Number, Viability, and Buoyancy of *Rhizoctonia solani* Sclerotia in Arkansas Rice Fields

FLEET N. LEE, Assistant Professor, Department of Plant Pathology, Rice Branch Experiment Station, University of Arkansas, Stuttgart 72160

ABSTRACT

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The number, viability, and buoyancy of sclerotia produced by *Rhizoctonia solani,* cause of rice sheath blight, in severely affected rice fields were studied. Samples (1 L) of crop debris to a 0.6 cm depth contained 136–562 buoyant and 68–334 nonbuoyant sclerotia. Viability of buoyant and nonbuoyant sclerotia varied from 41.1 to 60.8% and 25 to 55.6%, respectively. Samples from 0.6–3.8 cm contained 38–63 buoyant and 5–24 nonbuoyant sclerotia per liter of soil. Soil 3.8–7.6 cm deep contained 27–44 buoyant and 0–14 nonbuoyant sclerotia per liter. Viability of buoyant sclerotia in samples taken from below 0.6 cm was between 13 and 35%. In the same zone, viability of nonbuoyant sclerotia was between 12.5 and 22.6%. Nonbuoyant sclerotia became buoyant after drying for 48 hr but lost buoyancy after less than 48 hr in water.

Sheath blight has become the most frequently observed rice disease in Arkansas (9,13). The disease is incited by an aerial form of *Rhizoctonia solani* Kuehn and is favored by high temperature and humidity. This form of *R. solani* also causes aerial blight in soybean (12), the crop commonly grown in rotation with rice in Arkansas. The fungus overwinters in plant debris as sclerotia that, at maturity, are first nonbuoyant but become buoyant after 15–30 days when cells in the outer layer empty (5,7). These sclerotia, reported to be viable for longer than 21 mo under favorable conditions, are considered a primary source of inoculum (4,11). One of the major indexes used in forecasting sheath blight occurrence and intensity has been the number of sclerotia found floating on the water surface of rice fields (8,16).

This paper describes the number, viability, and buoyancy of *R. solani* sclerotia found in rice debris and soils of Arkansas rice-producing areas.

MATERIALS AND METHODS

Soil cores 9.5 cm in diameter and 7.6 cm long were collected at random in late February and early March 1979 from selected rice fields where a high incidence of sheath blight was observed in 1978. Samples were held at 4 C until processed. The previous crop debris as well as the top 0.6 cm of each core were collected by removal with a sharp knife in the field or by careful washing over sieves in the laboratory. The remaining portion of the core was divided to represent 0.6–3.8 cm and 3.8–7.6 cm depths. A minimum of 10 samples from the 0–0.6 cm sample zone or six of all other samples were averaged to estimate sclerotia numbers in the different zones and locations.

The sclerotia extraction procedure was a modification of several previously reported techniques (3,14,15). A large, well-mixed sample was subdivided and repeatedly extracted until a high degree of competence in sclerotia identification and recovery was obtained. All plant debris and soil in the samples were suspended in water and slowly poured into a 1.7-mm sieve stacked over a 0.6-mm sieve. The material retained on the 0.6-mm sieve was carefully washed, collected, and evenly distributed on filter paper. The filter paper was placed on a flat plate and examined through a dissecting microscope. *R. solani* sclerotia were separated from debris and other fungal sclerotia by size, color, shape, and texture.

The sclerotia were removed from the debris and immediately placed in water to determine buoyancy. Sclerotia were then removed from the water and allowed to air-dry on filter paper. After drying for 24 hr or longer, sclerotia were again placed in water and observed frequently during the next 72 hr.

Random sclerotia from the debris were also immediately placed beneath solidified water agar (2% agar) with forceps and incubated at 30 C for 48 hr. Sclerotia producing mycelia characteristic of *R. solani* were recorded as viable. Isolations were made from randomly selected sclerotia for further identification by cultural characteristics and pathogenicity.

Young soybean plants of the cultivar Davis with at least one fully developed trifoliolate leaf were used for pathogenicity tests. A 1-cm^2 block of an 8–12-day-old culture grown on rice agar (20 g of milled rice in 1 L of water) was placed on each plant near the base of the top petiole and held in place with a small aluminum strip. Plants were held in an incubator at 30 C for approximately 72 hr before pathogenicity was recorded. Selected pathogenic isolates were confirmed as being the sheath blight form of *R. solani* by inoculating recently headed rice plants on the top leaf sheath and incubating them at ambient temperature in a greenhouse humidity chamber for approximately 4 days.

A survey of *R. solani* sclerotia in field soils throughout the rice-producing areas of Arkansas was conducted. Core samples were vertically divided, and half the core was processed as a sample.

RESULTS AND DISCUSSION

In the samples collected from infested rice fields during late February and early March 1979, populations of 136–562 buoyant sclerotia and 68–334 nonbuoyant sclerotia per liter were recovered from the top 0.6-cm sample (Table 1). Evidence of new sclerotia production was not found during visits to the fields in the fall after the crop was harvested. Therefore, sclerotia collected in the top 0.6-cm sample containing the previous crop debris are considered to represent those produced on rice in 1978. The 2 million sclerotia per hectare reported by Chien et al (2) are comparable to the 1.4 million sclerotia per hectare represented by 136 sclerotia per liter but less than the 5.8 million sclerotia per hectare represented by 562 sclerotia per liter.

The 0.6–3.8 cm sample contained 38–63 buoyant and 5–24 nonbuoyant sclerotia per liter of soil, and 27–44 buoyant and 0–14 nonbuoyant sclerotia per liter were recovered from the 3.8–7.6 cm sample. The sclerotia population in the two sample zones was expected to be nearly identical because of the practice of thoroughly discing the soil to a depth of approximately 12 cm during land preparation. Sclerotia recovered from a depth of 0.6–7.6 cm represent those accumulated before 1978 in soil that was undisturbed after the rice crop was planted. Only sclerotia on or near the soil surface would have been available to initiate infections in the 1978 crop.

Approximately 78% of the cultures obtained from sclerotia from all zones were pathogenic when assayed to

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Table 1. *Rhizoctonia solani* sclerotia per liter of soil from fields with severe sheath blight infections

Location[a]	Field status[b]	Depth 0–0.6 cm Buoyant[c]	Viable (%)	Non-buoyant	Viable (%)	0.6–3.8 cm Buoyant	Viable (%)	Non-buoyant	Viable (%)	3.8–7.6 cm Buoyant	Viable (%)	Non-buoyant	Viable (%)
LN1	N	254	43.1	68	39.4	48	17.3	5	00.0	27	30.3	0	...
PH1	N	136	41.1	334	55.6	63	31.3	24	22.6	44	35.0	14	12.5
PH2	F	562	49.0	139	25.0	38	13.0	8	20.0	36	21.7	9	16.7
LW1	N	136	60.8	80	33.4	52	25.5	16	...[d]	38	31.6	4	...

[a]Samples were collected in late February and early March 1979.
[b]N = straw intact and undisturbed; F = straw intact and flooded soon after harvest until just before sampling.
[c]Buoyant in water immediately after extraction from soil.
[d]Not tested.

soybean. Representatives of these cultures were also pathogenic to rice and induced typical sheath blight symptoms.

Viability of the buoyant sclerotia in the three sample zones varied from 13–60.8% (Table 1). The degree of viability was consistently higher for those found in the top zone and was near the 40–60% reported for field-produced sclerotia (2,4,6). Nonbuoyant sclerotia were, with one exception, less viable than buoyant ones. Viability of naturally produced sclerotia is known to be influenced by such factors as chemical composition of the medium, size of the sclerotia or fragment, and number of previous growth cycles (1).

The proportion of buoyant to nonbuoyant sclerotia in the top 0.6 cm of the sample was dependent on location (Table 1). However, more buoyant than nonbuoyant sclerotia were consistently found in samples below 0.6 cm at all locations.

Nonbuoyant sclerotia that were air-dried for 24 hr floated briefly, then sank. Nonbuoyant sclerotia dried for 48 hr or longer floated at least 30 min, then gradually sank over a 48-hr period. Sclerotia originally classified as buoyant remained so. This is the first report of sclerotia from rice alternating from a nonbuoyant to a buoyant state and back again and supports the report that buoyancy depends on the water content of external cells (5). Lack of buoyancy, whether never attained or lost, in field-produced sclerotia may represent a state of degradation that eventually results in a noninfective propagule.

Results of the survey ranged from no sclerotia recovered in the entire 0–7.6 cm zone of AE1 to 43 buoyant and 10 nonbuoyant sclerotia per liter recovered at PH1 (Table 2). Fields with the higher levels of sclerotia tended to be those with a chronic history of sheath blight. Numbers varied considerably in fields that were relatively close. For example, AR1, with only two buoyant sclerotia per liter, was within 900 m of AR2, with 37 buoyant sclerotia per liter. AG2, with one buoyant sclerotia per liter, was within 450 m of AG3, with 21 buoyant sclerotia per liter.

Results of this study partially describe the inoculum potential of the *R. solani* causing rice sheath blight in Arkansas. Large numbers of viable buoyant and nonbuoyant sclerotia produced on diseased rice plants are scattered on the soil surface before and during harvest. Subsequent tillage incorporates the sclerotia into the soil, where they remain as potentially infective units to be returned to the soil surface by future tillage. The inoculum potential is reinforced by additional sclerotia production in alternate crop hosts, primarily soybean (12).

Options for control of rice sheath blight are somewhat limited. Desirable varieties have low inherent resistance (10,11). Adequate chemical control is not available at present. Short-term rotation of 1 or 2 yr with nonhost crops would not be expected to significantly lower the inoculum potential. Methods of inoculum manipulation or destruction require further research. Simply rendering the sclerotia nonbuoyant, as suggested by Hashiba et al (7), may not be effective because nonbuoyant sclerotia recovered from the soil are viable.

Table 2. *Rhizoctonia solani* sclerotia per liter of soil from selected Arkansas rice fields following the 1978 season

Location[a]	Field status[b]	1978 Disease incidence[c]	Depth of 0–7.6 cm Buoyant	Nonbuoyant
PB1	B	Unobserved	10	5
PW2	D	High	29	9
PS3	D	High	25	4
AE1	N	None	0	0
AE2	N	None	4	6
AR1	D	None	2	2
AR2	N	Unobserved	37	3
AS1	N	Unobserved	22	3
AS2	N	Unobserved	3	0
PF1	B	Unobserved	20	10
PH1	B	Light	43	10
AG1	N	Unobserved	2	0
AG2	D	Unobserved	1	2
AG3	D	Unobserved	21	3
AG4	D	Unobserved	1	0
CB1	D	High	18	3
CB2	D	Light	6	2
PT1	D	High	19	8

[a]Samples were collected from late February through March 1979.
[b]B = straw burned directly after harvest; N = straw intact and undisturbed; D = straw disturbed by thorough discing.
[c]Unobserved = not examined during 1978; none = sheath blight not found when examined during 1978; light = low to moderate incidence of sheath blight; high = high to very high incidence of sheath blight.

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