CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Mark Morreale; Nicholas Sercel

Project Number

S1018

Project Title

Investigation of CO2 Enhancement for Kratky Hydroponics in Greenhouses for Low Water Consumption Agriculture

Abstract

Objectives/Goals

The purpose of our experiment was to determine if Kratky grown plants in a controlled green house environment can benefit from controlled increases in the level of CO2 and to better understand how to limit water usage when employing the Kratky method by controlling VPD. Improving crop yield and reducing water usage are increasingly important in drought stricken areas such as California. Growing plants hydroponically may reduce water usage while producing abundant food crops.

Background: The Kratky Method, developed by the Prof. B.A. Kratky of the University of Hawaii, is a non-circulating method of hydroponics that is especially good for water conservation. It is well known in conventional agriculture that increased atmospheric CO2 increases plant growth rate. The Vapor Pressure Deficit (VPD) is a measure of humidity and is defined as the difference between the water vapor pressure and the saturation vapor pressure of water in the air. VPD is known to drive the rate of evaporation in standing water. Black Seeded Simpson lettuce is a cultivar of the species Sativa in the genus Lactuca.

Methods/Materials

We measured how changes in the level of atmospheric CO2 and VPD in small indoor greenhouses affected water usage and the growth rate of Black Seeded Simpson lettuce in Kratky hydroponics. We measured plant mass, plant physical dimensions, and water usage after a controlled growth period. Six plants were placed into each of three separate indoor home greenhouses where light, heat, water, and atmospheric composition were controlled. The CO2 level was varied between greenhouses using CO2 generators in which yeast metabolized sugar anaerobically in an aqueous solution inside the greenhouses. In a control greenhouse there was no CO2 generator and CO2 level was found to be in the range of 400 to 600 ppm. The two variable greenhouses were held at 800-1000 ppm and 1200-1500 ppm of CO2 respectively. Humidity and temperature were recorded in all cases to allow calculation of VPD.

Results

CO2 level was found to be a strong driver of plant growth and VPD was found to drive water consumption.

Conclusions/Discussion

Kratky hydroponic greenhouses with carefully controlled CO2 and VPD levels constitute a promising and environmentally friendly approach to agriculture. Crop yields can be maximized and water consumption minimized through the careful control of CO2 and VPD in this approach.

Summary Statement

We found that careful control of CO2 level and VPD can be used to increase agricultural yield and limit water consumption in Kratky hydroponic greenhouses with strong environmental and productive benefits.

Help Received

Mrs. Sercel taught us about gardening, hydroponics, and greenhouse methods. Alex Sercel showed us how to use Prizm. Dr. Sercel coached us on how to analyze and present data. Mrs. Morreale helped us with our board. We did the work, took the data, plotted it and analyzed it.