CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)
Wilder Bunke; Han Kim; Karl Marrett

Project Number
J1704

Project Title
Do Palm Trees Make Poor Street Trees?

Abstract

Objectives/Goals
The objective was to test which evergreen street tree had the highest carbon and ozone uptake (calculated over a year) for the following three species: California palm, Mugo pine, and Coastal live oak.

Methods/Materials
Materials: 3 oaks, 3 pines, 3 palms, notebook, plant gas exchange system, planimeter, micrometer, ruler.
Methods: We used a gas exchange machine, which measured the amount of carbon dioxide taken up by the leaf , and the amount of water released from the leaf, which was proportional to the amount of ozone absorbed, using a conversion factor. We clipped the machine onto a single leaf, and set a constant leaf temperature, light level, and air humidity, close to the outside conditions. We measured 3 leaves on each tree, and 3 trees of each species. We used data from already published scientific papers for average summer time gas exchange of the same or similar species. We measured leaf area of a subsample of leaves on the tree, and estimated the number of leaves per tree to calculate leaf surface area per tree. We used algebraic equations to calculate the photosynthetic rate and ozone uptake of the whole tree over a whole year. The winter photosynthetic rate was multiplied by the total leaf area of the tree (in meters square) and by the total amount of time the leaf might photosynthesize in the winter (4 months x 8 hours per day x 60 minutes per hour x 60 seconds per minute). Similarly, summer carbon and ozone uptake was calculated for the rest of the year using published photosynthetic and water loss rates.

Results
Palm trees had the highest rate of photosynthesis per leaf area during the wintertime measurements. The total absorption of ozone and carbon per plant was much less than any other species due to its small leaf area. Coast live oak had the highest rate of carbon uptake, but not the most ozone in the winter time measurements. Oak took up 17 times more ozone, and 14 times more carbon than palm. It did not have the highest leaf area but it was much more than palm. Mugo pine had the highest leaf area per plant. The pine absorbed the most carbon of the three trees at 20 times more than palm but lacked in ozone uptake with only 1.2 times greater than palm.

Conclusions/Discussion
Pines absorbed the most carbon and oak absorbed the most ozone. Palm trees make poor street trees due to low carbon and ozone absorption, primarily due to low leaf area per plant.

Summary Statement
Pine took up the most carbon, oak absorbed the most ozone, and palm trees, although a Californian icon, make poor street trees.

Help Received
Nancy Grulke, USDA Forest Service, provided a calibrated gas exchange system and micrometer. Eric Bunke of Krieger and Stewart, Inc., provided the planimeter. Nancy Grulke helped simplify how to estimate whole tree leaf area, and talked us through how to calculate carbon and ozone uptake over the