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BE AWARE Research Area

The research consisted on see the effect that the level of water moisture in the soil affects the growth of the corn plant when there is a cover crop present compared when without it. The research is being performed to see if there are any benefits or drawbacks of using cover crops when it comes to water moisture availability for the corn to use. In addition a device had to be designed and built to determine the relationship of temperature with the growth of a corn plant.

Motivation or Background

The motivation of the research is to find sustainable agricultural practices. Agriculture is one of the least sustainable industries due to the huge resource losses that occur to obtain the final product. In addition, due to overuse of herbicides some weeds have developed resistance that has made weed management practices relevant. Cover crops help to resolve these problems by managing the resources in an organic way; the cover crop can also help with weed management by competing with the weeds and also by serving as a mulch once it is killed. In this case a study had to be performed to determine if cover crops had an impact on the water availability for corn crops in the soil. This is important since this will allow to understand the effect of water stress on corn.



Fig. 1: *Corn Plot*



Fig. 2: *Corn Plot Node*



Fig. 3: *IRT Instrument Prototype*

Objectives

1. Study the relationship between soil moisture of agricultural systems with and without cover crops.
2. Design and build a non-invasive measurement instrument to measure the temperature of the corn leaves to determine the effect of temperature on moisture levels of the soil
3. Create a program to arrange and filter the data collected from the sensors in the fields so it can be imported and easily read into other data analysis programs.

Methodology

Objective 1: The sensors used use time domain reflectometry to measure soil water availability. Wireless sensors were used along with wired sensors in multiple corn plots. In each plot there are two equally sized areas where one side is classified as weedy and the other as non-weedy. The weedy sub-plot would be weeded to ensure no weeds were in the plot whereas the non-weedy did not receive any weeding thus allowing it to compete with the corn during its growth stage. The wireless sensors could be inserted to the ground whereas the wired sensors had to be placed at different depths. Each subplot had two wireless sensors to measure the surface water availability and there were wired sensors at 10, 20, and 30 inches depth to get a water profile on basis of depth. The data was stored either in a datalogger or a Moteino which was then wirelessly transmitted to a central hub for monitoring.

Objective 2: Infrared temperature sensors were chosen to measure the temperature in a non-intrusive manner. There were three different field of views that are being tested that are 10, 35, and 90 degrees. A frame had to be designed to house the sensors. The frame had to be easy to be fabricated, assembled and installed on the field while attempting to minimize cost as much as possible. The material of choice for this was PVC since it is a material that does not oxidize, is weather resistant, and is easily available and cheap. The sensor housing needed to be able to be adjusted at different heights in order to be able to measure the corn leaf throughout the stages of the corn growth that can be up to 6 ft. However, the leaf to be measured would be either the 3rd or 4th leaf counting from the top whichever was more accessible.

Objective 3: A program was developed in MATLAB using the app designer tool. The tool had to be easy to use and distribute so other collaborators could easily process the data to plot it in another site. The program had to require little to no pre-processing of the data and output an excel file that could be read in other programs. First the code had to be developed and tested and once the code was finalized then the app was made to create an application. Then using the compilation tool of MATLAB an installer for the application was made. It was preferable to have an executable file since it could be easily shared and required no connection so it could be used in the field.

Results

- **Objective 1: Ongoing Research.** The project is a study for a period of years so no conclusions have been drawn yet from the data. However, while looking at the data there were some issues that had to be resolved. One example was that the circuit on some of the Nodes in the farms had a solar cell but it was acting as a switch so it was only recording during daylight hours so the solar cells were removed so data could be collected for the whole day.
- **Objective 2: Complete.** The prototype was finished and it is being tested in the field. Data has been collected and the prototype seems to accomplish what it was designed for. The data collected from 3 days of testing has provided some insight of the sensitivity of the sensors as well so perhaps instead of having all of the three sensors in each station the number can be reduced since some seem to perform similarly. From this prototype multiple things have been learned in which the next iteration of the sensor will reflect.
- **Objective 3: Complete.** The executable file has been created that allows the user to easily process their data and allows them to name the location and name of the output file.



Fig. 7: *Node without solar panel.*

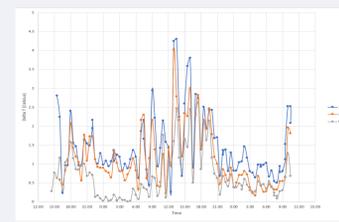


Fig. 8: *IRT Instrument Test Results (Temperature Difference)*

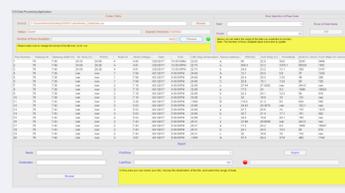


Fig. 9: *Application Developed*

What I Learned

The experience I got from working on the lab was very invaluable. I learned concepts from a different branch of science and this internship helped me to improve my communication skills with professionals who are not working on my same field of study. I also had the experience to design, build and test an instrument to be used in the field. Designing the instrument included designing the circuit layout, some programming, and the housing for the circuit and sensors.

Acknowledgments

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Fig. 4: *Water Availability Sensor setup*



Fig. 5: *IRT Circuit Designed*



Fig. 6: *Sensors Used*