Fusarium sporotrichioides as a Pathogen of Spring Wheat

R. H. VARGO, Graduate Research Assistant, and J. S. BAUMER, Assistant Professor, Department of Plant Pathology, University of Minnesota, St. Paul 55108

ABSTRACT

Vargo, R. H., and Baumer, J. S. 1986. *Fusarium sporotrichioides* as a pathogen of spring wheat. Plant Disease 70:629-631.

Fusarium sporotrichioides was routinely isolated from all plant parts of spring wheat from three Minnesota locations. Leaves and heads of Era spring wheat were inoculated with single-spore cultures of these isolates, and the plants were incubated in a mist chamber for 48–79 hr. Variable necrotic symptoms developed in leaves, leaf sheaths, and culms. The lesions expanded for several weeks. The symptoms on heads resembled scab (caused by *F. graminearum*), except the kernels were not affected. The fungus was reisolated from and also sporulated on necrotic tissues of inoculated plants in the greenhouse. *F. sporotrichioides* isolates from soil, oat roots, cornstalks and roots, white clover, and moldy corn grain also were pathogenic to wheat. Comparable inoculations with wheat isolates of *F. graminearum* produced scabby heads but usually limited leaf necrosis.

Additional key words: *Fusarium graminearum, F. poae, F. tricinctum, Triticum aestivum*

Experimental plots were surveyed during 1979 to identify fungi associated with hard red spring wheat (*Triticum aestivum* L.) in Minnesota (4). Fungi isolated during the survey usually were either pathogenic or nonpathogenic as described by the literature (5) when tested on cultivar Era in a greenhouse. *F. sporotrichioides* Sherbakoff (2) isolates were an exception. This paper presents and discusses data that established *F. sporotrichioides* as a pathogen of wheat. A preliminary report of this work has been published (3) using the name *F. trincinctum,* which has since been segregated and better delineated (2).

MATERIALS AND METHODS

Wheat plants were sampled at 2-wk intervals throughout the growing season from plots at the Crookston, Morris, and Rosemount, MN, agricultural experiment stations (5). The samples were washed in running tap water for 12 hr and placed on acidified half-strength Difco potato-dextrose agar (PDA). Isolates of *F. sporotrichioides* and *F. graminearum* selected for inoculum were incubated on full-strength Difco PDA at 24 ± 4 C with diurnal exposure to both fluorescent lights and indirect sunlight.

Preliminary pathogenicity test. Inoculum of each isolate was prepared by blending an 85-mm petri-plate culture for 30 sec in 100 ml of glass distilled water containing 100 ppm of Tween 20 (Union Carbide, New York, NY). Inoculum of each isolate was applied to at least 24 flag leaves on eight plants at the rate of 1 ml per leaf with a chromatography sprayer powered by aerosol cartridges. The plants, grown two per 13-cm pot, were 50% headed when inoculated. Plants were held at 19 ± 2 C for 48 hr with intermittent misting (plants did not dry off), then removed and provided with indirect sunlight in a headhouse for 1 day before being returned to the greenhouse.

Percentage of necrosis was estimated 7 days after inoculation. Selected lesions were surface-disinfested for 2 min with

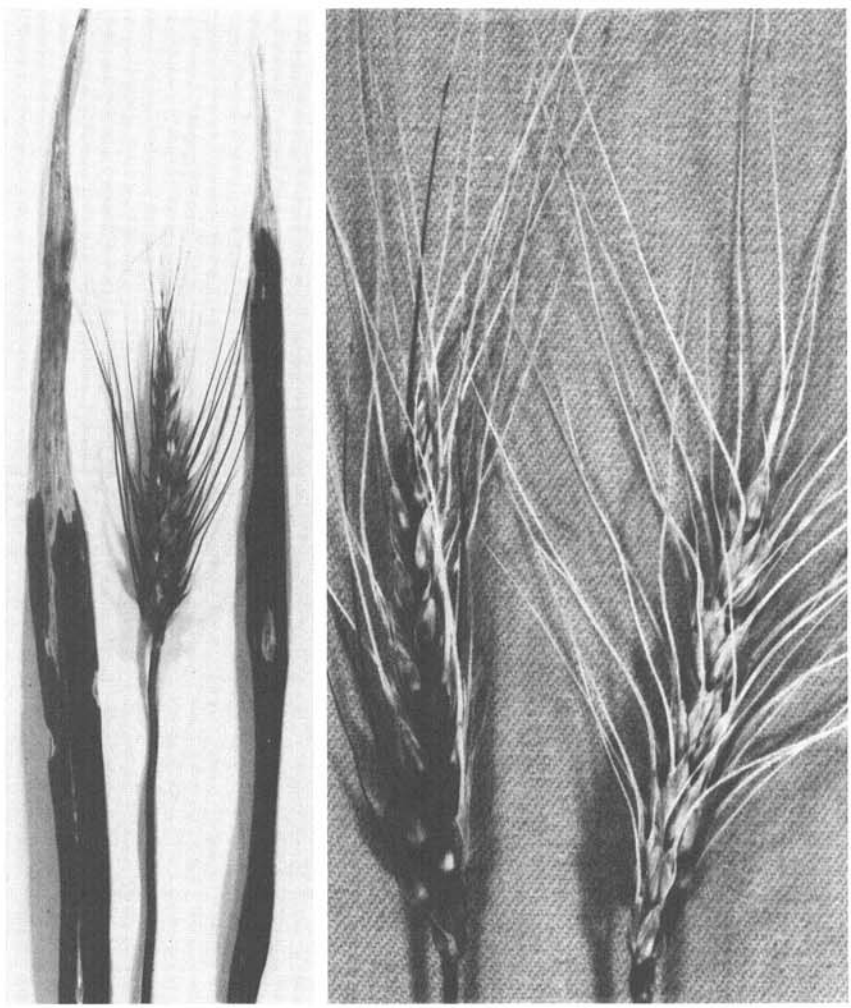

Fig. 1. Symptoms on flag leaves and heads of spring wheat cultivar Era after inoculation with *Fusarium sporotrichioides*.

Current address of first author: Mobay Chemical Corporation, 1317 Tulip Lane, Davis, CA 95616; of second author: Land O'Lakes, Research Farm, Route 2, Webster City, IA 50595.

Paper 14,087, Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul 55108.

Accepted for publication 2 January 1986 (submitted for electronic processing).

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

Table 1. Percentage of surface area necrotic on flag leaves and heads of Era spring wheat after inoculation with *Fusarium sporotrichioides* and *F. graminearum*

Isolate and source			Necrotic area per leaf or head (%)					
			Experiment 2[v]		Experiment 3[w]			
					Primary tillers		Secondary tillers	
Species	Plant part	Cultivar	Leaves	Heads	Leaves	Heads	Leaves	Heads
F. sporotrichoiodes	Leaf	Era	3 a[x]	5 a	96 c	51 b	70 bc	14 a
	Root	Era	11 a	7 a	92 c	70 d	80 cd	17 a
	Leaf	?	3 a	6 a	98 c	66 cd	75 bcd	13 a
	Root	Olaf	33 b	8 a	99 c	54 bc	86 d	38 b
	Head	Era	4 a	4 a	96 c	55 bc	64 bc	6 a
F. graminearum	Root	Era	1 a	62 b[y]	57 b	56 bc[y]	63 b	50 b[y]
	Leaf	Olaf	1 a	53 b[y]	...	...	...	...
	Leaf	Era	3 a	57 b[y]	...	...	...	...
Control[z]	...	...	0 a	0 a	30 a	0 a	9 a	0 a

[v] Means of six plants and a minimum of 18 tillers.
[w] Means of seven plants with, collectively, 14 primary tillers and a minimum of 10 heads and 22 flag leaves on secondary tillers.
[x] Means in a column followed by the same letter do not differ at $P = 0.05$ according to Duncan's new multiple range test.
[y] Kernels were invaded.
[z] Control plants were dipped in a solution of homogenized potato-dextrose agar, Tween 20, and distilled water.

Table 2. Percentage of surface area necrotic on flag leaves of Era spring wheat after inoculation with nonwheat and wheat isolates of *Fusarium sporotrichioides*

Isolated from	Necrotic area[w] (%)
Cornstalk	6 d[x]
Soil	6 d
Wheat leaf[y]	6 cd
Wheat head[y]	5 cd
White clover root	5 bcd
Sunflower stalk	5 bcd
Corn root	4 abcd
Soil	3 abcd
Cornstalk	3 abc
Oat root	2 ab
Cornstalk	2 ab
Cornstalk	2 ab
None (control)[z]	0 a

[w] Means of eight plants and a minimum of 16 tillers.
[x] Means in a column followed by the same letter do not differ at $P = 0.05$ according to Duncan's new multiple range test.
[y] Leaf isolate is listed third in Table 1; head isolate is fifth.
[z] Control plants were dipped in a solution of homogenzied potato-dextrose agar, Tween 20, and distilled water.

Table 3. Percentage of leaf length necrotic on seedlings of Era spring wheat inoculated in the three-leaf stage with *Fusarium sporotrichoiodes*

Isolate[v]	Necrosis of indicated leaf (%)[w]		
	Lowest	Middle	Top[x]
1	95 c[y]	62 c	10 bc
2	78 b	41 b	4 ab
3	98 c	80 d	39 d
4	73 b	61 c	15 c
5	85 bc	34 b	4 ab
Control	49 a[z]	9 a	1 a

[v] Arranged in the same sequence as in Table 1.
[w] Means of 24 plants, 10 days after inoculation.
[x] Top leaves were 75% expanded when inoculated.
[y] Means followed by the same letter are not significantly different at $P = 0.05$ according to Duncan's new multiple range test.
[z] Lower leaf necrosis on control was presumably due to low light intensity in the mist chamber and advanced leaf age at the time of evaluation.

0.5% NaOCl (w/v) containing 100 ppm Tween 20 and placed on "homemade" (2) PDA and water agar. Fungi obtained from lesions were identified and reisolated. *F. sporotrichioides* cultures were stored at 4 C.

Second pathogenicity test. Single-spore cultures were derived from the stored reisolated cultures from the preliminary pathogenicity test; all single-spore cultures were reidentified on homemade PDA. The second transfer of these single-spore cultures was 15 days old when used for inoculation.

Each isolate was used to inoculate three or more tillers of each of six plants in early anthesis. The heads and flag leaf of each plant were dipped into inoculum (with 50 ppm Tween 20) contained in a 100-ml graduated cylinder. Because of mist chamber malfunctions, the plants were incubated for 72 hr at 21–28 C with some periods of drying; they were held outside the chamber for 12 hr more before being returned to the greenhouse. As described for the preliminary test, necrosis notes and isolations were taken from leaves and heads 5 days after inoculation.

Third pathogenicity test. The cultures derived for the second experiment, on the fourth transfer, were blended at the rate of one 16-day-old plate per 50 ml of 100 ppm Tween 20. Plants were dip-inoculated 2 days before anthesis and incubated for 79 hr at 25 C. Visual notes and isolations were done 14 days after inoculation.

Pathogenicity of nonwheat isolates. Nonwheat isolates from Minnesota were obtained from the collection of C. Windels and T. Kommedahl. These and two isolates from the pathogenicity tests were blended at the rate of one plate (13 days old) per 50 ml of 100 ppm Tween 20. Plants in anthesis were dip-inoculated and incubated for 48 hr at 20 C. Disease was evaluated 8 days after inoculation.

Seedling pathogenicity test. From the fifth transfer, each 16-day-old culture was blended in 100 ml of 100 ppm Tween 20. Seedlings in the three-leaf stage were inoculated with a brush and incubated for 48 hr at 25 C. Plants were evaluated 10 days after inoculation.

RESULTS

F. sporotrichioides was frequently isolated from all parts of wheat plants collected from plots during 1979.

Preliminary, second, and third pathogenicity tests. Root, leaf, and head isolates from the field survey were pathogenic to leaves and heads (Table 1), causing necrosis, and were readily reisolated from lesions in apparently pure culture. All other fungi or bacteria obtained during reisolation from inoculated greenhouse-grown plants were infrequent, varied as to organism, and were not associated with the lesions.

Leaf symptoms caused by *F. sporotrichioides* were extremely variable (Fig. 1). Common lesions were small tan flecks with dark red borders; tan oval to elongate lesions of different sizes, occasionally appearing like mechanical abrasion; tan streaking, especially in young leaves; and tip burn. Red or reddish tan coloration of the lesions also occurred. Very young leaves were much more susceptible and were excluded from Table 1. Leaf sheaths were attacked, occasionally killing the leaf attached. Auricle infections occurred but appeared restricted to it. *F. graminearum* produced the same foliar symptoms but did so infrequently. It is possible that differences among isolates of both fungi affected the range of symptoms.

Agar was deposited on plants during inoculations; however, agar and lesions were generally not associated. Foliar necrosis reported for some control leaves was a normal background (with or

without agar) considering leaf age, handling, and other factors. Total necrosis was reported because *Fusarium*-induced necrosis could be so variable and nondescript.

Head symptoms were identical to those of scab (Fig. 1), except kernels were not visibly affected by *F. sporotrichioides* even weeks after inoculation. *F. graminearum*, causal agent of scab, rapidly invaded the grain. Culm infections by *F. sporotrichioides* sometimes killed the head.

Lesions continued to enlarge at a slow rate in the greenhouse after the data were taken, even though the foliage was not watered and relative humidity did not exceed 85%. Sporulating hyphae often developed on necrotic plant parts, particularly in the heads.

In the second experiment, *Erysiphe graminis* f. sp. *tritici* E. Marchal occurred on the lower halves of the plants. Inoculation with either of the two *Fusarium* spp. greatly enhanced the apparent necrosis caused by powdery mildew compared with that of the controls. The necrotic tissue of the inoculated plants became heavily infested by the respective *Fusarium* sp.

Pathogenicity of nonwheat isolates. *F. sporotrichioides* isolated from sources other than wheat were pathogenic to Era wheat leaves (Table 2). The extent of necrosis was low because of a short, cool incubation period, but pathogenicity to leaves was obvious. Symptoms were those already presented.

These data (Table 2) should not be used to imply virulence differences between isolates.

Seedling pathogenicity test. Seedlings were also susceptible (Table 3). Symptoms were an exaggerated tip dieback of leaves.

DISCUSSION

Foliar and glume necrosis caused by *F. sporotrichioides* appeared severe only under optimal conditions (third experiment), on very young plants (Table 2), or on young tillers. Kernels on affected spikelets appeared to fill and ripen normally. Consequently, one would expect minimal yield reduction caused by this fungus in the field. The foliar symptoms were variable and nondescript, however, and might easily be included in visual estimates of disease caused by another organism. Similarly, a head may appear scabbed without the eventual invasion of kernels, complicating preharvest evaluation.

Apparent synergism with powdery mildew by both *Fusarium* spp. also occurred. The increased necrosis observed on lower foliage was indistinguishable from that occurring to a lesser extent on controls. Infestation of this foliage could also provide an important source of inoculum for head infections. Powdery mildew is reported to substantially increase infection and yield loss caused by *F. graminearum* (1).

F. sporotrichioides often resembles the *F. roseum* group. Under conditions of mixed culture generally encountered with isolations from field samples, proper identification depends on pure culture.

ACKNOWLEDGMENTS

We thank W. F. O. Marasas (South Africa) for guidance in identifying the isolates. C. E. Windels (University of Minnesota) provided nonwheat isolates and R. D. Wilcoxson (University of Minnesota) provided facilities.

LITERATURE CITED

1. Mesterhazy, A., and Rowaished, A. K. 1977. Analysis of symptoms caused by *Fusarium graminearum* Schwabe and its relation to powdery mildew infection in wheat. Acta Phytopathol. Acad. Sci. Hung. 12:289-301.
2. Nelson, P. E., Toussoun, T. A., and Marasas, W. F. O. 1983. *Fusarium* Species: An Illustrated Manual for Identification. Pennsylvania State University Press, University Park. 193 pp.
3. Vargo, R. H., Baumer, J. S., and Wilcoxson, R. D. 1981. *Fusarium tricinctum* as a pathogen of spring wheat. (Abstr.) Phytopathology 71:910.
4. Vargo, R. H., Stromberg, E. L., and Baumer, J. S. 1982. The incidence of leaf-spotting fungi associated with hard red spring wheat in Minnesota. Proc. 1981 Tan Spot Workshop. N.D. State Univ., Fargo.
5. Wiese, M. V., ed. 1977. Compendium of Wheat Diseases. American Phytopathological Society, St. Paul, MN. 106 pp.