CHAPTER-2

REVIEW OF LITERATURE

Substantial works on Blast of Rice caused by *M. grisea* were done by various workers in our country and elsewhere. However, scientific studies on Rice blast in respect to its fungal airdsora and chemical control aspects in the North Eastern Region of India, particularly in Assam is very poor. Literature of the works on blast disease of rice has been reviewed, under the following heads.

2.1 Factors affecting blast disease development

2.2 Mechanism of Pathogenesis

2.3 Chemical control of blast disease

2.4 Biological control

2.1 Factors affecting disease development

Ramakrishnan (1948) reported that the optimum temperature for the growth of the fungus *M. grisea* was 30°C. However it was observed that the low temperature was probably more favourable for the infection of the host. It was also observed that a high relative humidity favoured the disease outbreak.

Chakrabarti and Padmanabhan (1968) mentioned the occurrence of Blast disease of rice with meteorological factors. They found that Blast occurred whenever there was a coincidence of minimum temperature of 26°C or below along with the relative humidity of 90% or more during any of the susceptible stages of crop growth. Infection was higher when the minimum temperature was 24°C, 22°C or 20°C. It was suggested, that outbreak
of Blast of rice could be forecast on the basis of meteorological factors, viz. temperature and relative humidity prevailing during the susceptible stages of the crop growth.

**Kuribayashi et al., (1952) and Suzuki, (1969)** investigated the air spora over rice fields in Japan and thus served a great deal in forecasting the outbreak of rice blast disease.

**Ono (1963)** has stressed on the study of quantity of spore flight and time, and their relationship with time and severity of outbreaks of neck and node blast disease of rice, for successful disease forecasting.

**Ramalingam (1966)** found spore production in *M. grisea* (blast disease of rice) varying with the type of infection spot on the leaf. Further he suggested that an acre of rice crop with only 25% of the leaf area infected with blast disease might produce about $4 \times 10^{12}$ conidia in a day if the weather conditions are optimum for sporulation. Studies have been carried out on air mycoflora around Jabalpur by Verma & Khare (1987, 1988) and in Gulbarga by Bhat and Rajasab (1988). Study on air mycoflora over the rice (High Yielding Variety) field in rabi season in the State of West Bengal was carried out by Uddin (2005). On pathogenic and non-pathogenic mycoflora in the air and phylloplane of *Triticum aestivum* L. by Uddin and Chakraverty (2006) and aerobiological studies in relation to allergy was carried out by Singh (2007).

**Kato and Kozaka (1974)** observed the effect of sporulation and lesion formation in *M. grisea* on rice leaves. They observed that temperature between 20- 24°C was most favourable for lesion enlargement and sporulation of *M. grisea*. 
Gregory (1973) emphasized that 10% of the spore released by any source get diffused upwards, while 90% of the released spores got deposited close to the source. The high percentage of disease incidence and disease intensity was closely related to the high percentage of $M.\ grisea$ spores in the air. The growth phase of the crop may affect the incidence of blast disease and is also influenced by the weather conditions such as humidity, wind velocity, temperature, etc.

Muralidharan and Venkata Rao (1980) worked on weather relation with disease development and host susceptibility. They estimated on spores density in the atmosphere over the crop canopy was based on spore trapping device, they have also attempted to predict Blast epidemic outbreak based on spore catch in air.

Ou (1985) attempted to predict Blast epidemic outbreak based on spore catch in air. Similar observation was also reported by Muralidharan and Venkata Rao (1987). They worked on weather relations with disease development and host susceptibility. They reported on all the available estimates on the spore density in the atmosphere over the crop canopy and attempted to predict Blast epidemic outbreak.

Choong- Hoe Kim et al. (1988) studied the effect of temperature on Blast development in rice and observed that the favourable temperature was $23^\circ C$- $26^\circ C$ that lasted for more than 16 hrs at relative humidity of 90%.

Tsai and Su (1984) analysed the relationships between meteorological variables and blast incidence of rice.
Teng et al. (1991) estimated the spore density in the atmosphere over the crop canopy.

Kim and Kim (1991) reported that all the spores produced were not released to the air as some remained in lesions. Kim (1994) predicted the blast epidemic outbreak based on spore catch in air.

Rajeswari and Mariappan (1992, 1993) reported that the blast disease of rice caused severe loss in its yield. According to them the blast fungus could attack the aerial parts of the rice plant at any stage of growth which was characterized by the appearance of lesions on the leaves, nodes and panicles.

Prabhu and Fillippi (2001) observed that grain loss due to rice blast caused by *M. grisea* was directly related to the prevailing climatic conditions.

Massimo et al. (2006) developed a new dynamic deterministic model (SiRBInt) simulating the rice-blast interaction and including both weather dependent-crop and pathogen growth patterns was developed. The model is mainly intended to serve technicians working in the extension service and will simulate the potential risk of blast infection. The four years work demonstrated that the model can simulate the blast appearance in field and that it can be used in advising on fungicide application.

Devi and Singh (2008) reported that optimum temperature (maximum temperature 28.5\(^0\)C -33\(^0\)C and minimum temperature (23\(^0\)C), relative humidity (75%-83%) and rainfall (0-8.2mm) are referred to be highly
favorable for blast development. According to them, the susceptible growth phase of the crop with *Pyricularia oryzae* spore was the panicle initiation to flowering stage of the rice plant.

**Munoz (2008)** designed to investigate the effect of temperature and relative humidity on the airborne concentration of *Pyricularia oryzae* spores and the development of rice blast. They have reported that relative humidity of 95% and an average temperature of 26-27°C were optimum for infection and substantially favoured spore release.

**Shafaullah et al. (2011)** studied the effect of epidemiological factors (temperature, relative humidity and rainfall) on the incidence and severity of paddy blast (*Pyricularia oryzae*), during the growing season 2008. The disease incidence increased with the decrease of temperature and increased humidity. Rainfall was also positively correlated with incidence of disease. However, they further concluded that more epidemiological studies are still required to characterize the actual and critical factors to forecast and predict the blast disease of rice.

### 2.2 Mechanism of Pathogenesis

**According to Talbot (2003)** rice blast disease (*M. grisea*) has evolved a remarkable mechanism involving production of a cell that is required for attachment to the rice leaf surface and for generation of mechanical force to penetrate the rice leaf cuticle. To bring about rice blast disease, *M. grisea* undergoes a series of defined morphogenetic developmental steps, leading to the production of a specialized infection structure called the appressorium.
These cells are produced on the surface of rice leaves, and bring about plant infection primarily by physical breakage of the leaf cuticle.

Howard et al. (1990) demonstrated that appressoria of the rice blast fungus generated substantial turgor and performed incipient cytorrhysis experiment by applying increasing concentration of polyethylene glycol to appressoria of *M. grisea*, and then determining the rate of cell collapse. In this way, the equivalent turgor within appressoria was estimated. These experiments provided evidence that appressoria of *M. grisea* generated up to 8MPa of pressure during plant infection.

Talbot (2003) and Valent, et al. (1991) reported that as a result of enormous turgor, the appressorium produced a narrow penetration hyphae at the base of the cell, which is forced through the underlying cuticle and later developed into invasive hyphae that filled the epidermal cells of the leaf and also the symptoms became apparent after 4–5 days of initial infection (Fig-1).

![Fig-1: Infection process of blast of rice by *M. grisea*.](image-url)
Rice infection by *M. grisea* was initiated when three-celled, teardrop-shaped conidia land on the surface of a rice leaf. These spores germinated immediately on contact with the rice leaf and adhered tightly to the hydrophobic surface by means of spore tip mucilage that is released from the apex of the spore (Hamer, 1988). Germination proceeded by extension of a narrow germ tube that emerged from the conidium within an hour of its landing on the leaf surface (Talbot, 2003; Hamer, 1988). Within 4 h, the germ tube started to swell at its apex, and flattened against the surface of the rice leaf. The germ tube apex then developed into a swollen dome-shaped cell, called the appressorium (Talbot, 2003; Valent, *et al.*, 1991; Howard *et al.*, 1991).

Fig-2: Life cycle of *M. grisea.*
2.3 Chemical control

The most common method for controlling fungal disease is by chemicals. These chemicals are used in diversified ways to suppress the disease. They are applied as seed treatment, soil drenching and foliar spray.

Georgopoukos and Ziogas, (1992), Moletti et.al (1988); Naidu and Reddy (1989) reported that Fongoren (pyroquilon) in the dose of 2 kg/ha provided good control against leaf and neck blast.

Mbodi et.al (1987) and Okhovot (1989) reported that the Beam (tricyclazole=0.75 kg/ha) effectively decreased the neck blast with one or more applications followed by pyroquilon. They further reported that the fungicides Hinosan (edifenphos) with 3.0 lb/100 gallons had moderate effectiveness while Kitazin (iprobenfos) Bla-S (blasticidin) reduced leaf but not neck blast infection.

Naidu and Reddy (1989) reported that granular Chlobenthiazone in the dose of 30-40 kg/ha was better in control of blast disease of leaf than neck infection.

Georgopoukos and Ziogas (1992) reported that Oryzemate (probenazole) and Neotopsin (thiopharate-methyl) provided a very good control against the blast disease development.

Varier et al.(1993) used eight fungicides for management of rice blast and seed treatment with tricyclazole @ 4kg/kg seed which proved effective after 40 days of sowing.
Dubey (1995) conducted field trials of eight fungicides for control of *P. oryzae*, Topsin M + Indofil M-45 was most effective against leaf blast disease of rice.

Minami and Ando (1994) reported that probenazole induced a resistant reaction in rice plants against infection by rice blast fungus.

Gouramanis (1995) found that fungicides carbendazim, pyroquilon, thiophanate methyl and chlobenthiazole reduced the leaf blast disease of rice on the other hand tricyclazole was effective in reducing the neck blast.

Enyinnia (1996) evaluated two systemic fungicides Benomyl and Tricylazole on Faro / 29, a rice cultivar, at full booting stage and reported good control of natural infection of rice leaf blast.

Dubey (1997) compared the efficacy of fungicide trycyclazole, against rice Blast (*M. grisea*), with carbendazim, copper oxychloride hexaconazole mancozeb, chlorothalonil, iprobenfos and thiophanate-methyl in field experiment. Three sprays of tricyclazole (0.015%) in combination with mancozeb (0.125%) were the most effective treatment in which minimum disease intensity (6%), node (3%) and neck 2% infections were recorded with the highest grain yield.

Filippi and Prabhu (1997) reported that propagation fungicide (40 g per Kg of seed) was effective in controlling leaf and panicle blast.
Sood and Kapoor (1997) evaluated 7 fungicides against leaf and neck blast of rice caused by *M. grisea* (*P. oryzae*). Tricylazole was the most effective in reducing leaf and neck blast.

Moletti et al. (1998) conducted field trial against *M. grisea*, and found that application of pyroqulion granules or wettable powder (2 kg / ha) once or twice gave good results against leaf blast disease of rice.

Tirmali and Patil (2000) conducted field experiment on susceptible rice cultivar E. K. 70 and 5 new fungicide formulations viz; Antaco 170, Carpromid 30 SC, Fliqiconazate 25 WP, Ocatve 50 WP and Opus 15.5 SC. They found that Opus 15.5 SC was highly effective in controlling neck blast and increasing grain yield.

Tirmali et al. (2001) reported the efficacy of new fungicides in controlling rice neck blast caused by *P. oryzae* on rice cultivar EK-70 (blast susceptible) treated with win 30 sc (Capropamid), Folicur 250, WE Swing 250 Ec and Beam 75 WP at maximum tillering panicle initiation and at heading stage of crop and found that all these new fungicides have significantly reduced neck blast.

Haq et al.(2002) also conducted an experiment to evaluate various fungicides like Captan, Acrobat, Bayeltan, Sunlet, Dithane M-45 Trimiltox and Derosal in controlling the mycelial growth of *Pyricularia oryzae* under the laboratory conditions and found that Captan and Acrobat were the most effective fungicides. The fungicides viz; Rabicide, Nativo and Score were the most effective against leaf blast disease with great reduction in the disease percentage while Tilt and Armure, exhibited intermediate effectiveness.
Sood and Kapoor (1997), Tirmali et al. (2001) and Prabhu et al. (2003) reported that fungicide application increased the yield of rice. But use of fungicides was expensive, polluting and toxic to soil system.

Munoz (2008) studied the effect of temperature and relative humidity on the airborne concentration of *Pyricularia oryzae* spores and the development of rice blast in Southern Spain.

Ghazanfar et al. (2009) reported that the fungicides, viz; Rabicide, Nativo and Score were the most effective against leaf blast disease with greater reduction in the disease percentage.

Ganesh et al. (2012) evaluated ten fungicides against leaf blast of rice during kharif 2010 and 2011 season. All the fungicides proved to be affective in the management of rice blast disease. Out of ten fungicides tested, Tricyclazole, Kitazine and Ediphenphos were found significantly superior in controlling the disease and yield.

2.4 Biological control

The development of environmental friendly alternatives to the extensive use of chemical pesticides for combating crop diseases is one of the biggest challenges to microbiologists and plant pathologists. The use of beneficial microorganisms is considered one of the most promising methods for more rational and safe crop management practices (Fravel, 1988). Biocontrol offers a powerful means to increase yield by destruction or suppression of pathogen’s inoculum, protect plant against infection or increase the ability of the plant to resist pathogen. It is defined as “the reduction of inoculum density or disease
producing activities of a pathogen or parasite in its active or dormant state by one or more organisms, accomplished naturally or through manipulation of the environment, host or antagonists or by mass introduction of one or more antagonist” (Baker and Cook, 1974). Alternative strategies for disease management are necessary and include the use of biological control.

**Beagle Ristaino and Papavizaw (1984)** reported that the fungal antagonist Gloiocladium roseum effectively decreased the disease development of rice blast. The mycelial growth, in case of *Trichoderma harzianum* treatment, was less upto 71% and conidial germination was 88%.

**Jagannathan and Narasimhan (1988)** screened products from garlic oil, neem oil, neem leaf, parthenium leaf, turmeric rhizome and garlic bulb extracts which were effective in inhibiting the spore germination and mycelial growth of the two pathogens, *Helminthosporium nodulosum* and *Pyricularia grisea*. The antifungal activity of the extracts in acetone medium had higher inhibitory effect on the mycelia.

**Miah et al. (1990)** tested extracts of 16 plant species against rice pathogen *Magnaporthe grisea*, *Fusarium moniliforme* (*Gibberella fujikuroi*), *Gerlachia oryzae* (*Monographella albescens*), *Rhizoctonia solani* and *Sarocladium oryzae*. The extracts inhibited more than 50% of normal fungal growth by *Leucaene leucocephala* against *M. albescens*, *G. fujikuroi*, *P. grisea* and *R. solani* against *M. albescens* and *G. fujikuroi*, *Targetes erecta* against *M. albescens*, *P. grisea* and *R. solani*.

**Tewari (1995)** reported an effective efficacy of *Ocimum sanctum*, as a botanical fungicide against rice Blast pathogen, *M. grisea.*
Amadioha (2000) reported that water and leaf extracts/oil extracts of seeds of *Azadirachta indica* (neem) reduced radial growth of mycelium of *M. grisea* in vitro and the development and spread of Blast disease in green house.

Han (2005) showed that the plant growth-promoting bacterium *Delftia tsuruhatensis* could suppress the growth of various plant pathogens effectively, especially the three main rice pathogens (*Xanthomonas oryzae* pv. oryzae, *Rhizoctonia solani* and *Pyricularia oryzae* Cavara).

Jaiganesh et al. (2007) reported that a new plant bio-control agent viz., *Serratia marcescens* appeared to be an ideal agent for the control of *P. oryzae*, because it produced a chitinolytic enzyme which caused degradation of the fungal cell wall, induction of plant defence reaction and certain antifungal low molecular weight molecules.

Patro et al. (2008) reported that *P. fluorescens strain* 0.6% as seed treatment and two foliar sprays at 10 days interval were found to be best for the management of blast in ragi.

Zakira et al. (2009) tested sixteen bacterial strains for their ability to promote plant growth and reduce the incidence of rice blast disease. When applied to the soil, many of the isolated rhizobacterial strains increased seedling growth and/or suppressed rice blast disease.

Saki et al. (2010) screened collagenolytic/gelatinolytic bacteria from rice leaves and soil against airborne fungal diseases such as rice blast disease *Magnaporthe oryzae*. The screened bacterial culture showed inhibitory
effects on spore adhesion on the plastic cover glass, and disease protective effects on rice.

Sukanya et al. (2011) isolated and tested the essential oils and oleoresin from *Piper nigrum, Coriander sativum and Curcuma domestica* for their effect on *Pyricularia oryzae* in rice. These were evaluated for their antifungal activity against *P. oryzae in vitro* by poison food technique. Maximum inhibition of mycelial growth was observed in pepper oil which showed 5.9%, 5.5%, 4.4% and 7.0% of inhibition at 100ppm, 200ppm, 300ppm and control, respectively. Mycelial growth was completely inhibited at 500ppm and 1000ppm concentration.