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Judy F. Shearer
Department of B~tany, Iowa State University, Ames, Iowa

Lois H. Tiffany
Department of B~tany, Iowa State University, Ames, Iowa

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Judy F. Shearer and Lois H. Tiffany
Department of Botany, Iowa State University, Ames, Iowa 50011

Abstract. Specific fungal foliar diseases were assessed on selected prairie plant species in relation to fire as a management practice on Hayden Prairie Preserve, Iowa. Selected plant species in burned and unburned areas were visually inspected and rated for presence and severity of specific fungal diseases at three sampling times in July and September 1987 and in June 1988. Less disease and lower disease severity ratings were recorded on plants in burned areas except for powdery mildew on Canada tickclover [*Desmodium canadense* (L.) DC.]. Increasing amounts of disease developed on plants in the areas unburned for one and two years.

Key Words. fungi, fire, prairie, disease, Iowa

INTRODUCTION

The effect of disease on plants in natural communities is poorly documented. Research with fungal pathogens of agriculturally important crop plants has established that these fungi affect their host species not only by reducing leaf area or root volume, but by altering processes of photosynthesis, respiration, nitrogen metabolism, ion uptake and transport, and water relations. Severely infected plants may eventually die from stunting and reduction in vigor (Burdon 1987).

Fire may play an important role in the reduction and severity of disease in grassland ecosystems. Burning destroys fungus propagules present on diseased plant parts in the litter layer. Changes in the microclimate of burned areas may further inhibit the establishment and growth of disease producing fungi due to changes in moisture, humidity, and air circulation. Historically, fire has been shown to be important as a control for brown needle spot disease of longleaf pine (*Pinus palustris* Mill.) and leafspot of blueberry (*Vaccinium* sp.) (Ahlgren 1974). Fire is currently used in Australia to control *Phytophthora cinnamomi* Rands, the fungus causing dieback in *Eucalyptus* (Groves and Burdon 1986).

METHODS

Hayden Prairie is a 240 acre black soil prairie preserve located in Howard County, Iowa. The northern section of the prairie is divided by mowed fire lanes into four units which in recent years have been spring burned on a three year rotation cycle (Christiansen 1969). These large tracts with similar plant species and well documented burn histories make them ideal sites for studying the effects of burning on plant parasitic fungi. Areas I, II, and III chosen as the experimental units were burned in 1985 and 1988, 1986, and 1987, respectively.

Seventy random plots (4 x 10 m), were delineated in each of the three areas. Plant species were selected for disease evaluation based on frequency of occurrence and on susceptibility to common distinctive fungal foliar pathogens. Plots were confined as nearly as possible to ridgetops to insure similar growth situations for the plant species examined for disease development.

Individual plants of each species were visually inspected for presence of the particular disease and then given a disease rating based on percent leaf area destroyed by lesions. Disease assessments and ratings were adapted from Clive (1971). The single individual of each species in each plot was randomly selected by its proximity to the plot center point. Names of vascular plants follow the Great Plains Flora Association (1986). Disease readings were made on two consecutive days during July 1987, September 1987, and June 1988.

RESULTS AND DISCUSSION

When disease readings were made in July 1987, three months after the spring burn, leaf disease incidence on six of the eight host plant species was significantly lower in the spring burn area (Table 1). These six plant species had the same amount of disease or progressively increasing numbers of diseased individuals in the areas unburned for one and two years respectively. On *Baptisia*, *Marsonnina* leaf spot development was not affected by burning and was equally common in all areas. On *Desmodium canadense*, powdery mildew (*Microsphaeria diffusa* Cke. & Pk.) was apparently stimulated by burning for it had higher incidence and disease ratings on plants in recently burned areas.

Table 1. Percent incidence of foliar pathogens on selected prairie plant species on Hayden Prairie July, 1987.

		Areas		
Host	Disease[1]	I (Burned 1985)	II (Burned 1986)	III (Burned 1987)
		%		
Anemone cylindrica A. Gray	Rust	83	86	0
Rosa sp.	LS	88	34	3
Eryngium yuccifolium Michx.	LS	72	65	3
Desmodium canadense (L.) DC.	ALS	100	79	6
Aster oolentangiensis Ridd.	LS	92	58	13
Calamagrostis canadensis (Michx.) Beauv.	LS	97	84	46
Desmodium canadense (L.) DC.	PM	26	98	93
Baptisia bracteata Muhl. ex. Ell. var. *glabrescens* (Larisey) Isely	LS	100	100	98

[1]Disease abbreviations: LS = leaf spot; ALS = angular leaf spot; PM = powdery mildew.

Ahlgren (1974) reported powdery mildew disease increase on blueberry following fire. A myriad of factors including inoculum levels, nitrogen availability to the host plant and microclimate all contribute to disease development in the field. Powdery mildews, unlike most other fungi, can thrive in the absence of free water (Butt 1978). Conditions in the burned area and the area one year out of the burn rotation must have been ideal for disease development during the early summer of 1987.

Insect transmission of *Marsonnina* spores may account for high incidence of *Marsonnina* leaf spot on *Baptisia* in all areas. *Baptisia*, a vernal prairie species, develops and flowers early in the growing season. Soon after *Marsonnina* leaf spot has developed on plants in unburned areas, spores are produced in a moist mass on the diseased tissue and could easily have been transported from plant to plant by insects. Although leaf spot incidence was high, severity was very low in areas which had been burned (Table 2).

Seven of eight plant species sampled in July 1987 had reduced severity of disease on plants in burned areas as compared to plants from unburned areas (Table 2). Disease severity increased on these species as the number of years since burning increased. On *Desmodium*, disease severity of powdery mildew was much higher in burned and one year unburned areas than in the two year unburned area. Microclimatic conditions were in all probability responsible for the high incidence and severity ratings of this disease. However the possibility for fungal interactions as a factor in disease development should be considered. Increases of angular leaf spot on *Desmodium* were coincident with decreases in powdery mildew. More research in fungus-host interactions is needed.

Table 2. Average disease rating for foliar pathogens on selected prairie plant species on Hayden Prairie July, 1987.

		Areas		
Host	*Disease*[1]	*I (Burned 1985)*	*II (Burned 1986)*	*III (Burned 1987)*
Anemone cylindrica A. Gray	Rust	2.66	2.29	.00
Desmodium canadense (L.) DC.	ALS	2.96	2.15	.01
Rosa sp.	LS	2.09	.47	.03
Eryngium yuccifolium Michx.	LS	1.68	1.30	.05
Aster oolentangiensis Ridd.	LS	2.05	.90	.14
Calamagrostis canadensis (Michx.) Beauv.	LS	2.38	2.29	.39
Baptisia bracteata Muhl. *ex* Ell. var. *glabrescens* (Larisey) Isely	LS	2.97	3.47	1.52
Desmodium canadense (L.) DC.	PM	.65	2.64	2.96

[1]Disease abbreviations: LS = leaf spot; ALS = angular leaf spot; PM = powdery mildew.

Disease readings of the same leaf spot fungi were made on the same eight host plant species in September 1987 (Table 3). Disease readings on *Baptisia* were attempted but abandoned because plants were dead and accurate disease readings were impossible.

Disease assessment on individual plants was difficult in the fall sampling period. During a growing season, more than one disease may develop on a host plant and attributing necrotic lesions to a specific fungus requires careful inspection. Since only attached leaves were considered for disease reading, severely infected leaves which had already dropped from the plant were not evaluated and some disease percentages are less than in the July 1987 sampling period.

In general, numbers of diseased individuals increased as the growing season progressed both in burned and in unburned areas. During this same time period, severity of disease also increased substantially on individual plants (Tables 3 and 4).

Area 1 became the burned tract in April 1988. Seven of the eight host species examined for disease in 1987 were included in the June 1988 sampling (Table 5). *Comandra umbellata* (L.) Nutt. was added because aecial stages of the*Comandra* -big bluestem

Table 3. Percent incidence of foliar pathogens on selected prairie plant species on Hayden Prairie September, 1987.

		Areas		
Host	*Disease*[1]	*I (Burned 1985)*	*II (Burned 1986)*	*III (Burned 1987)*
		%		
Desmodium canadense (L.) DC.	ALS	100	—[2]	—[2]
Anemone cylindrica A. Gray	Rust	78	97	0
Aster oolentangiensis Ridd.	LS	93	72	33
Fragaria virginiana Dunch.	LS	93	90	40
Calamagrostis canadensis (Michx.) Beauv.	LS	100	100	70
Desmodium canadense (L.) DC.	PM	—[2]	—[2]	86
Eryngium yuccifolium Michx.	LS	100	100	90
Rosa sp.	LS	98	100	9

[1]Disease abbreviations: LS = leaf spot; ALS = angular leaf spot; PM = powdery mildew.
[2]Complete plants not available for evaluation.

Table 4. Average disease rating for foliar pathogens on selected prairie plant species on Hayden Prairie September, 1987.

		Areas		
Host	*Disease*[1]	*I (Burned 1985)*	*II (Burned 1986)*	*III (Burned 1987)*
Desmodium canadense (L.) DC.	LS	5.00	—[2]	—[2]
Anemone cylindrica A. Gray	Rust	3.31	4.00	.00
Aster oolentangiensis Ridd.	LS	2.85	1.84	.56
Eryngium yuccifolium Michx.	LS	4.29	3.82	1.27
Calamagrostis canadensis Michx. Beauv.	LS	5.93	6.00	1.40
Rosa sp.	LS	3.55	3.19	2.34
Desmodium canadense (L.) DC.	PM	—[2]	—[2]	4.02

[1]Disease abbreviations: LS = leaf spot; ALS = angular leaf spot; PM = powdery mildew.
[2]Complete plants not available for evaluation.

(*Andropogon gerardii*) rust are present during late spring on *Comandra*. Diseased *Comandra* plants soon die, thus they are not evident later in the growing season. From past personal observation, the aecial spore stage on *Comandra* is usually lacking in areas which are spring burned. At the time disease readings were made in June, several portions of the burned area still had substantial litter remaining on the ground. The incomplete burn in the area apparently allowed survival of overwintering rust spores on big bluestem residues and in June an unusually high level of disease development on *Comandra* in the burned area.

Table 5. Percent incidence of foliar pathogens on selected prairie plant species on Hayden Prairie June, 1988.

Host	Disease[1]	*Areas* I (Burned 1988)	II (Burned 1986)	III (Burned 1987)
		%		
Baptisia bracteata Muhl. *ex.* Ell. *glabrescens* (Larisey) Isely	LS	0	0	0
Desmodium canadense (L.) DC.	ALS	0	0	0
Desmodium canadense (L.) DC.	PM	0	0	0
Eryngium yuccifolium Michx.	LS	0	0	3
Calamagrostis canadensis (Michx.) Beauv.	LS	0	1	8
Anemone cylindrica A. Gray	Rust	0	60	10
Rosa sp.	LS	0	29	13
Comandra umbellata (L.) Nutt.	Rust	56	93	89

[1]Disease abbreviations: LS = leaf spot; ALS = angular leaf spot; PM = powdery mildew.

Disease severity and incidence readings were low for all species except *Comandra* (Tables 5 and 6). Disease development on the other hosts, would normally be at low levels early in the growing season and become progressively higher later. Absence of diseases such as angular leaf spot and powdery mildew on *Desmodium* was unexpected, particularly after the high levels recorded in 1987. The unusually dry spring and higher than normal temperatures may have resulted in unfavorable conditions for spore germination and subsequent disease development.

Table 6. Average disease rating for foliar pathogens on selected prairie plant species on Hayden Prairie June, 1988.

Host	Disease[1]	*Areas* I (Burned 1988)	II (Burned 1986)	III (Burned 1987)
Baptisia bracteata Muhl. *ex.* Ell. var. *glabrescens* (Larisey) Isely	LS	.00	.00	.00
Desmodium canadense (L.) DC.	ALS	.00	.00	.00
Desmodium canadense (L.) DC.	PM	.00	.00	.00
Eryngium yuccifolium Michx.	LS	.00	.00	.05
Calamagrostis canadensis (Michx.) Beauv.	LS	.00	.01	.15
Rosa sp.	LS	.00	.21	.19
Anemone cylindrica A. Gray	Rust	.00	.52	.23
Comandra umbellata (L.) Nutt.	Rust	.65	3.75	2.62

[1]Disease abbreviations: LS = leaf spot; ALS = angular leaf spot; PM = powdery mildew.

In addition to the numerous effects commonly attributed to fire in grassland ecosystems, an additional benefit is documented by the data from this field research. Both the incidence and severity of most diseases were reduced in areas which had been recently burned. Removal of the litter layer destroyed fungus spores and any other survival structures which had developed on weathered plant parts. Therefore, young plants did not become immediately diseased as a result of colonization from fungal spores present on debris surrounding them. Rather infection must occur from spores produced on infected plants in surrounding areas as the spores are moved by wind and rains.

Although plant parasitic fungi and the diseases resulting from their growth on plants of the prairie are often inconspicuous, they may have significant effects in native prairie ecosystem dynamics. Plants killed or limited in reproductive capability will be replaced, often by individuals of a different species. Over time, a plant species may be eliminated from the prairie, especially if it has no resistance to a fungal parasite. Natural reintroduction of resistant strains of the species might never occur at the present time because of the isolation of our prairie remnants.

Fire interrupts the plant disease cycles by destroying the overwintering fungus propagules on plant debris. Disease development in burned areas may be greatly modified during the season immediately following a spring burn and also for the next one or two years.

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