

## 1. Diseases of Rice

### Fungal Diseases

**Blast** - *Pyricularia oryzae* (Syn: *P. grisea*) (Sexual stage: *Magnaporthe grisea*)

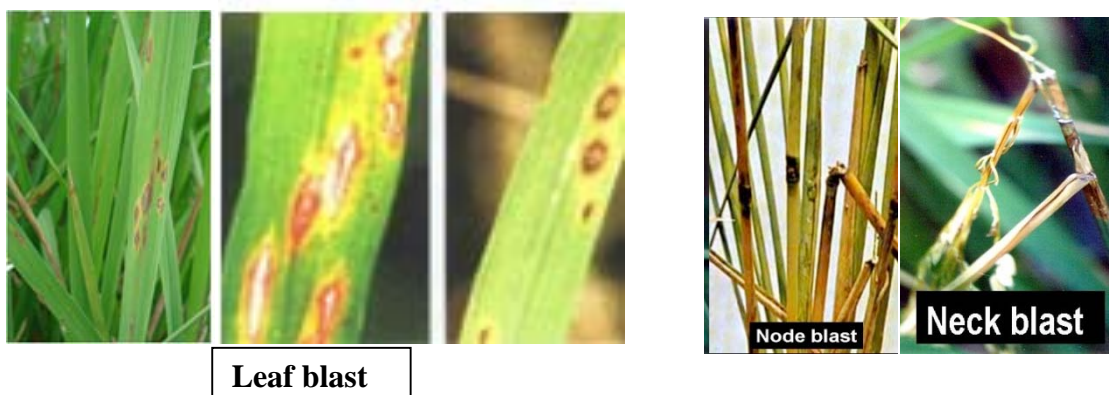
### Symptoms

The fungus attacks the crop at all stages of crop growth. [Symptoms](#) appear on leaves, nodes, rachis, and glumes. On the leaves, the [lesions](#) appear as small bluish green flecks, which enlarge under moist [weather](#) to form the characteristic [spindle shaped](#) spots with grey centre and dark brown margin (**Leaf blast**).

The spots [coalesce](#) as the disease progresses and large areas of the leaves dry up and wither. Spots also appear on sheath. Severely infected nursery and field appear as burnt. Black [lesions](#) appear on nodes girdling them. The affected nodes may break up and all the plant parts above the infected nodes may die (**nodal blast**).

During flower emergence, the fungus attacks the peduncle and the lesion turns to brownish-black which is referred to as rotten neck / neck rot / panicle blast (**neck blast**).

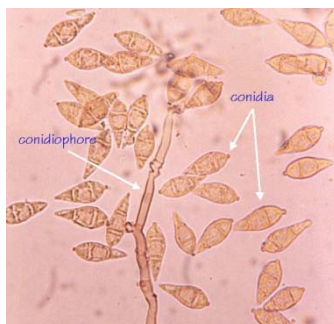
In early neck infection, grain filling does not occur while in late infection, partial grain filling occurs. Small brown to black spots may also be observed on glumes of the heavily infected panicles. The pathogen causes yield losses ranging from 30-61 per cent depending upon the stages of infection.



### Pathogen

The mycelium is hyaline to olivaceous and septate. [Conidia](#) are produced in clusters on long septate, [olivaceous conidiophores](#). Conidia are [pyriform](#) to [ellipsoid](#), attached at the broader base by a hilum. Conidia are [hyaline](#) to pale olive green, usually 3 celled. The perfect state of the

fungus is [\*M. grisea\*](#) producing perithecia. The [ascospores](#) are hyaline, fusiform, 4 celled and slightly curved.



Conidia and Conidiophore  
of *P. grisea*

### Favourable Conditions

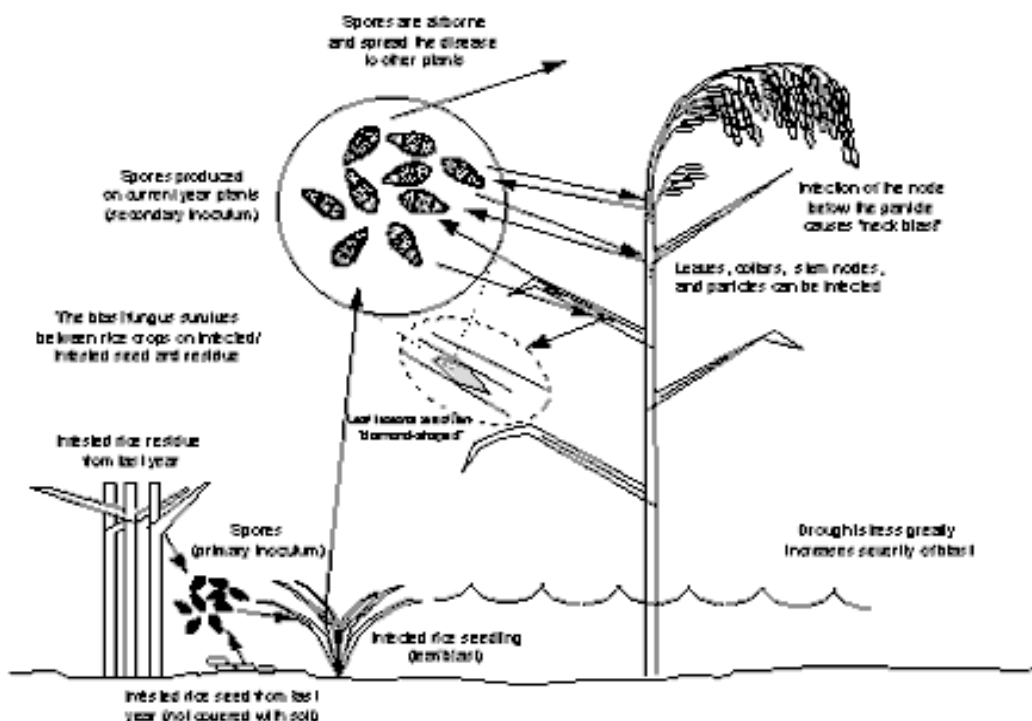
- Intermittent [drizzles](#), cloudy weather, more of rainy days, longer duration of dew and high relative humidity (93-99 per cent).
- Low night temperature (between 15-20°C or less than 26°C).
- Availability of [collateral hosts](#) and excess dose of nitrogen.

[Forecast](#) for rice blast can be made on the basis of minimum night temperature range of 20-26°C in association with a high relative humidity of 90 per cent and above lasting for a period of a week or more during any of the three susceptible phases of crop growth, viz., seedling stage, post transplanting tillering stage and neck emergence stage. In Japan, the first leaf blast forecasting model was developed named as BLAST. Later several other models have also been developed namely, [PYRICULARIA](#), [PYRIVIEW](#), [BLASTAM](#), [EPIBLA](#) and [PBLAST](#).

### Disease Cycle

The disease spreads primarily through airborne conidia since spores of the fungus present throughout the year. Mycelium and conidia in the infected straw and seeds are major sources of inoculum. Irrigation water may carry the conidia to different fields. The fungus also survives on [collateral hosts](#) viz., [Panicum repens](#), [Digitaria marginata](#), [Brachiaria mutica](#), [Leersia hexandra](#) and [Echinochloa crusgalli](#).

Spores land on leaves, germinate, penetrate the leaf, and cause a lesion 4 days later; more spores are produced in as little as 6 days. Infections from spores arriving from a distance are termed primary infections.



Primary infections generally result in a few widely scattered spots on leaves. Spores arising from the primary infections are capable of causing many more infections. This cycling is called secondary spread. Secondary spread is responsible for the severe epidemics of blast in fields and localized areas.

### Management

- Grow resistant to moderately resistant varieties CO47, IR 20, ADT36, ADT39, ASD 18 and IR64. Avoid cultivation of highly susceptible varieties viz., IR50 and TKM6 in disease favourable season.
- Remove and destroy the weed hosts in the field bunds and channels.
- Treat the seeds with [Captan](#) or [Thiram](#) or [Carbendazim](#) or [Tricyclazole](#) at 2 g/kg. or [Pseudomonas fluorescens](#) @ 10g/kg of seed. Spray the nursery with carbendazim 500mg/L or tricyclazole 300mg/L.

- Spray the main field with [Edifenphos](#) 500 ml or [Carbendazim](#) 500 g or [Tricyclazole](#) 500 g or [Iprobenphos](#) (IBP) 500 ml /ha.

**Brown Spot - *Helminthosporium oryzae*** (Syn: *Drechslera oryzae*; *Bipolaris oryzae*)

(Sexual stage: *Cochliobolus miyabeanus*)

### Symptoms

The fungus attacks the crop from seedling to milky stage in main field. Symptoms appear as minute spots on the coleoptile, leaf blade, leaf sheath, and glume, being most prominent on the leaf blade and glumes.



Leaf symptoms

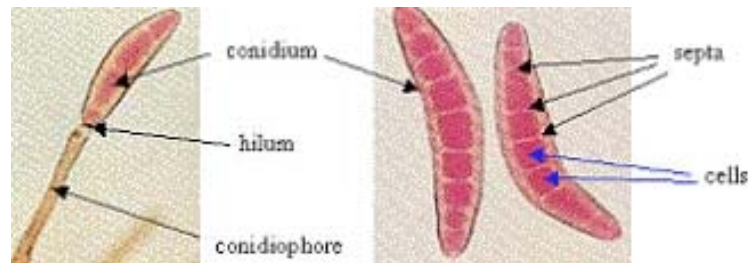


Glume infection

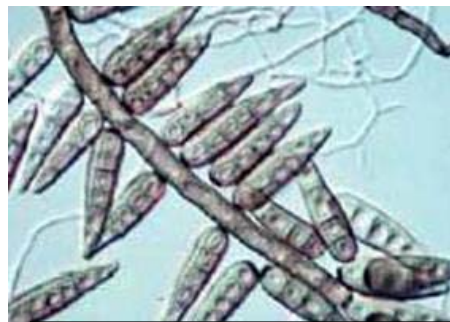
The spots become cylindrical or oval, dark brown with [yellow halo](#) later becoming circular. Several spots coalesce and the leaf dries up. The seedlings die and affected nurseries can be often recognised from a distance by scorched appearance. Dark brown or black spots also appear on glumes leading to grain discoloration. It causes failure of seed germination, seedling mortality and reduces the grain quality and weight.

### **Pathogen**

*Bipolaris oryzae* produces brown septate mycelium. Conidiophores arise singly or in small groups. They are geniculate, brown in colour. Conidia are usually curved with a bulged center and tapered ends. They are pale to golden brown in colour and are 6-14 septate. The perfect stage of the fungus is *C. miyabeanus*.



It produces perithecia with asci containing 6-15 septate, filamentous or long cylindrical, hyaline to pale olive green ascospores. The fungus produces terpenoid phytotoxins called ophiobolin A (or Cochliobolin A), ophiobolin B (or cochliobolin B) and ophiobolin I. Ophiobolin A is most toxic. These breakdown the protein fragment of cell wall resulting in partial disruption of integrity of cell.



**Coidia and Conidiophore**

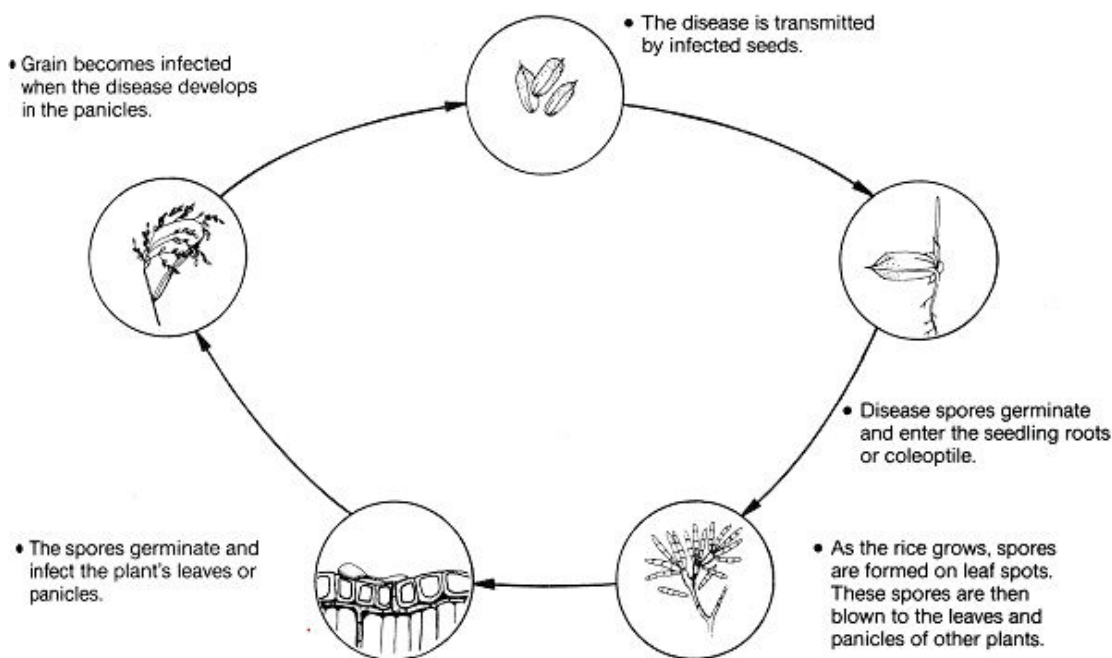
### Favourable Conditions

- Temperature of 25-30°C with relative humidity above 80 per cent are highly favourable.
- Excess of nitrogen aggravates the disease severity.

### Disease Cycle

Infected seeds and stubbles are the most common source of primary infection.

The [conidia](#) present on infected grain and mycelium in the infected tissue are viable for 2 to 3 years. Airborne conidia infect the plants both in nursery and in main field.



The fungus also survives on collateral hosts like [Leersia hexandra](#) and [Echinochloa colonum](#). The brown spot fungus is normally present in areas with a long history of rice culture. Airborne spores that are capable of causing infection are produced in infested debris and older lesions.

### Management

- Field sanitation-removal of [collateral hosts](#) and infected debris from the field.
- Use of slow release nitrogenous fertilizers is advisable.
- Grow tolerant varieties viz., Co44 and Bhavani.
- Use disease free seeds.
- Treat the seeds with [Thiram](#) or [Captan](#) at 4 g/kg. Spray the nursery with [Edifenphos](#) 40 ml or [Mancozeb](#) 80 g for 20 cent nursery.
- Spray the crop in the main field with [Edifenphos](#) 500 ml or [Mancozeb](#) 2 kg/ha when grade reaches 3. If needed repeat after 15 days.



**Narrow brown leaf spot - *Cercospora janseana*** (Sexual stage: *Sphaerulina oryzina*)

### Symptoms

The fungus produces short, linear brown spots mostly on leaves and also on sheaths, pedicels and glumes. The spots appear in large numbers during later stages of crop growth.



Symptoms

### Pathogen

*Conidiophores* are produced in groups and brown in colour. *Conidia* are hyaline or sub hyaline, cylindrical and 3-5 septate.

### Management

Spray *Carbendazim* 500 g or *Mancozeb* 2 kg/ha.

**Sheath rot - *Sarocladium oryzae* (Syn: *Acrocyndrium oryzae*)**

### Symptoms

Initial symptoms are noticed only on the upper most leaf sheath enclosing young panicles. The flag leaf sheath show oblong or irregular greyish brown spots. They enlarge and develop grey centre and brown margins covering major portions of the leaf sheath.

The young *panicles* remain within the sheath or emerge partially. The *panicles rot* and abundant whitish powdery fungal growth is seen inside the leaf sheath.



Symptoms

## Pathogen

The fungus produces whitish, sparsely branched, septate mycelium. [Conidia](#) are hyaline, smooth, single celled and cylindrical in shape.

## Favourable Conditions

- Closer planting
- High doses of nitrogen
- High humidity and temperature around 25-30°C
- Injuries made by leaf folder, brown plant hopper and mites increase infection

## Disease Cycle

The disease spreads mainly through air-borne [conidia](#) and also [seed-borne](#). Primary source of [inoculum](#) is by means of infected plant debris. Secondary spread is by means of air borne conidia produced on the leaf sheath.

## Management

- Spray [Carbendazim](#) 500g or [Edifenphos](#) 1L or [Mancozeb](#) 2 kg/ha at boot leaf stage and 15 days later.
- Soil application of [gypsum](#) (500 kg/ha) in two splits.
- Application of [Neem Seed Kernal Extract](#) (NSKE) 5% or neem oil 3 % or [Ipomoea](#) or [Prosopis](#) leaf powder extract 25 Kg/ha. First spray at boot leaf stage and second 15 days later.

**Sheath blight - [Rhizoctonia solani](#) (Sexual stage: [Thanetophorus cucumeris](#))**

## Symptoms

The fungus affects the crop from [tillering](#) to heading stage. Initial symptoms are noticed on leaf sheaths near water level. On the leaf sheath oval or [elliptical](#) or irregular greenish grey spots are formed. As the spots enlarge, the centre becomes greyish white with an irregular blackish brown or purple brown border.

[Lesions](#) on the upper parts of plants extend rapidly coalescing with each other to cover entire tillers from the water line to the flag leaf. The presence of several large lesions on a leaf sheath usually causes death of the whole leaf, and in severe cases all the leaves of a plant may be blighted



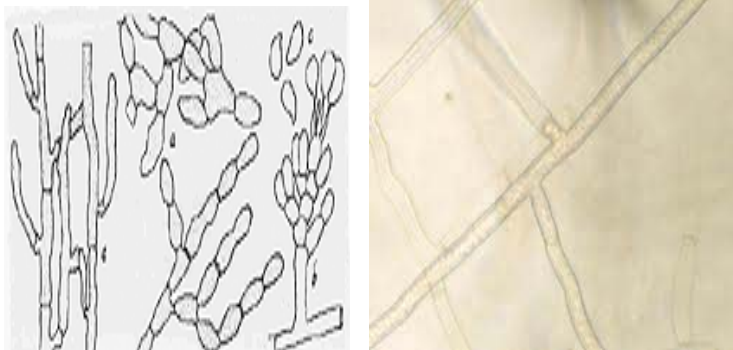


### Symptoms

The infection extends to the inner sheaths resulting in death of the entire plant. Older plants are highly susceptible. Plants heavily infected in the early heading and grain filling growth stages produce poorly filled grain, especially in the lower part of the panicle.

### Pathogen

The fungus produces septate [mycelium](#) which are [hyaline](#) when young, yellowish brown when old. It produces large number of spherical brown [sclerotia](#).

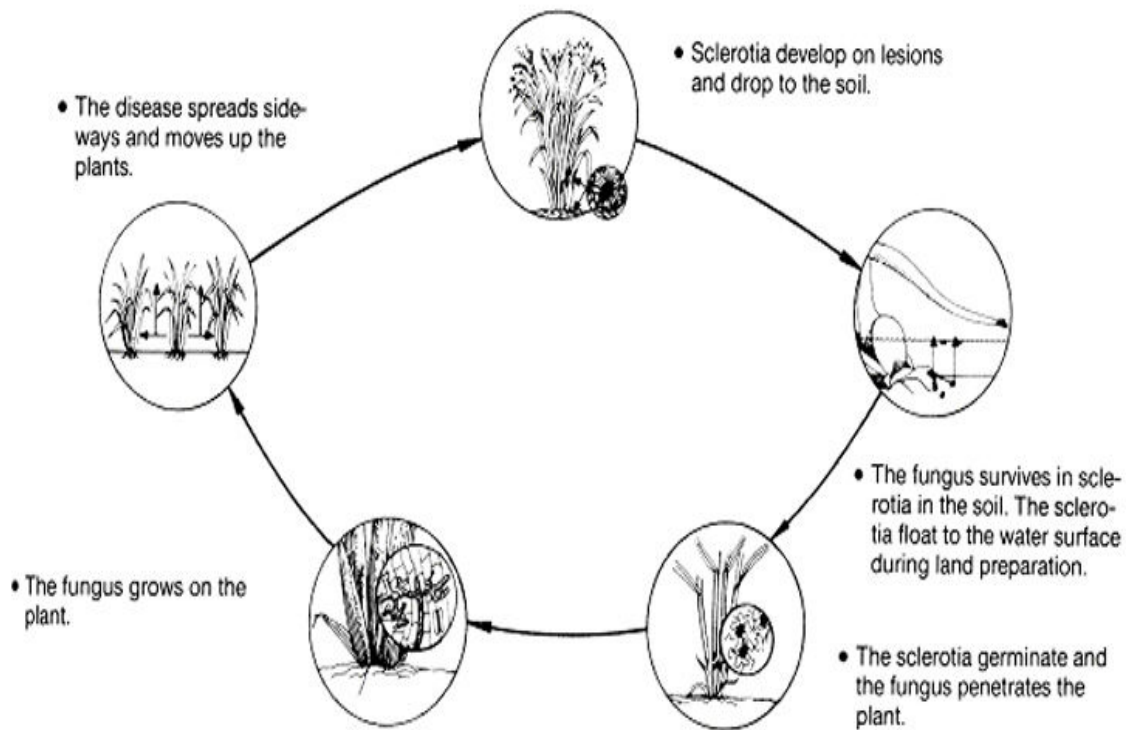


### Favourable Conditions

- High relative humidity (96-97 per cent), high temperature (30-32°C).
- Closer planting.
- Heavy doses of nitrogenous fertilizers.

### Disease cycle

The pathogen can survive as [sclerotia](#) or mycelium in dry soil for about 20 months but for 5-8 months in moist soil. Sclerotia spread through irrigation water. The fungus has a wide host range.



## Management

- Grow resistant varieties like Mansarovar, Swarau Dhan, Pankaj etc.
- Apply [organic amendments](#) viz., [neem cake](#) @ 150Kg/ha or FYM 12.5 tons/ha. Avoid flow of irrigation water from infected fields to healthy fields.
- Deep [ploughing](#) in summer and burning of stubbles.
- Spray [Carbendazim](#) 500 g/ha
- Soil application of [P.fluorescens](#) @ of 2.5 kg/ha after 30 days of transplanting (product should be mixed with 50 kg of FYM/Sand and applied).
- Foliar spray [P.fluorescens](#) at 0.2% at boot leaf stage and 10 days later

**False smut - [Ustilaginoidea virens](#) (Syn: *Claviceps oryzae - sativa*)**

## Symptoms

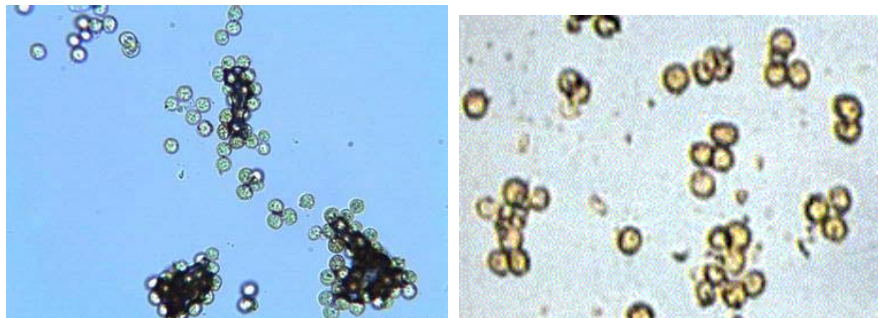
The fungus transforms [individual ovaries / grains into greenish spore balls](#) of velvety appearance. Only a few [spikelets](#) in a panicle are affected.



Symptoms

### Pathogen

[Chlamydospores](#) are formed as spore balls which are spherical to elliptical, warty and olivaceous.



Spore balls

### Disease Cycle

Grasses and wild rice species are [alternate hosts](#). The main source of inoculum is [air-borne](#) spores. [Ascospores](#) produced from [sclerotia](#) act as primary source of infection while [chlamydospores](#) are secondary source of infection. [Chlamydospores](#) are air - borne, abundant at heading stage.

### Favorable conditions

- Rainfall and cloudy weather during flowering and maturity

**Udbatta disease - [Ephelis oryzae](#) (Sexual stage: *Balansia oryzae-sativa*)**

### Symptoms

Symptoms appear at the time of panicle emergence. The entire ear head is converted into a straight compact [cylindrical](#) black [spike](#) like structure since the infected panicle is matted together by the fungal mycelium. The spikelets are cemented to the central rachis and the size is remarkably reduced. The entire spike is covered by greyish [stroma](#) with convex [pycnidia](#) immersed inside.



### Pathogen

### Symptoms

[Pycnidiospores](#) are hyaline, needle shaped and 4-5 celled.

### Management

- The pathogen is internally seed borne.
- Hot water seed treatment at 45°C for 10 min. effectively controls the disease.
- Removal of collateral hosts [Isachne elegans](#), [Eragrostis tenuifolia](#) and [Cynadon dactylon](#).

**Stackburn disease - [Trichoconis padwickii](#) (Syn: [Alternaria padwickii](#))**

### Symptoms

Leaves and ripening grains are affected. On leaves circular to [oval](#) spots with dark brown margins are formed. The center of the spot turns light brown or white with numerous minute dots. On the [glumes](#) reddish brown spots appear. The [kernels](#) may [shrive](#) and become [brittle](#).





Symptoms

### Pathogen

Conidia are elongated with a long beak at the tip, 3 to 5 septate, thick walled and constricted at the septa.

### Management

- Treat the seeds with Thiram or Captan or Mancozeb at 2g/kg.
- Hot water treatment at 54° C for 15 minutes is also effective.
- Burn the stubbles and straw in the field.

### Bunt or Kernel Smut or black smut - Tilletia barclayana

Minute black pustules or streaks are formed on the grains which burst open at the time of ripening. The grains may be partially or entirely replaced by the fungal spores. The sorus pushes the glumes apart exposing the black mass of spores. Only a few flowers are infected in an inflorescence. The fungus survives as chlamydospores for one or more years under normal condition and 3 years in stored grains.



Symptoms

**Stem rot – [Sclerotium oryzae](#) (Sexual stage: [Magnaporthe salvinii](#))**

### **Symptoms**

Small [black lesions are formed on the outer leaf sheath](#) and they enlarge and reach the inner leaf sheath also. The affected tissues rot and abundant small black [sclerotia](#) are seen in the rotting tissues. The [culm](#) collapses and plants lodge. The [sclerotia](#) are carried in stubbles after harvest.



**Symptoms**

### **Pathogen**

White to greyish [hyphae](#), [spherical](#) black and [shiny sclerotia](#), visible to naked eyes as black masses.

### **Favourable Conditions**

- [Infestation](#) of leaf hoppers and stem borer.
- High doses of nitrogenous fertilizers.

### **Disease Cycle**

The [sclerotia](#) survive in stubbles and [straw](#) those are carried through irrigation water. The fungus over winters and survives for long periods as sclerotia in the upper layers (2-3 inches) of the soil profile. The half-life of [sclerotia](#) in the field is about 2 years. Viable sclerotia have been found in fields for up to 6 years after a rice crop. The sclerotia are [buoyant](#) and [float](#) to the surface of floodwater where they contact, germinate, and infect rice tillers near the water line.

### **Management**

- Deep ploughing in summer and burning stubbles to [eliminate](#) sclerotia.



- Use of balanced application of fertilizer.
- Avoid flow of irrigation water from infected to healthy fields.
- Draining irrigation water and letting soil to dry.

**Foot rot or Bakanae disease - *Fusarium moniliforme* (Sexual stage: *Gibberella fujikuroi*)**

### Symptoms

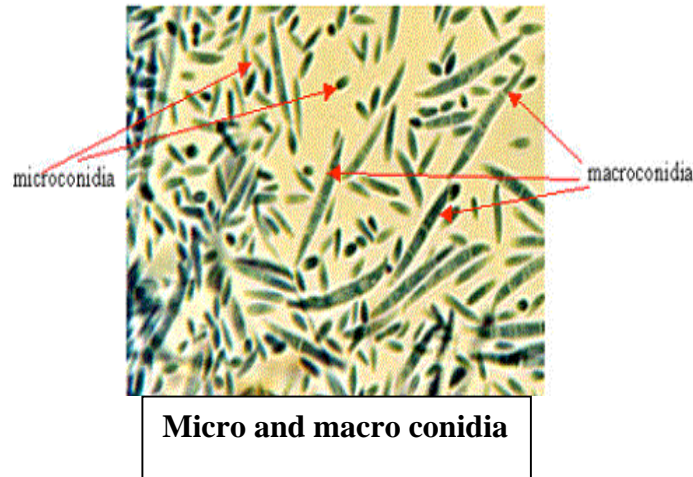
Infected seedlings in nursery are lean and lanky, much taller and die after some time. In the main field, the affected plants have tall lanky tillers with longer internodes and aerial adventitious roots from the nodes above ground level. The root system is fibrous and bushy. The plants are killed before earhead formation or they produce only sterile spikelets. When the culm is split open white mycelial growth can be seen.



Symptoms

### Pathogen

Fungus produces both macroconidia and microconidia. Microconidia are hyaline, single celled and oval. Macroconidia are slightly sickle shaped, and two to five celled. The fungus produces the phytotoxin, fusaric acid, which is non-host specific.



### Management

- The fungus is externally seed-borne.
- Treat the seeds with [Thiram](#) or [Captan](#) or [Carbendazim](#) at 2 g/kg.

**Grain discolouration** - [Drechslera oryzae](#), [D. rostratum](#), [D.tetramera](#), [Curvularia lunata](#), [Trichoconis padwickii](#), [Sarocladium oryzae](#), [Alternaria tenuis](#), [Fusarium moniliforme](#), [Cladosporium herbarum](#), [Epicoccum purpurascens](#), [Cephalosporium sp.](#), [Phoma sp.](#), [Nigrospora sp.](#)

### Symptoms

The grains may be infected by various organisms before or after harvesting causing discoloration, the extent of which varies according to season and locality. The infection may be external or internal causing discoloration of the glumes or kernels or both. Dark brown or black spots appear on the grains.

The discoloration may be red, yellow, orange, pink or black, depending upon the organism involved and the degree of infection. This disease is responsible for quantitative and qualitative losses of grains.



Symptoms

### Favourable Conditions

- High humidity and cloudy weather during heading stage

### Disease cycle

The disease spreads mainly through air-borne [conidia](#) and the fungus survives as [parasite](#) and [saprophyte](#) in the infected grains, plant debris and also on other crop debris.

### Management

- Pre and post-harvest measures should be taken into account for prevention of grain discolouration.
- Spray the crop at boot leaf stage and at 50% flowering with [Carbendazim](#) + [Mancozeb](#) (1:1) @ 0.2%.
- Store the grains with 13.5-14% moisture content.

### Bacterial Diseases

#### Bacterial leaf blight - [Xanthomonas oryzae pv. oryzae](#)

### Symptoms

The disease is usually noticed at the time of heading but it can occur earlier also. Seedlings in the nursery show circular, yellow spots in the margin, that enlarge, coalesce leading to drying of foliage. “[Kresek](#)” symptom is seen in seedlings, 1-2 weeks after transplanting. The bacteria enter through the cut wounds in the leaf tips, become systemic and cause death of entire seedling.



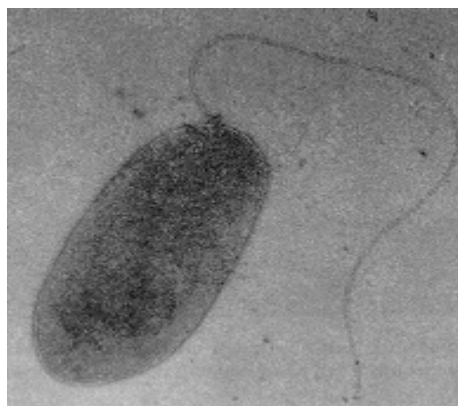
**Kresek symptom**

**Leaf blight symptom**

In grown up plants water soaked, translucent lesions appear near the leaf margin. The [lesions](#) enlarge both in length and width with a wavy margin and turn straw yellow within a few days, covering the entire leaf. As the disease advances, the lesions cover the entire lamina which turns white or straw coloured. Milky or [opaque](#) dew drops containing bacterial masses are formed on young lesions in the early morning. They dry up on the surface leaving a white encrustation. The affected grains have discoloured spots. If the cut end of leaf is dipped in water, it becomes turbid because of bacterial ooze.

### **Pathogen**

The bacterium is [aerobic](#), gram negative, non spore forming, rod with size ranging from 1-2 x 0.8-1.0µm with [monotrichous](#) polar flagellum. Bacterial colonies are circular, convex with entire margins, whitish yellow to straw yellow colored and opaque.



**Bacterium**

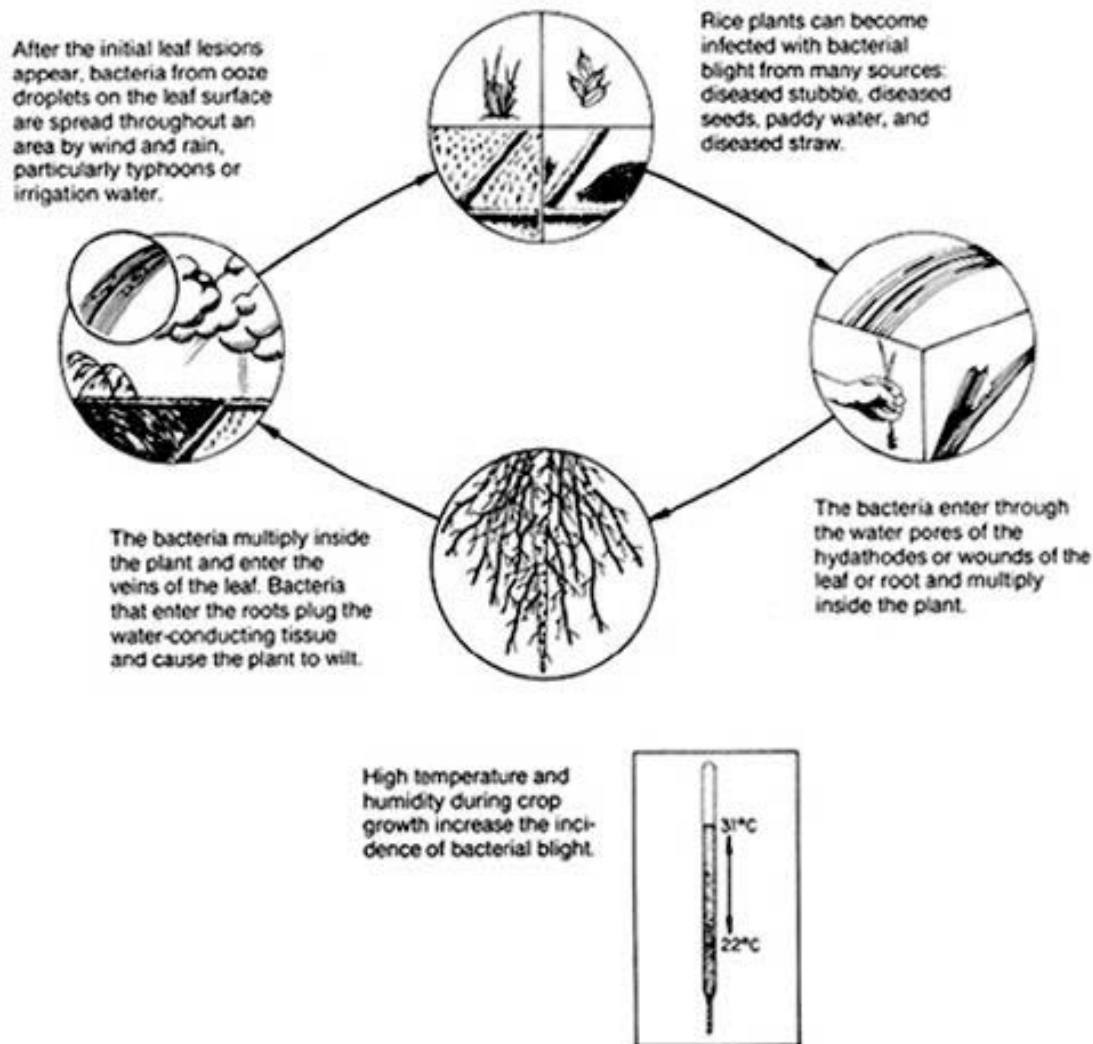
### **Favorable Conditions**

- Clipping of tip of the seedling at the time of transplanting

- Heavy rain, heavy dew, flooding, deep irrigation water
- Severe wind and temperature of 25-30 C
- Application of excessive nitrogen, especially late top dressing

### Disease Cycle

The infected seeds as a source of inoculum may not be important since the bacteria decrease rapidly and die in the course of seed soaking. The pathogen survives in soil and in the infected stubbles and on collateral hosts *Leersia* spp., *Plantago major*, *Paspalum dictum*, and *Cyanodon dactylon*. The pathogen spreads through irrigation water and also through rain storms.



## Management

- Burn the stubbles.
- Use optimum dose of fertilizers.
- Avoid clipping of tip of seedling at the time of transplanting.
- Avoid flooded conditions. Remove weed hosts.
- Grow resistant cultivars IR 20 and TKM 6.
- Spray [Streptomycin sulphate](#) and [tetracycline](#) combination 300g + Copper oxychloride 1.25 Kg/ha.

## Bacterial leaf streak - [Xanthomonas oryzae pv. oryzicola](#)

### Symptoms

Fine [translucent streaks](#) are formed on the veins and the lesions enlarge lengthwise and infect larger veins and turn brown. On the surface of the lesions, bacterial ooze out and form small yellow band-like exudates under humid conditions. In severe cases the leaves dry up.

## Management

- Burn the stubbles.
- Use optimum dose of fertilizers.
- Avoid clipping of tip of seedling at the time of transplanting.
- Avoid flooded conditions.
- Remove weed hosts. Grow resistant cultivars IR 20 and TKM 6.
- Spray [Streptomycin sulphate](#) and [tetracycline](#) combination 300g + Copper oxychloride 1.25 Kg/ha.

## Viral Diseases

### Rice Tungro Disease (RTD) - [Rice tungro bacilliform virus \(RTBV\)](#) and [Rice tungro spherical virus \(RTSV\)](#)

### Symptoms

Infection occurs both in the nursery and main field. Plants are markedly stunted. Leaves show yellow to orange discoloration and interveinal [chlorosis](#). Young leaves are sometimes mottled while rusty spots appear on older leaves. Tillering is reduced with poor root system.



Panicles not formed in very early infection, if formed, remain small with few, deformed and chaffy grains.



### Symptoms

### Pathogen

Two morphologically unrelated viruses present in phloem cells. [Rice tungro bacilliform virus \(RTBV\)](#) bacilliform capsid, circular [ds DNA](#) genome and [Rice tungro spherical virus \(RTSV\)](#) isometric capsid [ss RNA](#) genome.

### Disease Cycle

Transmission mainly by the leaf hopper vector *Nephotettix virescens* Males, females and nymphs of the insect can transmit the disease. Both the particles are transmitted [semi-persistently](#), in the vector the particles are [noncirculative](#) and [nonpropagative](#). Plants infected with RTSV alone may be symptomless or exhibit only mild stunting. RTBV enhances the symptoms caused by RTSV. RTSV can be acquired from the infected plant independently of RTBV, but [acquisition](#) of RTBV is dependent on RTSV which acts as a helper virus. Both the viruses thrive in rice and several weed hosts which serve as source of inoculum for the next. Ratoon from infected rice stubble serve as reservoirs of the virus. Disease incidence depends on rice cultivars, time of planting, time of infection and presence of vectors and favorable weather conditions

## Management

- Field sanitation, removal of weed hosts of the virus and vectors.
- Grow disease tolerant cultivars like Pankhari203, BM66, BM68, Latisail, Ambemohar102, Kamod253, IR50 and Co45.
- Control the vectors in the nursery by application of [Carbofuran](#) 170 g/cent 10 days after sowing to control hoppers.
- Spray [Phosphomidan](#) 500 ml or [Monocrotophos](#) 1lit/ha (2 ml/litre) or Neem oil 3% or NSKE 5% to control the vector in the main field 15 and 30 days after transplanting.
- Set up light traps to monitor the vector population.

## Rice Grassy stunt disease - [Rice grassy stunt tenuivirus](#)

### Symptoms

Plants are markedly [stunted](#) with excessive tillering and an erect growth habit. Leaves become narrow, pale green with small rusty spots. May produce a few small panicles which bear dark brown unfilled grains.



Symptoms

### Pathogen

[Rice grassy stunt tenuivirus](#), [flexuous](#), [filamentous](#) 950-1350nm long x 6nm wide, ssRNA genome

### Disease Cycle

Disease spreads by the brown plant hopper, [Nilaparvata lugens](#), in a [persistent](#) manner having a latent period of 5 to 28 days in the vector. Ratoon crop and presence of vector [perpetuate](#) the disease from one crop to other.