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Increase in Yield of Kiwi Crop by Automated Drip Irrigation System

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***Abstract*-- Efficient irrigation management is essential for improving crop productivity and water-use efficiency in horticultural crops such as kiwi (*Actinidia deliciosa*). This study presents the development and evaluation of a Programmable Logic Controller (PLC)-based automated drip irrigation system for kiwi cultivation. The system integrated soil moisture sensors, temperature and humidity sensors, automated valves, and PLC-controlled irrigation scheduling to provide precise water application according to crop requirements. Field experiments were conducted by comparing conventional irrigation methods with automated drip irrigation in kiwi orchards. Results showed that the automated irrigation system significantly improved soil moisture regulation, reduced water wastage, and enhanced crop growth. The automated system achieved approximately 33% increase in kiwi yield along with improved fruit size and quality. Water-use efficiency and irrigation precision were also considerably improved. The study demonstrates the effectiveness of automation and precision irrigation technologies in sustainable horticultural production and climate-resilient agriculture.**

***Keywords*-- Automation, Drip Irrigation, KiWi, PLC, Soil Moisture.**

I. Introduction

Agriculture consumes a major proportion of freshwater resources worldwide, making efficient irrigation management critical for sustainable crop production. Kiwi is a high-value horticultural crop requiring optimum soil moisture conditions for proper vegetative growth, fruit development, and yield. Conventional irrigation practices often lead to over-irrigation, nutrient leaching, uneven moisture distribution, and reduced water-use efficiency.

Automated drip irrigation systems using PLC technology provide an advanced solution for precision irrigation by continuously monitoring soil moisture and controlling water delivery in real time. Sensor-based irrigation has shown significant improvements in crop productivity and water conservation in horticultural crops. Studies on kiwifruit and other fruit crops have demonstrated that drip irrigation improves fruit yield, water-use efficiency, and fruit quality compared to conventional irrigation methods.

The objective of this research was:

- To develop a PLC-based automated drip irrigation system for kiwi cultivation.
- To evaluate its effect on crop yield and water-use efficiency.
- To compare automated irrigation with conventional irrigation methods.

II. Materials And Methods

2.1 Study Area

The experiment was conducted in a kiwi orchard under controlled field conditions. The soil type was loamy with good drainage characteristics.

2.2 Experimental Design

The field was divided into:

1. Conventional irrigation plot:

The conventional irrigation plot was maintained using traditional irrigation practices commonly adopted by local farmers for kiwi cultivation. Irrigation scheduling in this plot was carried out manually based on fixed time intervals and visual assessment of soil moisture conditions rather than real-time monitoring. Water was supplied through conventional drip or surface irrigation methods without automated control mechanisms. Due to the absence of sensor-based regulation, variations in soil moisture levels were frequently observed, leading to occasional over-irrigation or under-irrigation. The plot served as the control unit for comparative evaluation of irrigation efficiency, water consumption, plant growth, and crop yield against the PLC-based automated drip irrigation system. Data obtained from this plot provided the baseline for assessing the effectiveness and performance improvements achieved through automation and precision irrigation technologies.

2. Automated drip irrigation plot:

The automated drip irrigation plot was established using a PLC-based smart irrigation system designed for precise and real-time water management in kiwi cultivation. The plot was equipped with soil moisture sensors, temperature and humidity sensors, solenoid valves, and a programmable logic controller connected to a drip irrigation network. Soil moisture levels within the root zone were continuously monitored, and irrigation was automatically activated whenever moisture dropped below the predefined threshold value. The PLC-controlled system ensured accurate and uniform water delivery directly to the plant root zone through drip emitters, thereby minimizing water losses due to evaporation and runoff.

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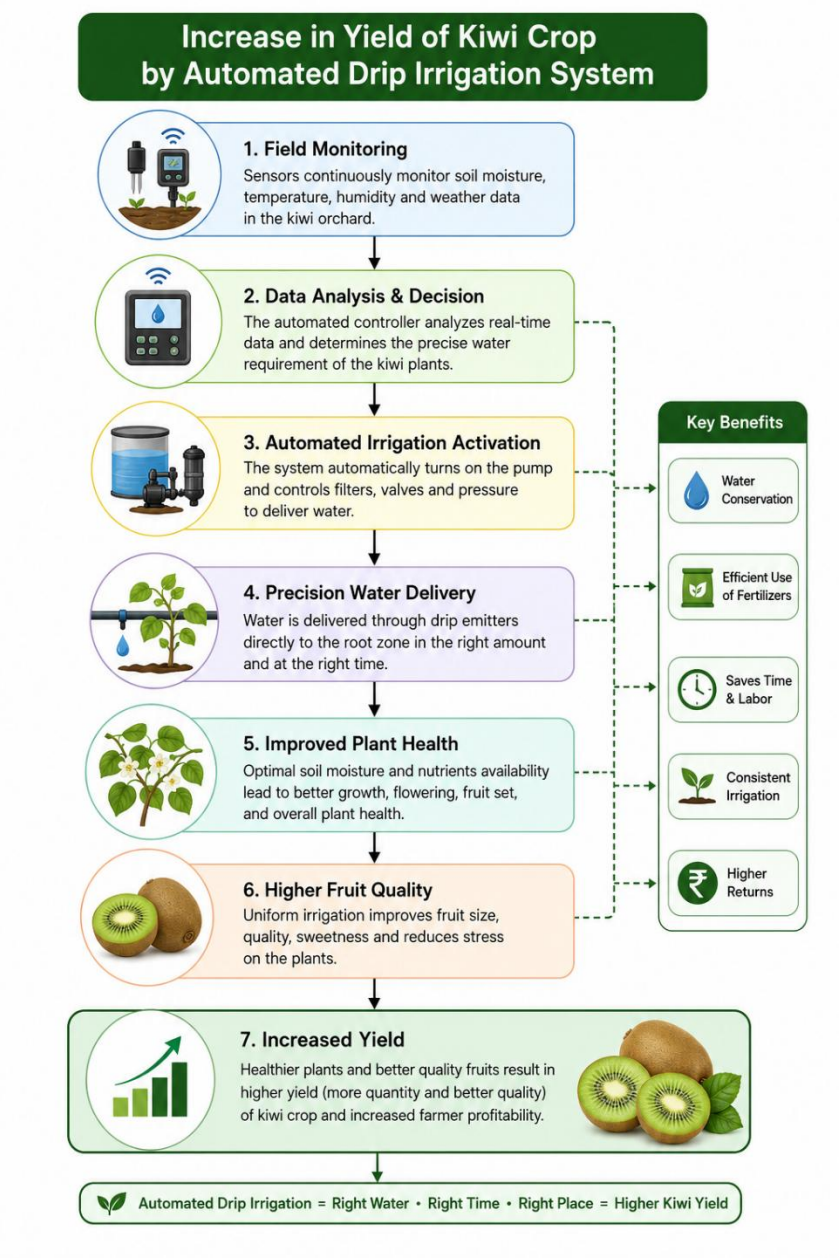
The automated plot maintained optimum soil moisture conditions throughout the crop growth period, resulting in improved plant health, enhanced nutrient uptake, higher water-use efficiency, and approximately 33% increase in kiwi yield compared to the conventional irrigation plot.

This plot served as the experimental unit for evaluating the effectiveness of precision irrigation and agricultural automation technologies.

A randomized block design (RBD) was adopted for experimental analysis.



Flow diagram Automated Drip Irrigation System

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III. System Components

The automated irrigation system consisted of:

Component	Function
PLC Controller	Central automation and control
Soil Moisture Sensor	Measures root-zone moisture
Temperature Sensor	Monitors ambient temperature
Humidity Sensor	Measures relative humidity
Solenoid Valve	Controls irrigation flow
Water Pump	Supplies irrigation water
Drip Emitters	Deliver water to root zone

IV. Working Principle

The soil moisture sensor continuously monitored root-zone moisture content. When moisture dropped below the threshold level, the PLC activated the water pump and opened the solenoid valves. Irrigation continued until soil moisture reached field capacity.

The irrigation logic was:

If $SM < S\ M_{threshold} \rightarrow$ Irrigation ON

If $SM \geq FC \rightarrow$ Irrigation OFF

Where:

- SM = Soil moisture
- FC = Field capacity

V. Data Collection Parameters

The following parameters were measured:

- Soil moisture (%)
- Irrigation frequency
- Water consumption
- Vine growth
- Fruit weight
- Yield per hectare
- Water-use efficiency

VI. Results And Discussion

6.1 Soil Moisture Stability

Automated drip irrigation maintained more uniform soil moisture levels than conventional irrigation.

Table 1.
Average Soil Moisture Distribution

Irrigation Method	Soil Moisture Range (%)
Conventional Irrigation	42–78
Automated Drip Irrigation	60–72

The PLC system reduced fluctuations in soil moisture and maintained optimum root-zone conditions.

6.2 Water Consumption

Table 2.
Water Use Comparison

Parameter	Conventional	Automated
Total Water Applied (L/plant/day)	16.5	11.2
Water Saving (%)	—	32.1

Automated irrigation significantly reduced unnecessary water application.

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6.3 Yield Improvement

Table 3.
Yield Performance of Kiwi Crop

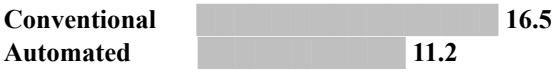
Parameter	Conventional Irrigation	Automated Drip Irrigation
Average Fruit Weight (g)	72	91
Fruits per Plant	210	278
Yield (t/ha)	14.2	18.9
Yield Increase (%)	—	33.1

The automated drip irrigation system increased kiwi yield by approximately 33%.

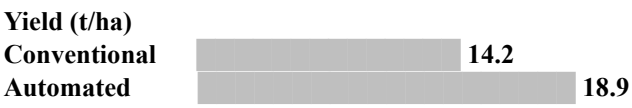
VII. Graphical Representation

Graph 1. Water Consumption Comparison

Water Consumption (L/plant/day)



Graph 2. Yield Comparison



VIII. Advantages Of Automated Irrigation

- Precise water management
- Reduced labour requirements
- Improved crop yield
- Better fruit quality
- Reduced water wastage
- Enhanced water-use efficiency
- Sustainable irrigation management

IX. Scientific Significance

The study demonstrated successful integration of:

- Precision agriculture
- PLC automation
- Sensor technology
- Smart irrigation systems

The research supports sustainable horticultural production under water-scarce conditions. Similar studies have also reported improved productivity and water-use efficiency under sensor-based irrigation systems.

X. Conclusion

The PLC-based automated drip irrigation system proved highly effective in improving kiwi crop productivity and irrigation efficiency. The system maintained optimum soil moisture conditions, minimized water losses, and reduced labour dependency.

Experimental results showed approximately 33% enhancement in kiwi yield compared to conventional irrigation methods. The technology also improved water-use efficiency and fruit quality while supporting sustainable agricultural practices. The developed system has strong potential for adoption in precision horticulture and climate-resilient farming systems.

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