Free-air ozone concentration enrichment of a soybean crop

INTRODUCTION

Field studies of the effects of ozone on crop yield have typically been performed using large gassampling chambers. While these studies have successfully demonstrated the effects of ozone at elevated concentrations, there is a need for field-scale studies that can assess the effects of ozone in agronomic fields. The SoyFACE facility, a high-pressure fumigation system, was designed to address this need by allowing large-scale studies of ozone damage in an agronomic crop while avoiding the uncertainties imposed by the enclosures required by past ozone fumigation methods. The information collected from the various varieties grown within the treatment area will allow researchers to better understand ozone damage to soybeans and better prepare for future environments.

METHODS

The current O3 FACE system at SoyFACE, based on the Miglietta design (Miglietta et al. 2001), was modified to fumigate soybeans with ozone. A bypass venturi injector was designed to blend low pressure ozone with high pressure ambient air for fumigation of the crop. Additional components of the existing O3 system were modified or replaced to prevent degradation by corrosive ozone.

RESULTS AND DISCUSSION

This ozone fumigation system is the first system to allow large-scale studies of ozone damage to an agronomic crop while avoiding the uncertainties imposed by the enclosures required by past ozone fumigation methods. The information collected from the various varieties grown within the treatment area will allow researchers to better understand ozone damage to soybeans and better prepare for future environments.

Ozone exposure causes stomatal closure, decreased transpiration, and, therefore, warmer leaves in sunlight. A thermal image of the soybean canopy within the treatment ring shows a dew point warming (~5 °C) relative to the crop outside of the ring. This study shows that the USDA method of Miglietta et al. (2001) can successfully be adapted to simulate rising tropospheric ozone. The system has the advantage over earlier O3 FACE systems of lower energy requirements to force air into the ring and much lighter release pipes (T. Lewin 1999; R. Midor 1999) which is more easily accessible on the crop. In a variable crop setting, this has the important advantage of far more rapid assembly after sowing but before emergence, and similar removal at the end of the growing season.

Ozone fumigation should be discontinued during the day under certain conditions, including wet leaves and safety issues. [1] Wet leaves. Leaf surfaces were used to shut down fumigation. [2] Safety. Once ozone is dangerous to people at high concentrations, the system was shut down to prevent pockets of high-concentration ozone from forming at the release points where wind speeds were low and variable. [3] Ozone levels fell below these conditions before the field received fumigation. [4] Ozone during operating hours, resulting in the 25.5% increase above ambient in the 2003 growing season.

METHODS

Free-air ozone concentration enrichment (FACE) technology processes information from various sensors inside a fumigation ring to regulate gas concentration increases through a series of control feedback loops. A computer control system directs the release of gases into the field to maintain ozone concentrations close to desired levels. Components of the equipment include the ozone generator, linear flow controller, ozone analyzer, Ozonanalyser, wind measurement, and ozone exposure meters.

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ACKNOWLEDGMENTS

Funding for construction and operation of the SoyFACE facility is provided by the following.

REFERENCES CITED


Ozone generator.