Sensor Based Irrigation Management in Crop Production: A review

Abstract

Efficient water management in agriculture is crucial for sustainable crop production~~,~~ especially in regions facing water scarcity. Sensor-based irrigation scheduling offers a promising solution by enabling precise and timely irrigation, optimizing water usage while maintaining or enhancing crop yields. This study was made in order to investigate~~s~~ the efficacy of sensor-based technologies in irrigation scheduling for improving water use efficiency in agricultural settings.Utilizing an array of sensors including soil moisture, weather and crop-specific indicators.~~,~~ real-time data was collected and analyzed to determine the optimum~~al~~ irrigation timing and volume. The ~~methodology~~ procedure integrated these sensor-derived insights with irrigation scheduling algorithms to dynamically adjust water delivery, aligning with the crop's actual water needs.This study reviews the importance of soil moisture sensors for irrigation, as well as sensor technology and its uses in various agricultural applications and irrigation scheduling.

Keywords: Sensor-based irrigation scheduling,Precision Farming, Sustainable Crop Production, Water Use Efficiency

Introduction

In many regions of the nation, the future of irrigated agriculture is seriously threatened by the growing demand for water. Therefore, understanding crop water demand is a crucial practical factor in enhancing irrigation systems' water usage efficiency.Conventional irrigation systems cause some areas of a field to receive superfluous watering while leaving other areas without any irrigation. An effective system for managing field irrigation is required due to the lack of water and changing environmental conditions. Water use that is not optimized is one of the main issues facing agriculture,~~.~~ An estimated 40% of the freshwater utilized in developing nations for agricultural purposes is lost due to evaporation, spillage or absorption into the ground's deeper layers. (Shah *et al*., 2012). Today, it is often acknowledged that the issue of agricultural water management is a significant difficulty that is frequently connected to problems with development. Agricultural practices have resulted in the overuse, nutrient pollution and salinization of numerous freshwater resources, all of which have caused degradation (Thompson *et al*., 2007). In order to address the issue of water waste in conventional techniques like flood irrigation and furrow irrigation, several irrigation techniques are being used, such as drip irrigation and spray irrigation. (Rehman *et al*., 2014).Thus, a novel method of obtaining data in real time from the field through the use of a soil moisture sensor presents a genuine possibility for the accurate monitoring of soil water status in agricultural areas. Due to the sensor nodes' very low cost, a dense population of soil moisture sensors may be installed, sufficiently representing the natural diversity in soil moisture seen in each field (Dursunet*et al*., 2014). This seminar's primary goal is to examine the necessity of sensor-based technology for an automated

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Sensors in Irrigation Management

So ~~M~~many techniques could ~~methods can~~ be used to measure the volumetric and gravimetric content of soil; these techniques ~~methods~~ can be sub-divided into two categories: (i) classical methods and (ii) modern methods. The former can be used for measurements in the laboratory and the latter for on-site conditions. Thermogravimetric, gypsum block, tensiometer, and calcium carbide neutron scattering methods are examples of traditional soil moisture monitoring techniques. In contrast, contemporary methods make use of soil resistivity sensors, infrared moisture balance, and dielectric methods such as heat flux soil moisture sensors, time domain reflectometry (TDR), frequency domain reflectometry (FDR), and micro-electromechanical systems~~.~~(Lekshmi*et al*., 2014).

The system known as a Wireless Sensor Network (WSN) is made up of numerous "nodes," or constituent parts. The application-oriented data requirements are collected by the smart devices known as nodes. Three fundamental tasks are carried out by a sensor network: (i) sensing; (ii) communicating; and (iii) computing through the use of hardware, software, and algorithms.

Role of Sensors in Irrigation

Irrigation sensors measure soil moisture levels, allowing farmers to irrigate only when necessary, preventing overwatering or underwatering. Some sensors can track weather conditions, including rainfall, temperature and humidity, to adjust irrigation schedules accordingly. By providing real-time data, irrigation sensors promote water conservation by reducing water wastage and saving resources. Maintaining optimal soil moisture levels improves crop health and yield, as plants receive the right amount of water. Efficient irrigation based on sensor data can lead to cost savings by reducing water and energy usage. Sensors can be integrated with irrigation systems to automate watering, reducing the need for manual intervention.

Tensiometermethod

Fruit number and weight measurements indicated some significant differences among treatments by date, however, overall fruit numbers and fruit weight for set schedule and soil water 25 kPa treatments were significantly greater than those of other treatments~~.~~(Migliaccio*et al*., 2010). On an average, irrigation scheduling on one acre of rice with the help of tensiometer helped in reducing the ground water use and power consumption by 5,38,179 liters and 101 kwh/acre in 2012 and by 3,72,042 liters and 70 kwh/acre in 2013 in different location.(Kamal *et al*., 2013). Tomato irrigated using tensiometer at the potential of -0.4 bar showed a 40% lower yield (mainly due to the lower fruit size) compared to that of plants irrigated at -0.1 bar. ~~A~~ W~~w~~ater saving of 35% irrigated at the

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Neutronprobe method

Dry grain yield positive responses from the automatic treatment plots compared well to those from manual scientific irrigation scheduling based on soil water content, in this irrigation treatment increase WUE.(Shaughnessy *et al*., 2012)

ET controller method

The study indicates that there was a saving in irrigation water by 5.84% and 20.8% and increase in the yield by 7.89% and 11.33% in the case of the ET controller compared to watermark (Wmark) sensors and control treatments, respectively in tomato (Ghobari, 2014). Cumulative irrigation water estimated by Pan ETc approach was higher and silver black plastic mulch recorded lower crop coefficient values at all growth stage of Bt. cotton compared to biodegradable plastic mulch, wheat straw mulch and control. Therefore, low irrigation requirement in sensor based Et_a. (Prajapati and Subbaiah, 2019).

Time domain reflectometer(TDR) method

Abdullah *et al*., (2018) reported that TDR is a suitable tool to measure soil water content without getting the physical soil samples as compared to oven dried method. On the other hand, once the moisture content increase, the accuracy in measurement will reduced.

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Nano sensor with drip in crop prouction

Irrigation scheduled based on nano sensors in maize recorded highest plant height, highest dry matter productionover other sensors under drip irrigation method (Durga*et al*., 2018). Soil moisture sensor base drip irrigation on sugarcane at different fertilizer levels and reported that the combination of 125 per cent Etc along with 100 per cent RDF as WSF recorded higher cane yield of while Drip irrigation at 75 per cent Etc along with fertigation of 100 per cent RDF as WSF recorded highest WUE. (Ramesh *et al*., 2019).In dry conditions soil moisture sensor will give a large output, while in wet conditions it will give a small response. (Sudarmaji*et al*., 2019). Water applied in Sensor LM 35 automated irrigation basedsystem was lower than conventional system and plant yield was higher in automated irrigation system as compared to conventional system (Debnath and Patel, 2016). VegApp and SMS-based irrigation regimes applied 15% and 29% less water, respectively, than the WB method in watermelon (Miller *et al*., 2018).

Conclusion:

The use of soil moisture sensors helps ~~to~~ farmers with irrigation scheduling by providing information about when to irrigate the crops. The water application based on sensor readings are effective in water saving, increase water use efficiency which ultimately improve water productivity without affecting yield.

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