Effects of altered rainfall patterns on *Puccinia dioicae* infecting goldenrod.

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Abstract

Altered precipitation patterns predicted by climate change models may affect the incidence and severity of plant disease in natural systems. We studied the effects of precipitation patterns on incidence of a leaf rust caused by *Puccinia dioicae* on Canada goldenrod, *Solidago canadensis*, a common native forb in tallgrass prairie. Growing season rainfall patterns were manipulated using rainout shelters fitted with sprinkler systems. An unsheltered plot and a shelter irrigated at ambient quantities and intervals were the controls. Goldenrod in plots receiving reduced rainfall quantity, rainfall at increased intervals between rain events, or both, had a significantly lower incidence of leaf rust than goldenrod in control plots. Both quantity and pattern of rainfall inputs may affect disease incidence in native grasslands. The percent cover of *Carex gravida* was predictive of the incidence of leaf rust on *S. canadensis* in 2001.

Introduction

Global climate change could alter the rainfall patterns of the Great Plains of the United States. Model predictions include reduced rainfall and greater intervals between rain events (1,3,4,5). A rainfall manipulation study at Konza Prairie Biological Station near Manhattan, Kansas, is designed to study the long term effects of altered patterns of precipitation on a mesic tallgrass prairie ecosystem (2).

Canada goldenrod, *Solidago canadensis* L., and prairie goldenrod, *Solidago missouriensis* Nutt., are common rhizomatous perennials. Although neither is a noxious weed in the U.S., introduced *Solidago* spp. may be invasive in Europe (6).

A leaf rust occurring on both *Solidago* species at Konza Prairie is caused by the aecial stage of *Puccinia dioicae* Magnus. A number of *Carex* species may be primary hosts of *P. dioicae*. Because higher moisture levels may be associated with higher rust incidence, we investigated the effect of altered precipitation on leaf rust of these two *Solidago* species in the tallgrass prairie ecosystem.

Materials and Methods

We studied disease levels in 15 6X6 m plots,12 of which were under rainfall exclusion shelters. The shelters were constructed with a steel tube frame and a transparent plastic roof. Each shelter had a rainfall collecting system, storage tanks and a sprinkler system for re-applying rainfall. Rainfall was collected and re-applied according to the protocol in Table 1. The controls were unsheltered plots. There were three replicates in a randomized complete block design.

We sampled three quadrats totaling 4 m^2 in each plot. We recorded the number of *Solidago canadensis* and *Solidago missouriensis* stems, the number of stems with leaf rust and the number of leaf rust lesions per stem. Percent cover for *Carex brevior, Carex meadii* and *Carex gravida* was estimated in 4 contiguous 1 m^2 quadrats per plot.

Table 1.

Rainfall manipulation treatments		
Treatment	**Amount of Precipitation**	**Interval between Applications**
Control	**Unsheltered: no manipulation**	**Unsheltered: no manipulation**
Ambient	**Natural Amount**	**Natural Interval**
Drought	**Decreased by 30%**	**Natural Interval**
Increased interval	**Natural Amount**	**Increased by 50%**
Drought + increased interval	**Decreased by 30%**	**Increased by 50%**

Figure1.

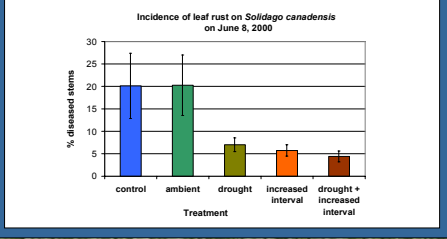
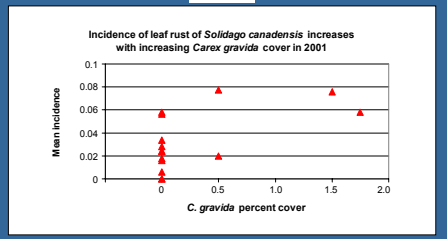


Figure 2.



Results

In 2000 there was significantly more disease in the ambient and control plots than in the drought, increased interval or drought + increased interval plots (Figure 1).

There was much higher disease incidence on *S. canadensis* than on *S. missouriensis* (total incidence 6.9% vs. 0.15%, respectively, in 2000).

The percent cover of *Carex gravida* was predictive of the incidence of leaf rust on *S. canadensis* in 2001. In plots in which *C. gravida* was found, incidence of leaf rust was greater (Figure 2). There was no predictive relationship between percent cover of *Carex brevior* or of *Carex meadii* and incidence of leaf rust on *Solidago canadensis*.

Overall incidence of leaf rust was lower in 2001 than in 2000. Incidence of leaf rust on *S. canadensis* was 11.5% on June 8, 2000, but 4.0% on the same date in 2001. There was no significant difference in incidence of leaf rust among the treatments in 2001, but there were few new lesions after rainout shelter construction to analyze in this year.

Discussion

Alterations in precipitation predicted by climate change models affected the incidence of leaf rust on *Solidago canadensis*. Long term changes in precipitation may alter the plant species composition of the tallgrass prairie, possibly affecting the abundance of both primary and alternate hosts of *P. dioicae*. Predicting the long-term effects of climate change on pathogen and plant communities will be challenging.

Proximity of the primary host *Carex* to patches of *Solidago* may be an important factor in epidemics. If disease levels on *S. canadensis* are consistently lower with reduced precipitation, this could alter competition between *S. canadensis* and other plant species, including competition between *Solidago* and *Carex*.

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