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Prevalence of dirty panicle disease of rice (*Oryza sativa* L.) in Madhya Pradesh

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Abstract
Under the changing weather conditions Dirty Panicle Disease is observed as a major problem that that indicates poor grain quality and reduces appeal to the consumers on account of grain discolorations. The prevalence of dirty panicle disease was determined in 12 most commonly cultivated rice varieties during Kharif 2017 & 2018 under agro-climatic conditions of Madhya Pradesh. Maximum panicle infection and seed discoloration (30%) was noticed in IR 64 followed by IR 36 (28%) and Kranti (22%). During second week of November the temperature ranged 11.9 to 28.3 C and relative humidity upto 87% at pre-harvest stage in the samples from 13 districts covering 6 agro-climatic zones. Incremental development of the disease indicate that at 50% grain filling stage during 3rd week of October 2017, incidence of the disease was upto 12.0% that enhanced to 19.0% during November 1st week (at 90% grain filling stage). Analysis of seeds from dirty panicle disease indicates that maximum percentage of (36.45) was recorded in IR 64 followed by 33.75% in IR 36 and least 28.87% in Kranti. Higher number of discolored seeds belonged to Level 9 and Level 7.

Keywords: Distribution of dirty panicle disease, rice, weather parameters, varietal reaction, seed surface covered

Introduction
Rice (*Oryza sativa* L.) is a staple food crop that provides more than one-fifth of the calories in the world for human consumption. It is grown in 160 million ha with 493 million tons milled rice production. Out of about 141 M ha of net cultivated area in India, the crop occupies around 43 M ha (Pathak *et al*., 2018) [9-10]. Rice accounts for upto 75 per cent of the calories for more than 3 billion Asians. The crop is grown in a wide range of climatic conditions spanning for 44^0 N latitude in North Korea to 35^0 S latitude in Australia. Uniquely the crop is cultivated from six feet below sea level, as in Kerala, India to 2700 feet above mean sea level (Patra *et al*., 2018) [10]. Rice is primarily grown under four major ecosystems broadly classified as (i) irrigated, (ii) rainfed lowland, (iii) rainfed upland and (iv) flood prone (Pathak *et al*., 2018) [9-10].

The rice plant suffers from several biotic and abiotic stresses that seriously affect its production. A wide range of pathogens, insects and nematodes attack the crop. Productivity of rice is often adversely affected by several biotic stresses these include diseases such as rice blast (*Magnaporthe oryzae*), bacterial blight (*Xanthomonas oryzae* pv. *oryzae*), sheath blight (*Rhizoctonia solani*) and have been identified as major threat for profitable cultivation (Ray *et al.,* 2016; Dash *et al.,* 2016; Pinson *et al.,* 2008) [12, 2, 11]. In recent years, it has been observed that due to high humidity and wet season during maturity stage the rice panicles become more prone to invasion by microorganisms. Narain (1992) [7] reported the discoloration of rice grains in a panicle as a minor disease which is now gaining more importance due to its severity in tropical rice growing areas. ‘’Glume discoloration or Dirty panicle’’ is prevalent in almost all part of the world (Ou, 1985; Sachan and Agarwal, 1995) [8]. In the present, communication the distribution of Dirty Panicle Disease is discussed which has become a new problem in profitable cultivation and marketing of rice (Silodia, 2019) [15] in agro conditions of Madhya Pradesh.

Material and methods
Status of Dirty Panicle Disease
The prevalence of dirty panicle disease was determined in 12 most commonly cultivated rice varieties at farmers’ field during Kharif, 2017 & 2018 under agro-climatic conditions of

Madhya Pradesh. Observations on incidence of dirty panicle disease were also recorded in the samples obtained from 13 districts covering 6 agro-climatic zones.

Table 1: Locations of districts for analysis of prevalence of dirty panicle disease

Agro-climatic zones	District
Kaymore-plateau and Satpura hills	Jabalpur, Katni, Seoni
Satpura plateau	Chhindwara, Betul
Central Narmada valley	Narsingpur
Vindhya plateau	Damoh
Northern hills of Chhattisgarh plains	Dindori, Umaria, Shahdol, Mandla, Annuppur
Chhattisgarh plains	Balaghat

Measurement of disease

The incidence of dirty panicle disease was recorded on randomly selected 100 plants in a particular variety grown in a plot of field. The disease was identified initially on the basis of visual and typical field symptoms and later confirmed by microscopic observations. Incidence of disease was measured as per formula (Mayee and Datar, 1986) [6]

$$PDI = \frac{\text{Total number of infected panicles}}{\text{Total number of panicles observed}} \times 100$$

Where,

PDI = Percent disease incidence i.e. percent plant infected

Measurement of Grain discoloration

Disease incidence

$$\text{Grain discoloration (\%)} = \frac{\text{Number of discolored seeds}}{\text{Total number of seeds}} \text{ X } 100$$

Table 2: Disease scale for the measurement of Dirty Panicle disease (IRRI, 1998)

Level	Area covered
Level 0	No incidence
Level 1	Less than 1%
Level 3	1-5%
Level 5	6-25%
Level 7	26-50%
Level 9	51-100%

Results and Discussions

Incidence of dirty panicle disease in select rice varieties

At farmers field

Incidence of dirty panicle disease was observed in popular rice varieties grown around Jabalpur during Kharif 2017 and 2018. Observations were recorded on the panicle infection as evident by presence of discolored grains in the panicles at pre-harvest stage. Panicle infection was in the range of 4.0-30.0% during Kharif, 2017. Panicle infection in the level 5 was recorded in 9 varieties out of 11 varieties. In these 9 varieties infection was in the range of 12.0 to 28.0%. Maximum panicle infection and seed discoloration (30%) was noticed in IR 64 followed by IR 36 (28%) and Kranti (22%). During second week of November the temperature ranged 11.9 to 2.83 and relative humidity upto 87% at pre-harvest stage.

A similar pattern of distribution was observed during Kharif 2018, except in Improved Chinnor, Improved Jeerashankar and Mahamaya (6-9%). Infection in other varieties exhibited the discoloration in the range of 11.0 (JR 201) to 28% (IR 64). On an average, incidence of discolored panicles ranged from 5.0-29.0%. Improved Chinnor and Improved Jeerashankar exhibited infection in the range of 5.0-6.5% whereas; other varieties had 12.0 to 29.0% panicles with discolored seeds. During second week of November, 2018 the temperature ranged from 8.7 to 28.8 C, relative humidity 84.8% at pre-harvest stage (Table 03 and Fig.01).

Significance of rice grain discoloration or ‘’dirty panicle’’ disease has been mentioned presence of disease that indicates the poor grain quality and reduces appeal to the consumers (Ou, 1985; Dash and Narain, 1988; Sachan and Agarwal, 1995; Silodia, 2019) [8, 3, 15].

Table 3: Incidence of dirty panicle in popular rice varieties at Jabalpur

Varieties	Per cent panicle infected		
	Kharif 2017	Kharif 2018	Average
MTU 1010	18.0	19.0	18.5
MTU 1001	16.0	20.0	18.0
Kranti	22.0	17.0	19.5
IR 36	28.0	25.0	26.5
IR 64	30.0	28.0	29.0
JR81	12.0	12.0	12.0
JR 201	15.0	11.0	13.0
Danteshwari	19.0	13.0	16.0
Improved Chinnore	5.0	8.0	6.5
Improved Jeerashankar	4.0	6.0	5.0
Mahamaya	19.0	9.0	14.0
Range	4.0-30.0	9.0-28.0	5.0-29.0

Observations made on 100 randomly selected hills during November 2017 and 2018 at framers field at pre-harvest stage around Jabalpur

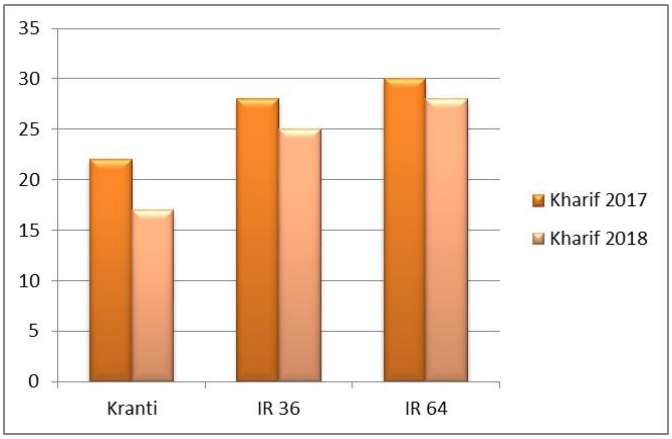

Fig 1: Incidence of Dirty Panicle disease in major three varieties during Kharif, 2017 and 2018

Incidence of disease at various growth stages

Employing the fixed plot technique, observations on the incidence of dirty panicle disease in select 11 popular rice varieties grown at Rice Experimental field, JNKVV, Jabalpur, during Kharif 2017 & 2018 indicate the incremental development of the disease. At 50% grain filling stage during 3rd week of October 2017, incidence of the disease was upto 12.0% that enhanced to 19.0% during November 1st week (at 90% grain filling stage). During October 2017-average temperature was 19.75 C; average RH 56% and rainfall 12.0mm. It finally reached upto 30% at pre-harvest stage during 2nd week of November. During October 2018 the average temperature was 27.7C; whereas, the relative humidity was 75.5% with rainfall 12.1mm. A similar trend

was noticed in Kharif, 2018. During October 3rd week at 50% grain filling stage, grain discoloration was 7.0% that increased to 16.0% during November 1st week (at 90% grain filling stage) and at pre-harvest stage during 2nd week of November the incidence was reached up to 20.0%. An increasing trend on the disease incidence during grain filling stages was noticed under agro-conditions of Jabalpur (Table 04 and Fig. 02).

The prevalence of discolored grains and development of the disease is dependent upon temperature, wind, humidity, rainfall and concurrent association of mycoflora has been reported (Lee *et al.*, 1986; Yamaguchi, 1983; Takedani and Yagi, 1983) [4, 17, 16].

Table 4: Incidence of dirty panicle disease in popular rice varieties grown at Rice Experimental field at Jabalpur

Variety	Percent panicle infected						Average	
	50% grain filling October III week		90% grain filling November I week		Pre harvest stage November II week			
	Kharif 2017	Kharif 2018	Kharif 2017	Kharif 2018	Kharif 2017	Kharif 2018	Kharif 2017	Kharif 2018
MTU 10101	10.0	7.0	14.0	13.0	18.0	19.0	14.0	13.0
MTU1001	9.0	5.0	12.0	10.0	16.0	20.0	12.3	11.6
Kranti	12.0	6.0	18.0	10.0	22.0	17.0	17.3	11.0
IR 36	5.0	3.0	19.0	10.0	28.0	25.0	17.3	12.6
IR 64	3.0	5.0	17.0	16.0	30.0	28.0	16.6	16.3
JR 81	0.0	0.0	10.0	12.0	12.0	12.0	15.3	8.0
JR 201	0.0	0.0	7.0	10.0	15.0	11.0	6.3	7.0
Danteshewari	4.0	2.0	7.0	10.0	19.0	13.0	10.0	8.3
I Chinnor	0.0	4.0	1.0	15.0	5.0	8.0	2.0	9.0
I Jeerashankar	0.0	2.0	3.0	5.0	4.0	6.0	2.3	4.3
Mahamaya	2.0	1.0	11.0	4.0	19.0	9.0	8.3	4.6
Range	2.0-12.0	1.0-7.0	1.0-19.0	4.0-16.0	4.0-30.0	9.0-20.0	2.3-17.3	4.3-16.3

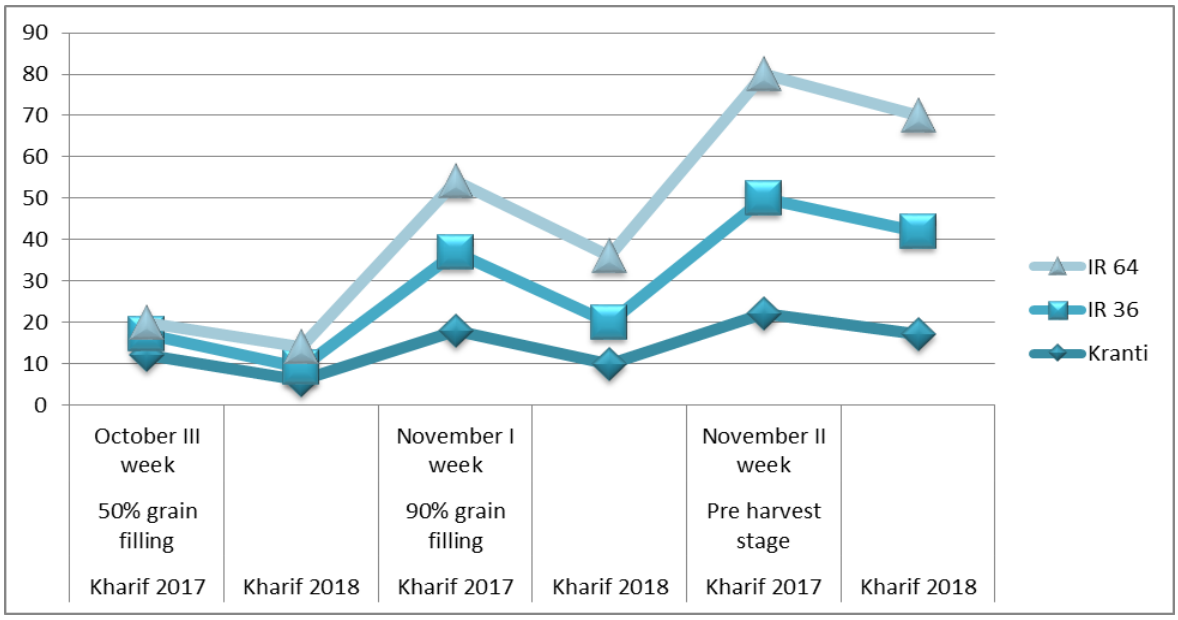

Fig 2: Incremental development of Dirty Panicle Disease at three crop growth stages

Incidence of disease at different crop stages from farmers' field

Rice panicles from farmers' field located at 13 districts covering six agro-climatic zones were analyzed. Based upon the visual observations, incidence of dirty panicle was in the range of 12.0 to 19.0% during 2017 and 18.0 to 28.0% during 2018 with an average upto 21.0 to 21.3%, respectively.

Maximum disease (19%) was observed in the panicles from pre-harvest stage during 2017. A similar trend exhibiting maximum panicles (28%) with grain discolorations was noticed during 2018. During 3rd week of October (Kharif, 2017) disease incidence was upto 12% in samples from Betul and Damoh districts, whereas, in 2018 samples from Umaria exhibited 18% infected panicles at 50% grain filling stage. During 1st week of November highest (17%) number of infected panicles were observed in the samples from Dindori and during Kharif, 2018 highest number of infected panicles was from Damoh (19%) at 90% grain filling stage.

Table 5: Incidence of dirty panicle disease of rice in samples from farmers' field

District/fields	Percent panicle infected*						Average	
	50% grain filling October III week		90% grain filling November I week		Pre harvest stage November II week			
	Kharif 2017	Kharif 2018	Kharif 2017	Kharif 2018	Kharif 2017	Kharif 2018	Kharif 2017	Kharif 2018
Kymore plateau and Satpura hills								
Jabalpur								
Field no1	4.0	7.0	10.0	15.0	13.0	19.0	9.0	13.6
Field no 2	9.0	8.0	10.0	16.0	17.0	22.0	12.0	15.3
Field no 3	8.0	5.0	13.0	9.0	19.0	11.0	13.3	8.3
Seoni								
Field no1	7.0	6.0	10.0	11.0	17.0	12.0	11.3	9.6
Field no 2	3.0	5.0	5.0	10.0	9.0	12.0	5.6	9.6
Field no 3	4.0	3.0	5.0	15.0	6.0	17.0	5.0	11.6
Katni								
Field no1	4.0	5.0	10.0	13.0	12.0	17.0	8.6	11.6
Field no 2	2.0	3.0	5.0	12.0	11.0	13.0	6.0	9.3
Field no 3	3.0	5.0	7.0	6.0	19.0	10.0	9.6	7.0
Chhattisgarh plains								
Balaghat								
Field no1	5.0	10.0	12.0	18.0	19.0	22.0	11.0	16.6
Field no 2	3.0	10.0	7.0	11.0	11.0	17.0	7.0	12.6
Field no 3	5.0	6.0	11.0	12.0	17.0	15.0	11.0	11.0
Vindhya plateau								
Damoh								
Field no1	5.0	6.0	9.0	6.0	11.0	10.0	8.3	7.3
Field no 2	5.0	10.0	3.0	11.0	19.0	12.0	9.0	11.0
Field no 3	12.0	10.0	17.0	19.0	19.0	20.0	16.0	16.3
Northern hills of Chhattisgarh								
Mandla								
Field no1	3.0	3.0	5.0	12.0	17.0	12.0	8.3	9.0
Field no 2	12.0	5.0	15.0	13.0	17.0	13.0	14.6	10.3
Field no 3	6.0	5.0	6.0	6.0	16.0	7.0	9.3	6.0
Dindori								
Field no1	2.0	10.0	17.0	11.0	19.0	22.0	12.6	16.3
Field no 2	2.0	5.0	10.0	6.0	15.0	7.0	9.0	6.0
Field no 3	4.0	5.0	10.0	5.0	11.0	13.0	8.3	7.6
Anuppur								
Field no1	2.0	8.0	5.0	9.0	12.0	12.0	6.3	9.6
Field no 2	2.0	5.0	7.0	10.0	11.0	17.0	6.6	16.0
Field no 3	5.0	3.0	13.0	10.0	13.0	17.0	10.3	10.0
Umaria								
Field no1	6.0	18.0	11.0	18.0	19.0	28.0	12.0	21.3
Field no 2	7.0	4.0	9.0	8.0	11.0	10.0	9.0	7.3
Field no 3	2.0	5.0	10.0	10.0	10.0	12.0	7.3	9.0
Shahdol								
Field no1	2.0	5.0	10.0	12.0	14.0	19.0	8.6	12.0
Field no 2	1.0	2.0	2.0	4.0	5.0	13.0	2.6	6.3
Field no 3	2.0	2.0	2.0	5.0	5.0	10.0	3.0	5.6
Satpura plateau								
Chhindwara								
Field no1	5.0	8.0	10.0	9.0	11.0	11.0	8.6	9.3
Field no 2	6.0	7.0	6.0	9.0	10.0	12.0	7.3	9.3
Field no 3	10.0	5.0	11.0	11.0	12.0	13.0	11.0	9.6
Betul								
Field no1	9.0	10.0	13.0	11.0	17.0	13.0	13.0	11.3
Field no 2	10.0	5.0	10.0	6.0	12.0	11.0	10.6	7.3
Field no 3	12.0	7.0	12.0	11.0	18.0	12.0	14.0	10.0
Central Narmada valley								
Narasinghpur								
Field no1	10.0	7.0	10.0	10.0	15.0	17.0	11.6	11.3
Field no 2	10.0	5.0	15.0	11.0	15.0	13.0	13.3	9.6
Field no 3	6.0	6.0	12.0	12.0	13.0	14.0	21.0	10.6
Range	1.0-12.0	2.0-18.0	2.0-17.0	4.0-19.0	5.0-19.0	7.0-28.0	6.0-21.0	6.0-21.3

Observations were made on 20 representative panicles from farmers' field

At pre-harvest stage during 2nd week of November in Kharif 2017, 19% infected samples were recorded in the samples from Jabalpur, Balaghat, Umaria, Damoh, Dindori indicating the widespread magnitude of disease problem. During Kharif, 2018 panicle samples from Umaria exhibited highest number of panicle infected (28%) followed by 22% (Jabalpur, Dindori and Balaghat districts) (Table 05).

Analysis of seed sample

Seed samples from IR 36, IR 64 and Kranti were chosen having 28, 30 and 19% basic seed infection, respectively. The seeds of three varieties were graded as per seed surface area covered/discolored. From each variety with basic seed infection four thousand seeds were randomly selected and sorted at different levels of infection.

Maximum number of discolored seeds were noticed in seeds from L7 having 26-50% seed surface area covered. The number of seeds, out of four thousand seeds worked out indicate that 1350 (IR 36), 1458 (IR 64) and 1155(Kranti). Maximum percentage of (36.45) was recorded in IR 64 followed by 33.75% in IR 36 and least 28.87% in Kranti. Higher number of discolored seeds belonged to L9 and L7. It was concluded that the seed samples having basic seed infection (19.0-30.0%) had the seeds with no infection (L0) in the range of 497 to 714 (12.4-7.85%). The individual profile of IR 64 (4000) seeds from 30% basic seed infection consisted of 185, 217, 713, 1458 and 613 number of seeds distributed in L1 to L9 including 714 seeds with no incidence of grain discoloration in L0 (Table 06 and Fig. 03).

Table 6: Number of seeds in different grades

Grades	Area covered	Number of seeds (out of 4000)*		
	IR 36		IR 64	Kranti
Basic seed infection		28.0	30.0	19.0
Level 0	No incidence	497(12.42)	714(17.85)	658(16.45)
Level 1	Less than 1%	214(5.35)	185(4.62)	197(4.92)
Level 3	1-5%	408(10.20)	217(7.92)	470(11.75)
Level 5	6-25%	619(15.47)	713(17.82)	633(15.82)
Level 7	26-50%	1350(33.75)	1458(36.45)	1155(28.87)
Level 9	51-100%	912(22.80)	613(15.32)	887(22.17)

*values in parenthesis are percentage of seeds of different categories

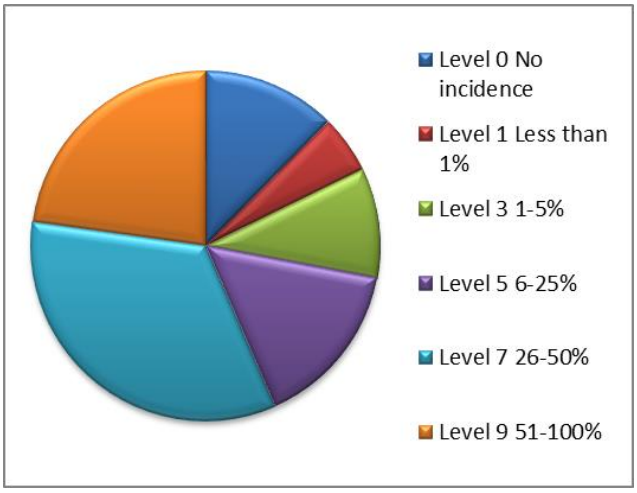

Fig 3: Number of discolored seeds observed under various levels of infection (IR 36)

Apart from the weather factors, the problem of increasing prevalence of grain discoloration is attributed for the introduction of high yielding varieties (Raymundo and Fomba, 1979) [13]. Association of various mycoflora from the discolored seeds has been reported (Majumdar *et al.*, 1976; Castano, 1983) [5, 1]. The degree of grain discoloration and percentage of isolation from grains has been discussed by Lee *et al.* (1986) [4].

Conclusions

Dirty panicle is a new disease problem in rice cultivation under agro-conditions of Madhya Pradesh. Association of mycoflora, discoloration and poor grain quality reduces the appeal to the consumers.

Out of most commonly grown 12 varieties, none of the variety was free from the disease. The disease was prevalent in all the 13 major rice growing districts covering six agro climatic zones of the State. Incidence of the disease ranged from 4.0-30.0% in commonly grown varieties. At farmers field in 6 agro-climatic zones, the incidence ranged from 6.0-21.3% during Kharif, 2017 and Kharif, 2018. Analysis of diseased seed samples indicates that higher number of discolored seeds was recorded in Level 7 where the discolored area was greater than 26-50%.

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