SURVIVAL AND PRIMARY INOCULUM SOURCES OF *BIPOLARIS ORYZAE* AND *B. SOROKINIANA*, CAUSAL ORGANISMS OF FUNGAL BROWN SPOT OF CULTIVATED WILD RICE

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Introduction and objectives

The survival and primary inoculum sources of *Bipolaris oryzae* and *B. sorokiniana* in cultivated wild rice (*Zizania palustris* L.) fields have not been documented. Infested crop residue and grass hosts on dikes have been suggested as possible sites of survival and sources of primary inoculum (3,4). The focus of this research was to determine the survival of *B. oryzae* and *B. sorokiniana* in Minnesota wild rice paddies and identify possible sources of primary inoculum.

The four main research objectives were to determine the following:

1. Survival of *B. oryzae* in wild rice residue and seed under various soil moistures.

2. Survival of *B. oryzae* and *B. sorokiniana* in wild rice residue and seed in Minnesota cultivated wild rice fields.

3. Survival of *B. oryzae* and *B. sorokinana* conidia in paddy water.

4. The role of infested wild rice residue, seed, and dike grasses as primary inoculum sources.

The results of these studies will, hopefully, aid the cultivated wild rice grower in identifying cultural practices that may reduce the primary inoculum of *B. oryzae* and *B. sorokiniana* by preventing or significantly reducing their survival.

Survival of *B. oryzae* in wild rice residue and seed in organic and inorganic soils at various soil moisture conditions

Introduction

Survival over winter of *B. oryzae* was determined in wild rice residue fragments and seed incorporated in and on the surface of organic and inorganic soils when flooded, at moisture holding capacity (MHC), and dry.

Results and discussion

- Under flooded conditions *Bipolaris oryzae* did not survive over winter in residue or seed regardless of the soil type or placement of the residue/seed (Table 1).

- At soil MHC, *B. oryzae* did not survive in residue or seed when buried in soil, but did survive on the soil surface (Table 1).

- Under dry soil conditions, the fungus survived whether buried or on the surface of either soil (Table 1).

Survival of *B. oryzae* and *B. sorokiniana* in wild rice residue and seed in Minnesota paddies

Introduction

Survival over winter (September, 1992 to April 1993) of *B. oryzae* and *B. sorokiniana* was determined in wild rice residue incorporated in soil and on the soil surface in two wild rice paddies near Aitkin, Minnesota. The following year, survival was determined in wild rice residue and seed in, on, and above the soil in a wild rice paddy near Grand Rapids, Minnesota from October, 1993 to August, 1994.

Results and discussion

- Neither *B. oryzae* nor *B. sorokiniana* survived in either year in the residue samples incorporated in or on the soil surface in the paddies.

- *Bipolaris sorokiniana* was recovered from 5% of residue raised above the soil surface during the second year.

Survival of *B. oryzae* and *B. sorokiniana* in wild rice residue over winter can be prevented by incorporating the residue into the soil and/or fall flooding fields. Neither pathogen survived in wild rice residue or seed buried in or on the soil surface in field studies. This lack of survival of the fungi is most likely due to microbial degradation of the infested wild rice residue. Buried or flooded residue was difficult to recover due to extensive degradation. The fungi survived best in residue on the surface of dry soil, or raised above the soil surface where the residue was buffered from continuous moisture and microbial degradation.

Large residue mats formed by combine discharge during harvest prevent much of the residue from coming in contact with the soil and remain largely intact into

the spring if the residue is not incorporated. In addition, wild rice plants at paddy margins and dike edges may escape harvest and incorporation, allowing survival of the pathogens.

Survival of *B. oryzae* and *B. sorokiniana* conidia in paddy water

Introduction

Survival of *B. oryzae* and *B. sorokiniana* conidia was determined in autoclaved paddy water. The water containing the conidia of each pathogen was incubated in the laboratory at -15, 5, 15, and 22 C for up to 24 weeks. The survival as determined by spore germination was evaluated after each requisite incubation period.

Results and discussion

- Conidia of *B. oryzae* retained germinability at all temperatures for 24 wk in one experiment (Figure 1), but lost germinability by 2 wk at -15 and by 24 wk at 5 C in a repeated experiment.

- Conidia of *B. sorokiniana* retained germinability at all temperatures for 24 wk in both experiments (Figure 1).

Conidia of both pathogens present on residue in the spring may be able to survive for long time periods when paddies are flooded in the spring with cold water.

Infested wild rice residue and seed as primary inoculum sources of *B. oryzae* and *B. sorokiniana*

Introduction

The ability of infested wild rice residue incorporated in, on the surface of, and raised above the soil, and infested seed to serve as inoculum sources for fungal brown spot infection was determined in a wild rice paddy near Grand Rapids, Minnesota. The inoculum source treatments were placed in the field in the fall (October, 1993) and disease progress for each treatment assessed the following growing season (May - August, 1994).

Results and discussion

- Disease progress was low for all inoculum source treatments (Figure 2).

- The area under the disease progress curve for plots with infested residue raised above the soil surface was significantly different ($p=.05$) from the control.

- None of the other inoculum source treatments resulted in disease progress curves with areas significantly different from the control.

Infested residue when buried or placed on the soil surface and infested seed could not be demonstrated to serve as a primary inoculum source. The ability of these inoculum treatments to infect wild rice plants may be limited both by their survival through the winter, and by the barrier to inoculum dispersal provided by the flooded conditions of the paddy soil. Inoculum sources that are not in contact with soil or flooded survive better and are not limited by this barrier. Therefore, only infested residue above the soil and floodwater surface contained a viable and infective inoculum source. In wild rice paddies, this raised inoculum source could come from wild rice plants along dikes or from upland hosts on dikes. In addition, residue in large mats formed by combine discharge during harvest, if not incorporated into the soil, may float when fields are flooded allowing production of conidia which could be either wind blown or rain splashed to wild rice plants.

Detection of airborne conidia as a primary inoculum source

Introduction

Rotorod Samplers (model 92, Sampling Technologies, Inc., St. Paul, Minnesota) were used to determine the presence or absence of conidia of *B. oryzae* and *B. sorokiniana* over wild rice paddies during the 1993 and 1994 wild rice growing seasons. The sampling rods were collected and observed for the presence of *B. oryzae* and *B. sorokiniana* at regular intervals.

Results and discussion

- During the 1993 and 1994 growing seasons, airborne conidia of *B. oryzae* and *B. sorokiniana* were present, but very low numbers were trapped.

The presence of airborne conidia from upland hosts on dikes or surrounding areas was not well supported by sampling with the rotorod spore sampler. The low number of conidia trapped in this study does not eliminate airborne conidia

from grass hosts as a possible source of primary inoculum. Samplers could only detect the presence of conidia in a small proportion of the possible sites of production. The airborne conidia may come from small patches of infected dike grasses which would be difficult to detect with such a small number of samplers.

Development of fungal brown spot symptoms on wild rice grown from *B. oryzae* infested seed

Introduction

Wild rice seed infested with *B. oryzae* by four different methods was sown and development of fungal brown spot symptoms assessed to determine if infested seed can serve as a primary inoculum source of *B. oryzae*.

Results and discussion

- Regardless of the type of wild rice seed inoculation technique, there was no development of fungal brown spot symptoms in plants grown from *B. oryzae* infested seed.

The role of infested seed as a primary inoculum source of *B. oryzae* was not supported.

Survey of possible survival sites and primary inoculum sources for *B. oryzae* and *B. sorokiniana*

Introduction

Samples of previous crop residue and dike and area grasses having lesions characteristic of fungal brown spot were collected during the 1992, 1993, and 1994 growing seasons and isolated from to identify survival sites and primary inoculum sources. In addition samples of common grasses on paddy dikes and surrounding areas were collected, identified, and compared with host range lists for each pathogen.

Results and discussion

- *Bipolaris oryzae* and *B. sorokiniana* were both found rarely in previous crop residue and dike grass samples collected (Table 2).

- Six grass species growing on paddy dikes and surrounding areas were identified (Table 3). One, *Agropyron repens* (L.) Beauv. (Quackgrass), is a known host of B. sorokiniana (1).

- Numerous other grass species that are known hosts of *B. oryzae* and/or *B. sorokiniana* are present in Minnesota (1,2,5) (Table 4).

During the 1993, and 1994 growing seasons, the presence *of B. oryzae* and *B. sorokiniana* was low in both previous wild rice crop residue and dike grass samples. However, the number of sites and samples was very small in comparison with the actual amount of previous crop residue and grasses present in and around wild rice fields. Although low in frequency, both pathogens were found in at least one site of previous crop residue and dike grasses during the three growing seasons. Thus, both previous crop residue and dike grasses can serve as survival sites and inoculum sources for *B. oryzae* and *B. sorokiniana.* In addition, all three sampling sites of previous crop residue that yielded either *B. oryzae* or *B. sorokiniana* were in fields in which the residue had not been incorporated in the fall, further emphasizing the importance of residue incorporation.

Only one of the six grass species, *Agropyron repens* (L.) Beauv., collected from paddy dikes is a known host of *B. sorokiniana* (1), and none are known hosts of *B. oryzae*. However, it is possible that some of these species are unknown hosts since both fungi attack such a wide variety of grasses. Numerous other species of wild and cultivated grasses that are known hosts of *B. oryzae* and *B. Sorokiniana* are found in Minnesota and may be present on or near paddy dikes but were not among the species collected. Avoiding the use of grasses on paddy dikes may be an important practice to reduce possible survival sites and inoculum sources.

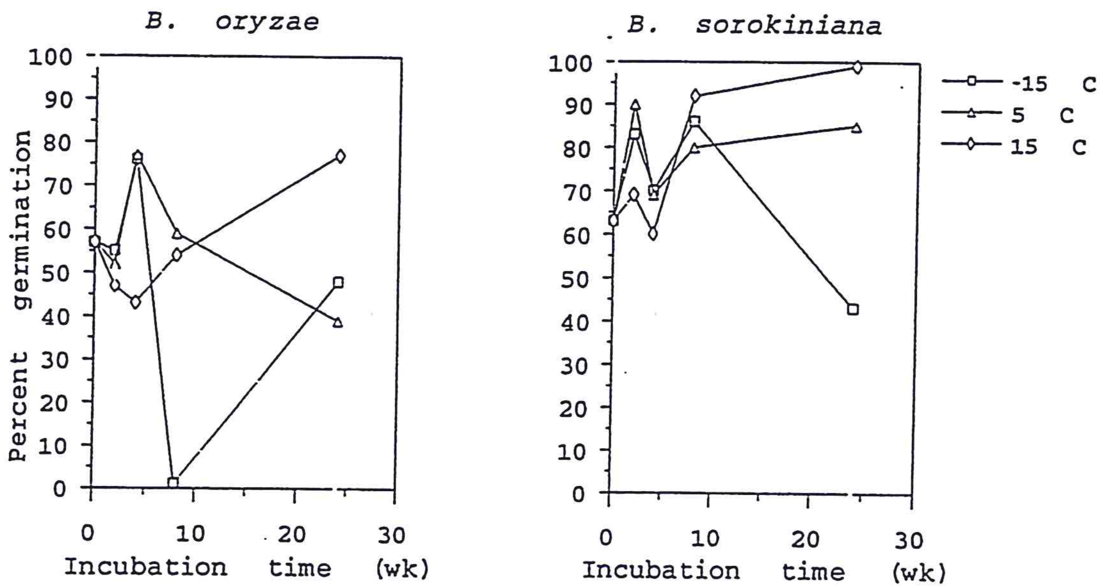

Figure 1. Percent germination of conidia of *Bipolaris oryzae* and *B. sorokiniana* after incubation in sterile paddy water at various temperatures. Data from the first experiment shown.

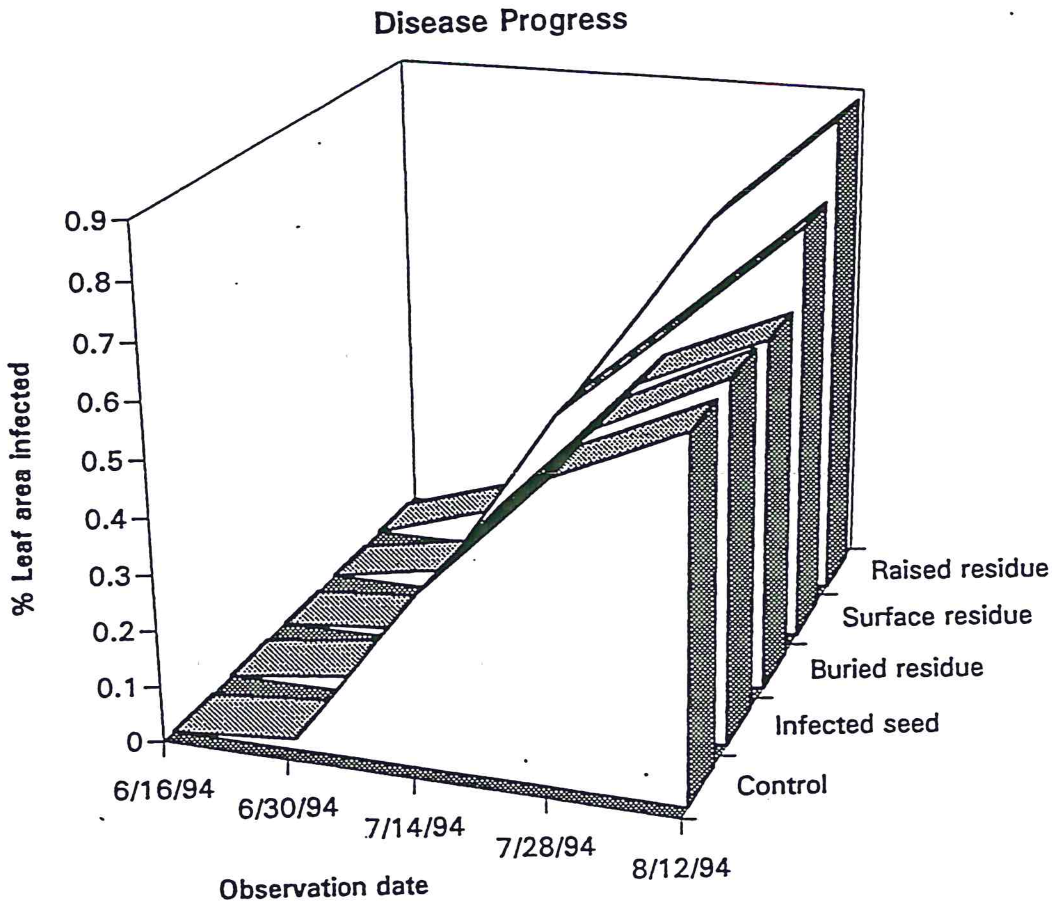

Figure 2. Disease progress curves for plots with different inoculum source treatments. Data are the mean of five replicates per inoculum source treatment.

Table 1. Survival of *Bipolaris oryzae* in wild rice reresidue and seed incorporated in and on the surface of organic and inorganic soils at various residue levels

Soil conditions	Surface		Incorporated	
	Residue	Seed	Residue	Seed
Flooded organic	0[y]	0	0	0
Flooded inorganic	0	0	0	0
Organic at MHC	24	0	0	0
Inorganic at MHC	0	43	0	0
Dry organic	15	10	30	67
Dry inorganic	17	0	0	13

x Initial infestation was 94 and 66% for residue and seed, respectively.

y Percent of 30 fragments or seed yielding conidia of *B. oryzae*.

Table 2. Presence of *Bipolaris oryzae* and *B. sorokiniana* in previous wild rice crop residue and dike grasses

Year Sample	Fragments observed	Fragments yielding *B. oryzae*	 *B. Sorokiniana*
1992			
Residue	50	5	0
Grass	860	8	29
1993			
Grass	390	0	0
1994			
Residue	240	2	2
Grass	200	0	2

Table 3. Grass species commonly found on wild rice paddy dikes in Minnesota

Scientific name	Common name
Agropyron repens (L.) Beauv.	Quackgrass[x]
Eragrostis cilianensis (All.) Lutati	Stinkgrass
Muhlenbergia frondosa (Poir.) Fern.	Wirestem Muhly
M. schreberi J.F. Gmel.	Nimbleweed
Panicum capillare L.	Witchgrass
P. dichotomiflorum Michx.	Fall Panicum

[x] Known host of *Bipolaris sorokiniana*

Table 4. Known hosts of *Bipolaris oryzae* and/or *B. sorokiniana* in Minnesota

Scientific name	*B. oryzae*[y]	*B. sorokiniana*[z]
Agropyron trachycaulum (Link) Malte.		X
Avena sativa L.	X	
Bromus inermis Leyss.	X	X
Dactylis glomerata L.	X	X
Digitaria sanguinalis (L.) Scop.	X	
Elymus canadensis L.		X
Festuca elatior L.		X
F. ovina L.		X
F. rubra L.		X
Hordeum jubatum L.		X
Hordeum vulgare L.	X	X
Lolium perenne L.		X
Phalaris canariensis L.		X
Phleum pratense L.		X
Poa compressa L.	X	
P. pratensis L.		X
P. trivialis L.		X
Secale cereale L.	X	
Zea mays L.	X	

[y] Gangopadhyay, 1983 and Ocfemia, 1924
[z] Berkenkamp, 1971

Literature cited

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