Influence of Weather Factors on Rice False Smut Disease Development (*Ustilaginoidea virens*) in Tamil Nadu

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ABSTRACT: Rice false smut caused by *Ustilaginoidea virens* (Cooke) Takahashi, is an emerging disease of rice. A field experiment was conducted during Rabi seasons (2019-20) to find out the influence of weather parameters on disease development. The data obtained was analyzed through correlation individually. The first symptom of false smut was appeared on 52nd SMW where disease severity was 7.44 per cent and reached the highest level of 50.67 per cent on 6th SMW during 2019-20. The influence of weather parameters on rice false smut development were correlated, the results were the maximum temperature, relative humidity, rainfall, dew and minimum temperature were showed significant positive correlation, were as wind speed and wind direction did not showed any significant correlation on disease development. Similarly, AUDPC were calculated from 52nd to 6th SMW with 26.05 to 220.03. The influence of weather parameters correlation with rice false smut disease development is very essential for forewarning and calendar based fungicidal schedule to control the false smut incidence and reduce the yield losses in rice crop.

Keywords: Rice false smut, weather parameters, correlation, Tamil Nadu.

INTRODUCTION

Rice is one of the staple cereal crop and food for billions of people around the world (Bhavya and Shivakumar, 2018; Channannavar *et al.,* 2020). False smut of rice caused by *Ustilaginoidea virens* (Cooke) Takahashi, was first reported by Cooke (1878) from Tirunelveli district in Tamil Nadu. False smut prevalent during Rabi season is gaining importance as a post flowering disease. In India, the disease has become most devastating in major rice growing states *viz.*, Haryana, Punjab, Uttar Pradesh, Bihar, Uttarakhand, Jharkhand, Gujarat, Maharashtra, Jammu and Kashmir, West Bengal, Tamil Nadu, Karnataka, Andhra Pradesh and Puducherry (Dodan and Singh 1996; Mandhare *et al*., 2008) and yield loss estimation due to false smut disease on different rice varieties growing in different ecosystems revealed up to 4.25 per cent yield loss (Muniraju *et al.,* 2017; Pramesh *et al.,* 2020; Sharanabasav *et al*., 2021). The symptoms produced by *U. virens* become visible only after flowering and it occurs in the field at the hard dough to mature stages of the crop. The spikelets in a panicle transform into globose, yellowish green and velvety spore balls that are two to five cm in diameter and covered by a thin orange membrane. The membrane bursts open and releases powdery spores which appear orange then become green, olive green and finally to greenish black

(Atia, 2004). In damp weather, the disease can be severe and losses can reach 85 per cent as has been reported from Tamil Nadu on different rice cultivars (Ladhalakshmi *et al.,* 2012; Pramesh *et al.,* 2020; Sharanabasav *et al.,* 2021). The climatic factors favoring rice false smut are cloudy weather, high relative humidity (>95 %), low temperature (25 to 30 °C), water stress and rainy days at the time of flowering (Raji *et al.,* 2016; Sanghera *et al.,* 2012). Besides, it was revealed that the disease incidence and disease severity index of false smut occurred at 23-32ºC temperature, 66-90 per cent relative humidity 5-8 mm rainfall and 4.81-6.20 h of sunshine. Such congenial environment is suitable for germination of sclerotia and superfluous dormant spores *i.e.,* chlamydospores (Bhargava *et al.,* 2018). Therefore, the present studies were done to know the effect of different weather parameters on the false smut disease incidence in rice.

MATERIALS AND METHODS

A field experiment was carried out for epidemiological studies during Rabi 2019-20 on false smut disease of rice at farmer field in pullagoundampatti village of salem district, Tamilnadu, India (Latitude 11.47, Longitude 77.86). Rice cultivar Dhanista was sown in the nursery and 30 days old seedlings were transplanted in plots of size 2.5 × 2.5 sq. m at a spacing of 20 cm ×

15 cm. The crop was raised following standard agronomical practices for the region.

To determine the influence of various environmental factors on the development of rice false smut, the disease severity data was correlated with different meteorological parameters viz. The weather parameters such as Maximum temperature (°C), Minimum temperature (°C), Relative Humidity (%), Rainfall (mm/day), Dew point (°C), Wind speed (m/s) and Wind direction (degree) were recorded during cropping seasons (45th and 6th Standard Meteorological Weeks of 2021-2022). through analysis of correlation and regression.

Disease Observations. Weekly observations on disease were recorded from flowering. Various parameters such as, per cent infected panicles and grains and disease severity were calculated as per the formulae given below (Mandhare et al., 2008; Singh and Dube 1978).

$$\text{Per cent infected tillers} = \frac{\text{Number of tillers infected /m}^2}{\text{Total number of tillers /m}^2} \times 100$$

$$\text{Per cent infected grains} = \frac{\text{Number of diseased grains/panicle}}{\text{Total number of grains/panicle}} \times 100$$

Disease severity (%) = Per cent infected tillers × Per cent infected grains.

The Area Under Disease Progress Curve (AUDPC) was calculated according Marcel et al. (2013) formula.

$$\text{AUDPC} = \sum_{i=1}^{n}\left[\left(x_i + x_{i+1}\right)/2\right]*t$$

Where,

xi, is rice false smut disease at the time i; n, is the number of taken,

t, is the number of days between the registration of xi and $xi+1$

RESULTS AND DISCUSSION

The weather and disease recorded during kharif 2019-20 and pullagoundampatti village are presented and first symptom of disease was recorded in the 52nd standard meteorological week (SMW) (Table 1 and Fig. 1). From this date the disease increased in linear manner during the entire crop season i.e. on 52nd SMW (7.44%) and reached the peak point on 6th SMW (50.67%) during 2019-20.

Table 1: Per cent disease incidence and weather factors during Rabi 2019-2020 from 45th to 6th SMW.

Sr. No.	Standard Meteorological Weeks	PDI	Temperature Maximum (°C)	Temperature Minimum (°C)	Relative Humidity (%)	Rainfall (mm/day)	Dew point (°C)	Wind speed (m/s)	Wind direction (degree)
1.	45th	0.00	26.69	20.72	88.71	8.65	21.27	0.96	259.01
2.	46th	0.00	27.22	21.54	89.79	10.89	22.14	1.06	238.03
3.	47th	0.00	26.96	20.65	89.30	4.13	21.51	1.14	129.97
4.	48th	0.00	26.47	20.29	91.02	3.82	21.34	1.23	78.58
5.	49th	0.00	27.94	20.36	86.65	1.75	21.21	0.97	108.55
6.	50th	0.00	27.03	19.05	87.64	0.61	19.97	1.35	57.43
7.	51st	0.00	26.24	15.30	80.16	1.02	16.51	1.03	199.14
8.	52nd	7.44	26.96	16.08	84.30	1.33	18.31	1.18	89.98
9.	1st	10.35	27.40	18.03	86.12	2.46	19.40	1.23	68.54
10.	2nd	16.25	27.89	18.48	85.43	2.27	19.77	1.02	110.85
11.	3rd	27.65	27.76	18.11	86.19	2.31	19.27	1.08	101.28
12.	4th	36.06	27.81	18.16	86.57	5.39	19.43	1.23	162.11
13.	5th	42.68	28.59	17.84	86.18	0.33	19.57	1.34	118.44
14.	6th	50.67	28.70	17.14	86.29	0.39	19.96	1.12	90.68
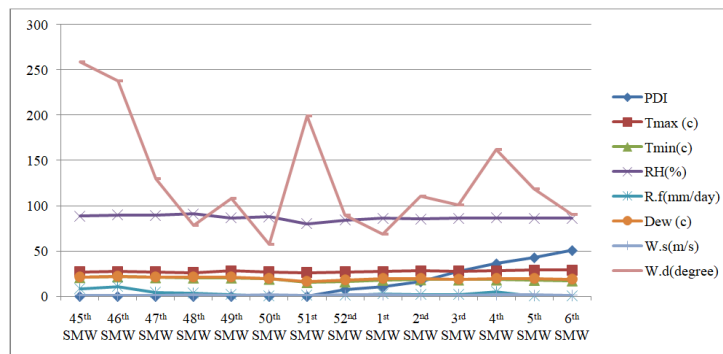
Fig. 1. Graph showing, per cent disease incidence and weather factors during Rabi 2019-2020 from 45th to 6th SMW.

Our results were conformity with Singh and Pophaly (2010) who reported that the intermittent rains in September and October (at flowering stage) and the associated increased humidity probably favored the disease. However, minimum and maximum temperature ranges recorded in October 2007 were 23–25 °C and 30–32 °C, respectively. Similarly, Bhargava et al. (2018) recorded optimum temperature (31.36 to 23.14 °C), high relative humidity (88.85 to 73.50%), least rainfall (6.66mm) and bright sunshine hours (6.20 hrs.) as more favorable weather conditions for the development of false smut in rice. Meanwhile, Kapse et al. (2012) recorded the incidence of false smut from 3.0 to 12.0 per cent. During the period of observation

minimum temperature was 17°C, while maximum temperature 31°C with corresponding average, relative humidity of 52 to 88 per cent.
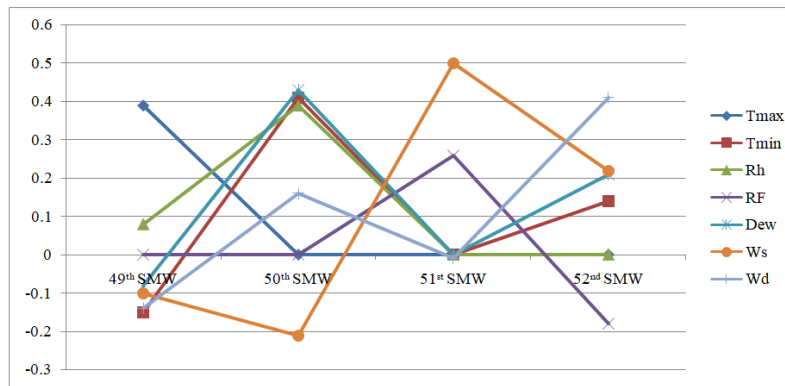
Correlation of weather parameters with rice false smut disease incidence. Influence of weather parameters prevailed during 49th to 51st SMW on the development of false smut symptoms was studied. An average maximum temperature (26.24°C to 27.94°C) prevailed over 49th to 51st SMW showed a significant positive correlation on the rice false smut development. Minimum temperature prevailed over 50th and 51st SMW also showed positive correlation. However, significant correlation was noticed with temperature (15.30°C) an 51st SMW. Relative humidity of 49th to 51st SMW showed positive correlation (80.16% to

87.64%). Average rainfall data of previous three weeks before symptoms development showed positive correlation with a significant correlation of 49th and 50th SMW (1.75mm and 0.61mm). An average of 16.51°C dew point showed a positive correlation, whereas wind speed and wind direction did not showed any significant influence on the rice false smut development (Table 2 and Fig. 2). The rice false smut disease incidence was assessed over a SMW of 52nd to 6th with percent disease incidence of 7.44 % to 50.67 %. Similarly, the area under disease curve were calculated SMW of 52nd to 6th with 26.05 to 220.03 (Table 3 and Fig. 3).

Table 2: Correlation over a 49th, 50th, 51st and 52nd SMW with weather parameters.

Standard Meteorological Weeks	Temperature Maximum (°C)	Temperature Minimum (°C)	Relative Humidity (%)	Rainfall (mm/day)	Dew point (°C)	Wind speed (m/s)	Wind direction (degree)
49 SMW	0.39	-0.15	0.08	0.76*	-0.08	-0.1	-0.14
50 SMW	0.86**	0.41	0.39	0.88**	0.43	-0.21	0.16
51 SMW	0.9**	0.70*	0.70*	0.26	0.69*	0.5	-0.01
52n SMW	0.91***	0.14	0.68*	-0.18	0.21	0.22	0.41

* Significance; ** Moderately significance; *** Highly significance; - Negative correlation

Fig. 2. Correlation over a 49th, 50th, 51st and 52nd SMW with weather parameters.

Table 3: Correlation from 52nd to 6th SMW with weather parameters.

S. No.	Weather parameters	Correlation
1.	Temperature maximum (°C)	0.91***
2.	Temperature minimum (°C)	0.14
3.	Relative Humidity (%)	0.68*
4.	Rainfall (mm/day)	-0.18
5.	Dew (°C)	0.21
6.	Wind Speed (m/s)	0.22
7.	Wind Direction (degree)	0.41

* Significance; ** Moderately significance; *** Highly significance; - Negative correlation
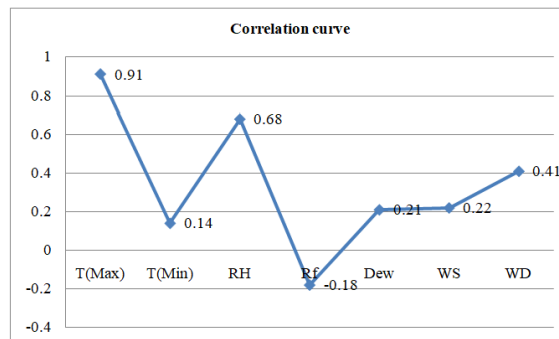
**Fig. 3.** Correlation from 52nd to 6th SMW with weather parameters.

The disease incidence was assessed from SMW of 52nd to 6th with disease incidence of 7.44 % to 50.67 %. Similarly, AUDPC were calculated from 52nd to 6th SMW with 26.05 to 220.03 (Table 4 and Fig. 4).

The influence of weather factors on disease development were correlated and revealed that, significant positive correlation were observed with maximum temperature, relative humidity, rainfall, dew and minimum temperature were as wind speed and wind direction did not showed any significant correlation. Similar results were observed, the disease forecasting of false smut disease of rice in West Bengal, India (Mouli *et al.,* 2021) who observed, disease severity was positively correlated with maximum temperature, minimum temperature, relative humidity and wind, were as negatively with rainfall were favourable conditions for rice false smut pathogen. Likewise, the epidemiological study of false smut of rice (*Oryza sativa* L.) in Gujarat (Chaudhari *et al.,* 2019), who observed maximum temperature, relative humidity were play a major role for disease development. Meanwhile. Saddamhusen alas *et al.* (2021) who reported correlation results reviled that, maximum relative humidity (0.387), minimum relative humidity (0.058) and evaporation (0.206) were found positively correlated while, maximum temperature (-0.435), rainfall (-0.225) and rainy days (-0.191) were negatively correlated.

Table 4: Weekly wise percent disease incidence (PDI) and Area under Disease Progress Curve (AUDPC) during cropping session.

Sr. No.	Standard Meteorological Weeks	PDI	AUDPC
1.	45th	0.00 (2.86)[h]	0.00[h]
2.	46th	0.00 (2.86)[h]	0.00[h]
3.	47th	0.00 (2.86)[h]	0.00[h]
4.	48th	0.00 (2.86)[h]	0.00[h]
5.	49th	0.00 (2.86)[h]	0.00[h]
6.	50th	0.00 (2.86)[h]	0.00[h]
7.	51st	0.00 (2.86)[h]	0.00[h]
8.	52nd	7.44 (15.80)[g]	26.05[g]
9.	1st	10.35 (18.76)[f]	43.68[f]
10.	2nd	16.25 (23.75)[e]	67.24[e]
11.	3rd	27.65 (31.72)[d]	113.02[d]
12.	4th	36.06 (36.90)[c]	153.85[c]
13.	5th	42.68 (40.79)[b]	185.44[b]
14.	6th	50.67 (45.38)[a]	220.03[a]
	SE(d)	0.31	1.51
	CD(0.05)	0.61	3.01
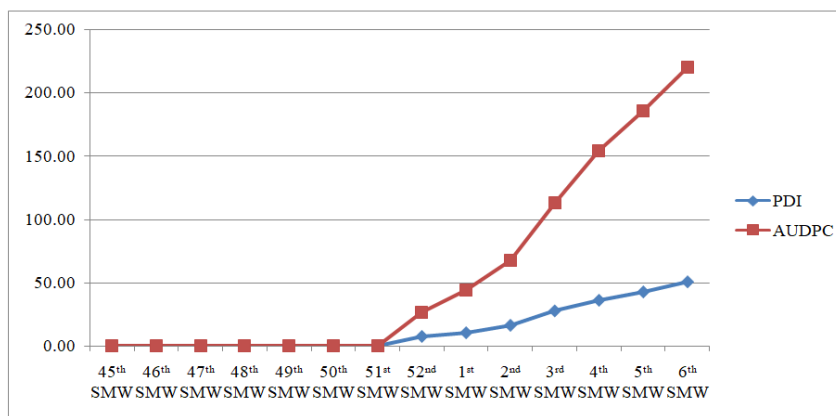
Fig. 4. The graph showing weekly wise Percent Disease Incidence (PDI) and Area Under Disease Progress Curve (AUDPC) of 45th to 6th.

CONCLUSION

To conclude this study, we have studied inflience of weather parameters and correlation with rice false smut diaseas develoment. Based on this to develop the fungicidual schdule in correct time as a prapolactic spray. This will be very helful for controle the disease and ultimately reduse the yield losses.

Conflict of Interest. None.

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