The St. Louis Ozone Garden Project
2013 Update

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What is an Ozone Garden?

-A public education and outreach exhibit with plants that are sensitive to ozone air pollution.
-With ozone (O\textsubscript{3}) and weather monitoring equipment.
-Panels describe ground-level O\textsubscript{3} air pollution and its effects on plants.
-Leaf damage data is collected.

The increasing levels of background O\textsubscript{3} air pollution and its effects on the environment are little known components of global change.

Youth Exploring Science (YES) student collecting O\textsubscript{3} injury data on cutleaf coneflower leaves in the Saint Louis Science Center/Forest Park garden in summer 2013.
Three Ozone Gardens around St Louis in 2013

- Saint Louis Science Center (SLSC) – 2nd year
- Grant’s Farm – 1st year
- Southwestern Illinois College (SWIC) – 1st Year
Ground-Level Ozone ($O_3$)

- A secondary pollutant formed by nitrogen oxides [$NO+NO_2$] and volatile organic compounds [$VOCs$] from fossil fuel burning.

- Not the “good” ozone in the stratosphere, which protects the earth from harmful ultraviolet (UV) radiation.

- Harmful to humans: causes respiratory problems, decreased lung capacity, and aggravated asthma.

- Ozone and its pre-cursors can travel long distances.
Dirty Air is Getting Cleaner; Clean Air is Getting Dirtier

Ozone trends in St. Louis for ‘dirty air’ and ‘clean air’
Background $O_3$ levels are rising

Green dots-The cleanest air days in MO
Red dots-The worst air pollution days in IL
Each year’s dot represents an average of ~1200 data points, and is an average of the six lowest (green) or highest (red) daily $O_3$ 8-hour average values for each month from May to September, 1980-2012
Visual O₃ symptoms include:
• Dark red, brown, or black “stippling”
• Stippling usually occurs on top side of leaf only
• Stippling does not occur on the veins of a leaf
• Stippling gradually progresses to become prominent dark areas
• Older leaves show more advanced symptoms than younger leaves
• After stippling, leaves can become chlorotic (yellow) and/or necrotic (cell death) and often drop early from the plant

Ozone also effects plants that may not show these symptoms. Either way, O₃ damages plants in a number of ways in varying degrees, including: reduced photosynthesis (the ability to produce and store food), reduced reproduction (decreasing flowering and seed production), and increased susceptibility to other diseases.
Ozone-injury at the SLSC garden in 2013

Common milkweed

Cutleaf coneflower
Wild Plant Conservation

Milkweed is the monarch caterpillar’s primary food source

Decreasing the amount of healthy milkweed effects monarch butterfly populations
Ozone Damage in Crop Plants

In the St. Louis Ozone Gardens:

-Potatoes, La Chipper variety, from Dr. John Skelly, Penn State. Were once grown on many acres in the Eastern U.S.

-Soybeans, from Dr. Lisa Ainsworth, USDA-ARS and Univ. of IL. The Univ. of IL studies soybeans, corn, and other crops exposed to elevated $\text{O}_3$ at their SOYFACE facility.

-Snap beans, $\text{O}_3$–sensitive and $\text{O}_3$–tolerant. From Dr. Kent Burkey, USDA-ARS and NC State.
Ozone Damage in Crop Plants

-The cost of ozone to the soybean farming community in the U.S. likely exceeds $1 billion (Fishman et al., 2010, Atmos. Environ., 44, 2248-2256)

-Ozone–induced yield reductions in the year 2000 ranged between 79-121 million metric tons of wheat, soybean, and maize, worth $11-18 billion; Global losses from O$_3$ in these three crops could rise as high as $12-21 billion annually by 2030 (Avnery et al., 2011, Atmos. Environ., 45, 1. 2284-2296 & 2. 2297-2309)

-Globally, the loss of value of all crops to ozone ranges between $14-$26 billion (Royal Society, 2008, RS Policy Document, London, 15/08)

-Ozone also damages: peanuts, cotton, corn, wheat, tomatoes, watermelon, lettuce, carrots, beans, broccoli, spinach, and others
Thank you

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Links

-Our website:
http://www.slu.edu/sustainability/center-for-environmental-sciences/ozone-garden-home

-NASA Publication: Ozone-Induced Foliar Injury Field Guide:

-O₃ monitor and weather station from the GO3 Project: http://go3project.com
  -To access the data from our monitors select “Graph GO₃ Data” and choose our location from the “Available Schools Table”