* Gupta *et al* (2018) [5]. Stem and root rot is caused by *(M. phaseolina)* is one of the important diseases of this crop all over the world (Rajput *et al.,* 1998; Dinakaran and Mohammed, 2001) [8, 4]. It is very serious and destructive in all sesame growing areas and cause 5-100% yield loss and 57% yield loss at about 40% of disease incidence (Vyas and Patel, 1981) [10]. The pathogen attacks root stem, leaf, pod and seeds (Mukharji and Bhasin, 1986) [7]. The most common symptoms of the disease is sudden wilting of growing plant mainly after the flowering stage, stem portion near the ground level show dark brown and dark black lesion at the collar region show shreding and to destroy the vascular bundles by causing the plant death. Stem portion can be easily pulled out leaving the rotten rot portion in the soil (Avila *et al.*, 1999) [1]. *Macrophomina phaseolina* is a seed and soil borne pathogen causing root and stem rot on sesame crops. The disease is veryimportant as infection occurs from seed germination and emergence to adult stage. *M. phaseolina* is an important phytho pathogen distributed worldwide and causes charcoal rot on more than 500 plant species (Das *et al.*, 2008) [2] It is a mithosporic 2 fungal species (Menezes and Oliveira, 1993) [6]. It is a member of Phylum-Deteromycetes, Class-Coelomycetes, Order-Sphaeropsidales, Family Sphaeropsidaceae. Pycnidia are 100-200 μm in diameter, dark brown to greyish, becoming black with age, globose or flattened globose, membranous to sub carbonaceous with an inconspicuous or definite truncate ostiole.

Corresponding Author:
Babli Verma
Ph.D., Research Scholar,
Department of Plant Pathology,
Rajmata Vijayaraje Scindia
Krishi Vishwa Vidyalaya,
Gwalior, Madhya Pradesh, India

The pycnida bear simple, rod-shaped conidiophores, 10-15 μm long. Conidia are 14-33 × 6-12 μm in diameter, single celled, hyaline, and elliptic or oval. The pycniospores are elliptical, thin walled, hyaline, and measure 10-42 x 6-10 μm. Micro sclerotia of fungus are jet black in colour and appear smooth and round to oblong or irregular. Colonies in culture range in colour from white to brown or gray and darken with age. Hyphal branches generally form at right angles to parent hyphae, but branching is also common at acute angles. The fungus is greatly influenced by environmental factors and produces the pycnidia when the atmospheric temperature ranges of 25°C to 35°C. The fungus survives in the form of sclerotia in soil and crop residues and also been reported to be seed born. The available literature revealed that not much research work is carried out on sesame disease in Madhya Pradesh particularly on root and stem rot.

2. Material and Methods
2.1 Influence of climate change on foliar disease of sesame
This experiment was conducted using susceptible variety VRI-1 and sown different date of interval on 1/8/17, 11/8/17 and 21/8/17 with three replications. The severity of root and stem rot was recorded at weekly intervals using 0-10 scale.
Weather observation obtained from meteorological department JNKVV Jabalpur. Environmental condition prevailed during the course of disease development were examined. Wise multiple regression analysis were performed using computer facility available at JNKVV Jabalpur. Stepwise multiple regression analysis were performed to find out the subset of environmental variable *viz*-maximum temperature, minimum temperature relative humidity (morning), relative humidity (evening) and total rainfall and no of rainy days for the purpose of forecasting. The Per cent disease incidence of root and stem rot was recorded at weekly interval.
The incidence was co-related with the weather parameter *Viz*; maximum temperature, minimum temperature relative humidity (morning), relative humidity (evening) sand total rainfall and no of rainy days prior to seven disease observation was use for correlation and regression analysis evaluations of sesame variety against *M. phaseolina* under field condition.

2.2 Statistical analysis
Year and season of Experiment: *Kharif* 2017
(I) Correlation coefficient:
Correlation and regression between percent disease index and meteorological parameters were worked out:

$$r\,(xy) = \frac{COV.\,(xy)}{\sqrt{Var.\,(x)\,Var.\,(y)}}$$

Where,
r (xy = correlation coefficient between character x and y.
COV (xy) = covariance between character x and y.
V(x) = variance of x character.
V(y) = variance of y character

Test of Significance of "r"

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

Where
r = correlation coefficient
n = Number of observations
df = (n-2)

(ii) Analysais of variance- Randomized Complete Block Design
The data were subjected to statistical analysis after tabulation. The data were transformed to their angular values as required. The data so obtained were analyzed by using the analysis of variance technique as given below:

Table 1: ANOVA for Randomized Complete Block Design

Sources of variance	d.f	S.S.	M.S.S.	F Cal	F Table
Replications	(r-1)	SSR	SSR/r-1=a	a/c	
Treatments	(t-1)	SST	SST/t-1=b	b/c	F at 5% (t-1), (r-1) (t-1)
Error	(r-1) (t-1)	SSE	SSE/(r-1)(t-1)=c	-	-
Total	(r×t-1)	-	-	-	-

Where,
r = number of replications
t = number of treatments
SSR = Replication mean sum of square
SST = Treatment mean sum of square
SSE = Error mean sum of square
d.f = Degree of freedom

The significance among different treatment means was judged by critical difference (CD) at 5% level of significance for comparison among the treatments, for which the marginal means of each treatment was considered. The following formula was used for various estimations.

1. $SEm\pm = \sqrt{EMS/r}$
2. Critical difference (CD) $= SEm \times \sqrt{2} \times$ t at 0.05

Where
Ems = Error mean sum of square
t = 't' value at 5% level at error d.f.
r = number of replications
S.Em± = standard error of any treatment mean\
CD = Critical Difference

(iii) Completely Randomized Design (CRD)

Table 2: ANOVA for CRD

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Calculated
Treatment	$t-1$	SST	$SST/t-1$	MST/MSE
Error	$t(r-1)$	SSE	$SSE/t(r-1)$	
Total	$(rt-1)$			

$SEm\pm = \sqrt{EMS/r}$
$SEd\pm = \sqrt{2EMS/r}$
$CD = SEd \pm \times$ t at 5%

Where,
$r =$ No. of replication
$EMS =$ Error mean square
$SEm\pm =$ Standard error of treatment mean
$SEd\pm =$ Standard error of difference to two treatment mean
$CD =$ Critical difference to two treatments mean

2.3 Meteorological data

The weather condition during the course of studies from September, 2017 presented in table

Table 3: Meteorological data during the crop season of 2017-18 at Jabalpur

Month	Date of observation	SMW	Temperature		Rain fall (mm)	No. of rainy Days	Relative Humidity	
			Max.	Min.			Morning	Evening
Sept	1SEP-7SEP	36.0	32.5	24.0	15.0	0.0	88.0	65.0
Sept	8SEP-14SEP	37.0	32.8	23.3	87.8	2.0	91.0	64.0
Sept	15SEP-21SEP	38.0	30.7	22.4	98.3	3.0	90.0	73.0
Sept	22SEP-28SEP	39.0	32.9	21.9	0.0	0.0	89.0	52.0
Oct	29SEP-5SEP	40.0	33.4	20.3	7.4	1.0	90.0	51.0
Oct	06OCT-11OCT	41.0	32.6	21.7	9.2	1.0	92.0	56.0
Oct	13OCT-18OCT	42.0	33.6	17.9	0.0	0.0	87.0	40.0
Oct	20OCT-25OCT	43.0	33.1	15.9	0.0	0.0	81.0	26.0
Nov	27OCT-1OCT	44.0	31.1	12.2	0.0	0..0	87.0	29.0
Nov	3NOV-8NOV	45.0	30.0	10.2	0.0	0.0	86.0	27.0
Nov	10NOV-15NOV	46.0	28.9	11.9	0.0	0.0	87.0	42.0

Source: Meteorological observatory, College of Agriculture Jnkvv, Jabalpur (M.P.)

3. Results

3.1 Disease development in relation to environmental factors:
This experiment was conducted using susceptible variety VRI-1 and sown three different date of sowing. Data presented in the (Table 4) indicate that maximum disease incidence (38%) was recorded in second date of sowing and minimum (33%) in first date.

Table 4: Effect of date of sowing for root and stem rot disease incidence of sesame

Date of observation	Percent disease incidence (%)		
	DOS 1.08.17	DOS 11.08.17	DOS 21.08.17
01.09.17	2.5	0.0	0.0
08.09.17	5.0	1.0	3.0
15.09.17	10.6	2.0	5.0
22.09.17	15.5	3.3	6.6
29.09.17	20.3	9.2	13.3
06.10.17	22.0	10.3	15.6
13.10.17	25.5	11.0	27.8
20.10.17	27.0	24.0	22.2
27.10.17	28.0	30.3	26.2
03.11.17	31.2	36.6	30.4

DOS= (Date of sowing)

The weather condition during to meteorological week were observed to the most congeneal for the crop infection and further rapid buildup of the disease. The rate of disease build up was correlated with the weather parameter during the crop growth for three date of sowing (Table 5). All the three date of sowing and meteorological factor *Viz*. Maximum temperature (x1) minimum temperature (x2) rainfall (mm) (x3) no of rainy days (x4) relative humidity morning (x5) relative humidity evening (x6) showed a negative correlation with the disease development 34.

The disease was negatively correlated with first date of sowing (1/8/2017) temperature maximum (r=- 0.43),minimum (r=- 0.888**) rain fall (r=- 0.655*) no of rainy days (r=- 0.527) relatively humidity morning (r=- 0.505) and evening (r=-0.850**) Second date of sowing (11/8/2017) temperature maximum (r= - 0.659*) minimum (r=- 0.978**) rain fall (r=- 0.532) no of rainy days (r=- 0.523) relatively humidity morning (r=- 0.575) and evening (r=- 0.827**) and third date of sowing (21/8/2017) temperature maximum (r=- 0.577), minimum (r=- 0.954**) rain fall (r= - 0.579), no of rainy days (r=- 0.515),relatively humidity morning (r=- 0.517) and evening (r=- 0.827**).This is clearly indicated that weather parameter play a crucial role in the root and stem rot disease development. Stepwise multiple regression analysis showed that predicated mean percent disease incidence of root and stem rot was greatly infection influenced by the variable. *Viz*. Maximum temperature (x1) minimum temperature (x2) rainfall (mm) (x3) no of rainy days (x4) relative humidity morning (x5) relative humidity evening (x6). Multiple regression equitation percent disease incidence and various exhibited strongly relationship among different component of the epiphytotics during all the date of sowing (Table no. 6). The R2 value of function ranged from 0.94 to 0.99, the line prediction equation for root and stem rot first date of sowing Y=48.97+(0.47x1)+(-1.67x2)+(-0.27x3)+(8.76x4)+(-0.13x5)+(-0.04x6)   Y=170.25+   (-3.55x1)+(-1.05x2)+(-0.09x3)+(2.58x4)+(-0.06x5)+(-0.36x6)   and   Y=64.31+   (-0.13x1)+(-2.25x2)+(-0.18x3)+(5.11x4)+(-0.07x5)+(0.08x6) were selected as the best fit for predicting the disease under normal epiphytotics.

Table 5: Simple correlations for sesame root and stem rot disease

Weather parameters	Per cent disease incidence (%)		
	D/S 1.08.17	D/S 11.08.17	D/S 21.08.17
Tem (MAX)	- 0.430	- 0.659*	- 0.577
Tem (MIN)	- 0.888**	- 0.978**	- 0.954**
Rainfall (mm)	- 0.655*	- 0.532	- 0.579
No of rainy days	- 0.527	- 0.523	- 0.515
RH(M)	- 0.505	- 0.575	- 0.517
RH(E)	- 0.850**	-0.827**	- 0.827**

Correlation is significant at the 0.05 level **
Correlation is significant at the 0.01 level

Table 6: Multiple regression equitation between weather parameter on root and stem rot disease

Disease index	Correlation Coefficient (R)	Coefficient of multiple determination on R2	Multiple regression equitation
DOS (01.08.17)	0.97	0.94	Y=48.97+(0.47x1)+(-1.67x2)+ (-0.27x3)+(8.76x4)+(-0.13x5)+ (-0.04x6)
DOS (11.8.17)	0.97	0.94	Y=170.25+(-3.55x1)+(-1.05x2)+ (-0.09x3)+(2.58x4)+(-0.06x5) (-0.36x6)
DOS (21.8.17)	0.97	0.94	Y=64.31+(-0.13x1)+(-2.25x2)+ (-0.18x3)+(5.11x4)+ (-0.07x5)+(0.08x6)

Y = predicated mean disease severity, X1 = Maximum temperature, (x2) = minimum temperature, (x3) = rainfall (mm), (x4) = no of rainy days, (x5) = relative humidity morning, (x6) = relative humidity evening, R2= regression square.

4. Discussion and Conclusion
4.1 Disease development in relation to environmental factor

The development of root and stem rot intensity was studies in relation to various climatic parameters *viz.,* First date of sowing (1/8/2017) temperature maximum (r = - 0.43), minimum (r = - 0.888**), rain fall (r = -0.655*), number of rainy days (r = -0.527), relatively humidity morning (r = - 0.505) and evening (r = - 0.850**), Second date of sowing (11/8/2017) temperature maximum (r = - 0.659*) minimum (r = - 0.978**) rain fall (r = - 0.532) no of rainy days (r = - 0.523) relatively humidity morning (r = - 0.575) and evening (r = - 0.827**) and third date of sowing (21/8/2017), temperature maximum (r=- 0.577), minimum (r=- 0 .954**) rain fall (r = - 0.579), no of rainy days (r = - 0.515), relatively humidity morning (r=-0.517) and evening (r = - 0.827**). Six regression coefficients were obtained for independent variables *viz.,* Maximum temperature (°C), minimum temperature (°C) rain fall (mm) number of rainy days and relative humidity (%) as the dependent variable disease incidence. Multiple regression equitation percent disease incidence and exhibited relationship between different component of the epiphytotics during all the date of sowing studied and combine effect of different weather variation favored disease development causing up to 99 percent variation in disease index (Table no.4) the R2 value of function ranged from 0.94 to 0.99 the line prediction equation for root and stem rot first date of sowing first DOS Y=48.97+(0.47x1) + (-1.67x2) + (-0.27x3)+(8.76x4)+(-0.13x5)+(-0.04x6) Second DOS Y=170.25+(-3.55x1)+(-1.05x2)+(-0.09x3)+(2.58x4)+(-0.06x5) (-0.36x6) and third DOS Y=64.31+(-0.13x1)+(-2.25x2)+(-0.18x3)+(5.11x4)+(-0.07x5)+(0.08x6) were selected as the best fit for predicting the disease under normal epiphytotics found to have a significant negative correlation Based on the regression coefficients obtained for root and stem rot disease, linear equations were derived to predict the disease depending upon weather conditions prevailing during crop season. The present findings are similar with the results of Satpathi and Gohel (2018)[9] who reported higher temperature (35 °C) and low relative humidity to be favorable for maximum disease incidence of charcoal rot of sesame (*M. phaseolina*). Similar results were also obtained by Deepthi *et al*. (2014) [3] for blight of green gram caused by *M. phaseolina* which maximum disease incidence was found in the month**.**

Root and stem rot intensity was higher in all the three dates of sowing. Correlation of root and stem rot with the weather parameters indicated that root and stem rot negative relationship with all the weather parameter *Viz.* Maximum temperature, minimum temperature, rainfall (mm),no of rainy days, relatively humidity (morning and evening).

5. Acknowledgement

6. References
1. Avila J, Aponte O, Pineda J, Colmenares. The cultivation of sesame. *FONAIAP Publication series,* Araure Venezuela. Centre of lnvestigaciones of Portuguesa state 1999, 83.
2. Das IK, Fakrudia B, Arora DK. RAPD cluster analysis and chlorate sensitivity of some Indian isolates of *Macrophomina phaseolina* from sorghum and their relationships with Pathogenicity. Microbial. Res 2008;163:215-224.
3. Deepthi P, Shukla CS, Verma KP, Reddy SS. Yield loss assessment and influence of temperature and relative humidity on charcoal rot development in sesame (*Sesamum indicum* L.) 2014;9(1):193-195.
4. Dinakaran D, Mohammed N. Identification of resistant sources to root rot of sesame caused by *Macrophomina phaseolina* (Tassi.) Goid. Sesame and Safflower Newsletter 2001;16:68-71.
5. Gupta KN, Naik KR, Bisen R. Status of sesame diseases and their integrated management using indigenous practices. International Journal of Chemical Studies 2018;6(2):1945-1952.
6. Menezes M, Oliveira SA. *Fungos fitopatogenicos.* Recife: UFRPE, 1993, 277.
7. Mukharji KG, Bhasin J. Plant disease in India. Today and Tomorrow Publisher. New Delhi 1986.
8. Rajput MA, Khan ZH Jafr KA, Fazal Ali JA. Field screening of sesame germplasm for resistance against charcoal rot (*Macrophomina phaseolina*). Sesame and Safflower Newsletter 1998;13:63-66.
9. Satpathi AK, Gohel NM. Role of meteorological factors on development of stem and root rot of sesame. Journal of Pharmacognosy and Phytochemistry 2018;7(6):1922-1924.
10. Vyas SC, Patel MC. Integrated biological and chemical control of dry root rot of chickpea. Indian J Mycol. Pl. Pathol 2015;24(2):132-34.