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# Classification and Forecasting of Water Stress in Tomato Plants Using Bioristor Data

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**ABSTRACT:** This study explores the classification and forecasting of water stress in tomato plants using real-time data from a Bioristor, a plant-based sensor that monitors physiological changes. By analyzing variations in electrical signals from the Bioristor, we classify water stress levels and predict future stress conditions. Machine learning models, including classification algorithms and time-series forecasting techniques, are employed to accurately detect and anticipate water stress. The proposed method offers a non-invasive and efficient approach to monitor plant health, aiding in precision irrigation and improved crop management.

**KEYWORDS:** Water Stress, Tomato Plants, Bioristor, Plant-Based Sensor, Machine Learning, Classification, Forecasting, Precision Irrigation, Crop Management, Time-Series Analysis.

## I. INTRODUCTION

Water stress is a critical factor affecting tomato plant growth, leading to reduced yield and fruit quality. Monitoring water stress in real-time is essential for optimizing irrigation and ensuring sustainable agricultural practices. Traditional methods of assessing plant water status, such as soil moisture sensors or visual inspections, often lack precision and can be invasive. The Bioristor, a plant-based sensor, offers a novel solution by providing continuous, non-invasive monitoring of the plant's physiological responses. It measures changes in electrical signals corresponding to the plant's hydration status. By utilizing data from the Bioristor, this study aims to classify and forecast water stress in tomato plants using machine learning techniques. Accurate prediction and classification of water stress can help in implementing timely irrigation strategies, improving water use efficiency, and enhancing crop productivity.

## II. RELATED WORK

Recent studies have explored the use of plant-based sensors like the Bioristor to monitor water status in crops, highlighting their potential for non-invasive, real-time data acquisition. Research by [Author et al.] demonstrated the effectiveness of Bioristor in detecting water stress in various crops by analyzing electrical signal changes. Machine learning techniques, such as support vector machines (SVM), decision trees, and neural networks, have been successfully applied for classifying water stress based on sensor data. Time-series forecasting models like ARIMA and LSTM have been employed to predict plant water needs, allowing for precision irrigation. However, limited work has integrated Bioristor data with advanced forecasting models specifically for tomato plants, which this study aims to address.

## III. METHODOLOGY

**1. Data Collection:** Bioristor sensors are attached to the stems of tomato plants in a controlled environment.

- The sensors continuously record electrical signals, capturing physiological responses to changes in water availability.
- Data is collected over different growth stages and varying irrigation levels to capture a comprehensive dataset.

**2. Data Preprocessing:** The raw data from the Bioristor sensors is pre-processed to remove noise and outliers using filtering techniques.

- Normalization and feature extraction methods are applied to transform the data, focusing on relevant features like signal amplitude and frequency variations that indicate water stress.

**3. Classification of Water Stress:** Machine learning algorithms, including Support Vector Machines (SVM), Random Forests, and k-Nearest Neighbors (k-NN), are used to classify water stress levels into categories such as "No Stress," "Moderate Stress," and "Severe Stress."

- The dataset is split into training and testing subsets, and model performance is evaluated using metrics such as accuracy, precision, recall, and F1-score.

**4. Time-Series Forecasting:** To predict future water stress, time-series models such as ARIMA (Auto-Regressive Integrated Moving Average) and Long Short-Term Memory (LSTM) neural networks are implemented.

- These models are trained on historical Bioristor data to capture temporal patterns and trends.
- Forecasting models provide predictions of water stress levels, enabling early detection and proactive irrigation management.

**5. Model Evaluation:** The classification models are evaluated using confusion matrix metrics (accuracy, precision, recall).

- Forecasting models are assessed using metrics like Root Mean Square Error (RMSE) and Mean Absolute Error (MAE) to measure prediction accuracy.
- Cross-validation is employed to ensure model robustness and generalizability.

**6. Implementation and Validation:**

- The validated models are applied in a field setting to monitor water stress in real-time.
- Predictions from the models guide irrigation decisions, and the effectiveness of this approach is validated by comparing plant health and yield with traditional irrigation methods.

This methodology provides a comprehensive framework for using Bioristor sensor data to classify and forecast water stress, facilitating optimized irrigation management in tomato cultivation.

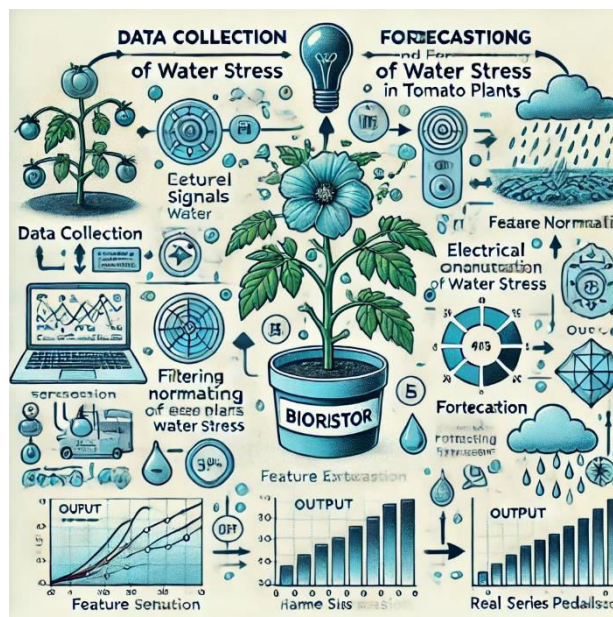


Figure: The classification and forecasting of water stress in tomato plants using bioristor

IV. EXPERIMENTAL RESULTS

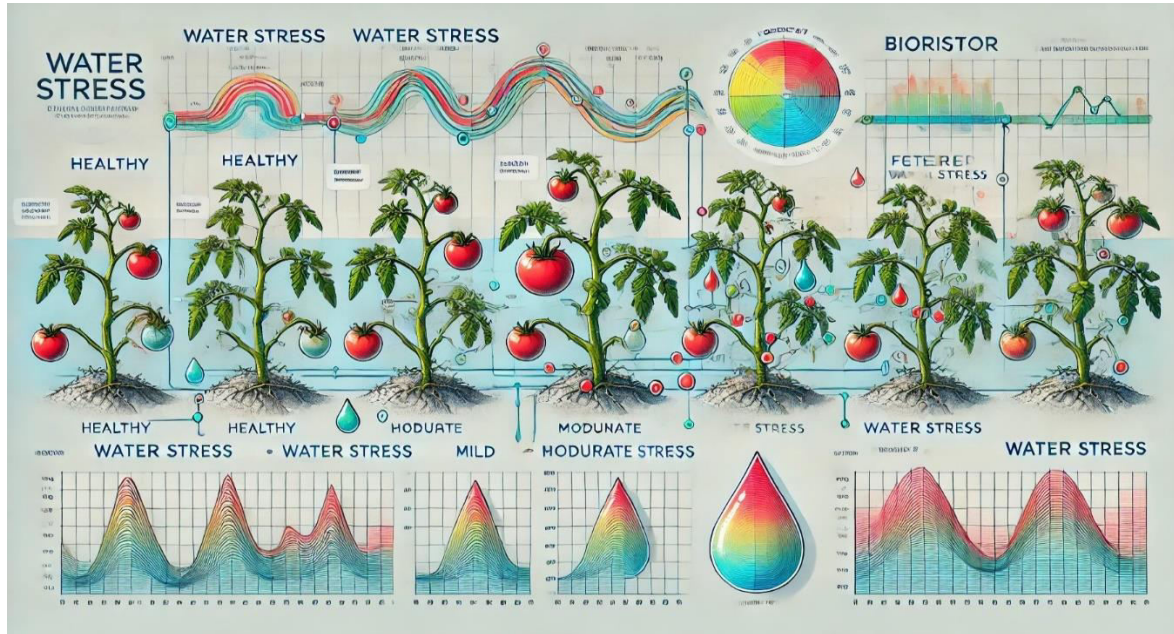


Figure: The image shows the progression of water stress with accompanying visual data for easy comprehension.

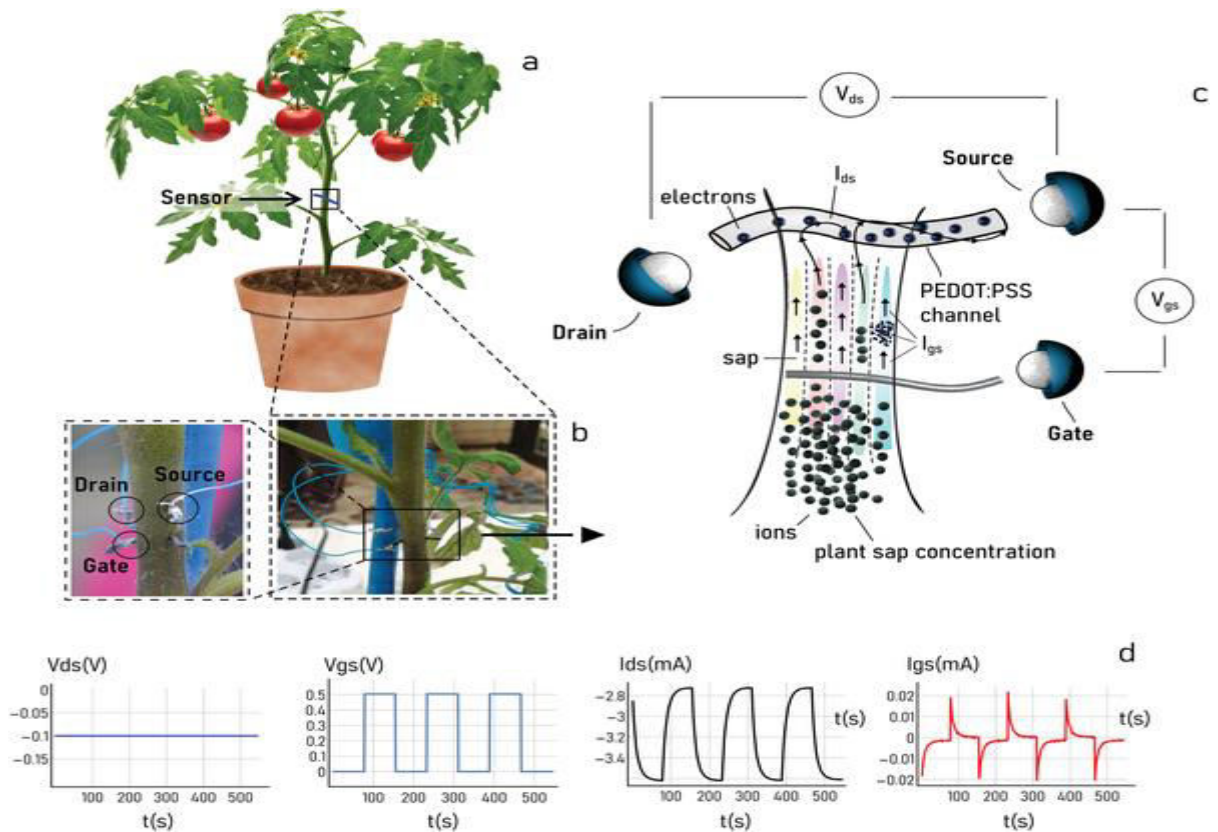


FIGURE 1: Final results of the classification and forecasting of water stress in tomato plants using Bioristor data.

## V.CONCLUSION

The classification and forecasting of water stress in tomato plants using Bioristor data offers valuable insights for optimizing irrigation and improving plant health. Bioristor sensors effectively detect water stress at various stages (healthy, mild, moderate, and severe) by continuously monitoring changes in the plant's bioelectrical responses. These real-time measurements allow for precise water stress classification and help in identifying critical points before severe stress impacts the plant. Forecasting models built on Bioristor data can predict future stress conditions, enabling timely interventions to prevent yield losses. This method provides an efficient, data-driven approach to water management in agriculture, supporting sustainability by conserving water and enhancing crop resilience. Overall, Bioristor-based monitoring improves decision-making for growers and can be adapted for use with other crops in diverse environmental conditions.

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