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Study of root capacitance in strawberry plants under physicochemical variations using RC model

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INTRODUCTION & AIM

Plants generate electrical signals associated with ion transport, environmental adaptation, and responses to external stimuli. Root capacitance provides a way to study these processes by reflecting changes in the electrical properties of plant tissues.

In this work, strawberry plants were analyzed under different physicochemical conditions, including light and darkness exposure. Differential equation models and numerical simulations were used to better understand the electrical behavior of the biological system.

AIM:
To analyze the behavior of root capacitance in strawberry plants considering different interpretable physiological parameters, using an RC mathematical model based on exponential dynamics.

METHODS

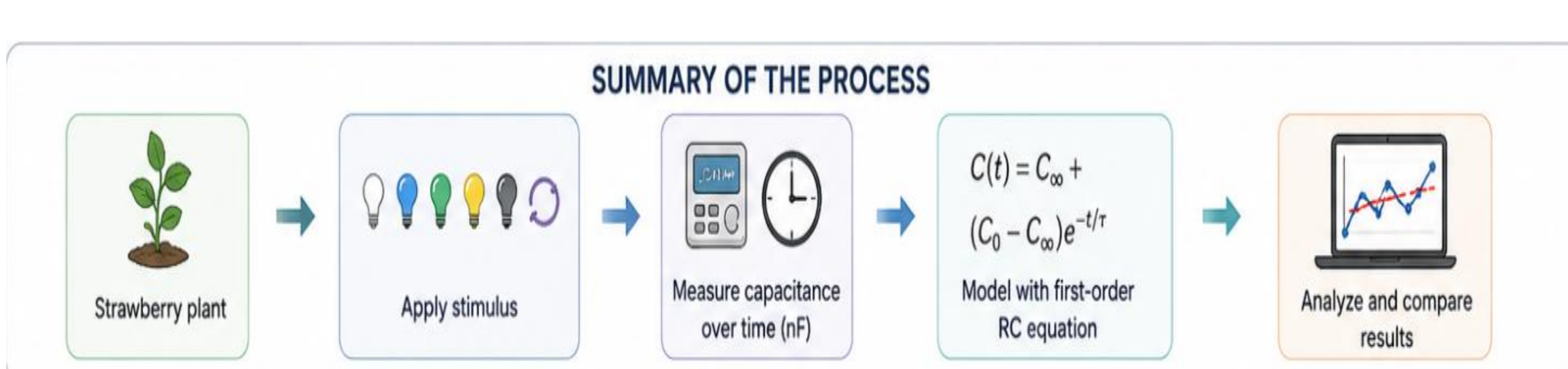
Changes in root capacitance were analyzed in strawberry plants under different physicochemical conditions. Plants were exposed to white, blue, green, yellow, and no light, as well as recovery and darkness conditions.

Capacitance measurements (nF) were recorded over time to evaluate the dynamic electrical response of the system. The experimental behavior was modeled using a first-order RC equation.

$$C(t) = C_\infty + (C_0 - C_\infty)e^{-t/\tau}$$

Numerical Analysis:

Data fitting and simulations were performed in Microsoft Excel.
VBA macros were used to automate calculations.
Numerical methods were applied to compare theoretical and experimental values.



RESULTS & DISCUSSION

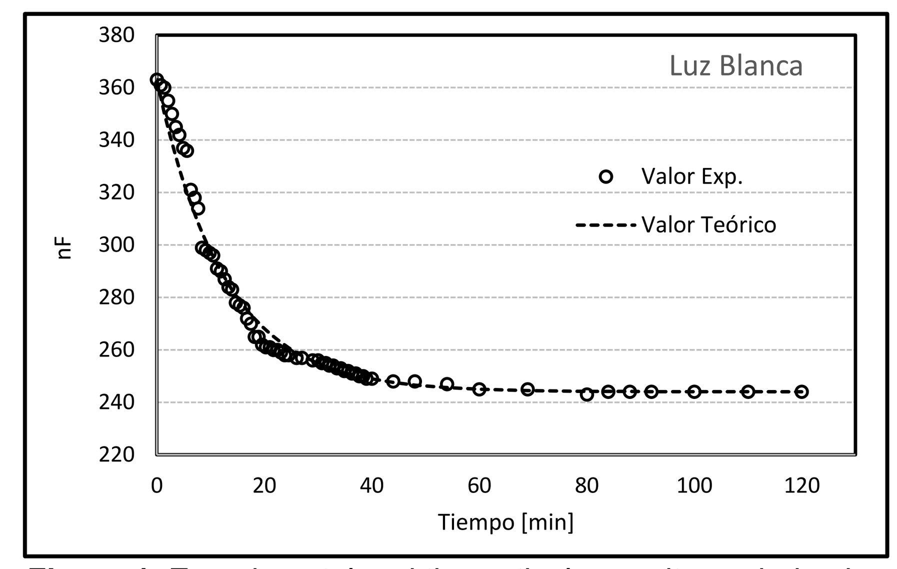


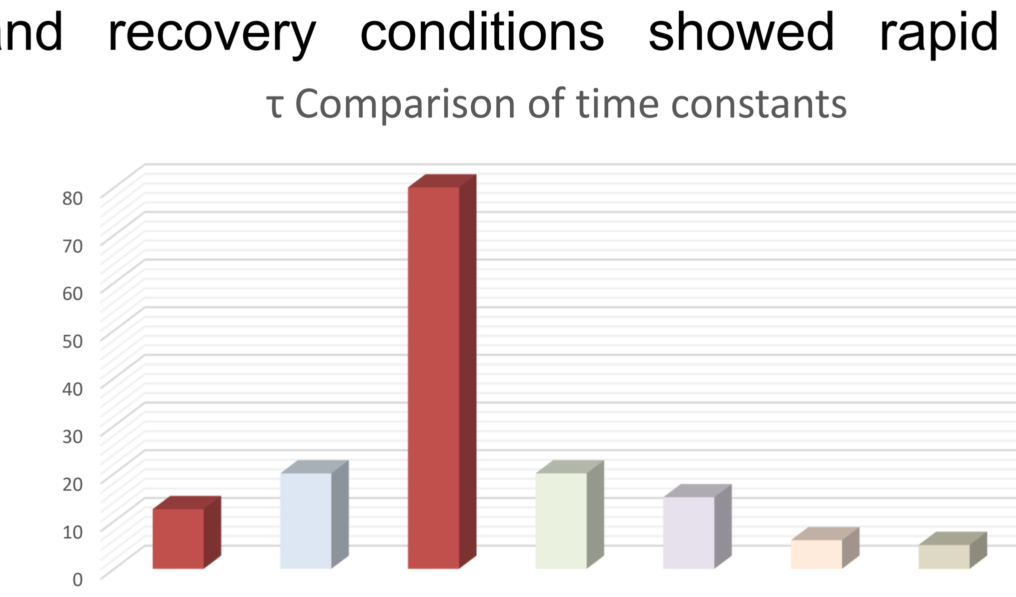
Figure 1. Experimental and theoretical capacitance behavior under white light conditions. The RC model shows a strong agreement with the experimental data.

The experimental results showed that root capacitance changes depending on the physicochemical condition applied to the strawberry plants. The electrical behavior of the system was successfully represented using a first-order RC model.

Condition	C_0 (nF)	C_∞ (nF)	τ (min)	Response Type
White light	363	244	12.5	Fast decay
No light	244	237	15	Stable
Green light	238	242	80	Slow growth
Recovery	341	331	6	Fast relaxation
Yellow ligth	332	339	20	Moderate growth
Blue ligth	370	364	20	Weak response
Inmediate darkness	366	376	5	Fast growth

Table 1. Summary of RC model parameters

Key observations:
White light produced the strongest electrical response.
Green light generated the slowest system dynamics.
Blue light caused minimal changes in capacitance.
Darkness and recovery conditions showed rapid stabilization processes.



The RC model successfully reproduced the experimental behavior.
The time constant τ characterized the speed of the response.
The electrical behavior of the roots followed a first-order exponential dynamic.

CONCLUSION

The RC model adequately describes the electrical behavior of strawberry plant roots.
Root capacitance depends on environmental conditions, especially light exposure. Different wavelengths produce different electrical responses.
The time constant τ allows the characterization of fast and slow responses in the system.
Excel and VBA provided an accessible tool for numerical simulation and data analysis.

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