CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Alexander J. Sercel

Project Number
S2017

Project Title
Study of and New Apparatus for Testing Effect of Environment on the Transpiration Driven Flux of Two Greenhouse Gases

Abstract

Objectives/Goals
This was a two part study. Part 1 investigated the effect of atmospheric CO2 level on plant transpiration. Related effects may be highly relevant to the environment because both CO2 and H2O are greenhouse gases. Part 2 was the development and testing of a new type of apparatus which sought to correct flaws in a commonly used apparatus for observing transpiration.

Methods/Materials
Part 1 started with fabrication of a commonly used apparatus consisting of watertight plastic tubing attached to a plant on one side and a pressure sensor on the other. To measure the influence of CO2 on transpiration rate, I added an airtight enclosure to control atmospheric conditions including different CO2 concentrations, directed air movement with measured temperature and humidity inside the box, and variable applied light levels. The part 2 apparatus was fabricated from glass tubing and flasks to increase and control accumulator volume to enable longer run times at modest pressure differentials.

Results
The lowest CO2 concentration yielded by far the highest transpiration rate, while those in the highest concentration yielded the lowest rates. Increases in light and wind levels were found to increase transpiration. While variability in the plastic tubing had little effect on results, the small accumulator volume of the Ward#s Scientific apparatus limited trials to short durations precluding observations of how transpiration rates fluctuate over time. With the part 2 apparatus, transpiration rate was found to vary widely with a characteristic cycle time of hours suggesting that quantitatively correct transpiration experiments must be run for longer periods.

Conclusions/Discussion
Transpiration may be a negative feedback mechanism related to global climate change. When there is excess CO2 in the environment, the stoma in the leaves are able to transpire less H2O. As water vapor is responsible for the majority of thermal blanketing, less H2O being transpired into the atmosphere from increased CO2 levels may have a cooling effect on the environment. Plant transpiration was found to vary widely over time periods of hours with periods of zero and even negative flow of liquid. Hence, the short duration of the standard AP biology experiment is suspect. In addition, the Ward's experiment uses uncalibrated pressure measurements, with pressure near the plant transpiration pressure as an incorrect surrogate for transpiration rate.

Summary Statement
My project is an investigation of transpiration's impact on climate change as well as a new approach to measuring transpiration in plants that provides unique insights into the interactions of plants and their environments.

Help Received
Father helped with apparatus design, Mother helped with board lay-out