Environmental Factors Influencing Airborne Ergot Ascospore Concentrations in Kentucky Bluegrass Grown for Seed in Central Oregon

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Abstract

Ergot, caused by the fungus *Claviceps purpurea*, is an important disease affecting Kentucky bluegrass seed production in central Oregon. Multiple fungicide applications are routinely applied before and during flowering, but fungicide applications during anthesis provide only partial control of ergot. Since the ergot fungus requires unfertilized ovaries for infection, ascospores must be present during anthesis in order for successful infection to occur. In some years, ascospore production does not always coincide with anthesis or they are not present and in these years fungicide applications would not be necessary to control the disease. However, in other years extremely high numbers of ascospores can be present and cause severe epidemics. The objective of this research was to identify environmental factors that contribute to ascospore production and develop a model for the prediction ascospore production events in Kentucky bluegrass fields of central Oregon. Only 55 spores were captured during the 55 day period which limited the ability to develop a predictive model. However, several factors were identified that were significantly ($P \leq 0.0009$) related to spore production including a minimum air temperature of 41° F, mean soil temperature of 61° F, minimum soil temperature of 53° F, maximum soil temperature of 70° F, and a volumetric water content between 25 and 30%. These results are consistent with previous studies in perennial ryegrass seed production systems. Additional data will be needed to develop a predictive model for ergot ascospore production that can be used as a tool by growers to make more informed fungicide application decisions.

Introduction

Ergot is an important disease of Kentucky bluegrass and can be a persistent problem in seed production systems. The disease is caused by the fungal pathogen *Claviceps purpurea*, which has a very wide host range among grasses and grains in North America. The fungus infects flowers prior to fertilization and colonizes the ovaries, resulting in the production of sclerotia rather than viable seed. Sclerotia are the overwintering structures of the fungus and produce airborne ascospores that serve as primary inoculum the following growing season. Ergot infection and infestation incurs economic losses at various stages of grass seed production, including direct yield loss due to the production of sclerotia instead of seed, costs associated with protective fungicide applications, seed loss during re-cleaning processes that are required to remove ergot sclerotia from infested seed lots, and rejection of certification.

Cool-season grass seed is produced in a wide range of climates in Oregon, ranging from mild and moist conditions in the Willamette Valley, semi-arid high elevation deserts in central Oregon and the Columbia Basin of eastern Oregon, and high mountain valleys in northeastern Oregon. Consequently, the incidence and severity of ergot epidemics in grass grown for seed can vary among and within growing regions and from year to year. In some years the timing of ascospore release by the fungus may not coincide with grass anthesis, which is the only period of host susceptibility. Previous studies have investigated the timing and aerobiology of ergot

ascospores production in western and eastern Oregon. In the Willamette Valley, ascospore release in the field was associated with rain events occurring 2 to 3 days prior and was not correlated with temperature or relative humidity. In the high desert of central Oregon, grass seed production fields are frequently irrigated and air or soil temperatures may play more important roles in ascospore release than precipitation events. A further understanding of the environmental conditions that contribute to ergot ascospore production in central Oregon grass seed production systems is needed and could provide information that can be used to predict ascospore release and improve the timing of fungicide applications.

The objectives of this study were to: 1) determine the seasonal timing and concentration of ergot ascospores in Kentucky bluegrass grown for seed in central Oregon; and 2) identify environmental factors that contribute to ascospore production. The ultimate goal is to develop a model that can be used to predict ascospore production events in Kentucky bluegrass seed fields located in central Oregon.

Materials and Methods

Spore sampling

A Burkard 7-day recording volumetric spore sampler was used to collect airborne ascospores of *C. purpurea* in an established Kentucky bluegrass field located at the Central Oregon Agricultural Research Center (COARC). The field was reported to have ergot infection the prior year. The spore sampler was placed in the middle of the field from May 10 to July 3, 2014 with the air intake orifice located just above the mature canopy height. Spore trap tapes were replaced weekly and each tape was cut into daily segments, stained, and the number of *C. purpurea* ascospores were determined for each hour and then totaled to establish daily counts.

Environmental data collection and analyses

Air and soil temperatures, relative humidity, dew point, and soil moisture were monitored at hourly intervals in each field using a Watchdog 1000 Series Micro Station (Spectrum Technologies, Aurora, IL). Air temperature, relative humidity, and dew point were recorded at a height of 3 ft and soil temperature and moisture were recorded at 2 inches below the soil surface. Similar data, as well as daily precipitation and average wind speed, were acquired from the MRSO weather station located at COARC. Cumulative air and soil degree days were calculated using air and soil temperature data collected from the MRSO station beginning on January 1. Daily and cumulative degree days were calculated for both air and soil temperatures using a base temperature of 50° F and an upper threshold temperature of 77° F for degree day calculations. These values were based on previous incubation studies which found that ergot sclerotia germination was inhibited by temperatures outside of this range. Poisson regression was used to model daily counts of ascospores with environmental variables. Local regression, which does not assume a linear relationship, and box-and-whisker plots were used to identify trends in daily ascospore counts against significant environmental variables and visually identify upper and lower threshold values of environmental factors that were significantly associated with ascospore occurrence.

Results and Discussion

The first occurrence of spores occurred on May 20 when accumulated air and soil temperature degree days reached 294 and 175, respectively. Only 55 spores were captured during the 55 day period, with the majority of spores captured between May 24 and May 31 (62% of total spores) and between June 13 and June 19 (31% of total spores) (Figure 1).

Minimum air temperature, mean, minimum, and maximum soil temperature, and mean soil moisture in the field were significantly ($P \leq 0.0009$) related to spore production, while minimum air temperature, maximum soil temperature, and dew point data collected from the MRSO weather station were significantly ($P \leq 0.0008$) associated with ergot spore production. Local regression and box-and-whisker plots were used to identify upper and lower threshold values for environmental factors significantly correlated with spore production. A minimum air temperature of 41° F, mean soil temperature of 61° F, minimum soil temperature of 53° F, maximum soil temperature of 70° F, and a volumetric water content between 25 and 30% in the field were associated with ergot spore production. These results are consistent with previous studies concluding that the highest percentage of ergot sclerotia germination was observed at incubation temperatures between 50 and 77° F and germination was reduced at temperatures below 41°F and above 77° F.

Overall, relatively few spores were observed in this study, which limited the ability to develop a preliminary model for spore prediction. Studies in 2015 will use artificially-infested plots to increase the chances of capturing a sufficient number of spores for analysis and model development. If a naturally-infested commercial field is available, a second spore trap will be deployed to collect additional spore count data. Nevertheless, several years of data will be required to develop and test a final model for ergot spore prediction in Central Oregon Kentucky bluegrass seed production.

Acknowledgements

The researchers would like to thank the Oregon Seed Council and Oregon Department of Agriculture Alternatives for Field Burning Research Financial Assistance Program for financial support.

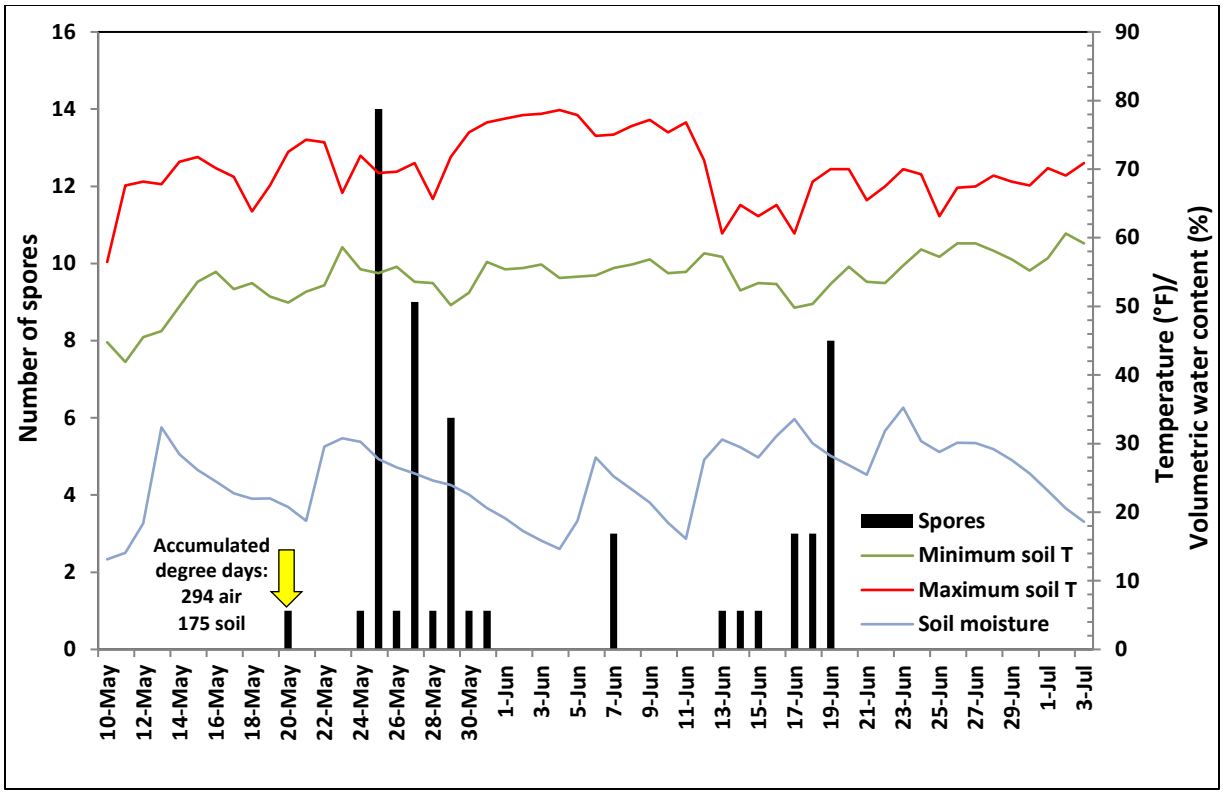

Figure 1. Daily number of ergot ascospores captured in a Kentucky bluegrass plot located at the Central Oregon Agricultural Research Center (black bars) plotted with daily minimum soil temperature (green line), maximum soil temperature (red line), and soil moisture measured as volumetric water content (blue line). Accumulated air and soil degree days are noted for the first occurrence of ergot ascospores on May 20 (yellow arrow).