

Fungal diseases of Rice in North East India

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Abstract

The North East India constitutes the Indo-Burma biodiversity hotspot and harbours the richest genetic diversity of agri-horticultural crops including different varieties of rice. As rice and rice cultivation serves as the main staple food and major source of employment in this region, therefore, any disease of rice can not only affect the economy of the states but also could affect the livelihood of the native paddy farmers. Fungal diseases are one of the major production constraints of rice plants in this region. Therefore detail knowledge of the common fungal diseases of this region and the suitable plant protection measures could help the farmers and agriculturist to prevent the diseases.

Key words : Fungal disease, North East India, Rice, *Oryza sativa*

Rice (*Oryza sativa* L.) is a nutritious cereal crop plant belongs to the family Gramineae (Poaceae) serves as a major source of energy and protein for human. The model plant for monocotyledons is also the second highest valued cash crop and used as the staple food for about half of the world's population⁵. Significantly 75% of the world's rice supply is consumed by people in Asian countries⁵. North East (NE) India is the agrobiodiversity hot spot comprising 9650 rice cultivars, occupies 6.07% area under cultivation of the total rice production in India²¹. Assam has the largest rice area of

around 73 per cent followed by Tripura (8 per cent)²¹.

In the fields, rice plants encounters several fungal diseases can be pandemic during heavy rainfall³⁷. Some important soil borne fungal pathogens reported from North east region are *Pythium*, *Fusarium*, *Rhizoctonia*, *Verticillium*, *Ralstonia solanacearum* etc.^{10,12,13,25}. Besides 36 fungal diseases rice may have 21 viral and 6 bacterial diseases³⁷. Major fungal diseases of rice are Rice Blast, Sheath Blight, False Smut, Brown Spot, Black Sheath Rot, Foot rot, Stem rot and Bakanae Disease causes by different groups of fungi⁹.

The present study comprises of a review of the various fungal diseases infecting rice biodiversity of NE India, suitable management strategy and various resistant and tolerant strains available in the region.

Rice biodiversity in North East India :

There are about 30,000 rice cultivars grown in NE India since old times including wild rice varieties, several landraces and primitive cultivars of special importance and thus it serves as the secondary centre of origin²³. Rice gene diversity of NE landraces is much higher than the overall gene diversity of rice core collection (0.544) from China, Philippines and US²⁹. Mahender *et al.*²³ reported two to seven blast resistance genes in the native landraces of Manipur, a region reported to be associated with origin of rice, indicates the richness of blast diversity in landraces of NE India²³. Umakanth *et al.*³⁸ studied 232 unexplored NE Indian landraces collected from all the NE Indian states and suggests seven unique landraces which could have potentiality for discovery of novel resistant gene against leaf and neck blast³⁸. Besides *Oryza sativa*, Assam is rich in several special landraces and cultivars of rice such as various related taxa eg. *Hygrorhiza aristata*, *Leersia hexandra* etc., aromatic rice variety *Joha*, wild rice species eg. *Oryza nivara*, *O. sativa f. spontanea*, *O. officinalis* etc.^{4,26}.

Other important popular rice cultivars are aromatic Kampti rice of Arunachal Pradesh, black rice (*Chakhao*) and the cultivar *Zizania latifolia* of Manipur, *Idaw*, *Akbuh*, *Zakew*, *Saii Buh*, *Zaitlai* of Mizoram, *Krishna Bhog*, *Brimphul*, *Kalanunia* and

local *Basmati* of Sikkim, *Nagaland Sinsatsu*, *Henigido*, *Akatan*, *Kemehyasopa* of Nagaland^{2,18,19,20,23,26,20}.

Important fungal rice diseases, causing agents and disease incidences at North East Indian states :

In spite of suitable soil and climate for rice cultivation, plants are getting effected by seed born fungal pathogens which are responsible for major economic loss in NE India. Rice blast (*Pyricularia oryze*) is one of the important endemic and major diseases of the region³³. Leaf and neck blast are predominant fungal diseases causing 40 - 46% yield damage followed by false smut^{11,26,27}.

Singh *et al.*,³² mentioned 19 seed borne mycoflora in rice from Himalayan hill range of Mizoram, reported *Fusarium moniliforme* to be the most occurring pathogen, and low seed germination rate in *Maipu*, *Manipur Nem* and *Idaw* land races is due to the infection of seed born fungal pathogen^{12,31}. In Manipur and Nagaland Sheath blight and Brown spot are the major rice diseases, in Meghalaya Brown spot and Sheath rot are causing greater damages²⁶.

Bhagawati⁸ reported declination of blast diseases primarily due to emergence of resistant varieties, improved management practices and other related factors⁸. However, intensity and severity of False Smut, Bakane and Brown spot have been increasing and being the major rice diseases in Manipur causing severe damage of the rice crop⁵. Singh *et al.*,³⁰ reported the maximum incidence of false smut disease on hybrid rice cultivars (PRH

Table-1. Common fungal diseases of Rice in North East India

Sl No.	Diseases name	Causative fungi	General symptoms	Reference
1	Aggregate sheath spot (AgSS)	<i>Rhizoctonia oryzae-sativae</i> (telemorph: <i>Ceratorhiza oryzae-sativae</i>)	Lesions appear on the lower surface of the leaf followed by fungal infection, then expanded to the upper leaf surface and gradually spread all over causes yield loss by reducing the photosynthetic area.	(15)
2	Bakanae Disease	<i>Gibberella fujikuroi</i> ; <i>Fusarium moniliforme</i>	Infected plants become several inches taller than normal plants and eventual-drying of leaves.	(6)
3	Black Sheath Rot	<i>Gaeumannomyces graminis</i>	Attacks the crown, lower leafsheaths, and roots, leaf become dark brown to black, causes reduced tillering, poor grain fill, and lodging	(27)
4	Blast	<i>Magnaporthe oryzae</i> (anamorph: <i>Pyricularia oryzae</i>)	Diamond shaped lesions occur on all parts of the plant	(6),(11)
5	Bordered sheath spot	<i>Rhizoctonia oryzae</i> Ryker etGooch	Greenish-gray circular, oval or ellipsoid, water-soaked spots occur on sheath	(27)
6	Brown leaf spot	<i>Helminthosporium oryzae</i> Brada De Hanm; <i>Bipolaris oryzae</i> , <i>Cochliobolus miyabeanus</i>	Brown, circular to oval spots appear on the leaves.	(6), (27)
7	Brown Spot	<i>Bipolaris oryzae</i> , <i>Cochliobolus miyabeanus</i>	Brown, circular to oval spots appear on the leaves.	(27)
8	False Smut	<i>Ustilaginoidea virens</i> (Cooke) Takah; <i>Claviceps oryzae sativae</i>	Large orange or olive-green fruiting structures develops on one or more grains of the mature panicle.	(27)
9	Foot rot	<i>Fusarium moniliforme</i>	Seed borne mycoflora	(24),(39)
10	Kernel smut	<i>Neovossia horrida</i>	Black mass of chlamydo spores appears and replace all or part of individual kernels near or at maturity.	(6),(27)
11	Rice Blast	<i>Magnaporthe grisea</i> (<i>Pyricularia oryzae</i>)	Spots appear on leaves, nodes, panicles, and collar of the flag leaves. Leaf spots are spindle-shaped with brown or reddish	(27)

			brown margins, ashy centers, pointed ends. Young seedlings, leaves, panicles and other aerial parts of the adult plant are affected and often called as leaf blast, neck blast, or panicle blast.	
12	Sheath Blight	<i>Rhizoctonia solani</i>	Symptoms apparent at tillering or flowering stage, affect all plant parts, oval or ellipsoidal spots appear on the leaf sheath, lesions are irregular and banded with green, brown, and orange colored appeared on the leaf blade.	(27)
13	Stackburn disease	<i>Trichoconis padwickii</i>	Seed or grain infection, leaf spots get covered with white cottony mass	(6),(40)
14	Stem rot	<i>Sclerotium oryzae;</i> <i>Fusarium</i> spp.	Formation of lesions and production of chalky grains and unfilled panicles.	(24),(27)

series) and minimum in a local cultivar of rice (*Phouoibi Phou*)³⁵. Common fungal diseases observed in the states of north east India are given below (Table-1).

Management of fungal rice diseases in North East Indian region :

The management of rice fungal diseases is commonly done through application of fungicides, organic amendments, bio controlling agents, balanced nutrition and growing resistant varieties. Due to the presence of several wild germplasm of rice in NE regions it harbours significant stress and disease tolerant traits⁵. From Manipur seven blast resistant genes, nine leaf and neck blast resistant germplasms and *Akhanaphou*, a unique rice landrace high field resistance to leaf and neck blast have been identified^{3,26,38}. Subhalakshmi and Devi³⁶ reported *Pseudomonas fluorescens* as a potent biocontrol agent of blast disease in Manipur which inhibits mycellial growth and combined application of *P. fluorescens* and *Trichoderma koningiopsis*

could be used as integrated management strategy for plant growth promotion and blast control¹⁶. Another severe affecting fungal disease of rice sheath blight is managed through the application of chemical fungicides²⁸. Li *et al.*²² proposed two major false smut resistant genes, identification, characterization and eventual transfer of these genes to common rice varieties of NE region could considerably help in the management of this disease²². *Boro* rice in Assam is susceptible to sheath blight, brown spot, sheath rot, neck blast and stem rot²¹.

Since 1965, ICAR has released 5,163 improved field crop varieties including 45 rice varieties/hybrids many of which are adopted in different parts of NE India. Few new promising varieties are rereleased and notified by the Central Sub-committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops (CSC on CSN&RVAC)³². Some of them are resistant to different fungal diseases which have been mentioned below (Table-2).

Table-2 List of promising resistant varieties/hybrids of cereals released by ICAR (DARE/ICAR annual report 2019–20) (32).

Sl No	Variety	Area of adoption (NE states)	Salient features
1	Bidhan Suruchi	Assam	Recommended for both boro and <i>Kharif</i> , moderately resistant to leaf blast.
2	Uttar Sona	Tripura and Assam	Suitable for both boro (irrigated) and <i>Kharif</i> (irrigated and/or rainfed), resistant to leaf blight and brown spot.
3	Eenotphou	Manipur	Suitable for semi deep water conditions, moderately tolerant to rice blast, rice brown spots.
4	Tomthinphou	Manipur	Suitable for rainfed direct seeded under real jhum rice agro-ecosystem of Manipur and North East Hill region, tolerant to rice blast, brown spots.
5	Mangalphou	Manipur	Suitable for irrigated medium and medium upland conditions, tolerant to blast, brown spot.
6	Gomati Dhan	NEH region, Tripura	For rain fed shallow lowland and irrigated land of Tripura in <i>Kharif</i> season, moderately resistant to blast, sheath blight
7	Tripura Nirog	NEH region, Tripura	For irrigated and favorable rain fed shallow lowland of Tripura, almost disease free reaction to all major diseases.
8	Tripura Chikan	NEH region, Tripura	For irrigated and favourable rainfed shallow lowland of Tripura, moderately resistant to blast.
9	Khowai	NEH region	For rain fed or irrigated lowland of Tripura, moderately resistant to blast and brown spot
10	Tripura Sarat	NEH region, Tripura	For irrigated and favorable rain fed shallow lowland of Tripura, moderately resistant to blast and brown spot.
11	Tripura Jala	NEH region, Tripura	For water stagnation condition of Tripura, moderate resistance to blast, sheath blight, sheath rot
12	Tripura Hakuchuk-1	NEH region, Tripura	For transplanted lowland and direct seeded upland of Tripura, moderate resistance to blast, sheath blight and brown spot.
13	Tripura AUS	NEH region, Tripura	For transplanted and direct seeded, can be grown in all seasons, moderate resistant to blast and sheath blight

Practices of traditional methods with poor skill, sorting and storage techniques are still done by local people resulting in the deteriorating quality and germination rate of the rice seeds. Therefore, this could be improved by skill development practices among local farmers^{14,17}. Besides, application of suitable chemicals or combination of certain chemicals (Copper oxychloride) and microbes (Trichoderma, Tricyclazole etc.) exhibit notable effect on better growth and yield of rice in Manipur^{7,30}. Application of beneficial bacteria such as *Pseudomonas aurogenosa* “NEIST 003” has been used as an alternative strategy to chemical control for fungal diseases by Gad *et al.*¹¹, and Rajashekara *et al.*²⁷.

Future prospect :

In spite of having great potentiality in global rice market NE region still encounters several constraints including fungal infections due to lack of awareness among farmers and practicing age old cultivation techniques. Along with the rich indigenous knowledge it is the time to adopt modern advanced technologies in cultivation practices.

Eco-friendly and economically feasible integrated disease management technologies comprises of suitable cultural practices such as crop- rotation, intercropping, soil solarization and phytosanitation etc., quarantine practices, regulatory control measures, judicious manipulation of resistant rice cultivars, use of chemicals or herbal products are the feasible and up to date means for controlling fungal diseases³⁶. There is a huge scope of extensive research and investigation on the fungal diseases of rice prevailing in all the states of

NE India, especially in Sikkim and Nagaland, as no enough data on fungal diseases of rice, their causes, management measures etc. are available in those states. The potential landraces and wild varieties of rice of NE region are not only the source of valuable gene for several economic important traits but also have resistance for various fungal diseases. Therefore, further investigation and research of such varieties and landraces with detail characterization and documentation could help in improving breeding programs for resistant varieties.

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