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Prevalence of Rice False Smut in Odisha, Jharkhand and Bihar

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ABSTRACT

False smut is emerging in many rice-growing regions. The disease is causing economic losses to the farmers. The fungus (Ustilaginoidea virens) produces mycotoxins which are poisonous to animals and human. In order to understand the nature of the disease, rice genotypes were surveyed at different geographical locations covering the paddy fields of Odisha, Jharkhand and Bihar. The disease affected almost all rice genotypes to varying severity. The average disease incidence was 14.43% while the disease severity ranged from 0.45-60.98%. In Odisha, the most susceptible genotype was Pooja followed by Swarna and Gayatri while in Bihar, the most susceptible genotypes were Mahsuri and Moti Gold.The classification of the genotypes based on disease reactions showed seven rice genotypes with moderate resistance while 18 genotypes showed moderately susceptible reactions and four genotypes showed susceptible reactions. Majority of the rice genotypes fall under moderately susceptible reactions. False smut was one of the most important disease of rice encountered in the regions. Due to high susceptibility, Pooja may be used as susceptible check in artificial false smut disease experiments. Therefore, false smut management should be paid attention to protect the rice crop from economic losses.

Keywords : Outbreak, Rice, False smut; Incidence

Introduction :

Rice is a staple food for many people around the globe especially the African and south Asian countries. False smut of rice is increasingly becoming severe in many rice-growing regions of India. The disease is caused by an ascomycete, Ustilaginoidea virens. It is highly specialised biotroph of the rice floral organs that feeds inside living tissues without killing them. The fungus forms chlamydospores and sclerotia and survive the winter in the soil. The sclerotia produce ascospores that serve as major source of infection to rice inflorescence. The airborne chlamydospore may be important as a secondary source of infection. Upon infection by Ustilaginoidea virens, the normal rice grain is converted to velvety smut balls that appear orange/yellowish green initially and later appear as dark green smut balls (Atia, 2004). The disease

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is being reported from many countries including India, wherever rice is grown in large scale (Singh and Pophaly, 2010; Baite *et al.*, 2014; Quintana *et al.*, 2016). Many workers in different countries reported yield loss due to rice ranging from which indicated that false smut is emerging rice disease and which must be paid attention to keep the disease under control. The false smut disease incidence varied from 5-85% and caused yield loss ranging from 0.2 to 49% depending on the genotype and environment (Dodan and Singh, 1996).

The disease is sensitive to weather fluctuations and therefore, is posing a great threat to rice production in this world of climate change. It was minor rice disease but due to various factors, become major disease of rice. Eastern India is major hub of rice production in the country. Disease incidence is a quantal measure, which implied whether a plant is infected, or not. It is quick and easy to measure and therefore more favoured than other methods of measurements (Seem, 1984). Therefore, in order to know the false smut incidence in these regions we have undertaken investigation for disease assessment in Odisha, Jharkhand and Bihar in Kharif season of 2018 during grain maturity stage of the crop. The disease incidence and severity were estimated for each rice genotype that was investigated.

Material and methods :

Survey was undertaken in Kharif season of 2018, against false smut in 19 different locations covering three states namely, Odisha, Jharkhand and Bihar. The geographical coordinates were taken for every locations of disease outbreak using Handy GPS app. Diseased samples were collected for further analysis of the pathogen. Observations were recorded for total number of tillers, number of infected tillers, number of healthy grains and smut balls/panicle at grain maturity stage of rice. The disease incidence and severity were calculated following standard method (Baite *et al.,* 2020). The disease reactions were scored based on a scale developed by Standard Evaluation System for Rice, IRRI 2013.

***Data analysis* :**

The data was angular transformed and used for statistical analysis using minitab 19 software. One way ANOVA was conducted and comparison was made using Tukey method of ranking.

Results :

Survey of false smut in 19 locations covering three states namely Odisha, Jharkhand and Bihar revealed that the disease was very much a major concern for famers. The disease affects almost all rice genotypes to varying severity (Fig. 1).

Figure 1. Rice field heavily infected with false smut.

In Odisha, the most susceptible genotype was Pooja followed by Swarna and Gayatri while in Bihar, the most susceptible genotypes were Mahsuri and Moti Gold. The average disease incidence was 14.43%. The highest disease incidence was observed in Kalachampa (47.62%) from Bhadrak, Odisha, followed by Moti Gold (45.45%) from Gadhani, Bihar (Table 1).

Table 1. False smut incidence and severity in different rice genotypes.

Sl. No.	Location in Odisha	Coordinates	Genotypes	Disease incidence (%)	Disease severity (%)	Smut ball (no.)
1	Cuttack	20°27'05.1"N 85°56'09.8"E	Pooja	5.13 (13.09)^{opqr}	1.90(7.93)^{rs}	2.67
			Sarala	5.88 (14.04) ^{nopq}	0.92(5.50)^{tu}	1.33
			CR Dhan 310	6.82 (15.14)^{nop}	2.06(8.26)^{rs}	2.66
			Naveen	5.88 (14.04)^{nopq}	4.44(12.17)^{ijklmn}	4.00
			Geetanjali	6.45 (14.71)^{nop}	3.29(10.45)^{mnopq}	2.50
2	Kisan Nagar	20°26'34.9"N 86°05'21.7"E	Pooja	38.81 (38.53)^{b}	42.71(40.81)^{c}	13.67
			Sarala	11.54 (19.86)^{jkl}	56.67(48.83)^{b}	34.00
			Swarna	15.38 (23.09)^{ghi}	60.98(51.34)^{a}	25.00
3	Badachana	20° 39'17"N 86° 63'8"E	Pradhan dhan	4.35 (12.04)^{pqr}	5.68(13.79)^{hij}	5.00
			Varsha dhan	6.67 (14.96)^{nop}	3.69(11.07) ^{lmnopq}	8.00
			Kalachampa	0.00 (0.00)^{s}	0.00(0.00)^{v}	0.00
4	Korai	20° 52'31"N 86° 12'6"E	Kalashree	5.26 (13.26)^{opqr}	11.11(19.47)^{f}	10.00
			Swarna	16.67 (24.09)^{fgh}	3.85(11.31)^{lmnopq}	4.00
			Swarna sub1	10.53 (18.93) ^{klm}	3.37(10.58^{lmnopq}	3.00
5	Bhandhari Pokhari	20° 95'97.32"N 86° 37'70.04"E	Singadhan	4.55 (12.31)^{pqr}	2.96(9.90)^{opqr}	5.00
			Savitri	7.69 (16.10)^{mno}	3.88(11.35)^{lmnopq}	5.00
			Swarna	7.69 (16.10)^{mno}	1.54(7.13)st	2.00
			Vijayta	18.18 (25.24)^{efg}	8.97(17.42)^{g}	2.00
			Siva	0.00 (0.00)^{s}	0.00(0.00)^{v}	13.00
6	Bhadrak	21° 04'68.58"N 86.4°8'60.38"E	Kalachampa	47.62 (43.64)^{a}	7.41(15.79)^{gh}	10.00
			Siva	3.45 (10.70)^{r}	3.33(10.52)^{mnopq}	5.00
			Dehradun	7.14 (15.50)^{no}	5.38(13.41)^{ijk}	5.00
			Rani dhan	0.00 (0.00)^{s}	0.00(0.00)^{v}	0.00
			Savitri	3.70 (11.10)^{qr}	1.55(7.15)st	2.00

Sl. No.	Location in Odisha	Coordinates	Genotypes	Disease incidence (%)	Disease severity (%)	Smut ball (no.)
7	Jajpur	20°54'27.9"N 86°16'26.5"E	Swarna	12.50 (20.70)^{ijk}	0.83(5.24)^{tu}	1.00
			Gayatri	25.00 (30.00)^{d}	15.09(22.86)^{de}	8.00
8	Jagatsinghpur	20p 35'80.69"N 86p 13'35.60"E	Pooja	7.69 (16.10)^{mno}	7.32(15.70)^{gh}	7.25
			Sarala	22.22 (28.13)^{de}	11.11(19.47)^{f}	10.00
			Pratikhya	14.29 (22.21)^{ghij}	4.80(12.66)^{ijkl}	6.00
	Location in Jharkhand					
9	Chanho	23° 30'51.73"N 84° 56'56.49"E	27P31	20.00 (26.57)^{ef}	2.73(9.51)^{pqr}	6.00
10	Lohardaga	23° 29'25.63"N 84° 44'5.84"E	27P31	20.00 (26.57)^{ef}	17.65(24.84)^{d}	6.00
	Location in Bihar					
11	Gaya	24° 49'6.78"N 84° 57'56.82"E	Sona Mahsuri	11.11 (19.47)^{jkl}	6.02(14.20)^{hi}	8.00
12	Tekari	24° 56'58.71"N 84° 49'50.39"E	Pooja	18.18 (25.24)^{efg}	2.83(9.69)^{pqr}	6.00
			Rupali	20.00 (26.57)^{ef}	0.45(3.87)^{u}	1.00
			Mahsuri	38.89 (38.58)^{b}	12.99(21.12)^{ef}	20.00
13	Kurtha	25° 8'4.73"N 84° 48'18.40"E	Rajendra 1	25.00 (30.00)^{d}	3.36(10.56)^{mnopq}	5.00
			Mahsuri	8.33 (16.78)^{lmn}	0.57(4.34)^{u}	1.00
14	Kinjar	25° 14'38.96"N 84° 50'28.71"E	Mahsuri	21.43 (27.58)^{de}	3.97(11.49)^{klmnop}	5.00
15	Paliganj	25° 18'37.57" 84° 50'11.83"E	Mahsuri	35.71 (36.70)^{b}	3.26(10.40)^{nopq}	7.00
16	Bhita	25° 34'53.51" 84° 58'48.03"E	Mahsuri	7.14 (15.50)^{no}	0.95(5.60)^{tu}	1.00
17	Udvan Nagar	25° 27'56.87"N 84° 36'6.56"E	Mahsuri	7.69 (16.10)^{mno}	2.65(9.36)^{qr}	5.00
18	Gadhani	25° 25'28.71"N 84° 34'44.40"E	Moti Gold	45.45 (42.39)^{a}	4.15(11.75)^{jklmno}	10.00
19	Piro	25° 20'24.21"N 84° 26'1.94"E	Mahsuri	13.16 (21.27)^{hijk}	4.72(12.55)^{ijklm}	6.00

*Values are the mean of three replications. The numbers in the parenthesis were angular transformed values. Means followed by a common letter are not significantly different at 5% level by DMRT.

The disease incidence of Kalachampa was 0% and 47.62% in Badachana and Bhadrak, respectively. The disease incidence of Pooja was 5.13%, 38.81% and 7.69% in Cuttack, Kisan Nagar and Jagatsinghpur, respectively. The disease incidence of Sarala was 5.88%, 11.54% and 22.22% in Cuttack, Kisan Nagar and Jagatsinghpur, respectively. Only three genotypes namely, Kalachampa from Badachhana, Siva from Bhandhari Pokhari and Rani dhan from Bhadrak were free from false smut infection. However, Kalachampa and Siva were found to be infected with false smut in other locations.

Seven rice genotypes showed moderate resistance while 18 genotypes showed moderately susceptible reactions and four genotypes showed susceptible reactions (Table 2).

Table 2. Reactions of rice genotypes to false smut.

Scale	Disease incidence (%)	Reaction	Genotypes
0	No incidence	Highly resistant HR)	Kalachampa, Siva, Rani dhan.
1	Less than 1%	Resistant (R)	Nil
3	1-5%	Moderately resistant (MR)	Naveen, Pradhan dhan, Kalashree, Singadhan, Siva, Savitri.
5	6-25%	Moderately susceptible(MS)	CR Dhan 310, Geetanjali, Sarala, Swarna, Varsha dhan, Swarna sub1, Savitri, Vijayta, Dehradun, Gayatri, Pratikshya, 27P31, Sona Mahsuri, Rupali, Rajendra
7	26-50%	Susceptible (S)	Pooja, Mahsuri, Moti Gold.
9	51-100%	Highly susceptible (HS)	Nil

Majority of the rice genotypes fall under moderately susceptible reactions. No genotypes were found free from false smut infection in Bihar. Sarala fluctuated between moderately resistant to moderately susceptible reactions while Pooja fluctuated between moderately susceptible to susceptible reactions.

The disease severity ranged from 0.45-60.98%. However, the average disease severity was low at 7.69%. The highest disease severity was observed in Kisan Nagar location in the following genotypes, Swarna (60.98%), Sarala (56.67%) and Pooja (42.71%). The lowest disease severity was found in the following genotypes

Rupali (0.45%), Mahsuri (0.57%) in Tekari and Kurtha of Bihar; Swarna (0.83%) and Sarala (0.92%) in Jajpur and Cuttack of Odisha.

In Odisha, Kisan nagar was found to be the hotspot for false smut as it contained high disease incidence and severity compared to other locations. Barring few exceptions, there was low false smut incidence and severity amongst the genotypes examined in three states. The disease severity of Swarna was 60.98%, 3.85%, 1.54%, and 0.83% in Kisan Nagar, Korai, Bhandhari Pokhari and Jajpur respectively. The most susceptible rice genotypes in Odisha were Swarna, Sarala and Pooja as they have higher significant disease severity than other genotypes. The most susceptible rice genotype in Bihar was Mahsuri as it had higher significant disease severity than other genotypes. The average number of smut balls was highest for Sarala (34) followed by Swarna (25) and Mahsuri (20%).

Discussion :

Locations play important role in influencing the disease outcome which may be probably due to differences in microclimate or methods of cultivation of the area. The disease expressions in Kalachampa and Siva genotypes changed with change in locations. Kalachampa at Bhadrak was observed with high disease incidence while it was free from infection in Badachana. Likewise, Siva at Bhadrak was infected with false smut but not in Bhandhari Pokhari. Geetanjali was free from false smut infection in earlier *kharif* season but the variety had manifested 6.45% disease incidence at Cuttack (Baite *et al.,* 2017). This is one small indication of how the disease is emerging and infecting even the less susceptible rice genotypes. The highest disease incidence in Odisha was found in Kalachampa (47.62%) and Pooja (38.81%) while the highest disease incidence in Bihar was found in Moti Gold (45.45%) and Mahsuri (38.89%).

All the rice genotypes examined in Bihar were infected with false smut with moderate to high disease incidence but low disease severity. Hence, false smut is one of the major problem of rice production in Bihar. Swarna sub1 is quite stable with respect to false smut reaction as it showed almost similar disease incidence in comparison to earlier incidence while other genotypes showed abrupt changes in disease incidence. Swarna and Swarna sub1 are categorised as moderately susceptible rice genotypes which is in agreement with the findings of Kumar *et al.*, 2017. Kisan Nagar in Odisha may be a hotspot for false smut because the genotypes under surveyed had high disease severity values than genotypes of other locations. The low disease severity indicated that false smut is emerging and gradually causing damage to rice and poses threat to rice production in the future.

Conclusion :

The farmers maintained some varieties that are popular and they keep growing those varieties year after year. Due to its high susceptibility across locations and seasons, *Pooja* may be suitably used as susceptible check in artificial false smut screening. The false smut was the most important single disease in the regions because the disease was observed in all varieties cultivated by the farmers.

Therefore, disease management should be prioritized to contain the destruction by caused by false smut.

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