



Survey and Isolation of Rice False Smut Pathogen *Ustilaginoidea virens* (Cooke) Takahashi

Arunprakash Soodamani ^a
and Paranidharan Vaikuntavasan ^{a*}

^a Department of Plant Pathology, TNAU, Coimbatore, Tamil Nadu, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Roving survey has been conducted during first quarter of 2023 at selected paddy fields of Cauvery Delta zone (Tanjore, Perambalur) and Western zone (Coimbatore, Erode) of Tamil Nadu to assess the Percent Disease Incidence for rice false smut disease in which the maximum disease incidence was recorded in Erode district (40%). The infected spikelet were observed with the characteristic symptoms where the individual rice grains turned into large, fluffy and velvety green balls, later these balls turns hard during maturity. The pathogen *Ustilaginoidea virens* was isolated from the infected smut balls in potato sucrose agar medium in which the fungus appears as small white colonies after seven days of isolation.

Keywords: Rice false smut; survey; isolation; *Ustilaginoidea virens*.

*Corresponding author: E-mail: paranidharan.v@tnau.ac.in;

1. INTRODUCTION

Rice (*Oryza sativa*) is one of the most important food crops worldwide, as it is a staple food for more than half of the world population. In India during 2021-22, the area, production and productivity of rice is 46.379 mha, 130.29 MT and 2,809 kg/ha respectively and in Tamil Nadu, the area, production and productivity of rice is 1.9 million ha, 7.55 MT and 3973 kg/ha respectively. Rice is affected by various fungal diseases such as blast, brown spot, false smut, stem rot, sheath blight and sheath rot causing much yield losses. For future food safety and security, the study of these diseases is absolutely essential. Among these diseases, Rice False Smut (RFS) is one of the most important sink infecting ascomycetes fungal diseases caused by *Ustilaginoidea virens* Cooke [1] and its teleomorphic stage is *Villosiclava virens* [2]. It was first reported at Tirunelveli district of Tamil Nadu, India [3]. The symptoms produced by *U. virens* are visible only after flowering when the fungus transforms individual grains of the panicle into a yellowish smut ball which further changes to yellowish orange, green, olive green and finally to greenish black [4]. Each matured false smut ball is composed of matured chlamyospore (outer layer), mycelia and immature chlamyospore (middle layer), white endosperm (inner part), and glume [5]. Mythologically rice false smut infection was recognized as a symbol of a bumper harvest once, it has been considered as a minor disease but now a days it causes high yield losses due to planting of high fertilizer responsive varieties and hybrids, application of enormous nitrogenous fertilizers and most especially global climatic change [6,7]. It is reported that the rice false smut disease (RFS) significantly reduces yield upto 75% [8] and releases varieties of secondary metabolites such as ustiloxins, ustilaginoidins and sorbicillinoids which makes it as one of the most harmful fungal diseases been identified in recent years [9-14]. These are the major type of ustiloxins produced highly during its early maturity stage especially in the middle layer containing mycelia and immature chlamyospores [15] which are easily released into environment by air currents and rain splashes and creating new environmental challenges [16,17].

With these points in view, we have carried out survey for assessing the disease incidence of rice false smut in major rice growing areas of Cauvery delta and western zone of Tamil Nadu. Then, the pathogen was isolated from false smut

balls collected during survey and characterized morphologically.

2. MATERIALS AND METHODS

2.1 Survey and Collection

Roving survey has been conducted during first quarter of 2023 at major rice growing areas of Cauvery delta zone (Tanjore, Perambalur) and Western zone (Coimbatore, Perambalur) Tamil Nadu where the false smut disease occurrence was recorded. The Percent Disease Incidence (PDI) for rice false smut disease was assessed [18] and the false smut balls were collected for pathogen isolation. The collected false smut balls were packed in 225 gauge transparent zip seal bags and labeled with date of collection, place of collection, variety of rice, stage of the crop and the collector name. After that the bags containing false smut balls were immediately kept in ice box and brought to the laboratory. The remaining false smut balls other than used for isolation were dried under shade up to getting constant weight and stored at -20 °C. Percent Disease Incidence (PDI) and Disease Severity were calculated by the following formulas.

Percent Disease Incidence (PDI)

$$= \frac{\text{Number of tillers infected}}{\text{Total no. of tillers}} \times 100$$

Disease severity = Percent tillers infected × Percent smut balls

In order to compare the percent disease incidence and disease severity, the number of infected tillers/panicles and the number of smut balls per panicle was recorded. All the experiment data were represented in mean.

2.2 Isolation of Rice False Smut Pathogen

The pathogen which has been causal of rice false smut disease was isolated from false smut balls collected from different districts of Tamil Nadu as per the procedure mentioned by Ladhakshmi et al., [7]. Initially, surface sterilization of infected spikelets was carried out using 1% sodium hypochlorite for a minute and washed repeatedly thrice with sterile distilled water. Using a sterilized scalpel, the smut ball was cut into small pieces and placed at the center of the plate containing Potato Sucrose Agar (PSA) medium (potato = 200 g, sucrose = 20 g, agar agar = 20 g, distilled water = 1000 ml).

To avoid bacterial contamination chloramphenicol (0.3 g / 1000 ml) was added to the PSA medium. The plates were incubated for 7-20 days at 27°C for pathogen growth. After growth of the pathogen, the mycelial disc was taken by using sterilized cork borer and placed on the center of the petri plate containing PSA medium to get pure culture of the pathogen.

3. RESULTS AND DISCUSSION

3.1 Survey for Disease Assessment of Rice False Smut

Survey results revealed that the variations in the disease incidence of false smut of rice was observed in Erode, Tanjore, Perambalur and Coimbatore districts of Tamil Nadu from January-2023 to March-2023 (Table 1). In Erode, the disease incidence was noticed between 5 to 40% among different cultivars. In Tanjore, the disease incidence was comparatively less among the varieties with the percentage range between 7 to

21%. In Perambalur, the false smut incidence was reported as 5.26%. In Coimbatore, the disease incidence varies from 12 to 32%, which causes reduction in grain yield. Among the areas surveyed, higher disease incidence was recorded in the rice variety Bhavani cultivated at Bhavanisagar, Erode district with the incidence of 40% (Fig. 1, Table 2). The minimum disease incidence was recorded in the variety ADT 54 collected from Perambalur district of Tamil Nadu having the disease incidence of 5.26%. The infected spikelets from the regions of Erode, Tanjore, Perambalur and Coimbatore districts of Tamil Nadu revealed that the disease incidence varied widely from one place to another through which disease severity was assessed. The maximum disease severity (342.8) was recorded in the variety Bhavani collected from Bhavanisagar, Erode followed by the variety TN 1 collected from Coimbatore (Table 2). The incidence of infected tillers was found to range between 5% and 40%, causing a substantial reduction in grain yield.

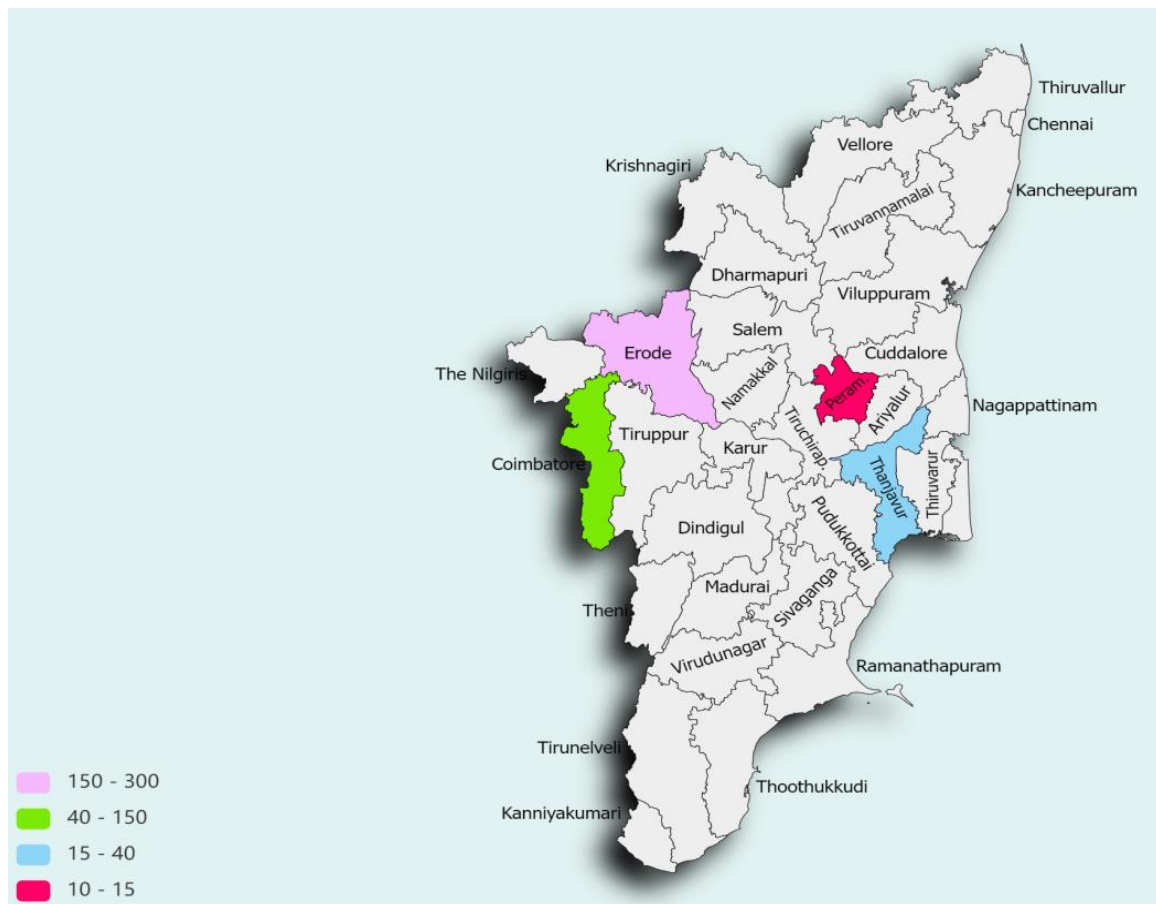


Fig. 1. Map depicting the surveyed areas of Tamil Nadu

Table 1. Collection of rice false smut isolates from major rice growing areas of Tamil Nadu

S. No.	Variety	Isolate	Place	Latitude	Longitude
1.	CR 1009	UvE-1	Erode	11°28'46"N	77°7'6"E
2.	ADT 45	UvE-2	Erode	11°28'59"N	77°7'8"E
3.	Bhavani	UvE-3	Erode	11°29'0"N	77°7'52"E
4.	VGD 1	UvT-1	Tanjore	10°59'56"N	79°28'47"E
5.	ADT 38	UvT-2	Tanjore	10°59'56"N	79°28'50"E
6.	CO 38	UvT-3	Tanjore	10°28'59"N	79°7'8"E
7.	ADT 54	UvP-1	Perambalur	11°22'12"N	78°47'46"E
8.	CO 51	UvC-1	Coimbatore	10°59'43.5"N	76°54'56.5"E
9.	TN 1	UvC-2	Coimbatore	11°00'10.3"N	76°55'29.0"E
10.	CO 52	UvC-3	Coimbatore	11°03'58"N	76°50'8"E

Table 2. Occurrence of rice false smut disease incidence and Disease severity in Tamil Nadu

S.No.	Isolate	Total no. of tillers	Infected tillers	Percent disease incidence (%)	Total no. of grains*	Smutted grains*	Percent smutted grains (%)	Disease severity (%)
1.	UvE-1	17	2	11.76 ^f	195	4.3	2.20	25.87 ^f
2.	UvE-2	19	1	5.26 ⁱ	123	2.7	2.19	11.51 ^j
3.	UvE-3	25	10	40 ^a	112	9.6	8.57	342.8 ^a
4.	UvT-1	28	6	21.42 ^d	197	2.2	1.11	23.77 ^g
5.	UvT-2	26	2	7.69 ^h	129	7	5.42	41.67 ^e
6.	UvT-3	32	3	9.37 ^g	167	3.1	1.85	17.33 ^h
7.	UvP-1	19	1	5.26 ⁱ	154	4.6	2.98	15.67 ⁱ
8.	UvC-1	16	2	12.5 ^e	136	5.1	3.75	46.87 ^d
9.	UvC-2	28	9	32.14 ^b	131	7.7	5.87	188.66 ^b
10.	UvC-3	23	6	26.08 ^c	102	2.3	2.25	58.68 ^c
Mean =								77.283

*denotes mean of the replications

CD ($p=0.05$) = 3.9095 for percent disease incidence

CD ($p=0.05$) = 0.6537 for Disease severity

The values denoted by same letter are not significant at 5% level of DMRT



Fig. 2. Collection of false smut balls from infected rice panicles

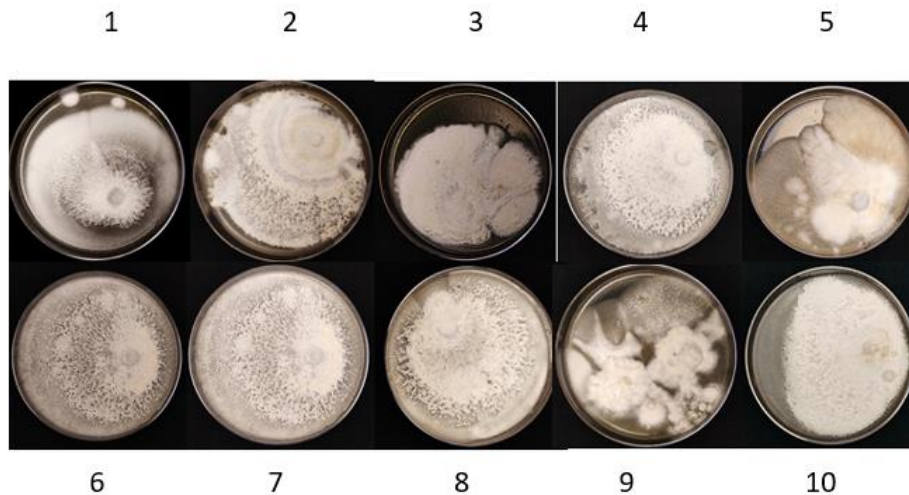


Fig. 3. Isolation of *U. virens* in PSA medium

Different isolates of false smut grown in PSA medium. 1-CR 1009, 2- ADT 45, 3- Bhavani, 4-VGD 1, 5- ADT 38, 6-CO 38, 7-ADT 54, 8-CO51, 9- TN 1, 10-CO 52

Similarly during 2012, Ladhakshmi et al. [7] conducted survey in northern states of India and revealed the variations of incidence observed between 2 to 75%. Singh et al., [19] conducted survey in different regions of Uttar Pradesh and Tamil Nadu in which the incidence of the infected tillers ranged between 5 - 80%. During Kharif (2017) and (2018), Savitha et al., [20] conducted a survey among different regions of Karnataka in which the maximum disease severity was recorded in Udupi taluk of coastal areas having the severity of 22.99%. Baite et al., [21] conducted survey at Odisha among different varieties during kharif, in which the maximum incidence of 33.33% was observed at Pooja variety of rice. Also, Navarasu et al., [22] conducted survey in different regions of Tamil Nadu with the false smut incidence ranged from 1.36 to 36.36% and the disease severity ranged between 1.08 to 379.23%.

3.2 Symptomatology

The infected spikelets were observed with the characteristic symptoms such as the individual rice grains turned into large, fluffy and velvety green balls, later these balls became hard after maturity. Initially, these balls were observed as yellow in colour and at later stages it was turned into olive green to greenish black. The visible symptom of RFS includes grain replacement with fungal mycelium known as false smut balls. On maturity, the smut balls was covered with powdery chlamydospores from which the colour

changes from yellowish orange to olive green and finally leads to greenish black (Fig. 2).

3.3 Isolation of the Pathogen

The pathogen *Ustilagoideae virens* was isolated from the infected smut balls in Potato Sucrose Agar (PSA) medium in which the fungus appears as small white colonies after seven days of inoculation. On observing the culture plate at 15th day after inoculation, the white mycelium turned yellow on maturity that was found similar to the smut balls found in the field condition (Fig. 3).

On observing the plate at 15th day after inoculation, the white mycelium turned into yellow on maturity that was found similar to the smut balls found in the field condition. According to Ladhakshmi et al., [7] the pathogen of RFS is slow growing in PDA plates in which the fungi appears as tiny white colonies after 7 days of inoculation. They isolated the pathogen by placing the mycelial discs in the plates containing PDA medium. Manu et al., [23] isolated the RFS pathogen by streaking the mass of chlamydospores in petri dishes containing PSA medium. Similarly, Khedkar et al., [24] reported that during maturity, chlamydospores becomes dark brown, echinulated with rough surface and the diameter is found to be 5.0 to 6.0 μm . Large colonies are appeared after 7-14 days. The morphological characters were described as milky white or olive green colonies with flat or convex surface, fluffy mycelium, compact and leathery [21,25].

4. CONCLUSION

In recent years the rice false smut incidence has increased due to planting of high fertilizer responsive varieties and hybrids, high application of nitrogenous fertilizers and most inevitably global climatic change. So, the high incidence of RFS not only reduces the yield but also produces high amount of toxins. Therefore screening of virulent pathogen from the infected field has to be carried out to evaluate of RFS resistant rice germplasm and to generate eco-friendly management strategies for the control of pathogen and toxins produced by them.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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