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Research Article

AUTOMATION OF RESERVOIRS

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ABSTRACT

Automation of irrigation is a promising approach in minimizing the wastage of irrigation loss and improving the efficiency of water use. Automation helps to irrigate only when there is acute requirement of water and deliver nutrients in controlled and precise manner which helps to save time, resource with increased efficiency and outcome of agriculture.

KEYWORDS

Automation, Irrigation, Fertigation, Growth, Yield.

INTRODUCTION

Efficient water management is a major concern in precision irrigation practices. There is a great need to modernize agricultural practices for better water productivity and resource conservation. The use of automated irrigation systems can provide water on a real-time basis at the root zone, based on the availability of soil water at the crop root zone, which also leads to saving of water (Ohja et al., 2015). Automated irrigation systems allow for high-frequency irrigation, thus maintaining the soil water potential (SWP) relatively constant. Irrigation scheduling remains a reliable technique for applying the required amount of water at the appropriate time and automated irrigation systems based on crop water needs can maximize water use efficiency (Munoz et al., 2003). Ganjeer (2019) studied on use of automated

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irrigation in comparison to manual irrigation in wheat by use of humidity controlled sensors and reported that maximum water use efficiency was obtained in sensor based irrigation and there was 15.85% water saving through sensor based irrigation.

Automation of drip/micro irrigation system refers to operation of the system with no or minimum manual interventions.

Irrigation automation is well justified where a large area to be irrigated is divided into small segments called irrigation blocks and segments are irrigated in sequence to match the flow or water available from the water source (Rajakumar et al., 2008).

Specific features of automated irrigation system

It eliminates the manual opening and closing of valves. It starts and stops pump exactly as and when required thus optimizing the energy requirement. Irrigation system can be started at any desired time. One need not worry to visit farm during odd time (night). This is especially in Indian condition, where power supply is available for agricultural operation during night time. Possibility to change frequency of irrigation and fertilizer application as per the crop need.

Types of automation Semi-automatic

Semi-automatic systems and controls require manual attention at each irrigation and are usually simpler and less costly than the fully automatic systems. Most semi-automated systems use mechanical or electronic timers to activate control structures at pre-determined times. The irrigator usually determines when to begin irrigation and its duration and manually resets or returns the devices to their original positions or moves them from one location to another before the next irrigation. The parts of given system may be automatic while other parts are semi- automatic or manually operated. Such systems require communication between the controller and system components located in the field.

Fully automatic

Fully automatic systems normally operate without operator attention except for periodic inspections and routine maintenance. The irrigator may determine when and how long to irrigate and turn water into the system or start programmed controllers to initiate the automated functions. Fully automatic systems may use soil moisture sensors, such as tensiometers or electrical resistance blocks to activate electrical controls when soil water is depleted to predetermined levels. Irrigation duration may be controlled by programmed timers, soil moisture sensors or surface water sensors. Fully automatic systems require a water supply available on demand such as from wells or farm reservoirs. Most farm systems however do not have the flexibility required for complete automation.

Types of controls Time based system

In time based system, time is the basis of irrigation. Time of operation is calculated according to volume of water required and the average flow rate of water. The duration of individual valves has to be fed in the controller along with system start-time, also the

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controller clock is to be set with the current day and time.

Volume based system

In volume based system, the preset amount of water can be applied in the field segments by using automatic volume controlled metering valves. The major advantage of volume based irrigation system over time-based system is that is assures to deliver the preset amount of water irrespective of continuous availability of electricity, but time based system is comparatively cheaper and hence gaining more popularity than the volume based system.

Open loop system

In an open loop system, the operator makes the decision on the amount of water that will be applied and when the irrigation event will occur. This information is programmed into the controller and the water is applied according to the desired schedule. Open loop control systems use either the irrigation duration or a specified applied volume for control purposes. Open loop control systems are typically low in cost and readily available from a variety of vendors. The drawback of open loop systems is their inability to respond automatically to changing conditions in the environment. In addition, they may require frequent resetting to achieve high levels of irrigation efficiency.

Closed loop system

This type of system requires feedback from one or more sensors. The operator develops a general control strategy. Once the general strategy is defined, the control system takes over and makes detailed decisions of when to apply water and how much water to apply. Irrigation decisions are made and actions are carried out based on data from sensors. In this type of system, the feedback and control of the system are done continuously. Closed loop controllers require data acquisition of environmental parameters (such as soil moisture, temperature, radiation, wind-speed, etc) as well as system parameters (pressure, flow, etc.).

Real time feedback system

Real time feedback is the application if irrigation based on actual dynamic demand of the plant itself, plant root zone effectively reflecting all environmental factors acting upon the plant. Operating within controlled parameters, the plant itself determines the degree of irrigation required. Various sensors viz., tensiometers, relative humidity sensors, rain sensors, temperature sensors, etc., control the irrigation scheduling. These sensors provide feedback to the controller to control its operation.

Computer-based Irrigation Control System

A computer-based irrigation control system consists of a combination of hardware and software that acts as a supervisor with the purpose of managing irrigation and other related practices such as fertigation and maintenance.

Automatic systems

In fully automated systems the human factor is eliminated and replaced by a computer specifically programmed to react appropriately to any changes in the parameters monitored by sensors. The automatic functions are activated by feedback from field units and corrections in the flow parameters by control of devices in the irrigation system until the desired performance level is attained.

Sensor controlled micro irrigation

Control by twin sensors - One sensor is placed in the root zone and actuates the opening of water flow. The second sensor, located on the limit of the wetted zone, triggers the closing of water flow.

Control by single sensor - One sensor open and closes the water supply.

Sensor

Sensor is defined as an element that senses a variation in input energy to produce a variation in another or same form of energy.

Different types of sensors used to monitor soil and plant parameters are as follows:

- Electromagnetic sensors
- Optical and Radiometric sensors
- Mechanical sensors
- Electrochemical sensors
- Acoustic and Pneumatic sensors

Measured soil EC has no direct effect on crop growth or yield. However, based on a measured soil data, a farmer can easily determine specific soil properties which may affect the crop yield.

Sensors	Soil texture (clay, silt & sand)	SOM or total carboncontent	Soil moisture content	Soil salinity	Soil bulk density	Depth variability	Soil pH	TotalN content	CEC	Other macro nutrient
Electrical & Electro-magnetic	x	x	x	x		x		x	x	
Optical and radiometric	X	x	x				x	x	x	
Mechanical Acoustic& pneumatic	X				X	x				
Electro-chemical				x			x	x		x

Optical and radiometric sensors

Optical sensors measure the reflectance, absorption, or transmittance characteristics of the soil. They use light reflectance to measure soil organic matter, soil moisture, mineral composition, clay content, soil color, organic carbon, pH, and Cation Exchange Capacity. Sensors determine the soil's ability to reflect light in different parts of the electromagnetic spectrum. Changes in wave reflections may indicate changes in soil density or restrict soil layers. Optical sensors use the combination of four different wavelengths to measure certain soil characteristics; ultraviolet (100-400 nm), visible (400-700 nm), near-infrared (700-2500 nm) and mid-infrared (2500-25000 nm) wavelengths.

Ultraviolet wavelengths are used in combination with visible spectra to determine inorganic minerals (iron oxide) in the soil. According to Baumgardner et al., (1985), moisture, organic matter, particle size, iron oxides, mineral composition, soluble salts, parent material and other attributes affect soil reflectance.

Soil-plant water monitoring sensors

Different types of devices used to monitor soil-plant water status and to automate irrigation system are listed below:

a) Tensiometer
b) Resistance block
c) Gypsum block
d) Granular matrix sensor
e) TDR based soil moisture sensor
f) Infrared sensors for leaf air temperature
g) High frequency capacitance type soil moisture sensor.

Effect of automated irrigation on crop growth

Majsztrik et al., (2013 a,b) and Saavoss et al., (2016) demonstrated that more timely irrigation decisions through the use of sensor networks in greenhouse production increased the yield and quality of snapdragon (cut- flowers) by 30% depending on season and cultivar.

CONCLUSION

In conclusion the automation results in higher production, increased productivity, better quality, improved safety, shorter workweeks for labour. Automated systems typically perform the irrigation process with less variability than human workers, resulting in greater control and consistency. Also, increased process control makes more efficient use of irrigation water, resulting in less water consumption or high water use efficiency. Automated irrigation systems (AIS) can save man power, reduce use of natural resources, dependency on rainfall can be avoided, improve quality and production efficiently, mix the fertilizers in the required ratio for the crops and feed it through the irrigation lines and also maintains the soil moisture content at optimum levels, thereby helping the farmers to increase their yield.

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