



Influence of Weather Parameters on Foliar Diseases of Sesame (*Sesamum indicum* L.) in Coastal Ecosystem of West Bengal, India

Nayan Kishor Adhikary^{1*}, Krishnendu Roy² and Kajal Kumar Biswas³

¹ICAR-All India Coordinated Research Project on Sesame and Niger, Institute of Agricultural Science, University of Calcutta, 51/2, Hazra Road, Kolkata - 700019, West Bengal, India.

²Sasya Shyamala Krishi Vigyan Kendra, Ramakrishna Mission Vivekananda University, Narendrapur - 700103, West Bengal, India.

³Advance Centre of Plant Virology, Division of Plant Pathology, ICAR- Indian Agricultural Research Institute, New Delhi - 11012, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author NKA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors KR and KKB managed the analyses of the study. Author KKB managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Sesame is one of the most important oilseed crops in India due to mainly its high quality seed oil and antioxidant properties. Occurrence of foliar diseases, like *Alternaria* leaf spot and *Cercospora* leaf spot has become a major constraint in recent years for successful and profitable cultivation of sesame. Field experiments were conducted with sesame var. savitri in a factorial randomized block design with three different dates of sowing with 15 days interval and two different plant protection situations (Protected *i.e.*, treated with disease control protocols and unprotected *i.e.*, control), replicated four times, during two consecutive summer seasons of 2018 and 2019 at Agricultural Experimental Farm, Institute of Agricultural Science, University of Calcutta, Baruipur, South 24 Parganas. The diseases incidence was estimated and correlated with the weather parameters. The

*Corresponding author: E-mail: nayan.bckv@gmail.com;

average of weather parameters viz., maximum temperature, minimum temperature, relative humidity (morning), relative humidity (evening) and rainfall prior to seven days of disease appearance were considered for study the correlation between the weather factors and the disease. In 2018, disease incidences of the plants shown at third date of sowing (26th April, 2018) in both the protected and unprotected plots had significant ($P=0.05$) but negative correlation with maximum temperature. For plants sown at first date of sowing (27th March, 2018) in 2018 had disease incidences significantly ($P=0.05$) and positively correlated with minimum temperature. However, in 2019, except for the relation between disease incidences in the unprotected plots and maximum temperature, all other disease-temperature correlations were non-significant. Disease incidences were positively and significantly correlated with relative humidity (both morning and evening) in all dates of sowing irrespective of experimental years, except with morning relative humidity at first date of sowing in first year. Total rainfall was positively and significantly correlated with disease incidences at all dates of sowing in 2018; however, such relation was non-significant in 2019.

Keywords: *Alternaria; cercospora; correlation; sesame; weather.*

1. INTRODUCTION

Sesame (*Sesamum indicum* L.) crop belongs to family Pedaliaceae (order: Tubiflorae) and is a native of India. It is called as the queen of the oilseeds in view of its high oil quality and protein. Sesame has a high oil content (about 50%) and nutritious protein content (about 23%) and also has sufficient carbohydrate (15%) [1]. Sesame oil has excellent stability due to the presence of the natural antioxidants viz., sesamol, sesamin and sesamol which highly increase the medicinal value of the oil [2,3,4]. India is the fifth largest vegetable oil economy in the world, next only to USA, China, Brazil and Argentina, and has an annual turnover of about Rs. 80,000 crore. India accounts for 12-15% of oilseeds area, 7-8% of oilseeds production, 6-7% of vegetable oils production, 9-12% of vegetable oils import and 9-10% of edible oils consumption [5]. Among the oilseed crops, sesame ranks first for its higher oil content with 6335 kcal kg⁻¹ of dietary energy in seeds [6].

The sesame crop suffers from several diseases which account for an approximate yield loss of about 15-20%. Phyllody, leaf curl, leaf spots, rusts, root and stem rot are the serious diseases of sesame causing significant reduction in the yield [7]. Among several diseases, *Alternaria* leaf spot and *Cercospora* leaf spot are most severe in recent climate change scenario in the coastal ecosystem of South Bengal and are affecting the plants partially or completely resulting in low productivity of the crop. Yield losses due to *Alternaria* leaf spot may even be ranging from 18 to 55% [8]. The crop damage due to *Cercospora* leaf spot had also been estimated up to as high as 70% [9,10].

In sesame growing areas of eastern part of India and particularly in coastal ecosystem of South Bengal there is no information on the influences of different weather parameters on foliar diseases prevalence and incidence. Hence, present investigation was undertaken to find out the relationship among different meteorological parameters and incidence of the foliar diseases in sesame under both protected (using disease control measures) and unprotected (control) conditions.

2. MATERIALS AND METHODS

The field experiments were conducted at Agricultural Experimental Farm, Baruipur, South 24-Parganas, West Bengal (22°21'56" N, 88°26'14" E) representing the alluvial part of coastal South Bengal in the consecutive summer seasons of 2018 and 2019. The experiment was laid out in a factorial randomized block design (RBD) with two factors viz. dates of sowing and disease control protocols, replicated four times. Seeds of sesame var. savitri were sown in three dates (27th March, 11th April and 26th April in 2018 and 28th March, 12th April and 27th April in 2019) under two disease control protocols (Protected and Unprotected). The per cent disease incidence (per cent leaf area occupied by the particular disease) for foliar diseases were recorded at weekly interval and weather data for standard weeks during the crop growth period were recorded. The disease control measures such as seed treatment with imidacloprid @ 3 ml and carbendazim @ 1 g per kg of seed, and spraying of insecticide (cypermethrin @ 1.5 ml/l) and fungicides (carbendazim + mancozeb @ 2.5 g/l and myclobutanil @ 1 g/l) were taken in protected treatment, whereas, no sprayings were done in

case of unprotected treatment. The diseases incidence was correlated with the weather parameters. The average values of weather parameters viz., maximum temperature, minimum temperature, relative humidity (morning), relative humidity (evening) and rainfall prior to seven days of disease observation was used for data analysis.

3. RESULTS AND DISCUSSION

3.1 Influence of Weather Parameters on Sesame Foliar Diseases

The rate of disease build-up during the crop growth period for first, second and third dates of sowing in both consecutive years (summer

seasons of 2018 and 2019) are presented in Tables 1 and 2.

3.1.1 Relationship between foliar disease incidence and weather parameters in summer, 2018

The correlation studies indicated that in summer season, 2018, maximum temperature of first, second and third dates of sowing were non-significantly and negatively, non-significantly and positively, and significantly ($P=0.05$) and negatively correlated with disease incidences under both protected and unprotected environments. Only in case of first date of sowing minimum temperature were positively and significantly ($P=0.05$) correlated with foliar disease incidences (Table 3).

Table 1. Influence of weather parameters on severity of foliar diseases of sesame in summer, 2018

Dates of observation	1 st Date of sowing (27.03.2018)				Dates of observation	2 nd Date of sowing (11.04.2018)				Dates of observation	3 rd Date of sowing (26.04.2018)			
	ALS		CLS			ALS		CLS			ALS		CLS	
	P	UP	P	UP		P	UP	P	UP		P	UP	P	UP
26.04.2018	1	2	0	1	11.05.2018	1	2	0	2	26.05.2018	1	4	0	1
03.05.2018	2	4	0	2	18.05.2018	2	4	1	4	02.06.2018	2	6	2	2
10.05.2018	4	6	1	4	25.05.2018	4	6	2	6	09.06.2018	2	8	6	8
17.05.2018	6	8	2	4	01.06.2018	6	10	4	8	16.06.2018	4	12	8	14
24.05.2018	8	10	2	6	08.06.2018	8	12	8	14	23.06.2018	10	16	10	16
31.05.2018	8	14	5	8	15.06.2018	12	18	10	16	30.06.2018	14	18	12	20
07.06.2018	10	16	6	12	22.06.2018	15	20	12	18	07.07.2018	16	24	14	22
14.06.2018	12	18	8	14	29.06.2018	18	24	14	22	14.07.2018	18	28	18	24
21.06.2018	16	26	10	18	06.07.2018	20	26	18	26	21.07.2018	22	34	20	26
28.06.2018	18	30	12	20	13.07.2018	24	30	22	32	28.07.2018	24	38	22	26

P: Protected, UP: Unprotected, ALS: Alternaria leaf spot, CLS: Cercospora leaf spot

Table 2. Influence of weather parameters on severity of foliar diseases of sesame in summer, 2019

Dates of observation	1 st Date of sowing (28.03.2019)				Dates of observation	2 nd Date of sowing (12.04.2019)				Dates of observation	3 rd Date of sowing (27.04.2019)			
	ALS		CLS			ALS		CLS			ALS		CLS	
	P	UP	P	UP		P	UP	P	UP		P	UP	P	UP
27.04.2019	0	3	0	2	12.05.2019	1	2	0	1	27.05.2019	1	2	1	3
04.05.2019	2	4	0	2	19.05.2019	3	3	0	3	03.06.2019	1	5	3	4
11.05.2019	5	7	2	3	26.05.2019	6	5	2	7	10.06.2019	4	6	5	7
18.05.2019	6	9	3	4	02.06.2019	7	9	5	9	17.06.2019	7	11	9	9
25.05.2019	7	10	3	7	09.06.2019	8	11	7	11	24.06.2019	11	18	13	11
01.06.2019	9	13	4	9	16.06.2019	11	19	11	16	01.07.2019	12	21	15	18
08.06.2019	12	17	7	11	23.06.2019	13	20	12	19	08.07.2019	14	24	16	23
15.06.2019	13	21	9	14	30.06.2019	14	26	16	21	15.07.2019	16	29	21	28
22.06.2019	16	25	13	18	07.07.2019	16	28	17	25	22.07.2019	21	36	23	31
29.06.2019	17	33	14	24	14.07.2019	21	32	19	31	29.07.2019	24	42	26	33

P: Protected, UP: Unprotected, ALS: Alternaria leaf spot, CLS: Cercospora leaf spot

Table 3. Correlation among foliar disease incidence and weather parameters in summer, 2018

Weather factor	First date of sowing (27.03.2018)				Second date of sowing (11.04.2018)				Third date of sowing (26.04.2018)			
	Alternaria leafSpot		Cercospora leaf Spot		Alternaria leaf spot		Cercospora leaf Spot		Alternaria leaf spot		Cercospora leaf spot	
	P	UP	P	UP	P	UP	P	UP	P	UP	P	UP
Temp. (Max.)	-0.44ns	-0.51ns	-0.42ns	-0.49ns	0.22ns	0.25ns	0.25ns	0.21ns	-0.79*	-0.74*	-0.73*	-0.79*
Temp. (Min.)	0.71*	0.68*	0.75*	0.70*	0.58ns	0.63ns	0.58ns	0.54ns	0.12ns	0.14ns	0.22ns	0.15ns
RH (Mor.)	0.03ns	0.13ns	0.05ns	0.13ns	0.64*	0.59ns	0.66*	0.70*	0.89**	0.88**	0.86**	0.87**
RH (Eve.)	0.80**	0.83**	0.78**	0.80**	0.87**	0.84**	0.87**	0.89**	0.92**	0.90**	0.90**	0.93**
TRF	0.69*	0.75*	0.68*	0.73*	0.84**	0.80**	0.85**	0.88**	0.85**	0.86**	0.80**	0.74*

Temp. (Max.): Temperature (Maximum), Temp. (Min.): Temperature (Minimum), RH (Mor.): Relative humidity (Morning), RH (Eve.): Relative humidity (Evening), TRF: Total rainfall, ns: non-significant; *significant at P= .05; **significant at P< .01

Table 4. Correlation among foliar disease incidence and weather parameters in summer, 2019

Weather factor	First date of sowing (28.03.2019)				Second date of sowing (12.04.2019)				Third date of sowing (27.04.2019)			
	Alternaria leaf spot		Cercospora leaf spot		Alternaria leaf spot		Cercospora leaf spot		Alternaria leaf spot		Cercospora leaf spot	
	P	UP	P	UP	P	UP	P	UP	P	UP	P	UP
Temp. (Max.)	-.519ns	-.679*	-.652*	-.726*	-.590ns	-.520ns	-.514ns	-.597ns	-.584ns	-.606ns	-.507ns	-.557ns
Temp. (Min.)	.364ns	.288ns	.265ns	.320ns	.349ns	.472ns	.464ns	.382ns	.389ns	.395ns	.408ns	.436ns
RH (Mor.)	.744*	.811**	.840**	.830**	.725*	.789**	.774**	.755*	.744*	.781**	.742*	.829**
RH (Eve.)	.802**	.902**	.905**	.917**	.822**	.816**	.809**	.837**	.818**	.840**	.786**	.856**
TRF	.259ns	.446ns	.452ns	.501ns	.311ns	.309ns	.310ns	.338ns	.362ns	.367ns	.282ns	.339ns

Temp. (Max.): Temperature (Maximum), Temp. (Min.): Temperature (Minimum), RH (Mor.): Relative humidity (Morning), RH (Eve.): Relative humidity (Evening), TRF: Total rainfall, ns: non-significant; *significant at P= .05; **significant at P< .01

In first date of sowing, relative humidity of morning time were positively non-significantly associated with disease incidences. In second date of sowing, morning relative humidity was positively and significantly ($P= .05$) related with disease incidences except *Alternaria* leaf spot in unprotected condition. In third date of sowing, positive significant ($P< .01$) relation was revealed between morning relative humidity and disease incidence. Irrespective of date of sowing and disease control measures, evening relative humidity were positively and significantly ($P< .01$) correlated with foliar disease incidences (Table 3). Relation of total rainfall with disease incidence was positively significant at $P= .05$, $P< .01$ and $P< .01$ in case of first, second and third dates of sowing respectively (Table 3).

3.1.2 Relationship between foliar diseases incidence build up and weather parameters in summer, 2019

In summer season of 2019, maximum temperature of first date of sowing was negatively and significantly ($P= .05$) correlated with disease incidences except in case of *Alternaria* leaf spot. In second and third dates of sowing, such relations were negative and non-significant. Minimum temperature at first, second and third dates of sowing had positive and non-significant relation with foliar disease incidences (Table 4). Relative humidity at both morning and evening were positively and significantly correlated with disease incidence. However, the relation between total rainfall and disease incidence was non-significant at all dates of observation (Table 4).

In present study, the disease incidences varied depending on the period of observations. The incidences were low in protected condition (where proper disease control measures were taken) as compared with unprotected condition (control plots, no disease control). Incidences of *Alternaria* and *Cercospora* leaf spots showed increasing trends at second date of sowing, when the temperature and relative humidity were higher. Sangeetha and Siddaramaiah [11] reported that the maximum temperature (27-28°C), minimum temperature (14-15°C) and average relative humidity more than 65% was found favourable for *Alternaria* blight development of Indian mustard (*Brassica juncea* L.). Prolonged high humidity and frequent rain showers favour spore dispersal, infection and development of leaf blight disease [12]. The present investigation is in line with the report of Swamy [13] who also stated that the severity of *Cercospora* leaf spot of chilli had positive

correlation with minimum temperature and rainfall, both of which can be named as the most influencing factors for disease development. In both consecutive summer seasons of 2018 and 2019, in out experiment, humidity were high (>80%) in morning time. A similar observation was made in case of groundnut [14].

4. CONCLUSION

Weather events largely dictate disease incidences in sesame crop. The present study took an attempt to estimate the relation between weather parameters and incidences of *Alternaria* and *Cercospora* leaf spots diseases in consecutive two years of summer season. Outcome of this study can be of much use while understanding the complex yet subtle relation between different weather parameters and disease incidences under the purview of changing climatic condition in the coastal belt of West Bengal, India.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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