Helminthosporium Spot Blotch of Switchgrass in Pennsylvania

K. E. ZEIDERS, Research Plant Pathologist, USDA, ARS, U.S. Regional Pasture Research Laboratory, University Park, PA 16802

ABSTRACT

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Spot blotch caused by *Helminthosporium sativum* was the most prevalent and important disease on leaves of switchgrass (*Panicum virgatum*) in Pennsylvania from 1976 through 1981. *H. sativum* was isolated from switchgrass in six counties. Isolates of *H. sativum* from switchgrass differed in virulence on switchgrass and other hosts. Isolates from switchgrass and deertongue grass (*Dichanthelium clandestinum*) were about equally pathogenic on the two species and on other susceptible hosts. Caucasian bluestem (*Bothriochloa caucasica*) was not susceptible to *H. sativum* from either host. Corn (*Zea mays*) and rice (*Oryza sativa*) were moderately to highly susceptible to *H. sativum* from switchgrass. Field disease ratings showed that Ky-729 switchgrass was the most resistant of 11 cultivars to spot blotch during each of 5 yr. NY-4006, PMT-788-77, and Ky-1625 were more resistant to spot blotch than seven other cultivars. The differential reactions of cultivars in the field indicate that genetic variability for resistance to spot blotch exists. At one location, severity of spot blotch on switchgrass cultivars was greater in plots low in available soil phosphorus (P) compared with the same soil fertilized with P. Severity of spot blotch increased with time if plants were not clipped. This buildup of disease can be alleviated considerably if the grass is cut twice or possibly three times per year. Disease severity was related to duration of high relative humidity and leaf wetness at two locations. Results of this study indicate that if switchgrass is grown to any great extent in the humid areas of the eastern and northeastern United States, spot blotch will probably be the most important disease.

Additional key words: disease resistance, warm-season grass

Switchgrass (*Panicum virgatum* L.) is an important perennial forage grass that occurs naturally throughout most of the United States east of the Rocky Mountains (3). It is one of several warm-season grasses being evaluated for midsummer pasture and hay production and for soil conservation at northeastern and midwestern agricultural experiment stations (4). Except for rust (type not stated), little is mentioned about leaf disease on switchgrass (2,3). In 1960 (10), two species of *Helminthosporium* were reported on switchgrass. *H. sativum* Pam., King, & Bakke (=*Bipolaris sorokinianum* (Sacc. ex Sorok.) Shoem.) is reported to cause root rot in Nebraska and *H. giganteum* Heald & Wolf is reported to cause zonate eyespot in Maryland. *H. sativum* is parasitic on many gramineous species and has worldwide distribution in the temperate zone (9).

Spot blotch caused by *H. sativum* was the most important leaf disease observed on switchgrass in research plots and production fields in Pennsylvania during six growing seasons from 1976 through 1981. The disease was usually prevalent from early July to late October. Because it was the predominant disease on switchgrass and there is little detailed information about it, studies were made of its prevalence and importance, including disease reaction of strains and cultivars in the field. Pathogenicity and host range of isolates of the pathogen were also investigated.

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MATERIALS AND METHODS

Cross-inoculation and host range studies. Plants of the nine gramineous species listed in Table 1 were grown from seeds in a 1:1 mixture of peat moss and vermiculite in 10-cm pots. Plants were 6–7 wk old when inoculated, except corn and sudangrass, which were 4 wk old. Conidial-mycelial suspensions of *H. sativum* for inoculations were prepared by flooding 7- to 8-day-old cultures on V-8 juice agar (V8A) with distilled water; conidia and mycelia were brought into suspension by gentle agitation with a rubber policeman, then blended in distilled water with two drops of Tween 20 surfactant per liter. Inoculum concentration was about 3,000 spores per milliliter. Inoculum was sprayed on test plants until leaves were thoroughly wet. Plants were then incubated 48 hr in a large chamber without light at 20–22 C. Control plants were sprayed with distilled water. Three replicate pots of each test species were inoculated with each isolate. Disease severity was rated 5 and 8 days after inoculation on a scale of 1–9, where 1 = no disease, 2 = trace, 3 = slight,

Table 1. Susceptibility of some gramineous species to isolates of *Helminthosporium sativum* from switchgrass and deertongue grass[a]

Species	No. of cultivars	Isolate source and no.		
		Switchgrass		Deertongue
		1270	1297	1302
Warm-season grasses				
Switchgrass (*Panicum virgatum* L.)	7	M	H	H
Indiangrass (*Sorghastrum nutans* (L.) Nash)	2	S1–M	M–H	M–H
Caucasian bluestem (*Bothriochloa caucasica* C. E. Hubb.)	1	N	N	N
Sudangrass (annual) (*Sorghum sudanense* (Piper) Stapf)	1	···	M	M
Cool-season grasses				
Reed canarygrass (*Phalaris arundinacea* L.)	1	M	H	M
Fall panicum (annual) (*Panicum dichotomiflorum* Michx.)	1	S1	M–H	H
Deertongue grass (*Dichanthelium clandestinum*)	1	S1	M–H	M–H
Cereal crops				
Corn (*Zea mays* L.)	1	S1	M–H	M–H
Rice (*Oryza sativa* L.)	1	S1	M–H	···

[a] Disease severity was rated 1–9, where 1 = no disease, 2 = trace, 3 = slight, 5 = moderate, 7 = severe, and 9 = very severe. N = not susceptible or highly resistant (mean rating 1 or 2), S1 = slightly susceptible (mean rating 3 or 4), M = moderately susceptible (mean rating 5 or 6), H = highly susceptible (mean rating 7 or 8), and ··· = not tested.

5 = moderate, 7 = severe, and 9 = very severe, plant sometimes killed. Ratings were based on size and number of lesions, but lesion size was considered most important in evaluating susceptibility of species.

Field disease studies. Prevalence and severity of leaf disease on switchgrass was determined by periodic surveys of field plots and hay fields in six Pennsylvania counties from 1976 through 1981. The counties and their geographic location were as follows: Centre and Huntingdon (central), Westmoreland and Washington (southwestern), Butler (western), and Lehigh (eastern). When spot blotch was sufficiently prevalent, disease severity was rated using the scale described previously. Diseased leaves and stems of switchgrass were collected from July to mid-October each year. Fungi were isolated from diseased material on potato-dextrose agar (PDA) and cultured on V8A.

RESULTS AND DISCUSSION

The pathogen. According to Luttrell (5), *H. sativum* causes spot blotch, blight, and root rot of cereals and numerous grasses including switchgrass. *H. sativum* was isolated from switchgrass leaves from all of the six counties surveyed and from other forage grasses in Centre and Huntingdon counties, including reed canarygrass (*Phalaris arundinacea* L.), deertongue grass (*Dichanthelium clandestinum* (L.) Gould), *Pennisetum flaccidum* Griseb., smooth bromegrass (*Bromus inermis* Leyss.), orchardgrass (*Dactylis glomerata* L.), perennial ryegrass (*Lolium perenne* L.), and *Bromus japonicus* Thunb. On diseased switchgrass leaves in a petri-dish moist chamber at 22 C, mature spores of *H. sativum* developed in 2 days. Spores were not confined to disease lesions but were scattered over the leaves. Although there were slight variations in appearance of colonies and spore morphology, spores of all isolates of *H. sativum* from switchgrass germinated only from end cells.

Symptomatology. Spot blotch lesions on switchgrass caused by *H. sativum* are elongated, dark to purple, and measure 1–1.5 × 3–5 mm. Leaves and leaf sheaths are affected. Older lesions may become light colored in the center. Lesions on field plants were the same as lesions that developed on artificially inoculated plants. As disease severity increases with time, spots often coalesce and leaves become blighted, thus reducing forage quality.

Cross-inoculations and host range. Susceptibility of several gramineous species to *H. sativum* isolates from switchgrass and deertongue grass is given in Table 1. Results from two greenhouse inoculations showed that isolates from switchgrass differed in virulence on switchgrass and other hosts. Isolate 1270 from Mifflin County consistently caused less severe spot blotch than isolate 1297 and several other virulent isolates from Centre County. Results also showed that virulent isolates of *H. sativum* from switchgrass and deertongue grass were about equally pathogenic on the two species and other susceptible hosts. Caucasian bluestem was not susceptible to *H. sativum* from either host. Corn and rice were moderately to highly susceptible to *H. sativum* from switchgrass. Corn was also susceptible to the isolate from deertongue grass, but rice was not inoculated with this isolate. Cultivars of switchgrass did not differ much in susceptibility to highly virulent isolates of *H. sativum* such as 1297 because the high concentration of spores in the inoculum used caused blighting and withering of leaves of all cultivars tested. An isolate of *H. sativum* from *Pennisetum flaccidum*, another warm-season grass, also caused severe spot blotch on switchgrass.

Field resistance in switchgrass strains and cultivars. As with most forage grass diseases, genetic resistance is considered the only practical means of reducing

Table 2. Average severity ratings for spot blotch disease on switchgrass cultivars and selections from 1976 through 1981 at three locations in central Pennsylvania[a]

Year	Date	Available soil P level	Cultivar or selection											Mean rating	Cultivar with lowest mean
			Ky-729	Ky-1625	PMT-788-77	Caddo	Blackwell	Path-finder	Carthage	NJ-50	NY-4006	NY-4598	NY-5195		
Huntingdon County															
1976	17 Aug.	Low	···	···	···	···	5.2	···	5.6	···	···	4.2	4.2	4.8	Ky-729
	17 Aug.	High	2.3	···	···	···	4.6	···	6.4	···	3.0	3.2	3.8	3.9	Ky-729
1977	31 Aug.	High	3.2	···	···	···	6.6	···	5.4	···	5.4	6.8	6.6	5.7	Ky-729
	28 Sept.	High	3.4	···	···	···	7.3	···	6.6	···	6.2	7.6	7.1	6.4	Ky-729
1978	16 Aug.	Low	···	···	···	···	5.3	···	6.0	···	6.0	6.8	7.4	6.3	Blackwell
	16 Aug.	High	···	···	···	···	···	···	···	···	2.8	5.4	6.0	4.7	NY-4006
	12 Oct.	Low	3.2	···	···	···	6.6	···	7.0	···	5.0	7.2	6.4	5.9	Ky-729
	12 Oct.	High	2.2	···	···	···	6.4	···	5.0	···	3.6	6.4	6.0	4.9	Ky-729
1980	6 Aug.	Low	2.0	···	···	···	3.0	···	2.8	···	2.8	2.4	2.4	2.6	Ky-729
	3 Oct.	Low	2.0	···	···	···	4.4	···	2.8	···	2.8	2.6	2.6	2.9	Ky-729
1981	20 Aug.	Low	1.2	···	···	···	3.6	···	2.0	···	1.8	1.8	2.2	2.1	Ky-729
	9 Oct.	Low	2.0	···	···	···	4.3	···	3.0	···	2.5	2.8	3.2	3.0	Ky-729
Mean			2.4				5.2		4.8		3.8	4.8	4.8		
Centre County (Milesburg)															
1979	3 Aug.	···	···	5.0	4.8	5.3	6.0	5.5	···	5.8	···	···	···	5.4	PMT-788-77
1980	6 Aug.	···	···	3.8	3.3	3.3	3.0	4.5	···	3.0	···	···	···	3.5	NJ-50
	10 Oct.	···	···	4.0	3.5	4.0	4.5	5.0	···	4.0	···	···	···	4.2	PMT-788-77
1981	7 July	···	···	2.5	3.3	4.0	3.3	4.0	···	2.8	···	···	···	3.3	Ky-1625
	8 Oct.	···	···	4.8	5.0	6.8	5.8	7.0	···	6.3	···	···	···	5.9	Ky-1625
Mean				4.0	4.0	4.7	4.5	5.2		4.4					
Centre County (Rock Springs)															
1981	20 Aug.	···	···	3.5	···	···	···	7.0	···	7.0	···	···	···	5.8	Ky-1625
	9 Oct.	···	···	4.0	···	···	···	8.0	···	8.0	···	···	···	6.7	Ky-1625
Mean				3.7				7.5		7.5					

[a] Values are means of five replications for Huntingdon County, four replications for Milesburg, and two replications for Rock Springs. Disease severity scale: 1 = no disease, 2 = trace, 3 = slight, 5 = moderate, 7 = severe, and 9 = very severe. ··· Indicates the cultivar was not included at the location or foliage had been clipped.

economic losses caused by spot blotch (1). Disease severity ratings presented in Table 2 give an indication of the relative susceptibility or resistance of strains and cultivars of switchgrass at three locations in Pennsylvania. All ratings were made on plants that had not been clipped during the growing season. Not all cultivars were included at each location. At the Huntingdon County site, Ky-729, with an overall mean rating of 2.4, was the most resistant to spot blotch during each of 5 yr; NY-4006 was less susceptible than four other cultivars (Table 2). In addition to its superior disease resistance, Ky-729 switchgrass was among the highest of five warm-season grass species in yield, phosphorus (P) concentration, P uptake, and P efficiency on a low available P soil in Huntingdon County (6). At Milesburg in Centre County, Ky-1625 and PMT-788-77 were more resistant to *H. sativum* over 3 yr than four other cultivars. In field-scale plots at Rock Springs, Ky-1625 had much less severe spot blotch in 1981 than NJ-50 and Pathfinder. In October 1978, spot blotch was prevalent on switchgrass in hay fields in Butler, Washington, Lehigh, and Westmoreland counties. In Westmoreland, as in Huntingdon County, spot blotch was less severe on NY-4006 than on three other cultivars.

At Huntingdon County, disease ratings showed that spot blotch on switchgrass cultivars was more severe in plots low in available P compared with the same soil fertilized with P (Table 2). In 1976, the average of the mean ratings for six switchgrass cultivars was 4.8 for the low P soil vs. 3.9 for the high P soil, and in 1978, the average for low P soil was 6.3 compared with 4.7 for high P plots. The only instance where the low P rating did not exceed the high P rating was on cultivar Carthage in 1976. A comparison of overall disease severity on switchgrass at Milesburg, PA, and Hungtingdon County for 1980 and 1981 showed that the average ratings at Milesburg were substantially higher than at Huntingdon County in every case. This was not surprising because wide differences in severity of Ascochyta leaf spot on big bluestem, little bluestem, and indiangrass at the two sites were observed in 1980 (11). Data on hours at 98–100% relative humidity showed that disease severity was related to differences in duration of high relative humidity and leaf wetness at the two locations (11).

Field ratings over 3–5 yr (Table 2) showed that severity of spot blotch on switchgrass increased with time on plants that were not clipped. This buildup of disease can be alleviated considerably if the grass is cut twice or possibly three times during the growing season. This will mean increased yield of higher quality forage for the producer.

Results of this study indicate that genetic variability for resistance to *H. sativum* exists among switchgrass strains and cultivars and that isolates of *H. sativum* differ in virulence on switchgrass cultivars. Nelson and Kline (7,8) have demonstrated that *Helminthosporium* spp. were capable of attacking a wide variety of gramineous hosts. In their studies, switchgrass was resistant to isolates of *H. sorokinianum* Sacc. ex Sorok. (*H. sativum*), ie, distinct leaf lesions were not produced in artificial inoculations. Their results showed an absence of host specificity among isolates of *Helminthosporium*. Because *H. sativum* is known to attack a large number of species (9), it is not surprising that isolates of *H. sativum* from different gramineous species used in this study did cross-infect.

Spot blotch caused by *H. sativum* was consistently the most important disease on switchgrass in Pennsylvania from 1976 through 1981. Rust, which is an important disease of switchgrass in the Great Plains states (3) was never observed in Pennsylvania.

The fact that inoculum of *H. sativum* can come from other gramineous host species as well as from switchgrass practically ensures that switchgrass will become infected with spot blotch when conditions of temperature and leaf moisture are favorable and there is an adequate supply of inoculum. Results of this study indicate that if switchgrass is grown to any extent in the humid areas of the eastern and northeastern United States, spot blotch will probably be the most important disease.

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