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Incidence of false smut on rice genotypes and the influence of weather factors on the disease

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Abstract

False smut disease of rice is evolving as severe grain disease in most of the rice growing regions of the world. During *Kharif*, 2020 heavy incidence of false smut was observed. Hence, assessment of the incidence of the disease on different rice genotypes under natural field conditions was done at Rajendranagar farm, IIRR. The results revealed that average disease incidence ranged between 26.5 - 87.8% and the average number of smut balls per panicle varied from 1-26 with the mean value of 57.77% and 10.15, respectively. The weather data indicated that maximum rainfall recorded during the months of September and October provided the most favourable environmental conditions for the pathogen *Ustilaginoidea virens*. This also coincided with the 50 % flowering date of the most of the genotypes leading to the increase in the disease.

Keywords: False smut disease**,** *Ustilaginoidea virens* and Disease incidence

Introduction

Rice (*Oryza sativa* L.) is one of the most significant cereal crops in India. It is nutritionally and agronomically most essential crop of the world and feeds nearly 3.2 billion people. Rice production in India has increased from 82.5 million tonnes during the period of 1997-98 to 114 million tonnes in 2018-19 (Anonymous, 2019). But projected figures for future indicate that the present levels of production are not sufficient to feed the population of the country. The low productivity of rice in India is ascribed to many abiotic and biotic stress factors. With respect to biotic factors, diseases *viz*., blast, bacterial leaf blight, sheath blight, sheath rot, false smut, and brown spot are wide-spread and economically important. In recent decades, a number of minor diseases have attained the status of major importance in rice. One such disease is the rice false smut (RFS) disease which is a threat to yield and grain quality. The disease has been reported in more than 40 countries, especially in rice growing Asian nations such as China, India and Burma (Wang *et al*., 2019).

RFS caused by *Ustilaginoidea virens* (teleomorph: *Villosiclava virens*) has become the most devastating grain disease of rice. The pathogen infects during booting to flowering stage and symptom can be observed on grains where individual grain is transformed into chlamydospores mass which results in reduced yield as well as grain quality. The disease can cause 2.8–81% yield losses in different rice-producing areas depending on the rice variety and disease intensity. Earlier the disease was considered as minor due to its sporadic occurrence but in recent decades there has been an increase in incidence because of extensive cultivation of rice hybrids and wider application of nitrogenous fertilizers (Ladhalakshmi *et al.,* 2019). RFS occurrence can be seen when incidence of rainfall coincides with the booting and heading stages of the rice crop. However, epidemics vary between varieties and season. In this study, we have undertaken a survey to know the natural incidence of false smut in various genotypes grown in Rajendranagar farm, ICAR-IIRR.

Materials and Methods

Assessment of incidence of rice false smut disease was carried out at grain maturity stage during *Kharif* 2020 at Rajendranagar farm, IIRR, Hyderabad. Data were recorded in 50 genotypes by randomly selecting 5 hills for observation. Disease incidence was assessed based on total number of tillers, number of infected tillers per hill and number of smut balls per infected panicle recorded on randomly selected hills to know the disease incidence under natural disease infestation. Percentage of infected tillers in each genotype was worked out. Weather parameters were recorded to know their effect on disease incidence.

Results and Discussion

Incidence of false smut was observed in most of the genotypes at Rajendranagar farm, IIRR. The number of yellow and greenish black coloured smut balls per panicle ranged from 1-50 with maximum disease incidence of 87.8 % (Table 1). The range, mean and standard error of mean was calculated for average disease incidence and number of smut balls. Disease incidence varied between 26.5 - 87.8% with the mean value of 57.77%. The range for smut balls per panicle varied from 1 to 26 with the mean value of 10.15 (Figure 1).

Table 1: False smut disease incidence in different genotypes at IIRR, Rajendranagar in *Kharif* 2020.

Sl. No	Genotype Numbers	Cross combinations	Disease incidence (%)	Average No. of smut balls	Range on the no. of Smut balls/ Panicle
1.	1799	ISM X Yield genes	78.92	26.0	10 - 49
2.	1755	HWR-23 X BPT	35.99	16.4	9-24
3.	1713	MTU1010 X Yield genes	61.51	22.0	15-28
4.	1708	HWR-23 X BPT	59.33	9.0	7-10
5.	2120	ISM X Yield genes	40.99	18.6	7-50
6.	1902	HWR-23 X BPT	49.95	8.8	4-20
7.	1963	HWR-23 X BPT	83.11	16.6	8-30
8.	2067	ISM X Yield genes	74.77	12.2	8-15
9.	1932	HWR-23 X BPT	46.56	3.4	2-5
10.	1583	ISM POPULATION	26.50	6.4	5-10
11.	1824	AKD Population	80.69	9.2	7-15
12.	3008	HWR-23 X BPT	41.37	4.8	1-10
13.	1564	HWR-23 X BPT	61.94	10.2	7-14
14.	2041	MTU1010 X Yield genes	73.65	11.4	3-20
15.	1966	ISM POPULATION	36.52	10.2	5-16
16.	816	HWR-23 X BPT	45.05	8.6	3-13
17.	1955	HWR-23 X BPT	79.01	18.6	14-22
18.	2724	ISM POPULATION	53.68	4.8	3-6
19.	3396	HWR-23 X BPT	49.79	12.4	8-20
20.	3061	MTU1010 X Yield genes	40.33	3.6	3-5
21.	2804	Swarna x Yield population	52.94	6.8	4-11
22.	2726	ISM POPULATION	45.05	5.6	2-11
23.	2410	ISM X Yield genes	57.61	4.0	1-9
24.	2387	ISM Parent	52.59	2.0	1 -3
25.	2728	AKD Population	47.46	11.6	7-19
26.	2972	HWR-23 X BPT	72.43	8.0	1-14

Sl. No	Genotype Numbers	Cross combinations	Disease incidence (%)	Average No. of smut balls	Range on the no. of Smut balls/ Panicle
27.	3133	HWR-23 X BPT	57.53	1.0	0-2
28.	2722	HWR-23 X BPT	33.40	3.6	1 -5
29.	3230	MTU1010 X Yield genes	51.14	8.4	5-12
30.	2798	AKD Population	50.32	3.2	1 -5
31.	2279	HWR-23 X BPT	55.37	5.2	4-7
32.	2400	ISM POPULATION	45.38	3.2	0-6
33.	2716	ISM Parent	65.21	15.6	5-29
34.	3450	ISM POPULATION	44.04	4.75	1-20
35.	2295	ISM X Yield genes	86.42	20.4	9-27
36.	2286	HWR-23 X BPT	61.00	6.4	4-9
37.	2096	HWR-23 X BPT	69.11	16.4	2-27
38.	2137	ISM POPULATION	68.90	7.8	2 - 17
39.	3080	ISM POPULATION	55.14	3.8	2-6
40.	2161	HWR-23 X BPT	55.72	11.4	5-23
41.	2039	ISM POPULATION	44.36	7.6	4-11
42.	1950	HWR-23 X BPT	87.83	24.0	10-45
43.	756	Swarna x Yield population	61.18	12.4	8-15
44.	2072	Swarna parent	75.29	3.2	2-4
45.	1830	HWR-23 X BPT	69.52	14.8	5-42
46.	65	ISM POPULATION	51.07	7.6	6-10
47.	903	HWR-23 X BPT	70.23	19.8	12-32
48.	750	ISM X Yield genes	55.51	12.4	5-23
49.	1637	MTU1010 X Yield genes	64.12	11.0	3-19
Range			**26.5 - 87.8**	**1-26**	
Mean			**57.7**	**10.15**	
SEM			**2.1**	**0.86**	

Weather data revealed that there was heavy rainfall (208.2 mm) in the third week of September 2020 followed by 4th week (85.8 mm) along with low maximum (29.4^{o}C) and minimum (21.3^{o}C) temperatures and sun shine hours (2.3 hrs). High rainfall continued in second and third weeks of October with total rainfall of 196.8 and 147.8 mm, respectively. Similarly, the maximum and minimum temperature was low in 2nd and 3rd weeks compared to 1st and 4th weeks of October, 2020 (Table 2).

The data also revealed that for different genotypes, days to 50% flowering ranged from 3rd week of September to last week of October, 2020, coinciding with the favourable weather conditions *viz*., low maximum temperature (28^{o}C - 29.5 ^{o}C); high humidity (96 to 98%) and high amount of rainfall (147 - 208 mm), which together played a major role in increasing the disease incidence in the field.

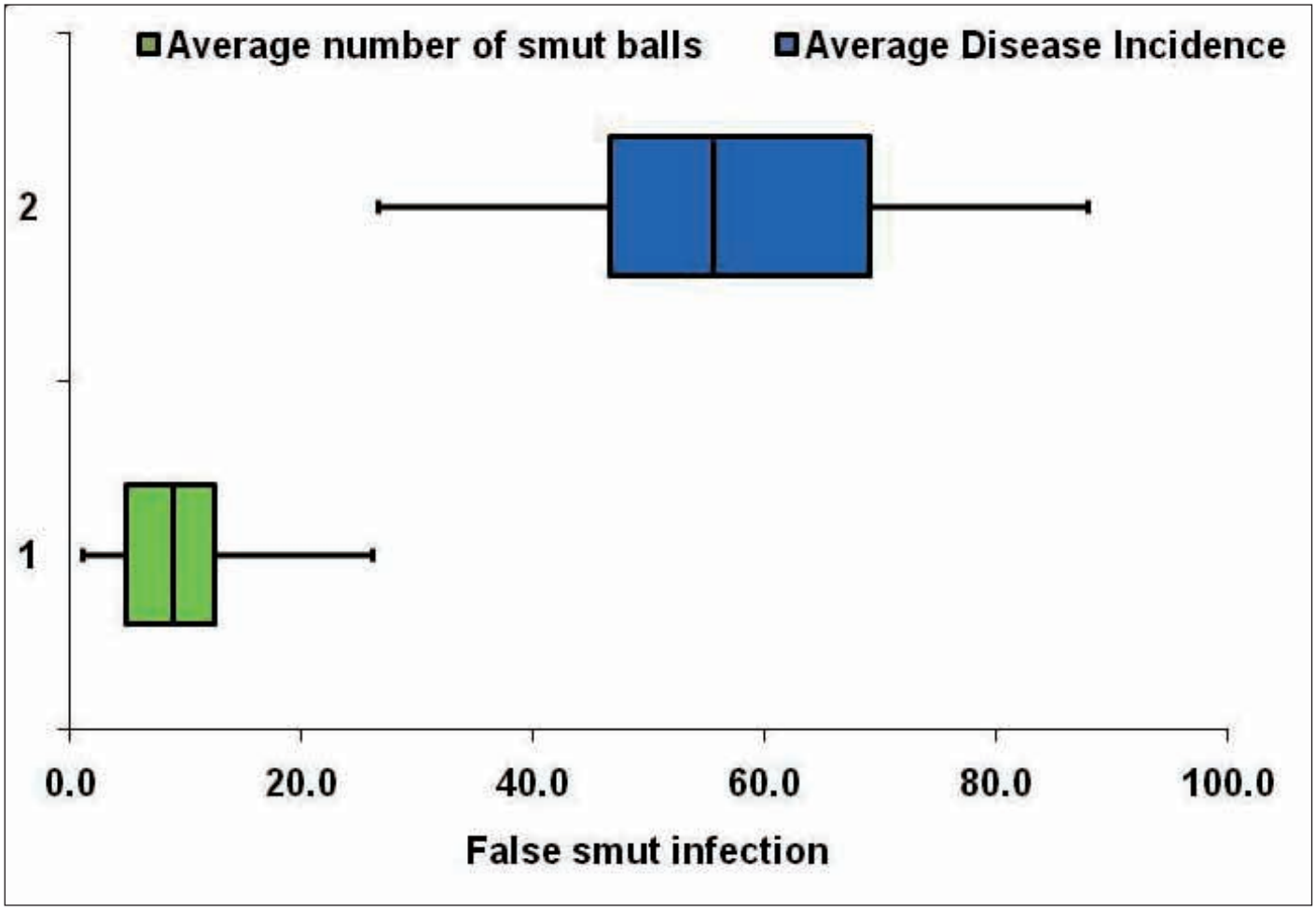

Figure 1: Box plot representation on average no. of smut balls and average disease incidence

Table 2: Meteorological data recorded at Rajendranagar for the month of September and October 2020

Weeks	Temperature (°C)		R.H. (%)		Total rainfall (mm)	Total Rainy days	SUNSHINE (hrs.)
	MAX.	MIN.	I	II			
September, 2020							
1st week	32.6	22.8	91	60	5.4	1	8.6
2nd week	31.6	21.4	96	72	69.6	5	4.8
3rd week	29.4	21.3	97	30	208.2	6	2.3
4th week	28.7	21.8	96	91	85.8	2	3.9
October, 2020							
1st week	31.42	22.0	89.8	61.1	0	0	6.0
2nd week	28.0	21.6	97	82	196.8	3	1.7
3rd week	29.5	20.6	98	77	147.8	4	4.9
4th week	30.9	17.9	94.8	60.2	0	0	7.1

Based on average disease incidence, the genotypes were categorized into three different groups *viz*., group I with disease incidence of 26.5% to 50.32%, group II with 51.07% to 65.21% and group III with 68.9% to 87.83%. Table 3 revealed that with few exceptions, MTU 1010 and yield genes cross combinations recorded highest percentage of false smut disease infection (68.9% to 87.83%) wherein the days to 50% flowering dates of the genotypes coincided with weather condition of October, 2020. Despite categorization, the overall false smut infection was moderate to high, indicating that conducive weather conditions are also the key pre-disposing factors for false smut incidence.

Table 3: Grouping of genotypes based on the false smut average incidence along with the details of days to 50 % flowering

False smut Disease incidence range (%) / Genotypes					
26.5 – 50. 32%	**Day to 50 % flowering**	**51.07 – 65.21%**	**Day to 50 % flowering**	**68. 9 – 87.83%**	**Day to 50 % flowering**
HWR-23 X BPT	25/09/20	ISM Parent	10/10/20	Swarna x Yield population	28/10/20
HWR-23 X BPT	12/10/20	ISM Population	18/10/20	MTU1010 X Yield genes	18/10/20
HWR-23 X BPT	23/09/20	HWR-23 X BPT	12/10/20	HWR-23 X BPT	23/09/20
ISM X Yield genes	22/10/20	ISM Population	12/10/20	HWR-23 X BPT	22/09/20
ISM Population	22/10/20	HWR-23 X BPT	10/10/20	ISM Population	21/10/20
Swarna parent	24/10/20	ISM Population	22/10/20	MTU1010 X Yield genes	15/10/20
ISM Population	22/10/20	AKD Population	16/10/20	MTU1010 X Yield genes	14/10/20
ISM Population	16/10/20	ISM Population	27/09/20/	MTU1010 X Yield genes	18/10/20
MTU1010 X Yield genes	10/10/20	Swarna x Yield population	24/10/20	HWR-23 X BPT	26/09/20
HWR-23 X BPT	21/09/20	ISM Population	16/10/20	ISM X Yield genes	22/10/20
HWR-23 X BPT	12/10/20	HWR-23 X BPT	15/10/20	HWR-23 X BPT	26/09/20
HWR-23 X BPT	13/10/20	HWR-23 X BPT	28/09/20	ISM X Yield genes	22/10/20
ISM X Yield genes	21/10/20	AKD Population	16/10/20	AKD Population	12/10/20
HWR-23 X BPT	11/10/20	HWR-23 X BPT	24/09/20	ISM X Yield genes	22/10/20
ISM Parent	26/10/20	HWR-23 X BPT	28/09/20		
ISM X Yield genes	21/10/20	HWR-23 X BPT	25/09/20		
ISM Population	13/10/20	HWR-23 X BPT	26/09/20		
		HWR-23 X BPT	11/10/20		

In the present study, the mean of average number of smut ball per tillers (10.15) and average disease incidence (57.77%) was higher compared to earlier reports of Baite *et al.,* (2017), Quintana *et al.,* (2016) and Singh and Pophaly (2010). However, Singh *et al.,* (2014) reported higher disease incidence between 5-80% in surveyed districts of Uttar Pradesh. Similarly, Ladhalakshmi *et al.,* (2012) also reported disease incidence of 2-75% in North western states and 5-85% in southern state of Tamil Nadu.

The study conducted at IIRR showed that rice false smut pathogen infected most of the genotypes under the natural field conditions when the weather factors were more favourable. Earlier reports have revealed higher disease incidence mostly in hot spot areas, however, the it is evident from the present study that when the weather conditions are more conducive and coincides with booting to flowering stage of the crop, the disease may occur in severe form even if the location is not a hot spot. A comprehensive study covering large areas reporting the false smut disease backed up by relevant weather data is needed to understand and prevent further spread of this disease to more areas in future.

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