

Cost-Effective and Optimal Control Analysis for Mitigation Strategy to Chocolate Spot Disease of Faba Bean

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Abstract : Introduction: Faba bean is one of the most important grown plants worldwide for humans and animals. Several biotic and abiotic elements have limited the output of faba beans, irrespective of their diverse significance. Many faba bean pathogens have been reported so far, of which the most important yield-limiting disease is chocolate spot disease (*Botrytis fabae*). The dynamics of disease transmission and decision-making processes for intervention programs for disease control are now better understood through the use of mathematical modeling. Currently, a lot of mathematical modeling researchers are interested in plant disease modeling. Objective: In this paper, a deterministic mathematical model for chocolate spot disease (CSD) on faba bean plant with an optimal control model was developed and analyzed to examine the best strategy for controlling CSD. Methodology: Three control interventions, quarantine (u_2), chemical control (u_3), and prevention (u_1), are employed that would establish the optimal control model. The optimality system, characterization of controls, the adjoint variables, and the Hamiltonian are all generated employing Pontryagin's maximum principle. A cost-effective approach is chosen from a set of possible integrated strategies using the incremental cost-effectiveness ratio (ICER). The forward-backward sweep iterative approach is used to run numerical simulations. Results: The Hamiltonian, the optimality system, the characterization of the controls, and the adjoint variables were established. The numerical results demonstrate that each integrated strategy can reduce the diseases within the specified period. However, due to limited resources, an integrated strategy of prevention and uprooting was found to be the best cost-effective strategy to combat CSD. Conclusion: Therefore, attention should be given to the integrated cost-effective and environmentally eco-friendly strategy by stakeholders and policymakers to control CSD and disseminate the integrated intervention to the farmers in order to fight the spread of CSD in the Faba bean population and produce the expected yield from the field.

Keywords : CSD, optimal control theory, Pontryagin's maximum principle, numerical simulation, cost-effectiveness analysis

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