

# Effects of elevated carbon dioxide and ozone levels on diseases of soybeans grown in a free air concentration enrichment (FACE) system.

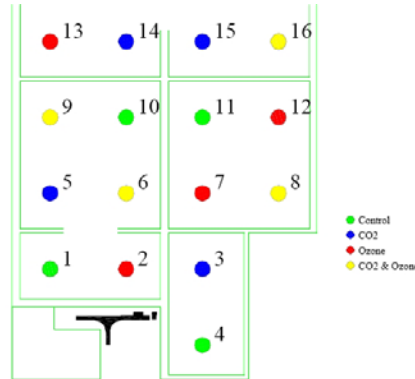
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## Summary

The SoyFACE (Soybean Free Air Concentration Enrichment) project is designed to evaluate the impacts of elevated levels of atmospheric carbon dioxide and ozone, alone or in combination, on the productivity of soybeans grown under field conditions. As part of this project, evaluations of soybean disease levels in response to these atmospheric treatments began in 2005. Disease levels of Septoria brown spot, downy mildew and sudden death syndrome were evaluated at weekly intervals between June 22 and September 1. Significant increases in the severity of brown spot occurred over time in all plots. Significant differences between treatments were observed starting on August 10, with the highest severity levels occurring on plants in the CO<sub>2</sub> and CO<sub>2</sub>/O<sub>3</sub> treated plots. Throughout most of the season there were no significant differences in downy mildew levels among the atmospheric treatments. However, on the August 25 and September 1 rating dates, severity levels were significantly higher on plants in the ambient (control) plots. Symptoms of SDS were not observed until the end of August, and incidence levels among treatments were not significantly different.

SoyFACE treatment layout



SoyFACE ring



## Materials and Methods

The SoyFACE study was designed to evaluate the effects of elevated levels of atmospheric carbon dioxide and ozone on the growth of soybean plants grown in a field setting. Segmented tubes with micropores are used to surround field plots, and computer controlled gas emissions from the tubing are used to elevate CO<sub>2</sub> and O<sub>3</sub> levels within the plot. Treatments include plots with elevated CO<sub>2</sub> (550 ppm), plots with elevated O<sub>3</sub> (1.2 x ambient), plots with elevated levels of both CO<sub>2</sub> and O<sub>3</sub>, and plots with ambient levels of these gases.

Soybean plants (Pioneer 93B15) were evaluated at 5 randomly selected 1 m sections of row in each plot for levels of naturally occurring diseases at weekly intervals from 22 June to 1 September. Incidence and severity (height in canopy) levels of Septoria brown spot were recorded for each plot, as well as severity (% leaf area affected) levels of downy mildew and incidence levels of sudden death syndrome.

## Results

The incidence of Septoria brown spot increased rapidly, from zero on July 7 to near 100% by July 26 in all plots. However, no treatment effects (O<sub>3</sub>/CO<sub>2</sub> amendments) were observed, and incidence levels in each of the treatments were not significantly different at any rating date. Significant increases in the height of Septoria symptoms in the canopy occurred over time, as would be expected, and significant differences in height ratings between treatments were observed starting on August 10, with the highest values observed on plants in the CO<sub>2</sub> and CO<sub>2</sub>+O<sub>3</sub> treated plots (Figure 1). These differences were not as pronounced when the values were expressed as % of total plant height, as the CO<sub>2</sub> and CO<sub>2</sub>+O<sub>3</sub> treated plants were taller than the ambient and O<sub>3</sub> treated plants.

The severity of downy mildew symptoms significantly increased over time on plants in all treatment plots. On the August 25 and September 1 rating dates the downy mildew severity levels were significantly higher on plants in the ambient plots when compared to plants in plots receiving the other three treatments (Figure 2).

Symptoms of sudden death syndrome (SDS) did not appear on plants in the plots until the end of August. Percent incidence levels of SDS averaged 2.6, 2.3, 1.0, and 8.7 for ambient, CO<sub>2</sub>, O<sub>3</sub>, and CO<sub>2</sub>+O<sub>3</sub> treatments respectively, but these means were not statistically different ( $\alpha=0.05$ ).

Figure 1

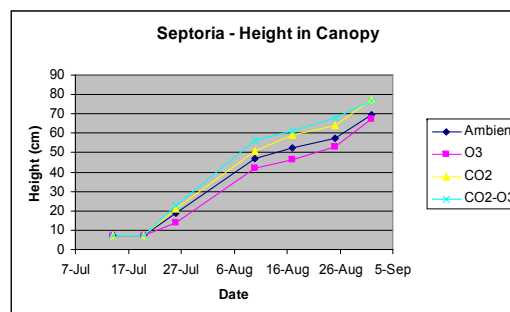
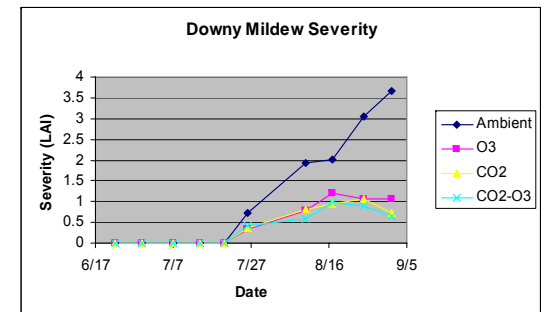


Figure 2



## Conclusions

Levels of all three diseases observed were rather low, resulting from very dry conditions during most of the growing season. The fact that downy mildew severity responded more significantly to atmospheric treatments than did Septoria brown spot is not too surprising. *Peronospora mancharica* is an obligate parasite that has a very intimate association with its plant host, and therefore it might be more sensitive to physiological changes the host. Soybean leaves also become more resistant to infection by downy mildew as they age. Maybe the O<sub>3</sub> treatment affects the aging process of the leaf, and thus the level of susceptibility of the leaf to downy mildew. *Septoria glycines*, by contrast, is not as dependent on host physiology, as it is not an obligate parasite and obtains its nutrients through the destruction of plant tissue. However the disease is favored by humid conditions, thus the denser canopy structure in the CO<sub>2</sub> treated plots may have favored the development of Septoria brown spot. Increased O<sub>3</sub> levels, on the other hand, delayed canopy closure and reduced canopy density, and lower brown spot levels were observed in those plots.