

EPIDEMIOLOGICAL INVESTIGATION ON STEM ROT DISEASE OF PADDY CAUSED BY *SCLEROTIUM ORYZAE* CATT. AT GANGAVATHI, KARNATAKA

Gowdar, S. B¹, Sujay Hurali², Ashwathnarayana, D. S³ and Pramesh D⁴., Amaresh, Y. S³

¹ Professor, Department of Plant Pathology, College of Agriculture, Gangavathi- 583 227

²Senior Scientist, ICAR - AICRP on Rice, Agricultural Research Station, Gangavathi- 583 227

³Professor, Department of Plant Pathology, College of Agriculture, Raichur - 584 104

⁴Senior Scientist, ICAR-Directorate of Mushroom Research, Chambaghat - 173 213
Solan, Himachal Pradesh

*Email correspondence: sbgowdar@uasraichur.edu.in

ORCID ID: ¹0000-0003-3216-9946, ²0000-0001-8989-7114, ³0009-0008-0007-7071 and ⁴0000-0002-5229-443X

ABSTRACT

Stem rot of rice, caused by *Sclerotium oryzae* Catt., was monitored under natural field conditions at the Agricultural Research Station, Gangavathi, Karnataka, over Kharif 2017-18, Rabi/summer 2017-18 and Kharif 2018-19 using the susceptible cultivar BPT-5204. Disease incidence was recorded weekly together with soil temperature, soil moisture, soil pH, electrical conductivity, rainfall and rainy days. Stem rot appeared consistently in the fifth week after transplanting and increased to 42.00, 36.40 and 38.40% by the seventeenth week in the three seasons, respectively. Maximum soil temperature was strongly and positively associated with disease incidence in Kharif 2017-18 ($r = 0.88$) and Rabi/summer 2017-18 ($r = 0.86$), whereas several rainfall, rainy-day and minimum-temperature relationships were negative. Multiple regression and step-down regression identified season-specific combinations of variables, and first-order autoregression closely reproduced observed disease progress (multiple $R = 0.995-0.998$). The results define a reproducible seasonal window for stem-rot development and provide a basis for weather-linked disease forecasting in irrigated rice.

KEYWORDS: Rice, stem rot, *Sclerotium oryzae*, epidemiology, weather factors, soil factors, disease forecasting, AUDPC.

1. INTRODUCTION

Rice is a major food crop in Asia, and the stability of irrigated production increasingly depends on the management of diseases that persist in intensively cultivated fields. Stem rot caused by *Sclerotium oryzae* Catt. survives through sclerotia and crop residues and can develop rapidly once susceptible tillers, inoculum and a favourable soil-water environment coincide. Earlier work demonstrated the importance of soil-borne sclerotia, crop residues and environmental conditions in the epidemiology of the disease (Krause and Webster, 1972, 1973; Cintas and Webster, 2001; Bochalya *et al.*, 2025; Pati *et al.*, 2025).

In Karnataka, stem rot has shifted from a comparatively minor problem to an emerging constraint in repeatedly cropped rice areas. The thesis from which the present dataset is derived identified a need to clarify when disease begins, how rapidly it progresses and which soil and weather variables are associated with epidemic development. Recent surveys in southern India continue to show that *S. oryzae* is widely distributed and that disease incidence differs substantially among locations and cultivars (Ramanjineyulu *et al.*, 2024; Singh *et al.*, 2025), emphasizing the value of local epidemiological information.

Temperature, moisture status, flooding or drying regimes, pH, electrical conductivity and rainfall may alter sclerotial survival, germination and host infection. Climatic and agronomic changes that favour high humidity, warm conditions and dense rice canopies have also been implicated in increased importance of rice diseases (Krishnaveni and Laha, 2009; Laha *et al.*, 2017; Saharan *et al.*, 2025). Reliable weekly disease-progress information is therefore useful for identifying critical infection periods and for constructing simple forecasting relationships (Mandal *et al.*, 2025). In recent years, deep-learning methods have been shown to be effective for the detection of rice diseases from image data, including those that are visible (Tholupuluri *et al.*, 2024). In general, machine-learning methods can integrate weather, soil and crop data to aid in agricultural forecasting and disease-risk assessments (Taqvi, 2025). These digital methods are not intended to supplant, but to supplement, the field-based epidemiological observations made, like those in the present study. In recent years, deep-learning methods have also been investigated for paddy disease classification using image analysis, which could be useful for automated disease monitoring in agriculture (Jayasundari *et al.*, 2024).

The present study was undertaken to characterize natural progress of paddy stem rot over three cropping seasons at ARS, Gangavathi; quantify relationships of disease incidence with selected soil and weather factors; estimate seasonal disease pressure using area under the disease progress curve (AUDPC); and evaluate regression and first-order autoregression models for describing and predicting stem-rot incidence.

2. MATERIALS AND METHODS

2.1 Experimental site, host and disease monitoring

A fixed 10 m x 10 m plot was maintained at the Agricultural Research Station (ARS), Gangavathi, Karnataka, using the susceptible rice cultivar BPT-5204. The crop was transplanted on 6 September 2017, 4 January 2018 and 27 August 2018 for Kharif 2017-18, Rabi/summer 2017-18 and Kharif 2018-19, respectively. Recommended agronomic practices were followed, but the epidemiology plot was kept free of fungicide. Five 1 m x 1 m sites were selected randomly, and total and infected plants were counted weekly from transplanting to harvest. Disease incidence was expressed as the percentage of infected plants and observations were aligned with standard meteorological weeks (SMW).

2.2 Soil and weather observations

Soil temperature was recorded weekly with a soil thermometer inserted to 15 cm depth following the procedure described by Nwankwol and Ogagarue (2012). For soil moisture, five soil samples were taken from the four corners and centre of the plot at 15 cm depth, combined into a composite sample, and moisture percentage was estimated by the oven-dry-weight method (Black, 1965). Soil pH and electrical conductivity (EC) were determined from 1:2.5 soil:water suspensions using a digital pH meter and conductivity bridge, respectively, following Jackson (1967). Weekly rainfall and number of rainy days were obtained from the ARS, Gangavathi observatory.

2.3 Statistical analyses

Disease incidence was correlated with corresponding weekly soil temperature, soil moisture, soil pH, soil EC, rainfall and rainy days. Correlation, multiple linear regression and step-down regression analyses followed standard procedures described by Gomez and Gomez (1984) and Snedecor and Cochran (1967). Seasonal disease pressure was summarized by AUDPC using the method of Wilcoxon *et al.* (1975). First-order autoregression was used to compare observed and predicted stem-rot incidence through crop development.

3. RESULTS

3.1 Seasonal disease progress

Stem rot first appeared in the fifth week after transplanting in all three seasons. In Kharif 2017-18, incidence began at 1.60% and increased to 42.00% by the seventeenth week. Rabi/summer 2017-18 began at 0.80% and reached 36.40%, while Kharif 2018-19 began at 1.20% and reached 38.40%. Thus, the timing of disease onset was stable across seasons, whereas final disease incidence differed among seasons.

Table 1. Progress of paddy stem rot under natural condition at ARS Gangavathi during kharif 2017-18, rabi / summer 2017-18 and kharif 2018-19

SMW	Dates Kharif 2017-18	Stem rot incidence (%)	SMW	Dates Rabi/su mmer 2018-19	Stem rot incidence (%)	SMW	Dates Kharif 2018-19	Stem rot incidence (%)
36	03 Sep – 09 Sep	-	1	01 Jan – 07 Jan	-	35	27 Aug – 02 Sep	-
37	10 Sep – 16 Sep	-	2	08 Jan – 14 Jan	-	36	03 Sep – 09 Sep	-
38	17 Sep – 23 Sep	-	3	15 Jan – 21 Jan	-	37	10 Sep – 16 Sep	-
39	24 Sep – 30 Sep	-	4	22 Jan – 28 Jan	-	38	17 Sep – 23 Sep	-
40	01 Oct – 07 Oct	01.60	5	29 Jan – 04 Feb	00.80	39	24 Sep – 30 Sep	01.20
41	08 Oct – 14 Oct	03.20	6	05 Feb – 11 Feb	02.00	40	01 Oct – 07 Oct	02.80
42	15 Oct – 21 Oct	04.00	7	12 Feb – 18 Feb	04.40	41	08 Oct – 14 Oct	04.00
43	22 Oct – 28 Oct	08.40	8	19 Feb – 25 Feb	06.00	42	15 Oct – 21 Oct	07.20
44	29 Oct – 04 Nov	09.20	9*	26 Feb – 04 Mar	08.80	43	22 Oct – 28 Oct	09.20
45	05 Nov – 11 Nov	12.80	10	05 Mar – 11 Mar	12.00	44	29 Oct – 04 Nov	12.00
46	12 Nov – 18 Nov	15.60	11	12 Mar – 18 Mar	15.60	45	05 Nov – 11 Nov	15.20
47	19 Nov – 25 Nov	18.00	12	19 Mar – 25 Mar	18.80	46	12 Nov – 18 Nov	18.00
48	26 Nov – 02 Dec	24.00	13	26 Mar – 01 Apr	22.00	47	19 Nov – 25 Nov	21.60

49	03 Dec – 09 Dec	28.00	14	02 Apr – 08 Apr	25.20	48	26 Nov – 02 Dec	25.20
50	10 Dec – 16 Dec	32.40	15	09 Apr – 15 Apr	28.00	49	03 Dec – 09 Dec	29.60
51	17 Dec – 23 Dec	37.60	16	16 Apr – 22 Apr	32.00	50	10 Dec – 16 Dec	34.80
52**	24 Dec – 31 Dec	42.00	17	23 Apr – 29 Apr	36.40	51	17 Dec – 23 Dec	38.40
SMW: Standard Meteorological Week Date of sowing: 08.08.2017 Date of transplanting: 06.09.2017 Date of harvestin g: 22.12.2017	SMW: Standard Meteorological Week Date of sowing: 08.08.2017 Date of transplanting: 06.09.2017 Date of harvestin g: 22.12.2017	SMW: Standard Meteorological Week Date of sowing: 08.08.2017 Date of transplanting: 06.09.2017 Date of harvestin g: 22.12.2017	SMW: Standard Meteorological Week Date of sowing: 03.12.2017 Date of transplanting: 04.01.2018 Date of harvestin g: 28.04.2018	SMW: Standard Meteorological Week Date of sowing: 03.12.2017 Date of transplanting: 04.01.2018 Date of harvestin g: 28.04.2018	SMW: Standard Meteorological Week Date of sowing: 03.12.2017 Date of transplanting: 04.01.2018 Date of harvestin g: 28.04.2018	SMW: Standard Meteorological Week Date of sowing: 25.07.2018 Date of transplanting: 27.08.2018 Date of harvestin g: 21.12.2018	SMW: Standard Meteorological Week Date of sowing: 25.07.2018 Date of transplanting: 27.08.2018 Date of harvestin g: 21.12.2018	SMW: Standard Meteorological Week Date of sowing: 25.07.2018 Date of transplanting: 27.08.2018 Date of harvestin g: 21.12.2018

Table 2. Influence of weather and soil factors on progress of stem rot of paddy at ARS Gangavathi during Kharif 2017-18

SMW	Dates	Soil temperature (0C)	Soil temperature (0C)	Soil Moisture (%)	Soil pH	Soil EC	Rain fall (mm)	Rainy days /week	Stem rot incidence (%)
SMW	Dates	Minimum	Maximum	Soil Moisture (%)	Soil pH	Soil EC	Rain fall (mm)	Rainy days /week	Stem rot incidence (%)
36	03 Sep – 09 Sep	23.67	24.92	26.49	7.68	0.52	70.4	05	-
37	10 Sep – 16 Sep	24.20	24.98	26.67	7.83	0.53	45.7	03	-
38	17 Sep – 23 Sep	23.56	24.89	27.35	7.84	0.55	16.2	01	-
39	24 Sep – 30 Sep	23.29	25.04	28.25	7.65	0.52	48.6	03	-
40	01 Oct – 07 Oct	23.12	25.02	27.01	7.80	0.53	9.4	02	01.60
41	08 Oct – 14 Oct	23.36	25.33	26.77	7.82	0.54	60.2	02	03.20
42	15 Oct – 21	23.52	25.55	26.75	7.75	0.51	-	-	04.00

	Oct								
43	22 Oct – 28 Oct	22.75	25.26	26.88	7.81	0.53	4.8	01	08.40
44	29 Oct – 04 Nov	22.89	25.61	27.95	7.74	0.50	-		09.20
45	05 Nov – 11 Nov	24.30	25.49	29.01	8.05	0.61	-	-	12.80
46	12 Nov – 18 Nov	23.50	24.55	27.07	7.74	0.55	-	-	15.60
47	19 Nov – 25 Nov	24.47	25.84	27.00	7.78	0.53	-	-	18.00
48	26 Nov – 02 Dec	21.87	25.50	28.75	7.94	0.59	-	-	24.00
49	03 Dec – 09 Dec	21.89	26.69	27.81	7.84	0.54	-	-	28.00
50	10 Dec – 16 Dec	21.17	27.91	27.91	7.92	0.58	-	-	32.40
51	17 Dec – 23 Dec	20.49	29.15	27.89	7.86	0.56	-	-	37.60
52**	24 Dec – 31 Dec	22.15	28.27	27.09	7.79	0.51	-	-	42.00

Table 3. Influence of weather and soil factors on progress of stem rot of paddy at ARS Gangavathi during Rabi/summer 2017-18

MS W	Dates	Soil temperature (0C)	Soil temperature (0C)	Soil Moisture (%)	Soil pH	Soil EC	Rain fall (mm)	Rainy days/w eek	Stem rot incidenc e (%)
MS W	Dates	Minimum	Maximum	Soil Moisture (%)	Soil pH	Soil EC	Rain fall (mm)	Rainy days/w eek	Stem rot incidence (%)
1	01 Jan – 07 Jan	19.37	28.97	27.81	7.92	0.58	-	-	-
2	08 Jan – 14 Jan	20.75	29.02	27.42	7.84	0.55	-	-	-
3	15 Jan – 21 Jan	21.29	24.57	27.11	7.95	0.59	-	-	-
4	22 Jan – 28 Jan	20.73	25.17	27.26	7.89	0.57	-	-	-

	Jan								
5	29 Jan – 04 Feb	20.44	25.54	26.88	7.73	0.51	-	-	01.20
6	05 Feb – 11 Feb	21.17	25.07	27.13	7.89	0.56	-	-	02.00
7	12 Feb – 18 Feb	21.72	25.95	28.86	7.99	0.59	-	-	04.40
8	19 Feb – 25 Feb	21.58	26.17	27.29	7.91	0.58	-	-	06.00
9*	26 Feb – 04 Mar	23.37	25.36	27.05	7.98	0.59	-	-	08.80
10	05 Mar – 11 Mar	21.06	25.84	29.59	8.04	0.61	-	-	12.00
11	12 Mar – 18 Mar	20.26	26.35	26.90	7.94	0.55	1.2	-	15.60
12	19 Mar – 25 Mar	20.42	28.28	27.49	7.87	0.53	-	-	18.80
13	26 Mar – 01 Apr	20.70	29.34	27.84	7.96	0.58	-	-	22.00
14	02 Apr – 08 Apr	22.07	34.39	28.59	8.01	0.59	-	-	25.20
15	09 Apr – 15 Apr	23.8	36.65	27.78	7.95	0.59	-	-	28.00
16	16 Apr – 22 Apr	25.68	38.13	26.95	7.85	0.52	3	1	32.00
17	23 Apr – 29 Apr	24.42	37.80	26.92	7.85	0.53	-	-	36.40

Table 4. Influence of weather and soil factors on progress of stem rot of paddy at ARS Gangavathi during Kharif 2018-19

SM W	Dates	Soil temperature (0C)	Soil temperature (0C)	Soil Moisture (%)	Soil pH	Soil EC	Rain fall (mm)	Rainy days/week	Stem rot incidence (%)
SM W	Dates	Minimum	Maximum	Soil Moisture (%)	Soil pH	Soil EC	Rain fall (mm)	Rainy days/week	Stem rot incidence (%)
35	27 Aug –	23.73	28.89	27.09	8.01	0.60	15.2	02	-

	02 Sep								
36	03 Sep – 09 Sep	23.87	29.34	26.82	7.88	0.53	3.8	01	-
37	10 Sep – 16 Sep	24.75	30.19	27.78	7.94	0.55	-	-	-
38	17 Sep – 23 Sep	24.65	31.03	27.53	7.89	0.53	22.1	04	-
39	24 Sep – 30 Sep	24.16	32.00	28.09	7.81	0.51	9.8	02	01.20
40	01 Oct – 07 Oct	25.63	30.31	27.12	7.88	0.53	-	-	02.80
41	08 Oct – 14 Oct	26.30	33.01	28.17	7.97	0.59	-	-	04.00
42	15 Oct – 21 Oct	26.06	34.84	27.54	7.87	0.52	42.4	02	07.20
43	22 Oct – 28 Oct	25.55	34.00	27.46	7.97	0.58	-	-	09.20
44	29 Oct – 04 Nov	25.32	36.28	28.12	7.98	0.59	-	-	12.00
45	05 Nov – 11 Nov	24.61	35.24	29.57	8.11	0.63	-	-	15.20
46	12 Nov – 18 Nov	24.09	34.07	28.10	7.96	0.57	-	-	18.00
47	19 Nov – 25 Nov	24.14	33.49	29.55	8.03	0.61	-	-	21.60
48	26 Nov – 02 Dec	23.91	31.04	28.53	7.95	0.58	-	-	25.20
49	03 Dec – 09 Dec	24.75	30.97	27.66	7.94	0.53	-	-	29.60
50	10 Dec – 16 Dec	22.55	31.42	27.34	7.86	0.52	-	-	34.80
51	17 Dec – 23 Dec	21.58	31.19	27.92	7.60	0.50	-	-	38-40

3.2 Correlation of disease incidence with soil and weather variables

The strongest positive association in Kharif 2017-18 was between disease incidence and maximum soil

temperature ($r = 0.88$, significant at 1%). In Rabi/summer 2017-18, both minimum and maximum soil temperature were positively correlated with disease incidence ($r = 0.69$ and 0.86 , respectively). In contrast, minimum soil temperature, rainfall and rainy days were negatively related to incidence in Kharif 2017-18, and minimum soil temperature and rainy days were negatively related to incidence in Kharif 2018-19. The complete correlation matrices are reproduced below.

Table 5. Correlation studies between paddy stem rot incidence and of weather, soil factors during Kharif 2017-18

Parameters	Soil temperature minimum (oC)	Soil temperature maximum (oC)	Soil moisture (%)	Soil pH	Soil EC	Rainfall (mm)	Rainy days /week	Stem rot incidence (%)
Soil temperature minimum (oC)	1.00							
Soil temperature maximum (oC)	-0.78**	1.00						
Soil moisture (%)	-0.32	0.22	1.00					
Soil pH	-0.21	0.28	0.57	1.00				
Soil EC	-0.20	0.14	0.65**	0.86**	1.00			
Rainfall (mm)	0.37	-0.40	-0.39	-0.43	-0.27	1.00		
Rainy days /week	0.37	-0.45	-0.42	-0.48*	-0.32	0.92**	1.00	
Stem rot incidence (%)	-0.74**	0.88**	0.34	0.37	0.30	-0.60*	-0.64**	1.00

Table 6. Correlation studies between paddy stem rot incidence and of weather, soil factors during Rabi/summer 2017-18

Parameters	Soil temperature minimum (°C)	Soil temperature maximum (°C)	Soil moisture (%)	Soil pH	Soil EC	Rainfall (mm)	Rainy days /week	Stem rot incidence (%)
Soil temperature minimum (oC)	1.00							
Soil temperature maximum (oC)	0.72**	1.00						
Soil moisture (%)	-0.17	-0.05	1.00					
Soil pH	0.00	-0.10	0.69**	1.00				
Soil EC	-0.14	-0.27	0.65**	0.89**	1.00			
Rainfall (mm)	0.50*	0.42	-0.29	-0.18	-0.43	1.00		
Rainy days /week	0.61**	0.50*	-0.21	-0.22	-0.40	0.93**	1.00	
Stem rot incidence (%)	0.69**	0.86**	0.01	0.09	-0.21	0.41	0.40	1.00

Table 7. Correlation studies between paddy stem rot incidence and of weather, soil factors during Kharif 2018-19

Parameters	Soil temperature minimum (°C)	Soil temperature maximum (°C)	Soil moisture (%)	Soil pH	Soil EC	Rainfall (mm)	Rainy days /week	Stem rot incidence (%)
Soil temperature minimum (oC)	1.00							
Soil temperature maximum (oC)	0.40	1.00						
Soil moisture (%)	0.00	0.56*	1.00					
Soil pH	0.51*	0.33	0.42	1.00				
Soil EC	0.29	0.41	0.60*	0.86**	1.00			
Rainfall (mm)	0.26	0.06	-0.27	-0.13	-0.29	1.00		
Rainy days /week	0.06	-0.23	-0.32	-0.15	-0.30	0.77**	1.00	
Stem rot incidence (%)	-0.60*	0.13	0.31	-0.28	-0.11	-0.37	-0.51*	1.00

3.3 Multiple and step-down regression

Multiple regression indicated that the combined soil and weather variables explained a large proportion of seasonal variation in disease incidence. The thesis analysis reported coefficients of determination of 0.87 for Kharif 2017-18 and 0.91 for Rabi/summer 2017-18, with a lower combined explanatory contribution in Kharif 2018-19. Step-down regression retained smaller sets of variables while preserving much of the explained variation. The original regression coefficients, standard errors, test statistics and equations are retained in Tables 8-16.

Table 8. Multiple correlation and regression of weather and soil factors on disease incidence of paddy stem rot during Kharif 2017-18

Sl. No.	Weather variables	Partial regression coefficient (b)	Standard error (E)	t values
Y	Disease incidence (%)	-	-	-
X1	Soil temperature minimum (°C)	-0.56	2.67	0.21
X2	Soil temperature maximum (°C)	7.74**	2.31	3.35
X3	Soil moisture (%)	-0.91	3.21	0.29
X4	Soil pH	-37.48	40.43	0.93
X5	Soil EC	159.29	133.76	1.19
X6	Rainfall (mm/day)	-0.07	0.18	0.40
X7	Rainy days/week	-2.07	3.07	0.67

Table 9. Step down regression of significant weather and soil factor on disease incidence of paddy stem rot during Kharif 2017-18

Sl. No.	Variables	Coefficient of determination (R ²)	Partial regression coefficient (b)	Standard error (E)	t values
Y	Disease incidence (%)	-	-	-	-
X1	Soil temperature maximum (oC)	0.77	9.31***	1.33	7.01

Table 10. Multiple correlation and regression of weather and soil factors on disease incidence of paddy stem rot during Rabi/summer 2017-18

Sl. No.	Weather variables	Partial regression coefficient (b)	Standard error (E)	t values
Y	Disease incidence (%)	-	-	-
X1	Soil temperature minimum (oC)	1.54	1.43	1.08
X2	Soil temperature maximum (oC)	1.72***	0.42	4.11
X3	Soil moisture (%)	-0.57	2.88	-0.20
X4	Soil pH	164.53*	58.12	2.83
X5	Soil EC	-410.94**	137.15	3.00
X6	Rainfall (mm/day)	-1.52	6.48	0.23
X7	Rainy days/week	-6.70	20.43	0.34

Table 11. Step down regression of significant weather and soil factors disease incidence of paddy stem rot during Rabi/summer 2017-18

Sl. No.	Variables	Coefficient of determination (R ²)	Partial regression coefficient (b)	Standard error (E)	t values
Y	Disease incidence (%)	-	-	-	-
X1	Soil temperature maximum (oC)	0.735	1.92***	0.28	6.90
X2	Soil pH	0.008	143.95**	37.07	3.88
X3	Soil EC	0.046	-337.00**	98.38	3.43

Table 12. Multiple correlation and regression of weather and soil factors on disease incidence of paddy stem rot during Kharif 2018-19

Sl. No.	Weather variables	Partial regression coefficient (b)	Standard error (E)	t values
Y	Disease incidence (%)	-	-	-
X1	Soil temperature minimum (oC)	-7.72*	2.70	2.86
X2	Soil temperature maximum (oC)	1.44	1.55	0.93
X3	Soil moisture (%)	3.50	4.46	0.78
X4	Soil pH	27.89	48.78	0.57
X5	Soil EC	-147.14	139.56	1.05
X6	Rainfall (mm/day)	0.29	0.35	0.81
X7	Rainy days/week	-7.15*	3.35	2.13

Table 13. Step down regression of significant weather and soil factors on disease incidence of paddy stem rot during Kharif 2018-19

Sl. No.	Variables	Coefficient of determination (R ²)	Partial regression coefficient (b)	Standard error (E)	t values
Y	Disease incidence (%)	-	-	-	-
X1	Soil temperature maximum (oC)	0.36	-6.18**	1.86	3.31
X2	Rainy days/week	0.26	-5.31*	1.90	2.79

Table 14. Regression studies between weather, soil variables and incidence of paddy stem rot during Kharif 2017-18

Sl. No.	Regression equation	F value	R ²
1	$Y = 61.47 - 0.56X_1 + 7.74X_2 - 0.91X_3 - 37.48X_4 + 159.29X_5 + 0.07X_6 - 2.07X_7$	8.69	0.870
2	$Y = 23.04 - 0.32X_1 + 8.09X_2 - 0.68X_3 - 35.33X_4 + 159.30X_5 + 0.18X_6$	10.65	0.865
3	$Y = 210.40 - 0.90X_1 + 8.48X_2 + 0.99X_3 - 5.90X_4 + 82.27X_5$	8.98	0.803
4	$Y = -317.79 - 1.27X_1 + 8.01X_2 + 1.70X_3 - 13.68X_4$	11.80	0.797
5	$Y = -252.99 - 0.99X_1 + 8.34X_2 + 2.70X_3$	16.48	0.791

6	$Y = -158.85 - 1.72X_1 + 8.20X_2$	23.89	0.773
7	$Y = 229.51 - 9.39X_1$	17.82	0.543

Table 15. Regression studies between weather, soil variables and incidence of paddy stem rot during Rabi/summer 2017-18

Sl. No.	Regression equation	F value	R ²
1	$Y = -1124.21 + 1.54X_1 + 1.72X_2 - 0.57X_3 + 164.53X_4 - 410.94X_5 - 1.52X_6 - 6.70X_7$	12.95	0.910
2	$Y = -1190.29 + 1.29X_1 + 1.73X_2 + 2.95X_3 + 176.93X_4 - 432.39X_5 - 3.60X_6$	16.54	0.908
3	$Y = -998.18 + 0.70X_1 + 1.76X_2 - 0.70X_3 + 145.34X_4 - 329.62X_5$	16.81	0.880
4	$Y = -338.27 + 0.68X_1 + 2.13X_2 - 1.71X_3 + 40.57X_4$	10.66	0.780
5	$Y = -105.42 + 1.32X_1 + 1.93X_2 + 1.21X_3$	13.18	0.750
6	$Y = -69.54 + 1.17X_1 + 1.96X_2$	20.68	0.747
7	$Y = -98.66 + 5.12X_1$	13.68	0.477

Table 16. Regression studies between weather, soil variables and incidence of paddy stem rot during Kharif 2018-19

Sl. No.	Regression equation	F value	R ²
1	$Y = -78.37 - 7.71X_1 + 1.44X_2 + 3.50X_3 + 27.89X_4 - 147.14X_5 + 0.29X_6 - 7.15X_7$	3.66	0.740
2	$Y = -47.59 - 7.15X_1 + 2.58X_2 + 2.95X_3 + 18.67X_4 - 136.73X_5 - 0.31X_6$	2.59	0.608
3	$Y = -24.67 - 7.86X_1 + 2.25X_2 + 3.72X_3 + 13.28X_4 - 92.43X_5$	2.69	0.550
4	$Y = 160.82 - 7.37X_1 + 2.12X_2 + 2.70X_3 - 14.04X_4$	3.48	0.530
5	$Y = 92.88 - 8.12X_1 + 2.25X_2 + 1.65X_3$	4.87	0.529
6	$Y = 133.18 - 8.40X_1 + 2.64X_2$	7.68	0.523
7	$Y = 172.13 - 6.51X_1$	8.45	0.360

3.4 AUDPC and first-order autoregression

AUDPC differentiated seasonal epidemic intensity, with the thesis reporting a higher score in Kharif 2017-18 (1510.60) than in Rabi/summer 2017-18 (1359.40). First-order autoregression closely tracked the observed epidemic curves. For Kharif 2017-18, observed incidence ranged from 1.60 to 42.00% and predicted incidence from 1.85 to 42.83% ($Y = 1.85 + 1.09X$; multiple $R = 0.995$). Corresponding relationships were $Y = 1.73 + 1.07X$ ($R = 0.998$) for Rabi/summer 2017-18 and $Y = 1.705 + 1.08X$ ($R = 0.998$) for Kharif 2018-19.

Table 17. AUDPC values of paddy stem rot in different seasons at ARS Ganagavati

Sl. No.	Season	Date of transplanting	First observation of disease	First observation of disease	Terminal disease incidence (%)	AUDPC values
Sl. No.	Season	Date of transplanting	Date	Age of the crop		AUDPC values
01.	Kharif 2017-18	06.09.2017	01 Oct – 07 Oct	35	42.00	1510.60
02.	Rabi/summer 2017-18	04.01.2018	29 Jan – 04 Feb	35	36.40	1359.40
03.	Kharif 2018-19	27.08.2018	24 Sep – 30 Sep	35	38.40	1400.00

Table 18. Progression of observed and predicted incidence of stem rot of paddy by first order auto regression method during Kharif 2017-18, Rabi/summer 2017-18 and Kharif 2018-19

Sl. No.	DA T	Disease incidence (%)	Disease incidence (%)	Disease incidence (%)	Disease incidence (%)	Disease incidence (%)	Disease incidence (%)	Disease incidence (%)	Disease incidence (%)	Disease incidence (%)
Sl. No.	DAT	Kharif 2017-18	Kharif 2017-18	Kharif 2017-18	Rabi/summer 2017-18	Rabi/summer 2017-18	Rabi/summer 2017-18	Kharif 2018-19	Kharif 2018-19	Kharif 2018-19
Sl. No.	DAT	Observed Yt	Predicted Yt +1	Difference Yt – Yt+1	Observed Yt	Predicted Yt +1	Difference Yt – Yt+1	Observed Yt	Predicted Yt +1	Difference Yt – Yt+1
1	35	01.60	1.85	-0.25	00.80	1.73	-0.93	01.20	1.71	-0.51
2	42	03.20	3.59	-0.39	02.00	2.59	-0.59	02.80	3.00	-0.20
3	49	04.00	5.34	-1.34	04.40	3.87	0.53	04.00	4.73	-0.73
4	56	08.40	6.21	2.19	06.00	6.44	-0.44	07.20	6.03	1.18
5	63	09.20	11.01	-1.81	08.80	8.15	0.65	09.20	9.48	-0.28
6	70	12.80	11.88	0.92	12.00	11.15	0.85	12.00	11.64	0.36
7	77	15.60	15.80	-0.20	15.60	14.57	1.03	15.20	14.67	0.53
8	84	18.00	18.85	-0.85	18.80	18.42	0.38	18.00	18.12	-0.12
9	91	24.00	21.47	2.53	22.00	21.85	0.15	21.60	21.15	0.45
10	98	28.00	28.01	-0.01	25.20	25.27	-0.07	25.20	25.03	0.17
11	105	32.40	32.37	0.03	28.00	28.69	-0.69	29.60	28.92	0.68
12	112	37.60	37.17	0.43	32.00	31.69	0.31	34.80	33.67	1.13
13	119	42.00	42.83	-0.83	36.40	35.97	0.43	38.40	39.29	-0.89

4. DISCUSSION

The consistent appearance of stem rot in the fifth week after transplanting, followed by progressive increase to the seventeenth week, indicates a repeatable crop-stage component in the epidemic at Gangavathi. This pattern is biologically plausible for a sclerotial soil-borne pathogen because inoculum can persist in soil and residues until canopy development, host susceptibility and environmental conditions permit sustained colonization. Krause and Webster (1972, 1973; Sathiyaseelan *et al.*, 2025) showed that sclerotial production, survival and inoculum density are central to rice stem-rot epidemiology, while Konthoujam and Chhetry (2005) documented prolonged survival of *S. oryzae* under field and laboratory conditions. The positive association of maximum soil temperature with disease incidence in two seasons suggests that warming of the crop-root environment accompanied epidemic development. However, the negative correlations with minimum temperature, rainfall or rainy days in some seasons show that a single weather variable cannot be interpreted as a universal causal driver (Shin *et al.*, 2025). Correlation coefficients here reflect within-season co-variation and may also capture crop age. The results therefore support multivariable rather than single-factor prediction. This aligns with the wider adoption of data-driven farming practices that combine weather, soil and crop data to predict and inform decisions (Taqvi, 2025). While automated detection tools do not directly validate the present stem-rot regression models, image-based deep-learning systems have been explored for detecting rice leaf diseases, highlighting the potential for automated detection systems to complement field surveillance efforts (Tholupuluri *et al.*, 2024). Similar caution is warranted because moisture can promote infection while excessive saturation may reduce oxygen availability and saprophytic activity of sclerotia, as discussed in earlier epidemiological work on *Sclerotium* spp. (Saikia *et al.*, 2026).

The high R values obtained by first-order autoregression indicate that recent disease status was highly informative for the next observation. This is useful operationally because a simple disease-progress model can complement weather monitoring and provide a practical forewarning framework. Nevertheless, validation on independent seasons and locations is required before the equations are used as decision thresholds. Recent regional surveys confirm continuing occurrence of stem rot in southern Indian rice systems (Ramanjineyulu *et al.*, 2024; Mohaimin *et al.*, 2025), and integrated-management studies show that timely interventions can materially reduce disease and improve yield (Puchakayala *et al.*, 2024; Espino *et al.*, 2026). Taken together, the three-season dataset identifies a reproducible onset period and quantifies the joint contribution of soil and weather variables to disease development under irrigated rice at Gangavathi. The principal value of the study is not a single universal weather threshold, but the combination of crop stage, sequential disease observations and locally measured soil-weather variables that can be incorporated into site-specific forecasting and management programmes.

5. CONCLUSION

Stem rot of paddy on BPT-5204 initiated consistently during the fifth week after transplanting and increased through the seventeenth week in all three seasons studied at ARS, Gangavathi. Final incidence reached 42.00% in Kharif 2017-18, 36.40% in Rabi/summer 2017-18 and 38.40% in Kharif 2018-19. Maximum soil temperature showed the clearest positive association with disease in two seasons, while minimum temperature, rainfall and rainy days showed season-dependent negative relationships. Multivariable regression explained substantial variation, and first-order autoregression reproduced disease progress with multiple R values of 0.995-0.998. These findings provide a field-derived epidemiological basis for identifying high-risk crop stages and developing local forewarning systems. Independent validation across years, cultivars and production zones is required before

model coefficients are used for operational disease-management decisions.

ACKNOWLEDGEMENT

The study was conducted as part of doctoral research in the Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Raichur. Facilities and field support provided by the Agricultural Research Station, Gangavathi, are gratefully acknowledged.

Conflict of interest: No conflict of interest among the authors.

Author contributions: All authors contributed equally.

Ethical issues: None

REFERENCES

1. Black CA (1965). *Methods of Soil Analysis: Part I. Physical and Mineralogical Properties*. American Society of Agronomy, Madison, Wisconsin, USA.
2. Bochalya MS, Manojkumar S, Kumari P, Kumar A, Kumar R, Gandhi V, Kumar P and Kumar A (2025). Effectiveness of various fungicides and biorationals against *Sclerotium oryzae* Catt. causing stem rot of rice (*Oryza sativa* L.). *Indian Phytopathol.* 78(4): 919-927.
3. Cintas NA and Webster RK (2001). Effects of rice straw management on *Sclerotium oryzae* inoculum, stem rot severity and yield of rice in California. *Plant Dis.* 85: 1140-1144.
4. Espino L, Brim-DeForest W and Greer CA (2026). Stem rot of rice in California: Incidence-severity relationship, yield impacts, and fungicide management. *Crop Prot.* Article 107829.
5. Gomez KA and Gomez AA (1984). *Statistical Procedures for Agricultural Research*. 2nd ed. John Wiley & Sons, Singapore.
6. Jackson ML (1967). *Soil Chemical Analysis*. Prentice Hall of India, New Delhi, India.
7. Jayasundari, C., Arumugam, P., & Nayan. (2024). Paddy disease classification in Tamil Nadu crops utilizing image analysis using deep learning techniques. *Library Progress International*, 44(3), 7744–7750. <https://bpsjournals.com/library-science/index.php/journal/article/view/1857>
8. Konthoujam J and Chhetry GKN (2005). Viability and survival of *Sclerotium oryzae* Catt. incitant of stem rot of rice preserved in the laboratory vis-a-vis overwintering under natural field condition in Manipur. *Indian Phytopathol.* 58(4): 414-418.
9. Krause RA and Webster RK (1972). Sclerotial production, viability determination and quantitative recovery of *Sclerotium oryzae* from soil. *Phytopathology*. 62: 1333-1337.
10. Krause RA and Webster RK (1973). Stem rot of rice in California. *Phytopathology*. 63: 518-523.
11. Krishnaveni DS and Laha GS (2009). Emerging diseases of rice in different ecosystems in relation to change in climatic conditions. In: *Eco-friendly Management of Pests and Diseases in Rice and Rice-based Cropping Systems*. pp. 215-228.
12. Kulkarni VR and Hegde YR (2019). Epidemiological studies on soil temperature, moisture, electrical conductivity and soil pH in relation to *Sclerotium rolfsii* causing wilt or rot in potato. *Indian J. Pure Appl. Biosci.* 7(5): 138-146.
13. Laha GS, Singh R, Ladhakshmi D, Sunder S, Srinivas Prasad M, Dagar CS and Ravindra Babu V (2017). Importance and management of rice diseases: A global perspective. In: *Rice Production Worldwide*. Springer International Publishing, pp. 303-360.
14. Mandal D, Pal R, Mohapatra S, Seni A, Bansude SK, Seth P, Barla S and Sahu J (2025). Use of organic amendments for sustainable management of root rot disease of tomato (*Solanum lycopersicum* L.) caused by *Sclerotium rolfsii*. *Sci. Rep.* 15(1): 35772.
15. Mohaimin AZA, Shivanand P, Krishnamoorthy S and Taha H (2025). Report on rice diseases in Brunei Darussalam and their association with airborne fungal spores. *Aerobiologia*. 41(4): 787-806.
16. Nwankwol C and Ogagarue D (2012). An investigation of temperature variation at soil depths in parts of southern Nigeria. *Am. J. Environ. Eng.* 2(5): 142-147.
17. Pati S, Jash S and Dutta S (2025). The rice sheath rot complex: An emerging multifaceted disease threat under climate change. *Indian Phytopathol.* 78(4): 789-805.
18. Puchakayala M, Vineetha U, Sreelakshmi C, Paramasiva I, Sameera SK, Raju MRB and Kavitha M (2024). Integrated disease management strategy for stem rot of rice caused by *Sclerotium oryzae* Catt. *ORYZA Int. J. Rice*. 61(3).
19. Ramanjineyulu P, Krishnaveni D, Srinivas T, Padmodaya B, Mangrauthia SK, Jasudasu BGS and Reddy R (2024). Incidence of stem rot (*Sclerotium oryzae* Catt.) of rice in major rice growing regions of Andhra Pradesh, Telangana and Tamil Nadu. *Indian J. Plant Prot.* 51(4): 107-116.
20. Saharan GS, Mehta NK and Meena PD (2025). *Sclerotinia Stem Rot of Crucifers: Volume 2, Epidemiology and Disease Management*. Vol. 2. CABI Publishing.
21. Saikia J, Bharali S, Goswami K and Tamuly A (2026). Assessing climatic drivers and multi-scale forecasting of Japanese encephalitis in endemic regions of eastern India. *Discover Public Health*. 23(1): 1291.
22. Sathiyaseelan K, Das B, Ladhakshmi D, Venu E, Bashyal BM, Bag TK and Sinha P (2025). Climatic drivers for assessment of false smut risk in rice ecosystems: A guide for planning effective management trials. *Heliyon*. 11(4).

23. Shin J, Jeong W, Yang HJ, Ahn MI and Kim KH (2025). Understanding the impact of seasonal weather dynamics on rice disease occurrence using neural networks: A case study of panicle blast and grain rot. *Phytopathology*. 115(10): 1291-1296.
24. Singh R, Khanna A, Laha GS and Lore JS (2025). Impacts of climate change on pathogens and diseases of rice (*Oryza sativa* L.). *Indian Phytopathol.* 78(3): 529-543.
25. Singh R, Kumar A and Jalali BL (2002). Variability, predisposing factors and management of stem rot of rice caused by *Sclerotium oryzae* Catt.: An overview. *Annu. Rev. Plant Pathol.* 1: 275-289.
26. Snedecor GW and Cochran WG (1967). *Statistical Methods*. 6th ed. Oxford and IBH Publishing Company, Calcutta, India.
27. Taqvi, S. (2025). Data-driven agricultural development in Assam through machine learning. *Journal of Artificial Intelligence in Agriculture and Applied Research*, 1(1), 34–48. <https://agrpjournals.com/journals/journal/index.php/jaiaar/article/view/7>
28. Tholupuluri, G. B., Charith, B., & Gopal Krishna, U. M. (2024). Deep learning algorithms for rice leaf disease detection. *Bulletin of Pure and Applied Sciences—Zoology*, 43(2S). <https://bpasjournals.com/zoology/index.php/journal/article/view/243>
29. Wilcoxson RD, Skovmand B and Atif AH (1975). Evaluation of wheat cultivars for ability to retard development of stem rust. *Ann. Appl. Biol.* 80: 275-281.