Research Article

EPIDEMIOLOGICAL STUDY OF FALSE SMUT OF RICE (*ORYZA SATIVA* L.) IN GUJARAT

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Abstract- Rice false smut [*Ustilaginoidea virens* (Cooke) Takahashi] is an upcoming major disease in India. The initiation of the disease was recorded the 88th day after sowing and 9th September in 2017 and 86th day after sowing and 14th September in 2018. The incidence of false smut starts from 1.55 percent at 36 MSW and reached to 7.22 percent at 42 MSW in 2017 while, 0.53 percent at 37 MSW and reached to 6.68 percent at 42 MSW in 2018. However, in pooled of two years, the first symptom of false smut was recorded on 36 MSW (0.77 %) and reached to 42 MSW (6.95 %). Correlation coefficient study between weather parameters and disease incidence indicated that all the parameters jointly played an important role in the development of false smut disease. Moreover, maximum and average temperature, morning and average relative humidity, morning and average cloudy weather and sunshine hours were found to play important role in the disease development. Stepwise regression, R-value *i.e.*, 0.89, 0.80 and 0.75 percent and co-efficient of determination, R^2-value *i.e.*, 79.90, 64.70 and 56.90 percent were found high during 2017, 2018 and pooled of two year, respectively. These high R-value indicating a strong association between percent disease incidence to weather parameters.

Keywords- *Epidemiology, False Smut, Rice, Correlation, Regression, Weather Parameter*

Introduction

Rice false smut caused by *Ustilaginoidea virens* (Cooke) Takahashi and epidemically it was reported in Tamil Nadu in India and later in many countries of world [16]. In recent years, rice false smut has become a serious problem in many parts of the world due to climate-change and growing high yielding rice varieties, which were more susceptible to diseases. The false smut occurs in more than 40 countries, including India [6] and it has already changed from a minor disease to a major disease. *U. virens* overwinters by producing fungal structures called sclerotia, which contain chlamydospores (resting spores) and compact masses of mycelia [7],[4]. The fungus forms chlamydospores and sclerotia late in the season which fall in the soil and to survive for at least 4 months under field conditions in the winter. Sclerotia germinate to produce ascocarp containing ascospores, which are the act as a primary source of infection to rice plant, whereas chlamydospores are a secondary source of infection may come from airborne. During *U. virens* life cycle, produces sexual stage known as an ascospores, and asexual stage known as a chlamydospore, both stages play a very important role to initiated *U. virens* infection process [4]. False smut galls have been reported to emerge about 20 days after the initial infection of kernels of the rice panicle during the flowering of the rice plant. Infection results in one or more kernels on mature heads of plants being replaced by globose, yellowish-green, velvety smut balls. When smut balls burst open, powdery dark green spores are released [2]. The rice false smut favouring the climatic factor is cloudy weather, high relative humidity (>95 %), low temperature (25 to 30 ºC), water stress and rainy days at the time of flowering [14],[15] and late sowing and application of higher nitrogen doses favours the development of disease [1]. Moreover, high relative humidity (89 to 95 %) and no rainfall were favourable for development of false smut in rice has also been reported [5]. Besides, optimum temperature (31.36 to 23.14 ºC), high relative humidity (88.85 to 73.50 %), least rainfall (6.66 mm) and bright sunshine hours (6.20 hrs.) weather conditions were recorded more favourable for development of false smut in rice [3]. In damp weather, the disease can be severe and losses can reach to 85 percent has been reported from Tamil Nadu on different rice cultivars

[12]. Therefore, the present studies were done to know the effect of different weather parameter on the false smut disease incidence of rice.

Materials and Methods

The experiment was conducted at N. M. College of Agriculture farm, NAU, Navsari, during kharif 2017 and kharif 2018. It's Latitude 200 57' 07.05" N, Longitude 720 55'16.50" E and altitude is 12.33 meter above sea level. Epidemiological study on the effect of weather parameters on the false smut disease of rice in the fixed plot was 20 m x 20 m and at a distance of 20 cm × 15 cm cultivar GR-11 was used. Two seedlings in each hill were planted. Fertilizers and other agronomical practices were followed according to the recommendations for growing high-yielding varieties. To determine the influence of various environmental factors on the development of rice false smut, the disease incidence data were correlated with different meteorological parameters *viz.*, rainfall, maximum temperature (Max. T.), minimum temperature (Min. T.) relative humidity (RH), wind velocity, cloudy weather, rainy days and sunshine hours through analysis of correlation and regression. The weekly observation on false smut incidence was recorded throughout the season. Correlation and regression equation between disease incidence dependent factors were worked out using the standard procedure given by Gomez and Gomez [8]. The false smut disease incidence on cv. GR-11 was recorded as per the formula was given by Singh and Dube [18].

Percent infected tillers

$$Percent\ disease\ incidence\ = \frac{Total\ number\ of\ infected\ tillers/m^2}{Total\ number\ of\ tillers/m^2} \times 100$$

Epidemiological Study of False Smut of Rice (*Oryza sativa* L.) in Gujarat

Table-1 *Epidemiological study of false smut of rice in field condition during kharif 2017*

MSW	Rainfall (mm)	Temperature (°C)			Relative Humidity (%)			Wind Velocity (km/hr)	Cloudy Weather (Octa)			Rainy Days	BSSH (hrs)	PDI (%)
		Max	Min	Av	I	II	Av		I	II	Av			
24	40	32.6	25.4	29.0	92.2	72.7	82.5	0.0	3	3	3	4	6.7	0.0
25	12	33.7	27.2	30.5	84.6	71.0	77.8	0.0	4	3	4	2	8.0	0.0
26	221	30.0	24.5	27.3	95.9	89.5	92.7	0.0	6	5	6	6	1.3	0.0
27	35	31.3	26.2	28.7	88.3	76.6	82.4	0.0	3	3	3	3	3.6	0.0
28	32	31.4	25.4	28.4	88.6	79.0	83.8	0.0	5	3	4	3	5.0	0.0
29	330	29.2	24.5	26.8	98.6	89.1	93.8	0.0	7	5	6	7	2.0	0.0
30	152	29.0	25.2	27.1	92.9	90.6	91.7	0.0	7	7	7	6	0.1	0.0
31	57	30.0	25.1	27.6	84.2	79.2	81.7	0.0	4	4	4	5	4.2	0.0
32	22	30.9	25.2	28.1	91.6	76.7	84.2	0.0	4	4	4	0	4.6	0.0
33	10	31.3	25.5	28.4	90.5	75.6	83.1	0.0	5	3	4	1	6.2	0.0
34	90	29.4	24.6	27.0	94.6	86.8	90.7	0.0	4	4	4	5	3.3	0.0
35	177	29.3	24.1	26.7	96.6	86.2	91.4	0.0	6	5	5	6	3.2	0.0
36	3	31.4	24.7	28.0	95.6	75.7	85.7	1.55	1	1	1	0	5.2	1.55
37	2	34.0	25.1	29.6	91.3	75.0	83.1	2.58	3	1	2	0	4.7	2.58
38	69	31.4	23.7	27.6	96.5	79.4	87.9	3.61	3	4	4	4	2.1	3.61
39	0	33.3	23.8	28.6	94.1	65.5	79.8	4.64	0	1	1	0	7.3	3.87
40	0	36.7	24.2	30.4	96.4	51.0	73.7	5.67	0	0	0	0	8.4	5.67
41	28	34.4	23.7	29.0	93.9	68.7	81.3	6.70	2	2	2	4	4.3	6.70
42	0	35.9	22.3	29.1	92.8	72.0	82.4	7.22	0	0	0	0	7.2	7.22

* MSW- Meteorological standard week, BSSH- Bright sun-shine hours, PDI- Percent disease incidence

Table-2 *Epidemiological study of false smut of rice in field condition during kharif 2018*

MSW	Rainfall (mm)	Temperature (°C)			Relative Humidity (%)			Wind Velocity (km/hr)	Cloudy Weather (Octa)			Rainy Days	BSSH (hrs)	PDI (%)
		Max	Min	Av	I	II	Av		I	II	Av			
25	1	33.4	25.9	29.7	86.9	71.9	79.4	0	7	5	6	0	6	0
26	67	31.3	24.6	28	95.9	78.3	87.1	0	6	6	6	3	3.7	0
27	340	30.7	23.9	27.3	98.7	94.3	96.5	0	8	7	7	6	3	0
28	619	28.1	23.1	25.6	99.5	97.3	98.4	0	8	8	8	7	0	0
29	314	26.8	23.3	25.1	98.5	97.3	97.9	0	8	8	8	7	0	0
30	9	29.1	25	27.1	89.2	85.9	87.6	0	8	8	8	2	0.2	0
31	4	30.3	25	27.7	80.3	81.1	80.7	0	6	7	7	0	1	0
32	11	30	24.7	27.4	91.6	81.3	86.4	0	8	8	8	2	1.5	0
33	53	29.7	23.8	26.8	92.7	83.7	88.2	0	8	8	8	5	0.6	0
34	127	29	22.8	25.9	98.8	85.2	92	0	8	8	8	7	2.1	0
35	27	29.9	23.5	26.7	92.6	77.9	85.3	0	8	7	7	3	2.3	0
36	35	29.7	22.2	26	90.1	73.3	81.7	0	6	6	6	2	5	0
37	1	30.8	21.8	26.3	89.9	69.7	79.8	0.53	5	7	6	0	6.8	0.53
38	15	32.7	21.8	27.3	90.6	60.1	75.3	1.6	1	4	3	1	6.8	1.6
39	0	33.8	21.5	27.7	90.9	50	70.5	3.21	0	2	1	0	8.1	3.21
40	0	36.9	22.7	29.8	82.9	48.6	65.7	4.81	1	0	1	0	8.6	4.81
41	0	36.8	21.9	29.4	88.6	52.9	70.8	5.88	1	0	0	0	8.4	5.88
42	0	36.4	20.3	28.3	81.6	58	69.8	6.68	0	1	0	0	8.5	6.68

* MSW- Meteorological standard week, BSSH- Bright sun-shine hours, PDI- Percent disease incidence

Table-3 Epidemiological study of false smut of rice in field condition during pooled of two years

MSW	Rainfall (mm)	Temperature (°C)			Relative Humidity (%)			Wind Velocity (km/hr)	Cloudy Weather (Octa)			Rainy Days	BSSH (hrs)	PDI (%)
		Max	Min	Av	I	II	Av		I	II	Av			
24	22	33.4	26.3	29.8	91.5	75.2	83.4	8.8	5	5	5	3	5.4	0
25	6.5	32.1	26.6	30.1	85.8	71.5	78.6	8.5	5	4	5	1	7	0
26	143.8	30.8	24.6	27.6	95.9	83.9	89.9	8.1	6	6	6	5	2.5	0
27	187.5	30.4	25.1	28	93.5	85.4	89.5	8.5	6	5	5	5	3.3	0
28	325.5	28.9	24.3	27	94.1	88.1	91.1	6.7	6	6	6	5	2.5	0
29	322	28.5	23.9	25.9	98.5	93.2	95.9	5.7	7	7	7	7	1	0
30	80.5	29.6	25.1	27.1	91	88.3	89.6	8.3	7	7	7	4	0.2	0
31	30.3	30.3	25.1	27.6	82.3	80.2	81.2	19.7	5	6	5	3	2.6	0
32	16.5	30.5	24.9	27.7	91.6	79	85.3	7.3	6	6	6	1	3	0
33	31.5	29.8	24.7	27.6	91.6	79.6	85.6	6.7	7	5	6	3	3.4	0
34	108.5	29.4	23.7	26.4	96.7	86	91.3	5.3	6	6	6	6	2.7	0
35	102	30.1	23.8	26.7	94.6	82	88.3	4.6	7	6	6	5	2.8	0
36	19	31.5	23.5	27	92.9	74.5	83.7	4.1	3	4	3	1	5.1	0.77
37	1.5	32.3	23.5	28	90.6	72.3	81.5	2.9	4	4	4	0	5.8	1.56
38	42	32.8	22.8	27.4	93.6	69.7	81.6	2.9	2	4	3	3	4.5	2.61
39	0	35.2	22.7	28.1	92.5	57.8	75.2	2.2	0	2	1	0	7.7	3.54
40	0	36.2	23.4	30.1	89.6	49.8	69.7	2.2	1	0	0	0	8.5	5.24
41	14	35.9	22.8	29.2	91.3	60.8	76	2.3	1	1	1	2	6.3	6.29
42	0	36.1	21.3	28.7	87.2	65	76.1	1.7	0	0	0	0	7.9	6.95

* MSW- Meteorological standard week, BSSH- Bright sun-shine hours, PDI- Percent disease incidence

Table-4 Correlation of percent disease incidence with weather parameters during experimentation

SN	Weather Parameters	Correlation		
		2017	2018	Pooled
1	Rainfall	-0.367	-0.275	-0.297
2	Temperature Maximum	0.704**	0.717**	0.695**
3	Temperature Minimum	-0.378	-0.382	-0.308
4	Temperature Average	0.477*	0.461*	0.464**
5	Relative Humidity Morning	0.309	-0.411	-0.083
6	Relative Humidity Evening	-0.425	-0.625**	-0.544**
7	Relative Humidity Average	-0.288	-0.649**	-0.462**
8	Wind Velocity	-0.549*	-0.511*	-0.518**
9	Cloudy Weather Morning	-0.653**	-0.760**	-0.683**
10	Cloudy Weather Evening	-0.595**	-0.786**	-0.645**
11	Cloudy Weather Average	-0.629**	-0.804**	-0.684**
12	Rainy Days	-0.386	-0.475	-0.418**
13	Bright Sun-Shine Hours	0.285	0.649**	0.475**

Note: Critical value (0.05) 2017= +/- 0.444* & 0.561**,
2018= +/- 0.456* & 0.575** and Pooled= +/- 0.325* & 0.418**

Results and Discussion

Progress of false smut in cv. GR-11 under natural condition

The observations on false smut incidence were recorded at a weekly interval in cv. GR-11 at N. M. college farm, Navsari during the year of 2017 and 2018 which was presented in [Table-1, 2 and 3]. The first symptom of false smut was recorded 88th days after sowing in susceptible variety GR-11. Which was sown on 12th June of 2017, transplanting on 7th July 2017 and harvesting on 24th October 2017. Since then, there was linear progress of the disease during the entire crop season. The main peak period of the false smut was recorded at 36 MSW to 40 MSW (1.55 to 5.67 %) and reached at its highest on 21st October of 42 MSW (7.22 %) during 2017. Whereas in 2018, first symptom of false smut was recorded after 86th days after sowing in susceptible variety GR-11. Which was sown on 18th June of 2018, transplanting on 13th July 2018 and harvesting on 25th October 2018. Since then, there was linear progress of the disease during the entire crop season. The main peak period of the false smut was recorded, at 37 MSW to 40 MSW (0.53 to 4.81 %) and reached at its highest on 26th October of 42 MSW (6.68 %) in 2018. However, in pooled of two years first symptom of false smut was recorded at 36th MSW in susceptible variety GR-11. Since then, there was linear progress of the disease during the entire crop season. The disease at the starting period (0.77 %) to reached (6.95 %). Comparatively, false smut incidence was more during 2017 than in 2018. The weather during 33rd to 35th MSW played an important role in initiation of the false smut. During 39th to 41st MSW, there was very fast development of the disease due to congenial condition. Hence, this period can be considered as a window period for the false smut of rice in Navsari condition. False smut infection starts from 36th to 37th MSW under favourable weather conditions. The infection on grain produced a huge quantity of inoculum in the presence of favourable climatic conditions, resulted yield loss. From the results of the present investigation, it is very clear that false smut of rice is very important and become a major disease in Navsari district. Hence, it causes heavy losses because, its infection starts at the flowering stage so, it directly effects on yield.

Correlation of false smut incidence with weather parameters

The disease started appearing at ripening stage of the crop and epidemiological studies were performed right upto harvesting of the crop. The false smut infection in susceptible cv. GR-11 and corresponding weather parameters at weekly interval were recorded which was presented in [Table-4]. During 2017, false smut was initiated on 36th MSW. Previous two weeks 34th and 35th MSW were recorded maximum temperature i.e., 29.4 and 29.3ºC, average temperature i.e., 27.0 and 26.7ºC, morning relative humidity i.e., 94.6 and 96.6 percent and bright sunshine hours i.e., 3.3 and 3.2 hrs., respectively. These conditions favoured for initiation of the false smut during flowering stage. More dominant favourable weather conditions viz., maximum temperature i.e., 31.4, 34.0 and 31.4ºC, average temperature i.e., 28.0, 29.6 and 27.6ºC, morning relative humidity i.e., 95.6, 91.3 and 96.5 percent and bright sunshine hours i.e., 5.2, 4.7 and 2.1 hrs. lead to more

progress of the disease during 36th, 37th and 38th MSW, respectively. There was a continuously increased of the false smut during 36th to 38th MSW in the presence of the warm and humid weather which considered a window period for the false smut of rice. After 38th MSW upto harvest, the disease incidence was continuously increased and recorded upto 7.22 percent disease incidence. Correlation matrix worked out showed that rainfall (-0.367), minimum temperature (-0.378), evening relative humidity (-0.425), average relative humidity (-0.288) and rainy days (-0.386) were found negatively correlated while, wind velocity (-0.549) was found significantly and negatively correlated whereas, cloudy weather at morning, evening and average i.e., -0.653, -0.595 and -0.629 were found highly significantly and negatively correlated with the false smut incidence, respectively. Moreover, maximum temperature (0.704) was found highly significant and positive correlated while, average temperature (0.477) was found significantly and positively correlated. Whereas, morning relative humidity (0.309) and bright sun-shine hours (0.285) were found non-significantly and positively correlated with the false smut incidence. Maximum temperature, average temperature and morning relative humidity were playing an impotant role in the disease development compared to other weather parameters. More or less similar trends were recorded during the subsequent year in the progress of the false smut due to closely similar weather. In 2018, the disease was initiated on 37th MSW. Previous two weeks 35th and 36th MSW were recorded maximum temperature i.e., 29.9 and 29.7ºC, average temperature i.e., 26.7 and 26.0 ºC, morning relative humidity i.e., 92.6 and 90.1 percent and bright sunshine hours i.e., 2.3 and 5.0 hrs., respectively. These conditions favoured for initiation of the false smut during flowering stage. More dominant favourable weather conditions viz., maximum temperature i.e., 30.8, 32.7, 33.8 and 36.9ºC, average temperature i.e., 26.3, 27.3, 27.7 and 29.8ºC and bright sunshine hours i.e., 6.8, 6.8, 8.1 and 8.6 hrs. lead to more progress of the disease during 37th, 38th, 39th and 40th MSW, respectively. There was a sudden jump of the false smut during 37th to 40th MSW in the presence of the warm and humid weather with bright sunshine which considered a window period for the false smut of rice. After 40th MSW upto harvest, the disease incidence was continuously increased and recorded upto 6.68 percent disease incidence. Correlation matrix worked out showed that rainfall (-0.275), minimum temperature (-0.382), morning relative humidity (-0.411), and rainy days (-0.475) were found negatively correlated while, wind velocity (-0.511) was found significantly and negatively correlated with the false smut incidence. Whereas, evening relative humidity, average relative humidity, morning cloudy weather, evening cloudy weather and average cloudy weather i.e., -0.625, -0.649, -0.760, -0.786 and -0.804 were found highly significantly and negatively correlated with the false smut incidence, respectively. Moreover, maximum temperature (0.717) and bright sun-shine hours (0.649) were found highly significant and positive correlated, while average temperature (0.461) was found significant and positive correlated with the false smut incidence. Maximum temperature, average temperature and sunshine hours were playing an impotant role in the disease development compared to other weather parameters. The results clearly reveal that there is two years that the false smut become a rising problem in Navsari district because of the presence of a pathogen, growing susceptible cv. GR-11 in most of the area and prevalence of congenial weather conditions. During mean of two years, maximum temperature i.e., 29.4 and 30.1 °C, average temperature i.e., 26.4 and 26.7ºC and bright sunshine hours i.e., 2.7 and 2.8 hrs. are more favourable for the progress of the false smut during 34th and 35th MSW, respectively. These conditions favoured for initiation of the false smut disease during flowering stage. More dominant favourable weather conditions viz., maximum temperature i.e., 31.5, 32.3 and 32.8ºC, average temperature i.e., 27.0, 28.0 and 27.4ºC and bright sunshine hours i.e., 5.1, 5.8 and 4.5 hrs. are very crucial for the disease initiation during 36th, 37th and 38th MSW, respectively. Moreover, disease fast progress during 39th to 40th MSW. However, the progress of the disease was slower during 41st to 42nd MSW as compared to the previous weeks. The crop before ripening period remains free from the false smut infection. Correlation matrix worked out showed that rainfall (-0.297), minimum temperature (-0.308) and morning relative humidity (-0.083) were found negatively correlated while, evening relative humidity (-0.544), average relative humidity (-0.462), wind velocity (-0.518), morning cloudy weather (-0.683), evening cloudy weather (-0.645), average cloudy weather (-0.684) and

Table-5 Stepwise regression equation for rice false smut on different weather parameters during 2017

Multiple linear regression equation $\hat{Y} = a + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n$	Multiple R	Co-efficient of determination (R^2)
$\hat{Y} = -64.826 + 1.158 (X_2) + 0.370 (X_7) + (-0.510) (X_9)$	0.89	79.9

Whereas, Y= Predicted disease incidence, X2= Maximum Temperature, X7= Average relative Humidity, X9= Morning Cloudy Weather

Table-6 Stepwise regression equation for rice false smut on different weather parameters during 2018

Multiple linear regression equation $\hat{Y} = a + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n$	Multiple R	Co-efficient of determination (R^2)
$\hat{Y} = -4.085 + (-0.562) (X_{11})$	0.80	64.7

Whereas, Y= Predicted disease incidence, X11= Average Cloudy Weather

Table-7 Stepwise regression equation for rice false smut on different weather parameters in pooled

Multiple linear regression equation $\hat{Y} = a + b_1 X_1 + b_2 X_2 + \ldots + b_n X_n$	Multiple R	Co-efficient of determination (R^2)
$\hat{Y} = -35.583 + 0.732 (X_2) + 0.148 (X_5)$	0.75	56.9

Whereas, Y= Predicted disease incidence, X2= Maximum Temperature, X5= Morning Relative Humidity

rainy days (-0.418) were found highly significantly and negatively correlated with the false smut incidence. Moreover, maximum temperature (0.695), average temperature (0.464) and bright sun-shine hours (0.475) were found highly significant and positive correlated with the false smut incidence. Maximum temperature, average temperature and sunshine hours were playing a greater role in the disease development compared to other weather parameters. Stepwise regression equation for rice false smut on different weather parameters at Navsari. The regression coefficient based on stepwise regression analysis for percent false smut incidence of rice with respect to weather parameters have been worked out and presented in [Table-5, 6 and 7]. The result presented in [Table-5] indicated, stepwise regression, it has been also observed that R-value was high (0.89 %) indicating a strong association between percent disease incidence to maximum temperature, average relative humidity and morning cloudy weather. The co-efficient of determination value was found to be 79.90 percent. This clearly indicates that at least 89 percent of variation in false smut incidence can be explained by the function of the weather parameter *viz.*, maximum temperature, average relative humidity and morning cloudy weather during 2017. The result presented in [Table-] indicated, stepwise regression, it has been also observed that R-value was high (0.80 %) indicating a strong association between percent disease incidence and average cloudy weather. The co-efficient of determination value was found to be 64.70 percent. This clearly indicates that at least 80 percent of the variation in false smut incidence can be explained by the function of the weather parameter *viz.*, average cloudy weather during 2018. The result presented in [Table-7] indicated, stepwise regression, it has been also observed that R-value was high (0.75 %) indicating a strong association between percent disease incidence to maximum temperature and morning relative humidity. The co-efficient of determination value was found to be 56.90 percent. This clearly indicates that at least 75 percent of variation in false smut incidence can be explained by the function of the weather parameter *viz.*, maximum temperature and morning relative humidity during pooled of two years. Thus, observed false smut incidence and predicted false smut incidence found closely related and regression equation established may be most reliable and useful for forecasting of the rice false smut disease. The loss caused by the false smut can be saved by forewarning to the farmers and thereby controlling the same at the proper time. The result was support with many workers. According to [9] conducted field experiment during *kharif* 1996-97 in Karnataka and noticed that weather parameters *i.e.*, maximum temperature (<31°C) and low rainfall (<5 mm) during 50 percent flowering was found to be favourable and significantly effect on false smut development in rice. The present findings are in agreement with those of [5] found that high relative humidity (89 to 95 %) and no rainfall at milking stage to be favourable for false smut development in rice. The rainy days, rainfall, maximum temperature 31°C and high humidity (90-95 %) from panicle emerging stage to full heading and flowering stage were favorable conditions for outbreak of rice false smut, these finding corroborate [10-17]. According to [3] recorded optimum temperature (31.36 to 23.14 °C), high relative humidity (88.85 to 73.50 %), least rainfall (6.66 mm) and bright sunshine hours (6.20 hrs.) weather condition was more favourable for development of false smut in rice.

Conclusion
The present study clearly reveals that there is an increase in the incidence of false smut of rice in the variety GR11 grown in Navsari (indicating its susceptibility). The weather prevailing during the kharif season is the most congenial that favour the occurrence of false smut, therefore its cultivation of this variety becomes non-profitable. Thus, maximum temperature, morning and average relative humidity, morning and average cloudy weather found to play an important role in the disease development. Moreover, the work to find out resistant variety, application of balanced fertilizers (especially nitrogen) because the heavy dose of nitrogen it favoured to false smut disease and skip the period of false smut infection, through a change of sowing date, because false smut disease infection initiates at flowering stage. So, management measures must be taken prior to infection get started to avoid huge losses.

Application of research: Results of the present study strongly reflected that the weather parameters play important role in disease development.

Research Category: Plant sciences

Abbreviation: PDI: Percent disease incidence, MSW: Meteorological standard week, BSSH: Bright sun-shine hours, mm: millimeter, km: kilometre, m: meter, hrs: hours, cm: centimetre, °C: Degree centigrade, %: percent

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Study area / Sample Collection: Experimental of N. M. College of Agriculture, Navsari Agricultural University, Navsari-396450, Gujarat, India

Cultivar / Variety name: GR-11

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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