Pellicularia Sheath Blight of Rice Plants and Its Control

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The first occurrence of *Pellicularia* sheath blight in Japan was reported by Miyake in 1910. The disease has since increasingly spread throughout the country and become one of the most common diseases and destructive next to rice blast. In the past five years, the average affected area was a range of 0.9 to 1.3 million hectares or about 30 to 40% of the cultivated rice plant area. The cumulative area sprayed with chemicals for the control of sheath blight was 0.7 to 1.8 million hectares.

The disease is widely distributed in Oriental countries and causes considerable damage, but few in the United States. For this reason, the disease is called also by the name of Oriental sheath and leaf spot.

Symptoms

Leaf sheaths, leaf blades and stems are affected. The lesions on leaf sheaths are first greenish-grey and ellipsoil, 2 to 3 cm. long or more, gradually becoming greyish-white with a blackish-brown narrow margin as shown in Fig. 1. On leaf blades the lesions are larger and somewhat irregular in shape, which are first watery greenish-grey and gradually enlarging and becoming greyish-white with brown margin.

On the stems the lesions are very similar in shape and color to those on the sheaths, which are produced when the disease is severe. The severely diseased plants often snap at the upper diseased parts or lodge entirely on the grounds. Inoue and Uchino (1963) showed that starch content in the sheath rapidly decreased and absorption of nitrogen and potassium was highly inhibited by infection. The crop loss from the disease is roughly estimated to be 30~40% when all of the leaf sheaths and leaf blades are entirely infected.

Fig. 1.

Causal organism

The causal fungus forms sclerotia in an imperfect state and basidiospores in a perfect state. Sclerotia are about 3~4 mm. in diameter, semi-spherical, oval or spherical, or cushiony, and white when young, then become dark brown in color. They are mostly produced superficially, particularly on the outer side of the lesions of leaf sheaths as shown in Fig. 2, then easily detached.

Fig. 2.

Ikata and Hitomi (1930) first found numerous basidiospores on the plants. The hymenia, white and powdery, are formed on only the host plants near the booting stage, usually on the healthy outer surface of the sheath or of the leaf blade some distance up the lesion when air moisture is almost saturated. The basidia and basidiospores are formed at night. The basidia are clavate or obovate, colorless, 13–16 × 6–10 μ. The sterigmata are 4–8 × 1–3 μ. The basidiospores are ovel or elongated, colorless, 6–11 × 5–8 μ.

Miyake (1910) named the causal fungus *Sclerotium irregular*, but Sawada (1912) identified it as *Hypochnus sasakii*, a fungus first found by Sasaki on the leaves of camphor trees and described by Shirai in 1906. Matsumoto (1934) made extensive studies on the fungus and concluded that the name *"Corticium sasakii"* was preferable to *Hypochnus sasakii*, but most Japanese researchers had used the name *"Hypochnus sasakii* for a long time until Ito (1955) proposed *Pellicularia sasakii*.

Pellicularia sasakii has received support from more recent Japanese investigators for the view that the causal fungus is to be regarded as a species distinct from *Rhizoctonia solani*. It should be noted, however, that there is considerable confusion regarding classification of species of *Rhizoctonia* and of the perfect state with which they have been linked. Opinion has been divided on the scientific name of the causal fungus even at present.

Mode of infection

Recently, the mode of infection was reinvestigated extensively by Kozaka *et al* (1957, 1961), Kawai *et al* (1958), Kitani *et al* (1958) and many other workers. The results are summarized as follows.

Primary infection is caused by sclerotia produced on the diseased rice plants and on the several wild grasses in the previous summer. In paddy field, the overwintered sclerotia appear from the soil, floating on the water surface as a result of paddling and come to adhere to rice plants by the action of water stream or wind or by weeding operation. Sclerotia germinate over a temperature range of 16 to 32°C with an optimum of 28 to 30°C. Water drops and high air moisture above 96% are required for the germination.

Fig. 3.

Sclerotia germinate directly by means of a germ tube, which comes into contact with the nearest surface of rice plants as shown in Fig. 3. Primary infection occurs usually on the middle part of the lowermost leaf sheaths. In the case of upland field, the sclerotia located on or near the soil surface can germinate. Soil is a good media for germination. The germ tubes creep on the soil surface to come into contact with the nearest rice plants developing as long as 10 cm. within two or three days.

Secondary infection is mostly from mycelium and rarely from basidiospores. The mycelia arise from the lesions and rapidly spread upwards or to the lateral side, directly through air spaces or interstics between sheaths, and along the outer surface of plants as shown in Fig. 4. The disease spreads also by way of

Fig. 4.

contact infection of healthy plant parts with the diseased parts.

The mycelia produce infection cushions in contact with the host surface from which arise small penetration tubes. On the leaf sheath the fungus penetrates only the inner surface, directly through the cuticle or through the stomata, while on the leaf blade the fungus invades both surfaces through the moter cells or through the stomata. Some difference in the mode of penetration is observed between the upper and lower sheaths. In the former, penetration through the cuticle is more common, while in the latter, the same can be said of penetration through the stomata.

Changes of susceptibilities of rice plant with ageing

Kozaka (1961) reported that since the leaf sheath and leaf blade older than 5 to 6 weeks are highly susceptible, while younger ones less than 2 to 3 weeks are very resistant, the disease is always limited in the lower leaves and sheaths below the 4th counted from the uppermost leaf prior to heading time, and then in the subsequent period after heading the disease develops upwards quite regularly, sheath by sheath even when the environmental conditions are very favorable to the infection. Infection is localized, however, if the plants are too old.

Effects of the environmental and cultural conditions on the disease

1) Climatic conditions

A temperature range of 23 to 35°C with an optimum of 30 to 32°C and high relative humidities above 96% are required for infection and enlargement of lesions (Henmi and Endo 1933, Kawamura 1942, Kozaka 1957). In Japan disease intensity is chiefly determined by air temperature in summer and severe disease occurs when summer is hot because Japan has much rain and moisture sufficient for disease infection almost throughout the year. In tropical districts, however, it is assumed that a critical factor determining disease intensity is humidity.

2) Time of maturity of rice plants

This is one of the most important cultural conditions determining disease intensity in Japan. The rice plants under conditions of earlier maturity are always more infected with the disease because the later growth stage after heading that is the most susceptible falls in with the higher temperature condition of summer that favors the infection (Kozaka 1954, 1961). For this reason, planting of early varieties or early transplanting generally results in severe disease infection.

3) Density of planting

Kitani *et al.* (1958) showed that dense planting, particularly transplanting with dense plants per hill, increases the disease because it allowed more sclerotia attaching to the plants and promoted much more contact infection by mycelia. In addition ,it kept the plants under higher humidity. For the same reasons, the varieties of higher tillering are more infected (Nozu and Yokogi 1936, Kozaka 1961).

4) Fertilizer

Many workers report that excessive application of nitrogen fertilizer or deficiency of potassium fertilizer makes the plants highly susceptible to the disease, but phosphorous or silica fertilizer does not affect susceptibility. Inoue and Uchino (1963), however, reported that the plants applied with higher amounts of phosphorous fertilizer became susceptible in the tests in which the detached sheaths were inoculated with mycelia on its inner surface.

Recently, the disease rapidly increased in Japan. This fact is ascribed to the following changes in cultural practices of rice plants. a) The varieties are replaced with more advanced ones that are shorter in plant height, higher in tillering, more erect and compact in plant habit. b) The time of transplanting becomes earlier. c) Dense planting and later divided top-dressing of nitrogen fertilizer by the time the milky ripping stage becomes popular. These are the major factors that favor the disease as described above.

Varietal reactions

Nozu and Yokogi (1936) and many other workers reported that there were many highly susceptible varieties among Japanese ones, but few highly resistant varieties which were possible to use as a parent for breeding resistant varieties. A few reports showed that there were some resistant varieties among *indica* type varieties. Quite recently, further studies using a lot of foreign varieties are made for varietal resistance in Japan.

Late varieties generally are less infected due to the disease escaping as mentioned previously.

Control

Chemical control with organoarsenic fungicides or with an antibiotic, polyoxin, has been widely applied. The amount of commercial fungicides used in 1968 for the control of the disease was estimated to be about 25,000 tons as dusting powder.

1) Arsenic compounds: An organoarsenic compound "Urbazid", methylarsenic dimethyldithiocarbamate, was first found to be highly effective in 1956 (Kozaka *et al* 1957). Several other arsenic compounds have since been developed, i.e., methylarsenic bis (dodecyl sulfide), poly (methyl-bis-(thiocyanato) arsine), calcium methanearsonate, iron methanearsonate and ammonium iron methanearsonate. The last two compounds have been most widely used at present.

The recommended concentration is 10 to 20 ppm for spraying and 0.2–0.4% for dusting. The best time for the first application is near the panicle formating period shortly after the primary infection, and for the second application just before earheading. The second application should be applied when the disease is severe. Excessive application above a dosage of 20 g. per hectar as arsenic should be avoided because most arsenic compounds are found to be phytotoxic to rice plants at higher dosage (Inoue and Uchino 1963). The rice plants become very sensitive to arsenic toxicity when they are deficient in nitrogen or potassium or root-rotted.

2) Polyoxin: Polyoxin is a new antibiotic produced by *Streptomyces cacaoi* var. *asoensis* found in Japan in 1965 (Isono *et at* 1965). The commercial product contains 12 different active substances which resemble each other in chemical structure. Of these, D substance is the most effective to the disease. Polyoxin is somewhat inferior to organoarsenic fungicides in its effectiveness but it does not give any phytotoxicity to many crops including rice. The recommended concentration is about 20 ppm for spraying and 0.2 to 0.3% for dusting. The best time of application is a little later than that of arsenic compounds. More than two times application from the panicle formating period to about 10 days after heading is recommended.

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