Aggregate Sheath Spot of Rice in California

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ABSTRACT

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Rhizoctonia oryzae-sativae, a binucleate *Rhizoctonia* sp., is the causal organism of aggregate sheath spot of rice in California. Recent increase in incidence and severity of the disease has paralleled an increase in the use of semidwarf cultivars by growers. Symptoms of the disease are very similar to those of sheath blight of rice caused by *R. solani* in the southern United States. The fungus is the first reported binucleate *Rhizoctonia* sp. pathogenic on a gramineous host in the United States that is not an *R. cerealis* isolate.

A sheath spot disease of rice has been observed in California since the late 1960s. The disease has been of minor importance on California rice cultivars under Californian climatic conditions. During the past 3 yr however, incidence and severity of the disease have increased markedly. This increase has coincided with a shift by growers in California from the use of tall rice cultivars to the use of new semidwarf, high-yielding cultivars.

In 1971, *Sclerotium oryzae-sativae* Sawada was found to be the causal organism of the disease (5). The fungus had previously been reported as a pathogen of rice in other parts of the world (3), but it had not been known to exist in the United States. In 1979, the fungus was transferred to the genus *Rhizoctonia* DC. by Mordue on the basis of its hyphal and sclerotial morphology (8).

The purpose of this paper is to provide a comprehensive description of the disease and pathogen as they occur in California.

MATERIALS AND METHODS

Pathogen isolation and characterization. In August 1981, 51 samples consisting of 50–75 rice tillers were collected randomly from rice fields in Yolo, Sutter, Butte, and Glenn counties in northern California. Each sample was inspected for disease and any lesions typical of aggregate sheath spot were excised, surface-sterilized for 3 min in 10% sodium hypochlorite, sectioned, and plated on 2% water agar at room temperature. Hyphal tip cultures of fungus that grew from the tissue were established on potato-dextrose agar (PDA).

The number of nuclei per hyphal cell of fungal isolates grown on potato-dextrose broth was determined using one of two staining methods. The first staining procedure was a modification of the HCl-Giemsa technique reported by Hrushovetz (4). Mycelia were fixed in Carnoy's solution for 15 min and put through a series of rinses as follows: 95% ethyl alcohol for 3 min; 70, 50, and 30% ethyl alcohol for 1–2 min each; and glass-distilled water for 15 min (two changes). Mycelia were then placed in 1 N HCl at room temperature for 5 min, hydrolyzed in 1 N HCl at 60 C for 7 min, rinsed in distilled water for 1–2 min, and rinsed in phosphate buffer (pH 6.5) for 2–4 min. Next, mycelia were stained in Giemsa stain for 1–2 hr or overnight, destained for 30 sec in distilled water, and placed in phosphate buffer. Then mycelia were mounted on a slide and viewed with a light microscope at ×400. The Giemsa stain consisted of 2 ml of stock stain solution as prepared by Ward and Cwrysek (12) in 10 ml of phosphate buffer (pH 6.5).

The second staining method used was a modification of a fluorescence microscopy technique reported by Yamamoto and Uchida (13). Mycelia were placed in a drop of acridine orange stain (4 mg of acridine orange in 10 ml of distilled water), rinsed in distilled water, and mounted immediately on a slide and examined with a Zeiss Ultraphot II microscope using a UV light source. Nuclei of *Rhizoctonia* spp. stained with acridine orange appear as light green fluorescent bodies under UV light (13).

To establish cardinal temperature ranges for growth of the fungus, radial growth of two isolates was measured for 6 days on PDA in dam tubes incubated in increments of three degrees from 6 to 42 C. Four tubes of each isolate were incubated at each temperature and the experiment was repeated once.

Anastomosis tests were carried out between the aggregate sheath spot pathogen and two binucleate *Rhizoctonia* tester isolates, Bn 20 of Burpee's *Ceratobasidium*-anastomosis group 1 (CAG-1) (2) and Ogoshi's AG-Bb (10), using a method similar to the one described by Burpee et al (2). The only modification made was that the area of hyphal contact was not stained.

RESULTS

Symptomatology. The diagnostic symptom of aggregate sheath spot is the occurrence of lesions on rice leaf sheaths. Lesions are circular to elliptical with gray-green to straw-colored centers surrounded by distinct brown margins. A strip of necrotic cells runs down the middle of the lesion center (Fig. 1A). Frequently, additional margins form around the initial lesion, producing a series of concentric bands (Fig. 1B). Initial lesions range in length from about 0.5 to 4 cm.

Aggregate sheath spot lesions first appear on the lower leaf sheaths at the

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water line during the tillering stage. Initial infections are produced by sclerotia of *Rhizoctonia oryzae-sativae* (Saw.) Mordue floating on the paddy water. The disease progresses from the lower to the upper leaf sheaths and sometimes to the lower portion of leaf blades (Fig. 2). On the sheath, lesions often coalesce and may cover the entire leaf sheath. Leaves of diseased sheaths are normally killed, at first turning bright yellow. Under favorable conditions, the disease can spread to the flag leaf and panicle rachises, killing entire tillers. The pathogen can also colonize the culm, where it may cause a culm rot, but this aspect of the disease is rare in California. As leaf sheaths become rotted, the fungus produces abundant brown sclerotia within and on diseased tissue. Sclerotia produced inside cells in the sheath are ordinarily cylindrical to rectangular and are readily visible through the diseased tissue (Fig. 3A). Sclerotia produced on the surface of leaf sheaths are irregularly globose (Fig. 3B).

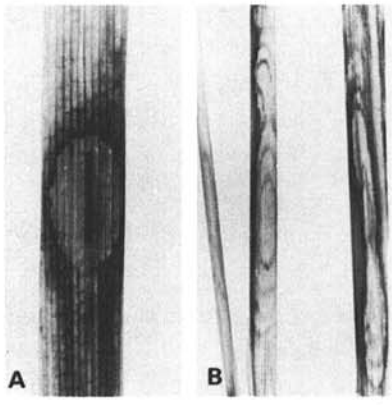

Fig. 1. (A) Typical aggregate sheath spot lesion caused by *Rhizoctonia oryzae-sativae*. Note the strip of necrotic cells running down the lesion center. **(B)** Aggregate sheath spot lesions showing series of concentric lesion margins.

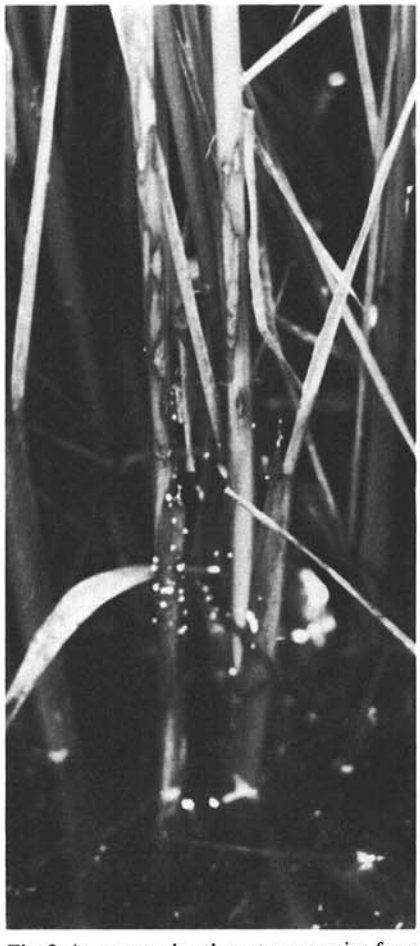

Fig. 2. Aggregate sheath spot progressing from lower to upper rice sheaths. Note also young white sclerotia of *Rhizoctonia oryzae-sativae* forming on the outside of the lower leaf sheaths.

Pathogen isolation and characterization. *R. oryzae-sativae* was consistently isolated from aggregate sheath spot lesions. Mycelium of the fungus was at first colorless on PDA, later white, and eventually developed a brown pigmentation. Hyphal cells were binucleate, although occasionally cells with three or four nuclei were observed. The fungus produced numerous irregularly globose sclerotia on PDA that were about 0.20–0.90 mm in diameter. Sclerotia were white when young and became brown as they matured. Sclerotia of the fungus were undifferentiated in cross section and were composed of near-spherical hyphal cells. Besides sclerotia, the fungus sometimes produced chains of elongate monoloid cells in culture.

From the samples, 26 isolates of *R. oryzae-sativae* were obtained, all of which differed from one another in degree and shade of mycelial and sclerotial pigmentation and habit of sclerotial production on PDA.

S. hydrophilum Sacc. and *Nigrospora oryzae* (Berk. & Br.) Petch were sometimes isolated from diseased sheaths but were not pathogenic.

Cardinal temperature ranges for fungal growth were 6–9, 30–33, and 36–39 C.

Isolates of *R. oryzae-sativae* obtained from affected plants anastomosed with the AG-Bb tester, which is an *R. oryzae-sativae* isolate from rice in Japan (10). None of the isolates anastomosed with the CAG-1 tester isolate Bn 20, which is an isolate of *R. cerealis* van der Hoeven from turfgrass in Pennsylvania (2).

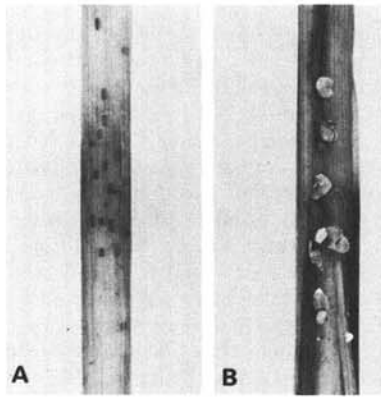

Fig. 3. (A) Cylindrical to rectangular sclerotia of *Rhizoctonia oryzae-sativae* within a rice sheath. **(B)** Irregularly globose sclerotia of *R. oryzae-sativae* on the surface of a rice sheath.

DISCUSSION

R. oryzae-sativae was first reported causing a sheath spot disease of rice in Taiwan in 1922 (11). Since then, the disease, referred to as aggregate sheath spot or brown sclerotial disease (3,10), has been reported to occur in Japan, China, Vietnam, Thailand, and India (3,9,11). The disease is very similar in symptomatology to sheath blight of rice caused by *R. solani* Kühn (AG-1), a destructive disease in the southern United States and worldwide (6). *R. oryzae-sativae* is reported to be a less aggressive pathogen on rice than *R. solani* (11). In greenhouse studies conducted at the University of California at Davis, *R. solani* isolates from rice in the southern United States were found to infect and spread up tillers of California rice cultivars much more rapidly than *R. oryzae-sativae* isolates. Because the two diseases are so similar, it is possible that in some cases disease attributed to *R. solani* has actually been caused by *R. oryzae-sativae*. In the United States, *R. oryzae-sativae* has not been reported on rice outside of California, and *R. solani* has not been found on rice in California.

Binucleate *Rhizoctonia* spp. pathogenic on gramineous hosts in the United States have so far been found to be isolates of *R. cerealis* and they comprise a common anastomosis group designated CAG-1 (1,7). *R. cerealis* isolates cause cool-weather diseases and are only pathogenic on hosts in the Gramineae (=Poaceae) (1). In the United States, *R. oryzae-sativae* is the first reported binucleate *Rhizoctonia* sp. pathogenic on a gramineous host that is not an isolate of *R. cerealis*. Furthermore, *R. oryzae-sativae* is a warm-weather pathogen and is reported to be pathogenic on hosts other than those in the Gramineae (3,11).

Preliminary field trial results indicate that the California semidwarf cultivars are more vulnerable to the disease than tall cultivars. Evidence indicates that differences in microclimatic conditions between short and tall cultivar stands, rather than genetic differences between cultivars, are responsible for the greater vulnerability of the semidwarf cultivars. The semidwarf cultivars have greater tillering capacity, can be seeded at denser rates, and respond to higher nitrogen levels than tall cultivars. Denser rice stands and higher nitrogen levels have been shown to favor disease development of sheath blight caused by *R. solani* (6,11). Such conditions may also enhance disease incited by *R. oryzae-sativae*.

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