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Survey for the severity of false smut of rice in hilly and coastal zones of Karnataka

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Abstract
Rice. (*Oryza sativa* L.) is the most extensively cultivated food crop of the asia and forms a major part of nourishment for half of the world's population. Roving survey conducted in *Kharif* 2017 provided the present status of the disease in different hilly and coastal zones of Karnataka. The overall mean disease severity of false smut disease of rice in hilly and coastal zones of Karnataka was ranged from 9.48 to 69.87 per cent. Highest mean disease severity was observed in hilly zone of Kodagu district (69.87%) followed by coastal zone of Udupi district (34.36%), hilly zone of Chickmagaluru (28.68%) and least mean disease severity (9.48%) were observed in hilly zone of Shivamogga district. Among different taluks, mean disease severity of false smut disease was ranged from 7.81 to 75.20 per cent of which highest mean disease severity was recorded from the Virajpet taluk (75.20%) followed by Somwarpet (64.53%), Brahmavar (50.96%) and least disease severity 7.81 per cent was recorded from Shivamogga taluk. Genotype-wise survey results indicated that the maximum disease severity was recorded in Tunga variety (67.27%) followed by MO-21 (53.64%), MO-4 (45.61%) and least disease severity (4.55%) was recorded in Jyothi variety.

Keywords: Survey, false smut, disease severity and rice

Introduction
Rice. (*Oryza sativa* L.) is the most extensively cultivated food crop of the asia and forms a major part of nourishment for half of the world's population. It is the primary source of energy and protein for 4.5 billion peoples in the most populous nations of Asia. Rice is a. staple. of in parts of Asia, Africa and South America to some extent of United States (Janick *et al*., 1981) [8]. More than 90 per cent of the world's rice is grown and consumed in Asia, where 60 per cent of the world's population lives. It accounts for 35-60% of the caloric intake of three billion Asians (Guyer *et al*., 1998) [7].

Worldwide, rice is cultivated in an area of about 161.4 million hectares, production of about 506.3 million tonnes and productivity of 3.14 tonnes per hectare. In India area under rice cultivation is 43.39 million hectare and production of about 104.32 million tonnes with 2.40 tonnes per hectare productivity. In Karnataka, it is grown in area of 1.06 million hectares with a production of 2.70 million tonnes and productivity of 2.67 tonnes per hectare (Annon, 2016) [2]. In India, rice crop is produced in almost all the zones including southern, northern and north-eastern zones. The major rice producing states of India are West Bengal, Andhra Pradesh, Tamil Nadu, Karnataka and Punjab. Rice not only a staple food but also a way of living in Asia, with more than 250 million farm households dependent on the crop for their livelihood.

The crop growth and production are affected by various biotic and abiotic factors. Biotic stresses include insect pests and diseases caused by fungi, bacteria, viruses, phytoplasmas and nematodes. abiotic stresses, drought, cold, heat, chemical injury, salinity and other non-parasitic disorders are also responsible for significant reduction in production and productivity. Fungal diseases like, blast (*Pyricularia oryzae*), sheath blight (*Rhizoctonia solani*), brown spot (*Helminthosporium oryzae*), bakanae disease or foot rot (*Gibberella fujikuroi*), sheath rot (*Sarocladium oryzae*), leaf scald (*Microdochium oryzae*), narrow leaf spot (*Cercospora* oryzae), leaf smut (*Entyloma oryzae*) and udbatta disease (*Balansia oryzae*), bacterial diseases such as bacterial leaf blight (*Xanthomonas oryzae* pv. *oryzae*) and bacterial leaf streak (*Xanthomonas oryzae* pv. *oryzicola*) are of economical importance. Viral disease such as rice tungro disease (*Rice tungro bacilliform virus* and *Rice tungro spherical virus*) is more prevalent and destructive under Indian condition. In addition to all these diseases, rice crop in recent past is prone to the false smut disease, which is one of the most emerging disease causing significant damage of rice yield and quality worldwide (Abbas *et al*., 2014) [1].

False smut. occurs in. most of the rice growing areas of the world including India, China, Japan, Southeast Asian countries, North and South America, Myanmar, Sri Lanka, Fiji, and Africa. Among the floral diseases of rice, false smut is gaining importance which is a post-flowering disease prevalent mostly during *Kharif* season. It is also known as Lakshmi disease and was believed to be a mark of a bumper harvest. Earlier it was regarded as sporadic but from the year 2000 onwards; it has been reported as an epidemic disease (Rush *et al.*, 2000, Singh and Pophaly, 2010) [13, 16].

False smut disease is caused by the pathogen *Ustilaginoidea virens* (Cooke) Takahashi, Whoseteleomorph is *Claviceps Oryzasativa* (Hashioka), was first reported from Tirunelveli in Tami Nadu (Cooke, 1878) [6] and most recently *Villosiclava virens* has been proposed as the new name for the teleomorph of the false smut fungus (Tanaka *et al.*, 2008) [20]. The fungus transforms individual grains of the panicle into greenish spore balls of velvety appearance. The spore. balls are small at first and grow to a size two inches or more in diameter. They are smooth and are yellow covered by a membrane. Later, the membrane bursts and the colour of the ball becomes orange / yellow. When cut open, the ball is white in the center with three outer layers (Sciumbato and Street, 2000) [14].

The fungus attack some of the weed species that commonly occur in rice fields and may also serve as sources of inoculum (Atia, 2004) [3]. The main reason for losses being incited is that the fungus attacks the panicles. About 15-20 percent losses have been reported by different workers from different provinces (Singh, 1998) [17].

It is an important devastating disease causing yield losses from 1 to 11 per cent (Atia, 2004) [3]. Disease incidence of 10-20 per cent and 5-85 per cent respectively has been reported from Punjab and Tamil Nadu on different rice cultivars (Ladhalakshmi *et al.*, 2012) [11]. Reports showed that rice false smut pathogen could produce two kinds of mycotoxins, namely Ustiloxins and Ustilaginoidins (Zhou *et al.*, 2012) [21]. This disease results in yield loss contaminated rice grains and. even more important, generating toxins poisoning to humans and domestic animals (Koiso *et al.*, 1994 and Zhou *et al.*, 2012) [9, 21].

Yield loss estimates due to *U. virens* were ranged from 0.2 to 49 per cent on different rice varieties in different regions of the country (Baruah *et al.*, 1992, Singh *et al.*, 1992 and Biswas, 2001a) [4, 19, 5]. In Karnataka, rice hybrids cultivation is becoming very popular and farmers are adopting the technology easily and obtaining a good yield. Hybrid rice is mostly affected by the incidence of minor diseases like false smut incidence and the crop yield are badly affected by high fertility levels in an irrigated ecosystem. Looking to the expansion of hybrid rice area in Karnataka region, where the farming community almost depends on this important food crop, there is an urgent need to address the biotic stress like false smut. Very meager information is available about disease incidence, resistance cultivars and management aspect of false smut disease under field condition. Therefore the present research studies entitled "Survey for the severity of false smut of rice in hilly and coastal zones of Karnataka"

Material and Methods

An intensive roving survey was conducted during *Kharif*-2017 to assess the severity of false smut in hilly and coastal zones of Karnataka which includes Kodagu, Uttar-Kannada, Chickmagaluru, Shivamogga and Udupi and recorded the false smut incidence at dough and grain maturity stages in farmer's field. In each district, two talukas were selected and in each taluka, three villages were randomly selected. In each village, three farmer's fields were selected randomly from both sides of the path. In each field, three random plots of 1 sq. metre was selected on different rice varieties and observations on a number of infected tillers/m^2anda number of smut balls/infected panicle was recorded.

1. Per cent infected tillers and per cent infected grains were calculated using the following formula (Mandhare *et al*., 2008) [12].

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

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

2. Disease severity (Singh and Dube, 1978)

$$\text{Disease severity (\%)} = \text{Infected tillers (\%)} \times \text{Smutted grains (\%)}$$

Table 1: Details of roving survey in selected districts of hilly and costal zones of Karnataka

District	Taluk	Villages
Shivamogga	Shivamogga	Dhalimane, Muddinkoppa and Gajanuru
	Hosanagar	Mumbaru, Belludi and Kusakundi
Chickmagaluru	Mudigere	Bettagere, Madakal and Kademadakal
	Chickmagaluru	Mallenhalli, Wastare and Chitavalli
Udupi	Brahmavar	Padukere, Varamballi and Agrahar
	Karkala	Anjaru, Jarkala and Ajekaru
Uttar-Kannada	Siddapur	Heddalli, Hajini and Basavanabaila
	Sirsi	Arasapur, Banavasi and Bommanalli
Kodagu	Virajpet	Tithimati, Hatoor and Bittangala
	Somwarpet	Hebbale, Chettalli and Shuntikoppa

Results and Discussion

The study on the survey for the severity of false smut, screening of promising rice genotypes against the disease, studies on cultural and morphological characteristics of *U. virens*, *in vitro* evaluation of fungicides and chemical management of false smut under field condition were carried out, the results obtained are presented here under.

An intensive roving survey was conducted during *Kharif* 2017 to assess the incidence of false smut in hilly and coastal zones of Karnataka *viz.* Kodagu, Uttar-Kannada, Chickmagaluru, Shivamogga and Udupi districts and recorded the false smut severity at dough and grain maturity stages. Observations such as infected tillers, grains infected and disease severity were recorded and tabulated in table 2.

Table 2. Indicated that, the false smut severity was noticed in all surveyed as are range from 4.55 to 77.31%. The infected tillers and infected grains varied from 3.27 to 11.44% and 1.39 to 7.47% respectively.

Among villages surveyed the maximum disease severity was recorded from Tithimati Villege (77.31%) followed by Hatoor (75.87%) and Bittangala Villege (72.42%) of Kodagu district and the minimum disease severity was recorded in Gajanuru villege (4.55%) of Shivamogga district.

In hilly zone of Shivamogga the disease severity ranged from 4.55 to 13.23 per cent. Highest disease severity of 13.23 per cent was recorded in Belludi village of Hosanagar taluk, followed by Dhalimane village (10.64%), Kusakundi village

(10.48%) and least disease severity of 4.55 per cent was observed in Gajanuru village.

Disease severity in hilly zone of Chickmagaluru ranged from 17.01 to 45.38 per cent. The maximum disease severity of 45.38 per cent was recorded in Madakal village of Mudigere taluk followed by Kademadakal (27.82%), Mallenhalli (27.75%) and minimum disease severity of 17.01 per cent was found in Wastare village of Chickmagaluru taluk.

False smut survey in coastal zone of Udupi indicated that the disease severity ranged from 8.04 to 54.60 per cent. Highest disease severity of 54.60 per cent was recorded in Varamballi village of Brahmavar taluk followed by Padukere village (52.68%), Agrahar village (45.61%) and least disease severity was recorded in Ajekaru village (8.04%) of Karkala taluk respectively.

Survey for false smut in coastal zone of Uttar Kannada, the disease severity ranged from 8.52 to 36.84 per cent. The maximum disease severity of 36.84 per cent was recorded in Banavasi village of Sirsi taluk followed by Bommanalli village (36.70%) of Sirsi taluk, Heddalli village (35.87%) of Siddapur taluk and least disease severity of 8.52 per cent was observed in Arasapur village of Sirsi taluk.

During 2017 in hilly zone of Kodagu, the false smut disease severity was ranged from 60.95 to 77.31 per cent. The highest disease severity was recorded in Tithimati village (77.31%) of Virajpet taluk followed by Hatoor village (75.87%), Bittangala village (72.42%) and least disease severity was recorded in Chettalli village (60.95%) of Somwarpet taluk respectively.

Data from Table 3. Showed that, among different taluks of hilly and coastal zones,mean disease severity of false smut disease of rice ranged from 7.81 to 75.20 per cent. The highest mean disease severity was recorded from the Virajpet taluk (75.20%) followed by Somwarpet (64.53%), Brahmavar (50.96%) and least disease severity of 7.81 per cent was recorded from Shivamogga taluk respectively.

Data from Table 4. Indicated that, District wise mean disease severity among hilly and coastal zones of Karnataka, ranged from 9.48 to 69.87 per cent. The maximum mean disease severity was observed in Kodagu (69.87%) followed by Udupi (34.36%), Chickmagalure (28.68%) and least mean disease severity was observed in Shivamogga (9.48%) district respectively.

Table 5. Showed that, Disease severity among different varieties in hilly and coastal zones of Karnataka was ranged from 4.55% to 67.27%. The maximum disease severity was recorded in Tunga variety (67.27%) followed by MO-21 (53.64%), MO-4 (45.61%) and least disease severity was recorded in Jyothi variety (4.55%). This variation of high and low incidence of false smut of rice at different localities can be normally attributed to environmental condition for the pathogen, use of varieties for cultivation and cultural practices like irrigation, amount of nitrogenous fertilizers applied and continuous mono cropping leads to the spread of the disease. Apart from these, low incidence of false smut of rice is due to cultivation of high yielding varieties such as Jaya, MTU-1001, IR-64 and KPR-1 which are moderately resistant and moderately susceptible to false smut of rice while the high incidence of false smut of rice is attributed to use of susceptible varieties such as Tunga, MO-4, MO-21 and local varieties in hilly and coastal zones of Karnataka. Our results showed that, the variability in disease severity was from 9.48-69.87 per cent in hilly and coastal zones of Karnataka. This is mainly due to the difference in weather, rainfall, varietal profile and other geographical features of respective location. Previous investigations have also reported the variation in disease severity within a region (Ladhalakshmi *et al.*, 2012, Singh *et al.*, 2014, Kumar, 2015 and Shivamurthy, 2017) [11, 18, 10, 15]. Therefore, we concluded that, cultivation of susceptible cultivars, high input cultivation, continuous moncropping and favorable weather conditions are very much essential for higher false smut disease severity.

Table 2: Survey for the severity of false smut of rice in hilly and coastal zones of Karnataka during 2017

Sl. No.	Districts	Taluks	Villages	Genotype	Infected Tillers (%)	Grains Infected (%)	Disease Severity (%)
1	Shivamogga	Shivamogga	Dhalimane	MTU 1001	4.57	2.33	10.64
			Muddinkoppa	Jaya	5.19	1.59	8.25
			Gajanuru	Jyothi	3.27	1.39	4.55
		Hosanagar	Mumbaru	MTU 1001	4.22	2.30	9.71
			Belludi	Burma	5.40	2.45	13.23
			Kusakundi	MTU 1001	4.44	2.36	10.48
			Mean		**4.52**	**2.07**	**9.48**
2	Chickmagaluru	Mudigere	Bettagere	KPR 1	8.46	3.13	26.48
			Madakal	Tunga	10.53	4.31	45.38
			Kademadakal	Intan	8.28	3.36	27.82
		Chickmagaluru	Mallenhalli	Intan	8.59	3.23	27.75
			Wastare	Ratnachudi	5.40	3.15	17.01
			Chitavalli	Holesalu	6.49	4.26	27.65
			Mean		**7.96**	**3.57**	**28.68**
3	Udupi	Brahmavar	Padukere	MO 21	10.31	5.11	52.68
			Varamballi	MO 21	10.36	5.27	54.60
			Agrahar	MO 4	10.46	4.36	45.61
		Karkala	Anjaru	Uma	7.50	4.43	33.23
			Jarkala	Jaya	5.26	2.28	11.99
			Ajekaru	Mukti	3.54	2.27	8.04
			Mean		7.91	3.95	34.36
4	Uttar-Kannada	Siddapur	Heddalli	Intan	8.46	4.24	35.87
			Hajini	Halaga	4.45	3.16	14.06
			Basavanabaila	Intan	8.45	4.19	35.41
		Sirsi	Arasapur	Mukti	3.58	2.38	8.52
			Banavasi	Intan	8.43	4.37	36.84
			Bommanalli	Intan	8.34	4.40	36.70

			Mean		6.95	3.79	27.90
5	Kodagu	Virajpet	Tithimati	Tunga	10.35	7.47	77.31
			Hatoor	Tunga	10.45	7.26	75.87
			Bittangala	Tunga	11.44	6.33	72.42
		Somwarpet	Hebbale	Tunga	10.35	6.37	65.93
			Chettalli	Intan	9.32	6.54	60.95
			Shuntikoppa	Tunga	10.49	6.36	66.72
			Mean		10.40	6.72	69.87

Table 3: Taluk-wise rice false smut disease parameters in hilly and coastal zones of Karnataka during 2017

Sl. No.	Districts	Taluk	Infected tillers (%)	Grains infected (%)	Disease severity (%)
1	Shivamogga	Shivamogga	4.34	1.77	7.81
		Hosanagar	4.69	2.37	11.14
2	Chickmagaluru	Mudigere	9.09	3.60	33.23
		Chickmagaluru	6.83	3.55	24.14
3	Udupi	Brahmavar	10.38	4.91	50.96
		Karkala	5.43	2.99	17.75
4	Uttar Kannada	Siddapur	7.12	3.86	28.45
		Sirsi	6.78	3.72	27.35
5	Kodagu	Virajpet	10.75	7.02	75.20
		Somwarpet	10.05	6.42	64.53

Table 4: District-wise rice false smut disease parameters in hilly and coastal zones of Karnataka during 2017

Sl. No.	Districts	Infected tillers (%)	Grains infected (%)	Disease severity (%)
1	Shivamogga	4.52	2.07	9.48
2	Chickmagaluru	7.96	3.57	28.68
3	Udupi	7.91	3.95	34.36
4	Uttar Kannada	6.95	3.79	27.90
5	Kodagu	10.40	6.72	69.87
Over all mean incidence		7.55	4.02	34.06

Table 5: Varieties -wise false smut disease severity in hilly and coastal zones of Karnataka during 2017

Sl. No.	Varieties	Infected Tillers (%)	Grains Infected (%)	Disease Severity (%)
1	Jyothi	3.27	1.39	4.55
2	MTU- 1001	4.41	2.33	10.28
3	Burma	5.40	2.45	13.23
4	KPR- 1	8.46	3.13	26.48
5	Ratnachudi	5.40	3.15	17.01
6	Holesalu	6.49	4.26	27.65
7	Mo-21	10.34	5.19	53.64
8	Mo-4	10.46	4.36	45.61
9	Uma	7.50	4.43	33.23
10	Jaya	5.23	1.94	10.12
11	Halaga	4.45	3.16	14.06
12	Mukti	3.56	2.33	8.28
13	Tunga	10.60	6.35	67.27
14	Intan	8.55	4.33	37.33
Mean		6.72	3.49	26.34

Fig 1: Symptoms of False smut of Rice in the Tunga variety

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