ISSN: 2329-955X
Volume-11
Journal of Plant Physiology & Pathology

4th Annual Congress on
Plant Biology & Agricultural Sciences
May 15-16, 2023 I Madrid, Spain
https://plantbiology.conferenceseries.com/

https://www.scitechnol.com/plant-physiology-pathology.php

Title: Computational modelling reveals insights into molecular signaling in plant stomatal closure

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Received: Received Date: 05-04-2023 **Accepted Date:**07-04-2023 **Published Date:** 22-05-2023

Statement of the problem: Stomatal Closure is the mechanism employed by plats to avoid drought stress. Drought stress causes phytohormone abscisic acid (ABA), an endogenous messenger in plant abiotic stress, to influence the closure of stomata, the aperture between two guard cells located on plant leaves, within few minutes of experiencing drought stress. ABA molecular signaling network is complex with many elements participating to achieve stomatal closure. The function of this system is not fully understood and many reactions in it are yet to be unraveled. This study explores the function of the ABA signaling network computationally to gain useful insights.

Methodology & Theoretical Orientation: This study used the ABA molecular signaling network expanded from literature to develop Boolean computational models to explore its function using synchronous and asynchronous updates.

Findings: The Boolean modelling in synchronous mode revealed a robust signal flow towards closure and closure maintenance. The model revealed rapid stomatal closure followed by convergence to eight limit cycle attractors representing steady state dynamics of the ABA system. The process was further refined in the more biologically realistic asynchronous update to identify biologically reliable dynamics of ABA signaling system. Results revealed that the model successfully captured the temporal hierarchy of ABA signaling events, as observed in the experimental literature. Further, the system achieved the stomatal closure within five minutes at the earliest and reached limit cycle attractors during steady state dynamics.

Conclusion: This study shows that ABA signaling system robustly achieves stomatal closure with a defined temporal hierarchy. The findings of the study are useful for improving plant resistance under climate change.

Biography

Sandhya Samarasinghe is a Professor in AI and Complex Systems at Lincoln University, New Zealand, where she is also the Head of Complex Systems, Big Data and Informatics Initiative (CSBII). She graduated with MS and PhD (Engineering) from Virginia Tech, USA. Her current research involves Computational Systems Biology where she uses AI, Neural Networks and Complex Systems Modelling to address complex intractable problems in biology from a holistic systems view. Her research covers modelling cell signaling networks including plant stress response, cell cycle and self-repair and regeneration in biological organisms. She has published books, book chapters and a significant number of peer-reviewed publications on modelling and biology and produced many AI models for industrial applications. She is a Fellow of the Modelling and Simulation Society of Australia and New Zealand and Senior Member of Institute of Electrical and Electronics Engineers (IEEE).