# Major Fungal Diseases of Rice: A Case Study

**Suchismita Samal, Sagarika Parida***

Department of Botany, School of Applied Sciences, Centurion University of Technology and Management, Odisha, INDIA.

## ABSTRACT

Disease screening and evaluation is a major parameter for measurement of host resistance of various rice germplasm and this study will facilitate for genetic mapping of resistance genes for researchers. The survey work was carried out on rice fields in National Rice Research Institute, Cuttack, to evaluate the distribution of different fungal diseases on various rice cultivars. Disease occurrence percentage was calculated as the proportion of cultivars showing the symptoms of a particular disease, out of total number of cultivars assessed. Fourteen different cultivars were namely CG (2090/226), Dhalaswarna, Tapaswini, TRB 1949, TRB 1156, TN1, BA115, BA90, BA13, Ajay 2006, Pradhandhan, M313 and aerobic variety assessed based on disease prevalence. Six different diseases were observed during the study period viz., sheath rot, sheath blight, false smut, blast, brown spot and bakane. Identification of these diseases was based on the specific morphological symptoms on leaves and other infected parts of these rice cultivars. Methods of isolation of casual organism and their colony character were also observed during survey in department of plant pathology. It was found that in the month of October four fungal diseases are most prevalent. These are blast, sheath blight, sheath rot and Bakanae. At the end of November false smut and brown smut symptoms were found. Among these diseases, leaf blast was found as the most prevalent disease at vegetative growth stage as it affected highest number of cultivars. Among these, blast is found to be more prevalent disease with 35.71% of occurrence which is caused by fungus *Magnoporthe oryzae* followed by sheath blight and sheath rot. Brown spot and bakane disease was found each with least percentage of occurrences.

**Key words:** Bakane, Casual organisms, Host resistance, Fungal diseases, *Oryzae sativa*, symptoms.

**Correspondence:**
*Dr. Sagarika Parida,*
Department of Botany, School of Applied Sciences, Centurion University of Technology and Management, Odisha, INDIA.
Phone no: +91-7008298535

Email: sagarika.parida@cutm.ac.in

## INTRODUCTION

Rice, *Oryzae sativa* L. is cultivated all over the world and is the first cultivated crop in Asian countries. This plant belongs to the grass family Poaceae (Gramineae).[1] Its production accounts for 90% of world population. India stands first in rice area and second in rice production after China. More than 40,000 varieties of rice plants are found in India. Rice plant occupies one quarter of total cropped areas and contributes about 40-43% of total food grain production. Indian rice is grown under four ecosystems viz., irrigated ecosystem, flood prone ecosystem, rain fed upland rice ecosystem

and rain fed low land rice ecosystem.[2] The major rice growing states of India are West Bengal, Bihar, Madhya Pradesh, Odisha, Andhra Pradesh Uttar Pradesh. The demand of rice is expected to be 125-130 m tones by 2025 ad this demand only can be met by enhancing the productivity and production of rice. Because of variable biotic and abiotic stresses, both the yield as well as the quality of the produce is affected.[3] It was reported that the rice crop is attacked by about 50 diseases including 6 bacterial, 21 fungal, 4 nematodes, 12 viral and 7 other miscellaneous diseases and disorders. Among different biotic stresses, fungal diseases amount as one of the most important factors responsible for low yield of rice. Sheath blight, Sheath rot, blast, false smut, brown spot and bakane diseases are major fungal diseases leading to variable losses in yield.[4] Screening of rice germplasm against sheath blight caused by fungal pathogen *Rhizoctonia solani* was observed by various methods for screening and evaluating rice germplasm

and was found to be helpful for genetic mapping of disease resistant genes.[5] Sheath rot caused by *Sarocladium oryzae* produces a phytotoxin that induces necrosis and discolouration, chaffiness and sterility in plants.[6] Near about 70% yield losses by blast damage caused by *Magnoporthe oryzae* was reported in upland areas of West Java.[7] Survey and characterization were carried out on false smut pathogen, *Ustilagenoidea virens* in India.[8] The impact of essential oils on brown spot disease caused by *Cochliobolus miyabeanus* was studied.[9] Bakane is caused by *Fusarium moniliformi*, which can be controlled by dressing of seeds by soluble silicate clays zeolite to control bakane disease of rice. Among different National organizations, National Rice Research Institute (ICAR), Cuttack, Odisha is a leading rice research institute in India and is known for rice research to ensure food and nutritional security. Survey conducted in rice growing areas of Haryana during 1997 to 2012 revealed that diseases of rice varied depending upon varietal spectrum and persisting environmental condition of those years. A survey was conducted in weekly intervals in different rice fields at National Rice Research Institute, Cuttack, Odisha with the objective to investigate about different fungal diseases associated with different rice cultivars growing in the institute premises and to identify the associations between the disease and plant traits.

## MATERIALS AND METHODS

### Description of the study area

Survey was carried out at National Rice Research Institute, Cuttack, Odisha, from October, 2018 to February 2019 in weekly intervals in different rice fields as well as inside the net house.

### Disease detection in rice plants

Identification was done on the basis of morphological symptoms on the affected parts of leaves. Methods of isolation of casual organisms and their affected colony characters were also observed during the survey in the department of plant pathology. The survey includes the collection of infected parts of the plant from the rice field. Infected parts include leaves, stem, nodes, root and grains. Proper picture has been taken to observe the disease. For detection of disease magnifying glass, digital camera and notebook to record the characteristics were required. A sample of each infected plant has been taken for microscopic identification and preservation as specimen. Information was also taken from the field assistants, research fellows and scientists about different diseases and cultivars grown. All the data and observations of the survey were recorded.

## RESULTS

During the survey, disease incidence was recorded in different rice fields and controlled plants grown in net house in NRRI (Figure 1 and Figure 2). Methods of isolation and their colony characters were observed during the survey in the department of plant pathology.
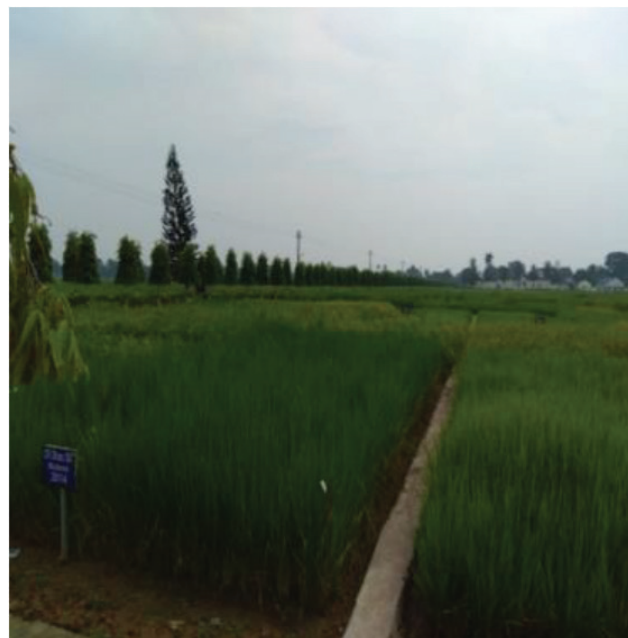


**Figure 1: Rice field, NRRI.**



**Figure 2: Rice cultivar in net house, NRRI.**

Occurrences of different fungal disease incidence in different months were observed and the causal organisms were also noted. In this study it was found that in the month of October four fungal diseases are most prevalent. These are blast, sheath blight, sheath rot and bakanae. At the end of November false smut and brown smut diseases were noticed (Table 1).

The data in Table 2 revealed that sheath blight, sheath rot, blast, false smut, brown spot and bakanae diseases were observed during the survey. Fourteen rice varieties were found to be infected with different fungal diseases like sheath blight, sheath rot, blast, false smut, brown spot and Bakane disease. Amongst these diseases, blast disease was noticed in rice cultivar viz. TN1, BA115, BA90, BA13 and Ajay 2006. Sheath blight was noticed in three rice cultivars viz. CG (2090/226), Tapaswini and Dhalaswarna. Two rice varieties viz., Tapaswini and Pradhandhan were found to be infected by false smut disease, and sheath rot was noticed in two rice varieties TRB 1949 and TRB 1156. Bakanae was noticed in only one aerobic rice variety and the rice variety M313 was infected by brown spot disease. Out of 14 rice varieties, maximum varieties of 35.71% were recorded for blast disease infection; followed by sheath blight with 21.42%, sheath rot and false smut with 14.28% and brown spot and bakane disease each with 7.14%. Among these, blast is found to be more prevalent disease followed by sheath blight and sheath rot. Amongst these disease blasts disease was noticed in rice cultivar viz. TN1, BA115, BA90 and BA13 followed by sheath blight which was noticed in rice cultivar CG (2090/226), Tapaswini and Dhalaswarna followed by sheath rot was noticed in rice variety TRB 1949 and TRB 1156 followed by false smut disease which was noticed in two rice varieties Tapaswini and Pradhan dhan, while bakanae was noticed in only one aerobic rice variety followed by brown spot which is noticed in only one rice variety M313.

### Blast disease

Blast disease was found in rice cultivars in the fields of NRRI Cuttack. The causal organism of leaf blast was *Magnoporthe oryzae*. Reddish brown spindle shaped spots with ashy grey center was found to be appeared on the leaves (Figure 3 and Figure 4). Two types of blast has been noticed in the cultivated rice varieties namely, leaf blast and neck blast. Maximum numbers of cultivars were found to be affected by blast in NRRI. This might be due to variability nature of the fungal pathogen and occurrence of new races. Blast disease was observed in

| SI. No. | Types of diseases in rice plant | Causal organism | Month of occurrence |
|---|---|---|---|
| | **Table 1: Causal organisms of various fungal diseases and their occurrence in different months.** | | |
| 1 | Sheath blight | *Rhizoctonia solani* | October |
| 2 | Sheath rot | *Sarocladium oryzae* | October |
| 3 | Blast | *Magneporthe oryzae* | October |
| 4 | False smut | *Ustilaginoidea virens* | November |
| 5 | Brown spot | *Helminthosporium oryzae* | November |
| 6 | Bakanae | *Fusarium fujikori* | October |

| SI. No. | Types of diseases in rice plant | No. of varieties affected | Varieties | Total No. of varieties surveyed | % of occurrence |
|---|---|---|---|---|---|
| | **Table 2: Diseases Found in Different Rice Varieties.** | | | | |
| 1 | Sheath blight | 03 | CG (2090/226) | | 21.42 |
| | | | Dhalaswarna | | 14.37 |
| | | | Tapaswini | | 13.42 |
| 2 | Sheath rot | 02 | TRB 1949 | | 14.28 |
| | | | TRB 1156 | | 12.43 |
| 3 | Blast | 05 | TN1 | | 29.76 |
| | | | BA115 | 14 | 35.71 |
| | | | BA90 | | 27.52 |
| | | | BA13 | | 24.56 |
| | | | Ajay 2006 | | 23.75 |
| 4 | False smut | 02 | Tapaswini | | 14.28 |
| | | | Pradhandhan | | 13.23 |
| 5 | Brown spot | 01 | M313 | | 7.14 |
| 6 | Bakanae | 01 | Aerobic variety | | 7.14 |

**Figure 3 and 4: Blast disease found on leaves of rice plant.**



**Figure 5 and Figure 6: Bakanae disease in aerobic rice variety at NRRI.**



**Figure 7: Sheath blight disease.**

five varieties namely TN1 (29.76%), BA115 (35.71%), BA90 (27.52%), BA13 (24.56%) and Ajay 2006 with 23.75% of disease occurrence.

### Bakanae Disease

Bakanae disease was also found on aerobic variety raised on earthen pots inside net house of NRRI Cuttack. *Fusarium fujikori* was the causal organism for bakane disease. The symptom shows chlorotic, pale, thinner and abnormally elongated nodes. Plants are tall and lanky. Adventitious root arises from nodes near the ground. (Figure 5 and Figure 6). Bakane was only observed in aerobic rice variety with 7.14% of occurrence (Table 2).

### Sheath blight disease

Sheath blight disease was found in rice fields of NNRI Cuttack Odisha. Sheath blight was caused by the fungus *Rhizoctonia solani*. The symptom shows lesions coalescence and extended to leaf blade having typical snake like appearance. White to off-colored mustard seed like sclerotia appears. During the survey, sheath blight was noticed on rice cultivar CG (2090/226), Tapaswini and Dhalaswarna (Table 1; Figure 7). Amongst these cultivars more incidences was noticed in cultivar CG (2090/226) with 21.42%. Least disease incidence was recorded in rest two cultivars i.e., Tapaswini and Dhalaswarna with 21.42, 14.37 and 13. 42% respectively.



**Figure 8: Sheath Rot disease.**

### Sheath rot disease

Sheath rot disease was found in rice fields and also on the potted plants inside the net house of NRRI Cuttack. Sheath rot was caused by *Sarocladium oryzae*. Oblong spots appeared with brown margin and grey center and discolouration of flag sheath and rotting occurred (Figure 8). Sheath rot was observed in TRB 1949 and TRB 1156 with 14.28 and 12.43% respectively.

### Brown Spot Disease

Brown spot was found in rice fields of NRRI Cuttack, Odisha. Brown spot disease was caused by *Helminthosporium oryzae*. Typical ellipsoidal dark brown

**Figure 9: Brown spot disease in M313 variety.**



**Figure 10: False smut disease in Tapaswini and Pradhandhan.**

spots appeared on coleoptiles, leaf blade, leaf sheath and glumes. Yellow halo is observed around the lesion (Figure 9). Brown spot disease was reported in M31 with 7.14% disease occurrence.

### False smut

False smut disease was found in rice fields of NRRI Cuttack. This disease was caused by *Ustilaginoidea virens*. Green smut balls appeared on grains and later on changes to yellowish green or greenish black colour. During the survey, false smut was noticed on rice cultivar Tapaswini and Pradhandhan (Table 1; Figure 10) with 16.23% and 14.28% of occurrence.

## DISCUSSION

Different fungal diseases are reported to affect the rice plants all over the world.[10] It was reported that major crop was lost due to blast in Andhra Pradesh and Telengana along with brown spot disease of rice caused by *Helminthosporium oryzae* during 2014-2015. In this study, blast disease was found to be more prevalent disease followed by sheath blight and sheath rot. Blasts disease was noticed in rice cultivar viz. TN1, BA115, BA90 and BA13 followed by sheath blight in rice cultivar CG (2090/226), Tapaswini and Dhalaswarna. Maximum numbers of cultivars were found to be affected by blast in NRRI. This might be due to variability nature of the fungal pathogen and occurrence of new races. It was recorded that chemical fungicide spray in the juvenile stage and use of bio fungicide will reduce the disease severity. Apart from this resistant cultivars should be raised and crop rotation is required to minimize the disease incidence and increased the yield.[11] Distribution and prevalence of blast disease during Kharif season from 2005 to 2007 with maximum of 15% nodal blast and 25% neck blast were also recorded as the most destructive phase in Kupwara district of Kashmir valley caused by *M. grisea*.[12] Survey on rice leaf blast severity in Prakasam and Sri Potti Sreeraulu Nellore (SPSR) districts of Andhra Pradesh during Kharif and Rabi season from 2010-2012 and disease incidence was calculated and reported that transplanting and tillering stages were highly susceptible as compared to their from one stage to the other (Ali, 2009).[13] Kihoro *et al.* (2013) investigated the impact of rice blast disease using GIS map for blast disease distribution and its impact on livelihoods of local farmers of Mwea region and reported that excessive use of nitrogen fertilizer, shortage of water, lack of proper drainage and change in climatic condition were the reasons to be the cause of blast disease. Sheath rot in rice variety TRB 1949 and TRB 1156 and false smut disease in two rice varieties Tapaswini and Pradhan dhan, while bakanae was noticed in only one aerobic rice variety followed by brown spot in only one rice variety M313. These diseases are caused by frequent showers and application of higher dose of nitrogen fertilizer, while some diseases are soil borne like Bakanae. These diseases can be controlled by green manuring with dhanicha to promote beneficial soil microorganism and also by applying fungicides.[10] Leaf spot, leaf rust, stem rot, sheath rot; foot rot and false smut disease of rice were found to be the major diseases of rice in Andhra Pradesh and Telengana. These diseases can be controlled by green manuring with dhanicha to promote beneficial soil microorganism and also by

applying fungicides.[10] Amongst these cultivars, more incidences were noticed in cultivar Pradhandhan. Least disease incidence was recorded in cultivar Tapaswini.[14] Highest false smut disease incidence was detected in variety Pooja with 55.61% disease incidence followed by CR Dhan 1014 and Swarna sub 1 each with 33.33% during the survey conducted for 15 rice varieties in the paddy fields of Kishan Nagar and NRRI, Cuttack.[15] Fifteen major diseases and two disorders were recorded and blast, foot rot and bakane diseases were the major diseases of scented varieties and bacterial leaf blight and false smut were found to infect the non-scented high yielding hybrid rice varieties. Among these sheath blight was considered as the minor disease initially upto 2005 and later on became the major disease both in scented and non-scented rice varieties during 2010 to 2012. Brown spot, narrow brown leaf spot, leaf smut and kernel smut and bunt were reported as minor diseases two disorders were found to occur were due to zinc and iron deficiency leading to khaira and chlorosis respectively.[16] It was reported that leaf blight, sheath blight and web blight are caused by *Rhizoctonia* species on species belonging to Poaceae and Fabaceae in Brazilian Amazon agroecosystem. *R. oryzae-sativae* (*Ceratobasidium oryzae-sativae*) was the predominant species associated with rice sheath spot disease in lowlands of Sao Paulo during 2012-2013. This survey results coincided with the earlier findings but a variation in the disease occurrence was also noticed with respect to varieties. This might be due to the prevalent climatic condition and also the presence of variable pathotypes.

## CONCLUSION

Among various diseases, the most critical rice diseases prevalent across the globe are caused by the fungus. Results showed that all these fungal diseases affected the overall plant growth. Climatic conditions affect the disease establishment, development and severity. This study provides the concept of disease detection by observing the symptoms along with the sensitivity of different rice cultivars to different fungal diseases. Six different diseases were observed which affected different rice cultivars during the study period viz., sheath rot, sheath blight, false smut, blast, brown spot and bakane. The disease can be control by manipulating the planting time with relation to climatic factors, fertilizer management, burning or composting of diseased plant parts, weeding of alternate hosts, seed treatment with appropriate fungicides, by green manuring with dhanicha to promote soil microorganisms, checking flow of irrigation water from infected fields to healthy fields and also by crop rotation.

## ACKNOWLEDGEMENT

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## ABBREVIATIONS

**ICAR:** Indian Council of Agricultural Research; **GIS:** Geographic Information System; **NRRI:** National Rice Research Institute; **SPSR:** Sri Potti Sreeraulu Nellore.

## REFERENCES

1. Singh RS. Plant disease. 8th ed. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.; 2005; 439.

2. Anonymous A. World rice production in metric tones. Food and Agriculture Organization of the United Nations. 2013.

3. Anonymous, State B. Ministry of Agriculture, Government of India. Season-wise production of rice in India. Available from: http://www.Indiastat.com.

4. Jia Y, Liu G, Park DS, Yang Y. Inoculation and scoring methods for rice sheath blight disease. Methods Mol Biol. 2013;956:(257-68). doi: 10.1007/978-1-62703-194-3_19, PMID 23135858.

5. Bigirimana Vde P, Hua GK, Nyamangyoku OI, Höfte M. Rice sheath rot: an emerging ubiquitous destructive disease complex. Front Plant Sci. 2015;6:1066. doi: 10.3389/fpls.2015.01066, PMID 26697031.

6. Sobrizal S, Anggiani S. Rice blast disease in Indonesia. JIRCAS. Vol. 53. Tsukuba, Japan: Japan International Research Center for Agricultural Sciences Working Report No. 2007. p. 71-9.

7. Ladhalakshmi D, Laha GS, Singh R, Karthikeyan A, Mangrauthia SK, Sundaram RM, et al. Isolation and characterization of Ustilaginoidea virens and survey of false smut disease of rice in India. Phytoparasitica. 2012 Apr;40(2):171-6. doi: 10.1007/s12600-011-0214-0.

8. Nguefack J, Wulff GE, Lekagne Dongmo JB, Fouelefack FR, Fotio D, et al. Effect of plant extracts and an essential oil on the control of brown spot disease, tillering, number of panicles and yield increase in rice. Eur J Plant Pathol. 2013 Dec;137(4):871-82. doi: 10.1007/s10658-013-0298-0.

9. Kang YS, Kim WJ, Kim YJ, Jung KH, Choi US. Bakanae disease reduction effect by use of silicate coated seed in wet direct-seeded rice. Korean J Crop Sci. 2016;61(1):9-16. doi: 10.7740/kjcs.2016.61.1.009.

10. Surapu RB, Srinivas P, Aruna J, Vijay S, Rani PCD, Reddy N, et al. Survey of Magnaporthe grisea isolates around Andhra Pradesh and Telangana states, India. Int J Curr Microbiol Appl Sci. 2017;6(5):61-70. doi: 10.20546/ijcmas.2017.605.008.

11. Dar MS, Hussain S, Joo GN, Majaz M. Prevalence and distribution of blast disease (*Magnaporthe grisea*) on different components, of rice plants in paddy growing areas of the Kashmir Valley. Int J Pharm Biol Sci. 2010;1(3):1-4.

12. Anwar A, Teli MA, Bhat GN, Parry GA, Wani SA. Characterization status of rice blast (*Magnaporthe grisea*), cultivar reaction and races of its causal fungus in temperate Agro-ecosystem of Kashmir, India. SAARC J Agric. 2009;7(2):25-37.

13. Kihoro J, Bosco NJ, Murage H, Ateka E, Makihara D. Investigating the impact of rice blast disease on the livelihood of the local farmers in greater Mwea region of Kenya. SpringerPlus. 2013 Dec;2(1):308. doi: 10.1186/2193-1801-2-308, PMID 23888278.

14. Baite MS, Raghu S, Lenka S, Mukherjee AK, Prabhukarthikeyan SR, Jena M. Survey of rice false smut caused by *Ustilaginoidea virens* in Odisha. Bioscan; 2017; 12(4). p. 2081-5.

15. Singh R, Sunder S, Dodan DS. Status of rice diseases in Haryana. Plant Dis Research. 2013;28(2):181-5.

16. Chavarro-Mesa E, Ceresini P, Pereira D, Vicentini S, Silva T, Ramos-Molina L, Negrisoli M, Schurt D, Vieira Júnior JR. A broad diversity survey of Rhizoctonia species from the Brazilian Amazon reveals the prevalence of R. solani AG-1 IA on signal grass and the new record of AG-1 IF on cowpea and soybeans. Plant Pathol. 2020 Apr;69(3):455-66. doi: 10.1111/ppa.13142.