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Optimised regulatory surveys for the regional-scale early detection of Huanglongbing

Parnell, S.[1], Gottwald, T.R.[2], and Cunniffe, N.J.[3]

[1]Rothamsted Research, Harpenden, United Kingdom
[2]USDA, ARS, U.S. Horticultural Research Laboratory, Fort Pierce, FL 34945, USA
[3]University of Cambridge, Department of Plant Sciences, Cambridge, United Kingdom

Prior to the arrival of HLB in a region large-scale surveillance programs are usually instigated in order to detect the disease as early as possible. Early detection is necessary to minimise the impact of the disease and facilitate any containment or eradication interventions. Large-scale surveillance surveys are however expensive, covering large geographic regions and stretching fiscal and manpower resources. Available resources must thus be deployed in the most optimal way. The choice of which locations within a region to survey is a complex problem since there may be hundreds of thousands of possibilities to choose from. Predicting how the epidemic will spread through a heterogonous landscape of citrus plantings and how this relates to where sampling resources should be deployed to find the 'needle in the haystack' is challenging and most surveys are consequently sub-optimal. We bring together state of the art epidemiological modelling and stochastic optimisation techniques to determine the optimal pattern of sampling deployment across a landscape. We find that the optimal pattern of sampling resources in a region is often counter-intuitive; for example simply targeting the highest risk locations is rarely the optimal course of action. We show how the optimal pattern depends subtly on epidemiological factors such as the spatial pattern of citrus plantings and vector densities in a region. We also show how geo-referenced information on likely entry points into a region, e.g. trade and travel hubs, can be incorporated to improve the probability of achieving early detection.