日植病報 63 : 324-327 (1997)
Ann. Phytopathol. Soc. Jpn. 63 : 324-327 (1997)

Relationship between Incidence of Rice Sheath Blight and Primary Inoculum in the Philippines: Mycelia in Plant Debris and Sclerotia

Takashi KOBAYASHI*,***, Twng Wah MEW** and Teruyoshi HASHIBA*

Abstract

Plant debris floating on the water surface after puddling was collected and applied in a sclerotia-free experimental field to confirm that mycelia in plant debris act as primary inocula for rice sheath blight in the Philippines. As we were able to isolate sheath blight fungus from plant debris, the mycelium apparently survived in debris until the following growing season. The percentage of diseased hills in plots without plant debris reached 3.9% by one month after heading, whereas in plots containing plant debris at a rate of 2 kg and 4 kg per 35 m^2, the values were 11% and 18%, respectively. Inoculum potential of sclerotia was about three times as much as that of plant debris. These results suggest that mycelium in plant debris may play a role as primary inoculum of the disease in the Philippines.

(Received October 2, 1996; Accepted April 22, 1997)

Key words: rice sheath blight, sclerotia, plant debris.

INTRODUCTION

Sheath blight disease of rice, caused by *Rhizoctonia solani* Kühn AG-1 IA, has become one of the major rice diseases in recent years. Rice sheath blight occurs in all temperate and tropical rice production areas and is especially important in irrigated intensive production systems. Cultivar characteristics and culture conditions are thought to be associated with increases in disease outbreaks. High-tillering and semidwarf rice cultivars are widely grown under heavy fertilizer and dense planting conditions to achieve high yields. These cultivars and growing conditions are also conducive to the development of sheath blight[5,6,8,10,11].

The most effective and economical control of the disease is to develop cultivars resistant to the sheath blight fungus. However, cultivars may lose their resistance, because resistance is combined with characteristics that do not achieve high yields. Nor have molecular biology techniques such as host-vector systems yet been applied to *R. solani*. Cultural and biological control methods, however, have been applied to minimize the incidence of rice sheath blight[2,3,6,12]. The use of fungicides to control the disease is most common. Accurate forecasting of disease development and yield loss may enable growers to apply fungicides more judiciously.

The primary inoculum for rice sheath blight consists mostly of sclerotia floating on the water surface after puddling[3,9]. Mature sclerotia detached from rice plant can survive on the surface of soil or in soil. In the following growing season, sclerotia float on the water surface, germinate and infect rice tillers[4]. In addition to sclerotia, basidiospores of *Thanatephorus cucumeris* and mycelium in plant debris are also considered to be a source of infection[8]. Although the inoculum potential of basidiospores produced in hymenia on rice plants is unknown, they are not expected to play an important role in primary infection; hymenia are formed when the development of sheath blight is active under high temperature and high relative humidity conditions. In a temperate country such as Japan, mycelia in plant debris lose viability due to the cold winter conditions prevailing after harvest. However, mycelia may act as inoculum in the tropics without losing its viability, since hot, humid conditions prevail year round, with short intervals between growing seasons.

To confirm the existence of mycelium in plant debris, we attempted to isolate the sheath blight fungus from debris. Thereafter, we examined the percentage of diseased hills in an experimental field and in pots when various amounts of infected plant debris were applied. Finally, we compared the inoculum potential of sclerotia with that of plant debris.

* Faculty of Agriculture, Tohoku University, 1-1 Tsutsumidori-Amamiyamachi, Aoba-ku, Sendai 981, Japan 東北大学農学部

** International Rice Research Institute, P.O. Box 933, 1099 Manila, Philippines 国際イネ研究所

*** Present address: Tohoku National Agricultural Experiment Station, 4 Aza-Akahira, Shimo-Kuriyagawa, Morioka 020-01, Japan (Japan Science and Technology Corporation, Domestic Research Fellow) 現在：東北農業試験場（科学技術振興事業団科学技術特別研究員）

MATERIALS AND METHODS

Culture conditions Field experiments were carried out at the International Rice Research Institute (IRRI), the Philippines in the wet season of 1994. Rice cultivar IR72 plants raised in the nursery were transplanted on August 9, 1994 at a 20×20 cm density under irrigation. IR72 was also used in pot tests. Basal application of fertilizer was performed at the rate of 40-30-30 kg per ha ($N-P_2O_5-K_2O$) with an additional application at the rate of 40 kg per ha (N). Heading time occurred on October 10, 1994. The experiment was laid out in a randomized block design with two replications. The experimental field was surrounded and separated by a concrete fence with an area of 5×7 m for each plot.

Isolation of sheath blight fungus from plant debris Rice plant debris floating on the water surface after puddling in the field was collected from various areas and sampled for the isolation of *R. solani*. Plant debris was cut in about 3 cm long pieces and the fresh weight of 500 pieces measured. A piece of debris sterilized in 70% ethanol was plated on water agar and incubated at 27°C for 2 days. All isolates were tested by using the tester strain of *R. solani* to determine the anastomosis group[13,15].

Inoculation of plant debris To verify whether mycelium in plant debris could act as primary inoculum, we investigated the inoculum potential in pot tests. Plant debris was applied on the water surface in pots or attached to the lower part of the rice sheath at the booting stage.

In the field, plant debris was applied at 0, 2 and 4 kg per plot on the water surface before transplanting.

Inoculation of sclerotia Sclerotia floating on the water surface were collected after puddling and applied in an experimental field at 0.5 and one million sclerotia per ha. In this experiment, we took out the original soil and put in different soil without sclerotia in each plot.

Disease assessment The percentage of diseased hills was counted based on 100 hills randomly selected in each plot. Disease assessment was examined at 7-day intervals for two months around heading time.

RESULTS

Isolation of sheath blight fungus from plant debris

The rate of sheath blight fungus in plant debris collected from various spots in the field was 47.7 per 500 pieces (Table 1). The fungus were isolated from 9.6% of the plant debris pieces.

Inoculum potential of plant debris

After plant debris was applied on the water surface or attached to the sheath in pots at the booting stage, sheath blight lesions occurred on the lower part of sheaths 2 to 7 days after inoculation (data not shown).

The infectivity of mycelium was confirmed by applying debris to an experimental field. The number of diseased hills in the plots amended with plant debris was higher than that in the plots without debris (Fig. 1). One month after heading, 3.9% of the hills without debris were diseased, whereas in plots with plant debris added at 2 kg and 4 kg per 35 m², the values were 11% and 18%, respectively.

Percentage of diseased hills depending on density of sclerotia

An experimental field was amended with 0.5 or one million sclerotia per ha or plant debris of 1140 kg per ha, which was estimated from isolating the fungus to be equivalent to about one million sclerotia per ha. Diseased hills in the plots amended with one million scle-

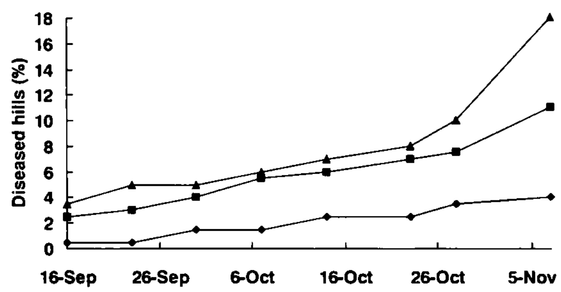

Fig. 1. Percentage of diseased hills in plots without plant debris (◆: control) and amended with debris (■ : 2 kg per 35 m² and ▲ : 4 kg per 35 m²) in the Philippines. Heading time was on October 10.

Table 1. Sheath blight fungus content in plant debris collected from the water surface in the field

Experiment No.[a)]	Fresh weight of debris per 500 pieces (g)	Number of pieces of debris containing sheath blight fungus	Sheath blight content (%)[b)]
1	245.1	83	16.7
2	235.9	19	3.8
3	227.1	80	16.0
4	204.5	39	7.7
5	212.8	18	3.7
6	279.5	47	9.4
Average	234.2	47.7	9.6

a) 500 pieces of plant debris were applied for each experiment.

b) Percentage of pieces containing sheath blight fungus per 500 pieces.

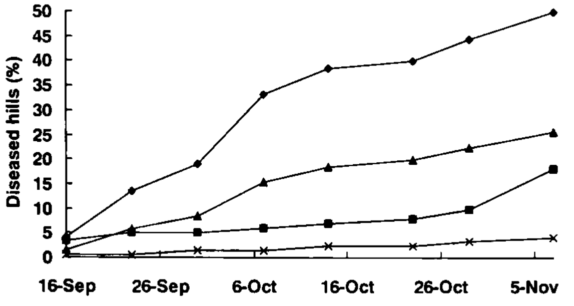

Fig. 2. Percentage of diseased hills in plots without sclerotia (×: control), amended with plant debris (■: 1140 kg of plant debris per ha) and sclerotia (▲: 0.5 million sclerotia per ha and ◆: one million sclerotia per ha). The density of 1140 kg plant debris per ha was equivalent to one million sclerotia per ha.

rotia reached 50% one month after heading, as opposed to 18% for the hills with 1140 kg plant debris per ha (Fig. 2). The plots amended with sclerotia only showed a greater number diseased hills in proportion to the number of sclerotia than the plots without sclerotia.

DISCUSSION

Sclerotia floating on the water surface after puddling are considered to be the main primary inoculum of rice sheath blight. Mature sclerotia, produced on or near the sheath lesions, are loosely attached and can be easily removed from leaf sheaths or blades. Sclerotia can survive on or in soil during the winter, then germinate and infect plants after floating to the surface of the water[4,8,10,14]. In this study, to examine whether a source other than sclerotia could act as the primary inoculum of the disease in the tropics, we investigated mycelia in plant debris as a possible source of primary inoculum. Rice sheath blight fungus could be isolated from debris, indicating that mycelia were viable into the following growing season. Further, sheath blight lesions developed on sheaths with plant debris attached in pot tests at the booting stage of rice. These mycelia also seemed to retain their infectivity. The plots amended with plant debris showed a significantly higher incidence of diseased hills than the plots without plant debris, indicating that mycelia may act as primary inoculum in the field. Several diseased hills were also observed in plots without plant debris. Some sclerotia may have been preserved in the soil in spite of removal of sclerotia and acted as primary inoculum.

In conclusion, our findings demonstrate that though sclerotia are the main primary inoculum of the disease, mycelia in plant debris may also act as primary inoculum in tropical regions. Judging from the difference in disease incidence between the plots amended with sclerotia and plant debris, the inoculum potential of plant debris seems to be about one-third that of sclerotia. In addition, the incidence of diseases, associated with infection by sclerotia, can be estimated based on the number of sclerotia floating on the water surface. Our data set based on the relationship between disease incidence and primary inoculum may be valuable in developing an accurate forecasting model for disease incidence to secure a more judicious application of fungicides[1,5,7].

Literature cited

1. Arunyanart, P., Surin, A., Dhitikiatpong, R., Rojanahusdin, W., Disthaporn, S. and Heuel-Rolf, B. (1989). Crop loss assessment and chemical control of rice sheath blight disease. J. Plant Prot. Trop. 6 : 49-60.
2. Belmar, S.B., Jones, R.K. and Starr, J.L. (1987). Influence of crop rotation on inoculum density of *Rhizoctonia solani* and sheath blight incidence in rice. Phytopathology 77 : 1138-1143.
3. Damicone, J.P., Patel, M.V. and Moore, W.F. (1993). Density of sclerotia of *Rhizoctonia solani* and incidence of sheath blight in Mississippi. Plant Dis. 77 : 257-260.
4. Hashiba, T. and Mogi, S. (1976). Development changes in sclerotia of the sheath blight fungus. Phytopathology 65 : 159-162.
5. Hashiba, T. (1984). Estimation method of severity and yield loss by rice sheath blight disease. Bull. Hokuriku Natl. Agric. Exp. Stn. 26 : 115-164 (in Japanese with English summary).
6. Jones, R.K. and Belmar, S.B. (1988). Characterization and pathogenicity of *Rhizoctonia* spp. isolate from rice, soybean, and other crops grown in rotation with rice in Texas. Plant Dis. 73 : 1004-1010.
7. Kobayashi, T., Ijiri, T., Mew, T.W., Maningas, G. and Hashiba, T. (1995). Computerized forecasting system (BLIGHTASIRRI) for rice sheath blight disease in the Philippines. Ann. Phytopathol. Soc. Jpn. 61 : 562-568.
8. Kozaka, T. (1975). Sheath blight in rice plants and its control. Rev. Plant Prot. Res. 8 : 69-80.
9. Lee, F.N. and Courtney, M.L. (1981). Number, viability, and buoyancy of *Rhizoctonia solani* sclerotia in Arkansas rice fields. Plant Dis. 64 : 298-300.
10. Lee, F.N. and Rush, M.C. (1983). Rice sheath blight: A major rice disease. Plant Dis. 67 : 829-832.
11. Marchetti, M.A. (1983). Potential impact of sheath blight on yield and milling quality of short-statured rice lines in the southern United States. Plant Dis. 67 : 162-165.
12. Mew, T.W. and Rosales, A.M. (1986). Bacterization of rice plants for control of sheath blight caused by *Rhizoctonia solani*. Phytopathology 76 : 1260-1264.
13. Ogoshi, A. (1987). Ecology and pathogenicity of anastomosis and intraspecific group of *Rhizoctonia solani* Kühn. Annu. Rev. Phytopathol. 25 : 125-143.
14. Ou, S.H. (1985). *In* Rice Disease, 2nd ed., Commonwealth Mycological Institute, Kew, U.K.
15. Parmeter, J.R., Jr., Sherwood, R.T. and Platt, W.D. (1969). Anastomosis grouping among isolates of *Thanatephorus cucumeris*. Phytopathology 59 : 1270-1278.

和 文 摘 要

小林　隆・T.W. Mew・羽柴輝良：フィリピンにおけるイネ紋枯病の被害度と初期感染源(被害藁中の菌糸体と菌核)との関係

フィリピンにおいて，イネ紋枯病に感染した被害藁が次の作期に初期感染源としてはたらくかどうかを検討するために，代かき後に浮上した被害藁を集め，これらの被害藁を紋枯病菌(*Rhizoctonia solani* Kühn AG-1 IA) 菌核を含まない実験圃場に投入した。まず，被害藁からは紋枯病菌が分離されたので，被害藁中で菌糸体は次の作期まで生存していると考えられた。次に，実験圃場において被害藁を投入しなかった区では出穂1カ月後の発病株率が3.9%であったのに対して，被害藁を1区(35 m^2) あたり2kgまたは4kg投入した区ではそれぞれ11%，18%であった。また，被害藁の感染能力を菌核のそれと比較したところ，前者の感染能力は後者の約3分の1程度であると推測された。これらの結果より，フィリピンでは被害藁中の菌糸体も初期感染源としてはたらいている可能性が示唆された。