CALIFORNIA STATE UNIVERSITY SAN MARCOS

PROJECT SIGNATURE PAGE

PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

MASTER OF SCIENCE

IN

BIOTECHNOLOGY

PROJECT TITLE: Development of Fertigation Monitoring System

AUTHOR: Mike Vo

DATE OF SUCCESSFUL DEFENSE: 4/23/13

THE PROJECT HAS BEEN ACCEPTED BY THE PROJECT COMMITTEE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

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5/8/2013

5/3/2013

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ABSTRACT

Development of Fertigation Monitoring System

Seacoast Science, Inc.

Mike Vo

05/2013

Professional Master’s Degree Program

California State University, San Marcos

The hydroponic growth method involves growing plants in water and supplying the plants with nutrients directly to their root system. Hydroponic farmers can directly monitor important variables that influence plant growth such as pH, nitrates, phosphates, and conductivity. Since hydroponic plants are connected by a continuous irrigation system, if a problem occurs in the system it affects all of the plants in that system, which may have devastating effects on the crop. Therefore, it is important to constantly monitor the nutrient medium in the hydroponic system to make sure conditions are optimal for healthy plant growth. Seacoast Science is developing a fertigation monitoring system (FERM-Sys) to be installed at Dramm and Echter (Encinitas, CA). This system will allow farmers to accurately track components in their water and maximize their resources. The goal of this project was help Seacoast Science develop the FERM-Sys from the electronic components to the individual nutrient monitoring (INM) unit. This was done by building the INM units, testing the electrodes, and adjusting the different electronic components involved. The pH and conductivity calibration test showed that these electrodes were functioning properly through multiple tests. The nitrate electrode calibration test showed unfavorable results due to the short-circuiting of the probes. Fixing the nitrate probes from short-circuiting and further long-term testing must be accomplished before the system can be installed at a hydroponic farm.
Development of Fertigation Monitoring System

Seacoast Science, Inc.

Mike Vo
05/2013

Faculty Advisors
Project Chair: Geoff Landis
Committee Member: Betsy Read
Committee Member: Matthew Escobar

Professional Science Masters
California State University, San Marcos
Why?

- Current systems only perform periodic monitoring
- Developing a system that can measure nutrients in real time over a extended period of months
- Will help farmers maximize their yields and resources
Hydroponics

- Farming method that does not require soil
- Delivers the mineral nutrients that plants need to grow directly to their roots in water
FERM-Sys

- Allow individuals running a hydroponic system to be able to continuously and accurately monitor the nutrients supplied to the plants by tracking the following parameters:
  - pH
  - Nitrates
  - Conductivity
  - Temperature and humidity
pH, Conductivity, & Nitrate Levels

- pH range: 5.5-6.5
  - Affects the availability and absorption of the elements in the hydroponic solution to grow

- Conductivity range: .5 - 4.5 mS/cm
  - Measures the strength of the nutrient solution

- Nitrate range: 100 ppb – 100 ppm
  - Synthesis of amino acids and make proteins for cell growth
pH, Conductivity, and ISE-NO$_3^-$ Probes

pH Probes  Conductivity Probes  Nitrate Probes
Example of pH Probe Set Up

- pH Probes
- Transmitter
- Signal Isolator
- SCADA Board
LabView
pH Calibration

Value (%) vs pH

Value (%) vs pH
Conductivity Calibration
Nitrate Calibration

Value (%) vs Nitrate (ppm)

- Out (3/6/13)
- In (3/6/13)
- In (3/13/13)
- Out (3/13/13)
- Out (3/15/13)
- In (3/15/13)
Nitrate Probe (Normal & Short Circuit)
FERM-Sys Setup

- Long term test performed over three days
- Weidne’s Fertilizer
  - 2.8% nitrates
  - 1.8% phosphorous
  - 4.72% potassium
FERM-Sys Setup (INM Units)

- Importance of having two INM Units
- Measuring in and out
Conductivity (Long Term Test)
pH (Long Term Test)
Nitrate (Long Term Test)
Future Development of FERM-Sys

- Solve the short circuiting of Nitrate Probes
  - Installation of reference electrodes

- Installation of calcium, potassium, chloride, etc. electrodes

- Drift of Conductivity Probe
  - Fouling

- Longer testing studies for 1-3 months
  - See if software works for this long of a time period

- Install FERM-Sys for field testing at Dramm and Echter
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