

Ear Blighting of Rice Plants and Its Control

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'Ear blighting' or 'ear discoloration' of rice plants which occurs at later ripening stage is well known in Japan. Its symptoms resemble those of rice blast, showing dark brown discoloration of the uppermost internodes, neck nodes and panicles with poor grain, and until recently, it had been believed to be another symptoms of rice blast caused by *Pyricularia oryzae*.

However, it has become to be considered that ear blighting is caused by several factors except blast fungus, since it can not be controlled with mercuric compounds and other chemicals which are highly effective against rice blast, and it has increasingly received much attention as a factor causing a reduction of both yield and quality of rice.

At present, ear blighting is widely rampant in Formosa, Thailand, India and other rice growing countries in Asia. This paper tries to review recent information obtained in Japan.

Fungi concerning ear blighting of rice plants

Recently Japanese scholars (Mori and Matsuda 1963, Ibaraki et al. 1967, Ibaraki 1969, Kitani et al. 1970, Suzuki and Yamaguchi 1970) have conducted studies to make clear the causal agents of ear blighting.

According to the results of these investigations, *Helminthosporium oryzae*, *Cercospora oryzae*, *Fusarium nivale* (This fungus had been identified as *Rhynchosporium oryzae* until recently, but it was identified as *F. nivale* by

Tominaga), *Helminthosporium sigmoidium*, and *H. sigmoidium* var. *irregulare* are main causal agents of ear blighting.

Of these, *H. oryzae* is the most important agent causing serious damage over a wide area. *F. nivale* causal fungus of "Kassyoku-hagare-byo", "scald" of rice plants, is found widely in northern Japan and some mountainous basins in southwestern Japan.

Cercospora oryzae also attacks seriously rice ears, but its occurrence is rather restricted to some heavily depleted paddy fields.

Helminthosporium sigmoidium and *H. sigmoidium* var. *irregulare*, stem rot fungi of rice plants, play an important role as causes of ear blighting in Hokuriku, Tohoku and Kyushu districts in Japan.

Some other fungi, such as *Curvularia lunata*, *Alternaria oryzae*, *Epicoccum neglectum*, *Phoma glumarum*, *Nigrospora oryzae* and *Fusarium* spp., are commonly isolated from the ears showing ear-blighting symptom, but they are all weak in pathogenecity to the ears of rice varieties cultivated in Japan.

Akai and Oguchi (1967) isolated many fungi such as *Phoma* sp. *Curvularia lunata*, *Nigrospora oryzae*, *Helminthosporium oryzae*, *Alternaria oryzae* and *Fusarium* spp. from the ear-blighting samples in Formosa and Thailand. They pointed out that kinds of the fungi isolated from the ears differed due to the countries or the regions in the countries.

In India, the damage by sterile panicles or glume discolorations has become a major limiting factor to higher rice production. According to the author's investigation, the damage

partially depends on *Helminthosporium oryzae* and an unidentified fungus.

I described the causal fungi of ear blighting in Japan and some other countries in Asia, but it is easily assumed that the most common causes or the most important causes of ear blighting may differ by countries, climatic conditions, cultural measures or varieties.

Symptoms and diagnosis

Symptoms of the diseases causing ear blighting and rice blast resemble each other on the ears, but these diseases show clear characteristics in the symptoms on the uppermost internodes, panicle bases and panicle axes.

The blast lesions are water-soaked grayish green in color, surrounded by yellowish green zone and become dark lesions with grayish-white and dead parts at the center (Fig. 1-A).

In the ears severely attacked, there is no filling-out of the grain and the ears remain erect and dry out. The glumes attacked by the blast at early stage of heading usually show grayish white, with no filling-out of the grain. In some cases, brown to dark brown spots can be seen on the glumes infected at later stage.

In *Helminthosporium* leaf spot, dark brown to black streaks 0.5 to 5 cm in length and 0.3 to 0.5 mm in width appear on the uppermost internodes and panicle axes.

In severe cases whole surface of these parts changes to dark brown in color and dry out later (Fig. 1-B). When the glumes are attacked, well defined brown spots with collapsed center appear on the surface. In particularly severe cases the whole surface of the glumes may be coated with a dense, black mass of sporophores and spores.

In "Kassyokuhagare-byo" (*F. nivale*), many purplish brown lesions with obscure margins appear on the uppermost internodes at early stage and the lesions cover the whole surface of them (Fig. 1-C). Infected glumes turn to purplish brown and then to reddish brown in color. The margins of the discolored areas are

generally obscure, not producing well defined spots.

In *Cercospora* leaf spot, purplish brown long streaks 3 to 10 cm in length, not exceeding one mm in width appear on the uppermost internodes. Usually the streaks are longer and wider than those of the *Helminthosporium* leaf spot (Fig. 1-D). Purplish brown streaks appear on the glumes, but in most cases the streaks are not so clear in shape.

The first manifestation of stem rot is the appearance of small, black points or short streaks on the outer surface of the uppermost internodes. As the disease develops, the infected internodes turn to dark brown in color and they collapse, allowing the internodes to lodge (Fig. 1-E). Many small sclerotia are produced on the inner surface of the internodes (Fig. 1-F). Small brown spots with obscure margin appear on the glumes.

Generally, these symptoms are apt to lose their characteristics at a later stage of disease development; therefore, it is desired to diagnose the diseases using the fresh samples and also using the leaves and sheaths in addition to the ears.

Ecology

Ear blighting is caused by the diseases as described above. The ecology of its occurrence, of course, differs by the kind of diseases causing ear blighting.

Ear blighting due to *Helminthosporium* leaf spot shows an endemic aspect in its occurrence in comparison with rice blast showing an epidemic aspect. Its occurrence has the most close relation to the soil conditions of paddy fields among the environmental factors affecting disease occurrence.

The disease occurs particularly in autumnal declined paddy fields or depleted paddy fields deficient in nitrogen, potassium, iron, manganese and magnesium as a result of leaching.

The disease occurrence is also accelerated under the conditions of rainfall at heading stage and of higher temperature during

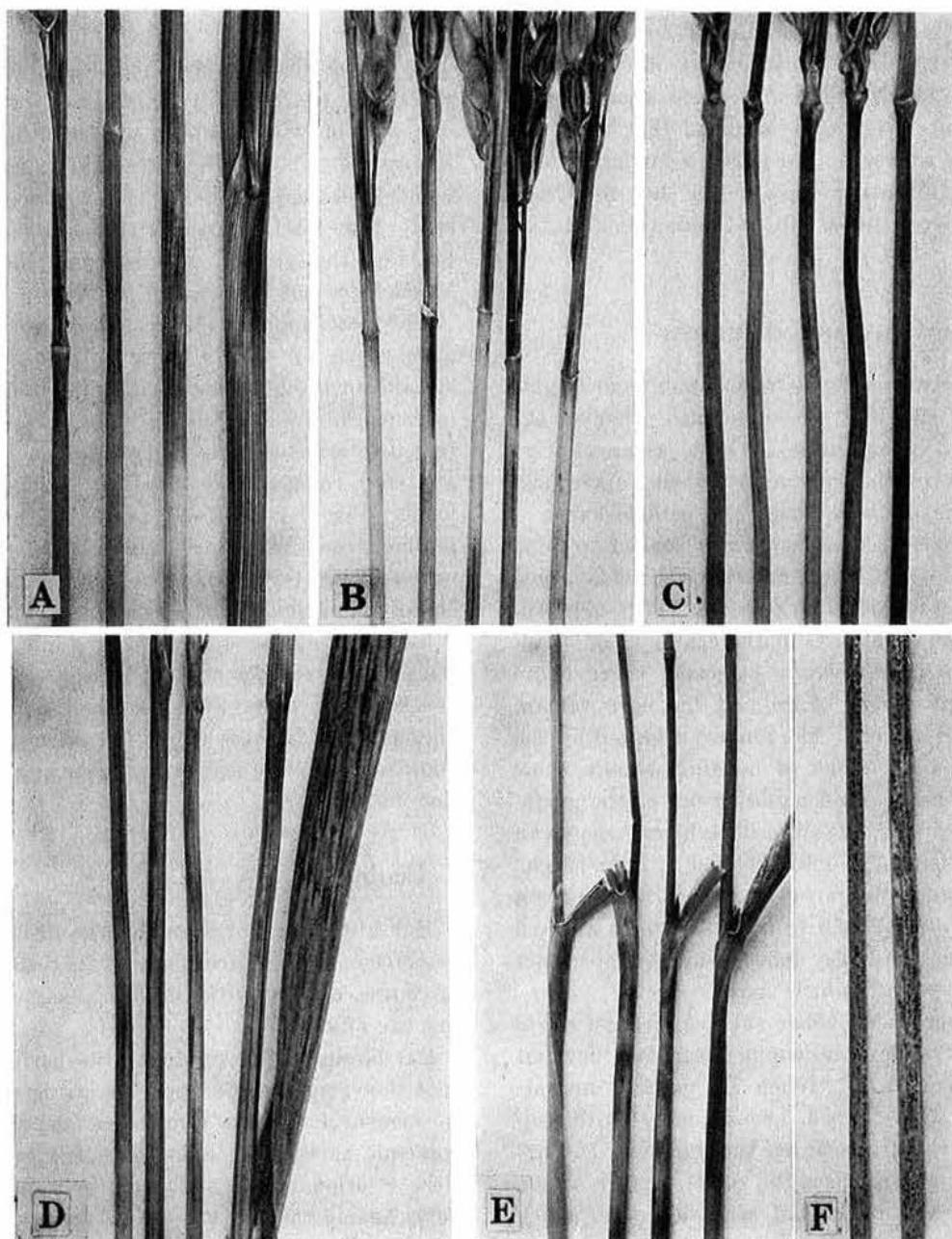


Fig. 1. Symptoms on the uppermost internodes infected by the fungi concerning ear blighting of rice plants

- A: Blast
- B: *Helminthosporium* leaf spot
- C: Kassyokuhagare-byo (*Fusarium nivale*)
- D: Cercospora leaf spot
- E: Stem rot
- F: Sclerotia on the inner surfaces of the uppermost internodes infected by stem rot

ripening stage. The fungus easily attacks only the glumes at heading stage, and easily attacks the uppermost internodes, neck nodes, panicle axes and primary branches at later stage of ripening in contrast to *Pyricularia oryzae* attacking easily the neck nodes and the other parts of the ears from heading to later ripening stage.

"Kassyokuhagare-byo" chiefly occurs in northern districts or in some mountainous basins in both central and southwestern Japan. Lower temperature and rainfall at heading stage and super application of nitrogenous fertilizer are favorable to the disease outbreak.

The occurrence of Cercospora leaf spot is limited to the heavily autumnal-declined paddy fields where nitrogen, potassium and some other minor elements are deficient.

Stem rot is prevalent in the paddy fields or water-logged soils and its occurrence is accelerated by the super application of nitrogenous fertilizer or by the lack of potassium.

Although ear blighting is caused, of course, by one kind of the diseases mentioned above, it is rather common that ear blighting in a paddy is caused by two or three kinds of the diseases, for instance, blast and *Helminthosporium* leaf spot in autumnal-declined paddy fields, blast and "Kassyokuhagare-byo" in north Japan, or *Helminthosporium* leaf spot and Cercospora leaf spot in some heavily depleted paddy fields.

Control

Among these major diseases concerning ear blighting, *Helminthosporium* leaf spot is most important and its control measures are well studied. The disease mainly occurs in autumnal-declined paddy fields or in depleted paddy fields; it is, therefore, recommended for controlling the disease by soil improvement or proper fertilizer application at first.

In these paddy fields, fresh-soil dressing and application of slags such as open-hearth furnace slag containing silicon, iron, magnesium,

manganese, and phosphate are highly effective to control the disease.

Another silicate fertilizer such as calcium silicate is also effective. As the lack of nitrogen and potassium in the later growing stage also increases disease development, top dressing of these fertilizers is recommended.

As a chemical control, twice spraying of Manzeb (coordination product of zinc ion and manganese ethylenebisdithiocarbamate) at booting and later heading stages or at heading and soft-dough stages is highly effective (Kitani et al.).

For "Kassyokuhagare-byo" control, application of EDDP (o-ethyl-s, s-diphenylthiophosphate) is effective, but we have no efficient chemicals for controlling Cercospora leaf spot and stem rot. Therefore, the improvements of cultural measures are recommended for controlling the latter two diseases.

Application of potassium and less application of nitrogen are effective for the control of "Kassyokuhagare-byo", and these are quite true in the case of stem rot control.

For the control of Cercospora leaf spot, soil improvement, application of minor elements such as magnesium, manganese, iron and top dressing of nitrogen and potassium fertilizers at later stage of rice growing are effective as well as in the case of *Helminthosporium* leaf spot. Using of resistant varieties is also effective against the disease.

As described above, it is rather common that ear blighting in a field is caused by two or three kinds of the diseases, diagnosis of the diseases concerning ear blighting is important at first, and it is necessary to take suitable measures for controlling the disease and/or the diseases concerning ear blighting in the field.

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